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

Local Plan Transport Model Forecasting Report (T4)

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Version Status:	APPROVED	**Prepared by:**	Transport for Greater Manchester on behalf of the 10 Local Authorities of Greater Manchester
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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

1.1.1 This report describes the transport modelling process for the Greater Manchester Clean Air Plan Project and presents baseline and scenario forecasts for the preferred option which will be taken forward for consultation. This report is part of a suite of documents that have been produced to describe the transport modelling deliverables for the study. The documents in the series include:

- 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 Model Validation Report (T2), which explains in detail how the road traffic model was validated against real-world data;
- Local Plan Transport Modelling Methodology Report (T3), which describes the approach taken to forecast traffic;
- Local Plan Transport Model Forecasting Report (T4), this document;
- Local Plan Air Quality Modelling Methodology Report (AQ2), which provides an overview of the air quality modelling process; and
- Local Plan Air Quality Modelling Report (AQ3), which provides details of modelled NOx and NO_2 concentrations for the base and forecast years, including comparisons with measured concentrations for the base year.

1.1.2 The purpose of this report is to present the baseline transport and emissions modelling approach and results for the study and to describe the cumulative impacts of the Clean Air Plan proposals.

1.1.3 The report is divided into seven sections, as follows:

- Section 2 provides an overview of the CAP project and the scope of the study;
- Section 3 describes the modelling process;
- Section 4 describes the transport modelling methodology;
- Section 5 presents the baseline road traffic and emission forecasts;
- Section 6 presents the scenario forecasts;
- Section 7 provides a summary of the results and the key findings for the study (to follow); and
- Further details of the study are provided in the Appendices, which include information considered too detailed for inclusion in the main body of the text.

1.1.4 The report should be read in association with the documents described above and alongside the Analytical Assurance Statement (AAS).

2 Background and scope of the study

2.1 Background

2.1.1 In July 2017 the Government published the UK plan for tackling roadside nitrogen dioxide (NO_2) concentrations. This set out how the Government would bring UK concentrations of NO_2 within the statutory annual limit of 40 micrograms per cubic metre ($\mu g/m^3$) in the shortest possible time. The plan sets out a number of national and local measures that need to be taken.

2.1.2 Transport for Greater Manchester is considering options to reduce emissions from transport sources within the county, to help meet the target values for NO_2 concentrations as soon as possible. A variety of measures are being proposed for consultation, including the introduction of a GM-wide Clean Air Zone (CAZ). Table 1 shows the measures proposed for the 'Option for Consultation, which has been developed following the submission of the Outline Business Case.

Table 1: Package of Measures proposed for Consultation

Reference	Measure	Description
Implementation Fund		
1	Sustainable Journeys	Targeted measures to encourage shift to more sustainable travel options
2	Bus Fund	Funding to support the retrofit or replacement of non-compliant buses
3	GM-wide Clean Air Zone category C	Greater Manchester CAZ C, with daily charges for non-compliant vehicles: • Taxi/PHV £7.50; • HGVs/buses/coaches £60; and • LGVs/minibuses £10.
Clean Air Fund		
5	Taxi Fund	Grant funds to support the replacement of non-compliant Hackney Cabs and PHVs
6	Commercial Vehicles Fund	Grant funds to support the replacement of non-compliant HGVs, coaches, LGVs and minibuses
7	Loan Finance	Preferential access to more affordable loans to support upgrade to a compliant vehicle
8	Electric vehicle charging infrastructure	Funding to provide electric vehicle charging infrastructure for taxis and a try-before-you-buy scheme

2.1.3 Government guidance sets out charging Clean Air Zones (CAZ) as the measure most likely to achieve EU Limit Value for NO_2 in towns and cities in the shortest possible time. A charging CAZ places a penalty on the most polluting vehicles if they travel into, within or through a designated area. Government specifies four classes of CAZ that apply penalties to different types of vehicle that are classified as non-compliant because they fall below particular euro emission standards. Cleaner vehicles are unaffected.

- Category A: Buses, coaches, taxis and private hire vehicles (PHVs);
- Category B: Buses, coaches, HGVs, taxis and PHVs;
- Category C: Buses, coaches, HGVs, large vans, minibuses, small vans/ light commercials, taxis and PHVs; and
- Category D: Buses, coaches, HGVs, large vans, minibuses, small vans/ light commercials, taxis and PHVs, cars, motorcycles/mopeds

2.1.4 The Greater Manchester CAP 'Option for Consultation' is proposing a Category C CAZ across Greater Manchester.

2.2 The associated emissions standards for the GM CAZ are as follows:

- Euro 4 for petrol PHVs, vans, minibuses and other specialist vehicles. Applied since 2006;
- Euro 6 for diesel PHVs, Hackney Cabs, vans and minibuses and other specialist vehicles. Applied since 2015 (for PHVs) and 2016 (for vans); and
- Euro VI for lorries, buses and coaches and other specialist heavy vehicles. Applied since 2013.

2.3 A vehicle's Euro emission standard is shown in the vehicle registration document – also known as a V5C.

Scope of the Study

2.4 The CAP study is being undertaken using guidance produced by Defra and the DfT's Joint Air Quality Unit, (JAQU), to help local authorities develop strategies for improving air quality (References 1, and 2). The project is being led by Transport for Greater Manchester (TfGM), the transport delivery arm of the Greater Manchester Combined Authority (GMCA). TfGM is leading the project on behalf of the ten districts of Greater Manchester (Manchester, Salford, Wigan, Bury, Rochdale, Stockport, Oldham, Bolton, Tameside and Trafford) who are the local highway authorities and will represent their interests in delivering the project plan.

2.5 JAQU's initial modelling, Pollution Climate Mapping (PCM) suggested that 11 links in 7 of Greater Manchester's 10 districts would exceed target values of NO_2 concentrations by 2020. Subsequent modelling carried out by TfGM has shown this to be a significant under estimation and 203 points are now forecast to be in exceedance across all 10 districts.

2.6 The scope and phasing of the study is set out in Table 2 below. Transport, traffic and air quality modelling has been used to inform each phase.

Table 2: Timeline of option development process

Phase	Stage	Process Undertaken	Approval
Phase 1: **Strategic Outline Case** (Winter / Spring 2018)	Identification of a long list of nearly 100 measures in 12 categories. With shortlisting to 17 measures.	Brainstorming of all measures – shortlisting using professional judgment against the Critical Success Factors.	LA governance and submitted to JAQU in Spring 2018.
Phase 2: **Target Determination** (Spring / Summer 2018)	Identification of the local air quality challenge.	Modelling & analysis to identify the scale of the challenge and points of exceedance of air quality levels in 2021, confirmation of locations of non-compliance to be addressed by the CAP.	Submitted to JAQU and approved by them for publication as a GMCA paper in Autumn 2018.
Phase 3: **High Level assessment** (Summer / Autumn 2018)	a. Expansion of shortlisted measures to 95 implementation options.	Detail was added to the shortlisted measures, which were expanded to give multiple variants on how they could be delivered.	Steering Group and engagement with Executive Members and Leaders.
	b. Examination of the 95 implementation options and identification of measures	Stakeholder engagement -industry expert feedback -capacity assessments - traffic and air quality modelling – application of bespoke MCA toolkit.	
	c. Aggregation of measures into 6 Clean Air Plan Options.	Aggregation based on differing measures of incentives, parking and scales/severity of CAZ.	
Phase 4a: **Appraisal of 6 options and further shortlisting** (Autumn 2018 / Winter 2019)	a. Selection of 3 Clean Air Plan Options to progress to full analysis.	Modelling and appraisal.	Discussed with Steering Group, Executive members and Leaders (Further refinement identified).

Phase	Stage	Process Undertaken	Approval
Phase 4b: **Re-evaluation & Outline Business Case** (Winter / Spring 2019)	b. Addition of two further Options, as the risk of unintended socio-economic consequences was not fully understood and other options had not been explored in sufficient depth to be ruled out.	Further analysis on the CAZ D Clean Air Plan Options was undertaken to understand socio-economic implications and further traffic and air quality modelling carried out to consider alternatives.	Approved via full LA governance and submitted to JAQU in the Outline Business Case March 2019.
Option for Consultation (Summer / Autumn 2019)	Refinement of preferred option following Outline Business Case Review by JAQU	Further evidence review, including development of cost models and refinement of project assumptions	Discussed with JAQU October 2019. Governance tbd.

3 The Modelling Process

3.1 Overview

3.1.1 At the highest level, the modelling process for producing the GM Clean Air Plan consists of:

- Stage A – Transport Modelling to Estimate Traffic Flows;
- Stage B – Converting Traffic Flows to Mass Emissions; and
- Stage C – Converting Mass Emissions to Air Quality Concentrations.

3.1.2 For future years the forecasts include:

- National changes to the vehicle fleet mix and engine technology, which deliver improvements to air quality over time; and
- Future road and travel demand changes.

3.2 Data Sources

3.2.1 The following data is being used in the study alongside a series of assumptions and values drawn from JAQU, WebTAG and Green Book guidance:

- Traffic speed and flow data from TfGM's county-wide highway model;
- Information about the vehicle fleet composition in Greater Manchester from Automatic Number Plate Recognition surveys (ANPR) undertaken in 2016 and 2019;
- Road traffic emission factors and national fleet composition data from version 9.1a of DEFRA's Emission Factor Toolkit (EFT); and
- Information about the bus fleet composition in Greater Manchester from TfGM's Punctuality and Reliability Monitoring Survey (PRMS) and the Greater Manchester Bus Route Mapping system.

3.2.2 A fuller summary of the data collated for each mode is available in the following Technical Notes:

- Note 3: Analysis of the Freight Market
- Note 4: Analysis of the Coach Market
- Note 5: ANPR Surveys
- Note 18: Analysis of the Minibus Market
- Note 19: Analysis of the Taxi and PHV Market
- Note 20: GM Specialised Goods Vehicle Surveys
- Note 22: Addendum to Note 3 Comparative Statistics

3.3 Model Specifications

3.3.1 The modelling system of the study consists of five components:

- Cost Response models, which are cost response models developed to better understand the Commercial Vehicles, Taxis, and Coaches/minibuses behavioural changes to the GM-CAP. These have been developed by assembling available data on the known fleets and movements within GM;
- A Demand Sifting Tool (DST), which has been developed to allow the behavioural change of measures to be estimated before passing data on for further assessment using the highway and air quality models;
- The highway model (in 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 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 the EFT to provide estimates of annual mass emissions for a range of pollutants including Oxides of Nitrogen (NOx), Particulate Matter (PM10 and PM2.5) and CO_2; and
- The dispersion model, which uses ADMS-Urban software to combine information about mass emissions of pollution (from EMIGMA) with emissions from non-traffic sources and other data such as wind speed and direction, topography and atmospheric chemical reactions to predict pollutant concentrations.

3.3.2 The DST 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. GM did consider modelling the impacts of the CAP schemes on suppressed traffic using the elastic assignment procedures available within the SATURN model. Tests suggested, however, that this would not be necessary as the schemes that were being considered would not have a significant impact on highway congestion. Tests showed, for example, that the implementation of the consultation option (which modelled a Category B CAZ across the whole of Greater Manchester implemented in 2021, extending to a Category C CAZ in 2023) would result in an approximate 0.2% reduction in total vehicle kilometres on roads within the County in the 2023 peak hours relative to the do-minimum and a 0.3% reduction in total PCU hours, which is was not thought would have a significant impact on congestion or supressed traffic.

3.4 Model Availability

3.4.1 An appropriate variable demand model was not available. Therefore, bespoke vehicle cost models were developed to assess the possible behavioural responses to a CAZ and/or the introduction of incentives to upgrade. These were then incorporated within the DST to understand the change in compliant vehicle trips due to the CAP.

3.4.2 A detailed description of the methodology applied is included as **Appendix A**.

3.4.3 The highway modelling is being undertaken using TfGM's county-wide SATURN model.

3.4.4 Several versions of the SATURN model were available for use in the project, which had been previously developed for the appraisal of different transport schemes for different future year forecasts and development assumptions. It was decided, however, to use the do-minimum model that had been developed for the appraisal of the planned extension of the Greater Manchester Metrolink system through Trafford Park. 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 proposals.

3.4.5 For a detailed discussion of the traffic modelling validation and methodology, see associated reports T2 and T3.

3.5 Modelled Years

3.5.1 Separate versions of the DST and the SATURN model have been developed for three years comprising: 2021, which represents the assumed opening year of the CAP scheme, 2023 and 2025.

3.5.2 The 2023 and 2025 models were developed to assist in confirming the year of compliance and to help with modelling the phased introduction of a GM-wide CAZ C.

3.6 Time Periods

3.6.1 The SATURN model represents three time periods comprising:

- a weekday morning peak hour 08:00-09:00;
- an evening peak hour 17:00-18:00; and
- an average inter-peak hour for the 10:00-15:30 time period.

3.6.2 As the DST uses the outputs of the Do Minimum SATURN modelling this also uses the same 3 modelled periods.

3.7 User Classes

3.7.1 The assignment matrices that are used with the DST and the SATURN model represent 8 user classes:

- User Class 1: Compliant Car trips;
- User Class 2: Non-Compliant Car trips;
- User Class 3: Compliant LGV trips;

- User Class 4: Non-Compliant LGV trips;
- User Class 5: Compliant OGV trips;
- User Class 6: Non-Compliant OGV trips;
- User Class 7: Compliant (all purpose) Taxi trips; and
- User Class 8: Non-Compliant (all purpose) Taxi trips.

3.7.2 Buses are not included in the assignment matrices, but are represented in the SATURN model as fixed link loads, with routes defined as chains of nodes in the buffer and simulation networks. Modelled bus services in the forecast year models are based on 2019 service patterns and flows, suitably adjusted to reflect changes in the bus fleet mix over time.

3.8 Model Coverage

3.8.1 Geographically, the model is focused on Greater Manchester, although it does extend to cover all of Great Britain, albeit in increasingly less detail with increasing distance from the county boundary, as illustrated Figure 1. A model of this size was required to fully capture the impacts of the options under consideration, which cover the whole of Greater Manchester and have environmental impacts across the whole of the County.

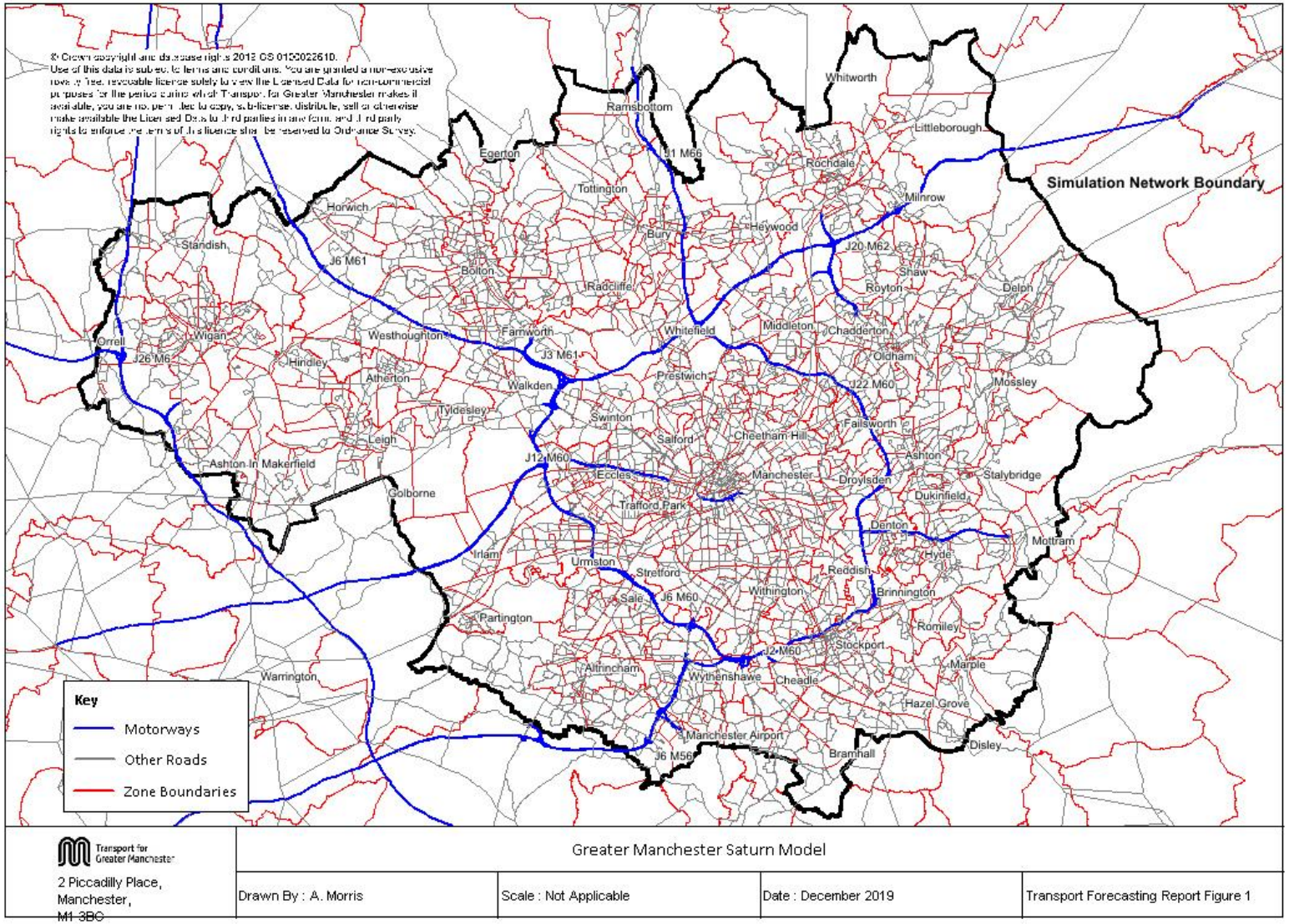
3.8.2 Further details of the SATURN model are available in the T2 and T3 reports (References 3 and 4).

3.9 Boundaries Considered

3.9.1 The proposed CAZ, 'Option for Consultation' comprises a clean air zone covering the whole of Greater Manchester. During the option development process several alternative boundaries were considered, and the GM-wide boundary was progressed as the most effective.

3.9.2 In the modelling process there are differences between how zones are modelled in the DST and the SATURN model given the zone structure of the GM SATURN model, as zones have been based on Lower Super Output Area (LSOA) and District boundaries they do not always match with the road network. However, any Clean Air Zones would be expected to make use of physical boundaries to aid enforcement. A plot of the boundaries considered in the development of the GM CAP are in **Appendix B**.

Figure 1: Greater Manchester SATURN Model



4 Transport Modelling Methodology

4.1 Modelling of the Do Minimum

4.1.1 The Do Minimum model represents what is likely to happen in the absence of the CAP proposals. The Do Minimum modelling process comprises 4 stages, as shown in Table 3.

Table 3: Do-Minimum Modelling Process

Stage	Description	What is involved
A	Transport modelling to estimate traffic flows	Demand modelling and traffic assignment via the GM countywide SATURN model to estimate traffic flows
		Validation following DfT WebTAG guidance to compare modelled and observed traffic flows and speeds
		The process includes committed road changes appropriate to the year being modelled
B	Converting Traffic Flows to Mass Emissions	Traffic flows and speeds, split by vehicle and engine type, are input to TfGM's EMIGMA software to convert traffic demands to vehicle emissions
		The process includes all traffic, comprising cars, Light Goods Vehicles, Heavy Goods Vehicles, Buses and taxis
		The emissions are validated by comparing local outputs to JAQU PCM model outputs
		Note that the most recent emission rates for converting traffic flows to vehicle emissions (as calculated from the EFT) have increased compared to outputs from earlier versions of the software, so that emissions for this study are greater than estimates from EMIGMA in previous GM air quality exercises
C	Converting Mass Emissions to Air Quality Concentrations	Using the ADMS Urban dispersion modelling software to convert traffic emissions to air quality concentrations
		The process includes urban topology and other data such as wind speed and direction
		The process includes emissions from non-traffic sources from Defra data and outputs modelled concentrations at 'receptor points' corresponding to sites close to the road network
D	Validation/Verification for the Base Year	Comparison of the NO_2 outputs from steps A to C above against GM monitoring data
		The calculation of adjustment factors to improve the fit between modelled and observed concentrations at the GM level

4.1.2 In modelling of the future year Do Minimum scenarios, the process runs through stages A, B and C and includes forecast national changes to vehicle fleet and engine technology, so that air quality improves over time. Forecasts include future road network and travel demand changes, where these are known. Further Details on methodology for the Do Minimum scenario is provided in T3.

Do Minimum model updates post OBC

4.1.3 Since the OBC modelling, there have been a number of updates to the future year Do Minimum modelling process. During discussions with JAQU it was confirmed that these alterations did not constitute a change to the Target Determination process, but were appropriate technical refinements based on more up to date datasets

4.1.4 These updates are:

- Update of Bus Routes and services and fleets. This has had two effects. Firstly, the OBC used a 2015/16 operational dataset which was correct for the Base Year model verification, and the fleet was then projected to the future years of 2021/2023/2025. The current modelling update has used the most recently available 2019 bus dataset and projected forward based on the OBC fleet-rollover method. This has resulted in an older future year bus fleet than was projected in the OBC, because bus operators have not invested in a newer bus fleet as much since 2016 as in preceding years, which has the effect of increasing future emissions on a per vehicle basis. Secondly, overall bus mileage across GM has reduced by approximately 11% compared with the OBC forecasts, as operators have stopped running some less profitable routes. These factors in combination will have the overall effect of increasing the Do Minimum bus emissions compared with the OBC, because the impact of the older fleet is more significant than the reduced mileage. However, in Do Something scenarios, a 100% Euro VI fleet was assumed in the OBC and this modelling version. Therefore, the reduced mileage will be the only variant, and bus emissions will be reduced compared with the OBC.
- Updates to the Emission Factor Toolkit. This has primarily affected the split of petrol and diesel cars, increasing the petrol and EV/hybrid fleet in line with more recent sales trends. Overall this has reduced NOx emissions compared with OBC by approximately 2%, however this varies depending on the vehicle mix on a given road. Furthermore, because petrol cars have lower f-NO_2 than diesel cars, there is a secondary effect which further reduces the final NO_2 concentrations.
- Growth of LGVs. The LGV demand matrix growth had been mis specified in the OBC modelling, which caused LGV trips to be over-estimated in future years. The adjustment to the LGV forecasts reduced the numbers of LGV trips by approximately 5% in each of the forecast years.

- Reduced number of modelled output points. In order to speed up model processing, only those sites that were predicted to be >38 ug/m^3 in the OBC Do Minimum 2021 have been calculated herein. This reduces the number of output points reported from ~17,000 to ~2,500.

4.2 Modelling of the Do Something

4.2.1 The Do Something modelling follows similar procedures to the Do Minimum as shown in Table 4 and outlined in the sections below.

Table 4: Do Something Modelling Process

Stage	Description	What is involved
A	Behavioural Modelling of Measures	Behavioural Responses to the CAP proposals are identified within the Vehicle Cost Models
		Within the DST, estimated responses to behavioural modelling are applied to the Do Minimum traffic due to measures being introduced to represent vehicles upgrading, trips being cancelled etc.
		This leads to new Do Something matrices being produced, which are extracted from the DST for input into SATURN for use in Stage B
B	Highway Assignment Modelling	Changes to the SATURN network are made to represent any changes as appropriate (for example introducing cordon charges to represent distinct CAZ boundaries)
		New Do Something Matrices are assigned to the Do-Something network to investigate the impact of changing traffic volumes and re-routing due to any cordon charges.
		Produces outputs for use in Stage C
C	Converting Traffic Flows to Mass Emissions	Traffic flows and speeds, split by vehicle and engine type, are input to TfGM's EMIGMA software to convert traffic demands to vehicle emissions
		The process includes all traffic, comprising cars, Light Goods Vehicles, Heavy Goods Vehicles, Buses and taxis
D	Converting Mass Emissions to Air Quality Concentrations	Using the ADMS Urban dispersion modelling software to convert traffic emissions to air quality concentrations
		The process includes emissions from non-traffic sources from Defra data and outputs modelled concentrations at 'receptor points' corresponding to sites close to the road network

4.2.2 This process is carried out for each modelled year.

4.2.3 In early tests used to sift potential options not all measures were progressed through all four stages with some options only progressing through Stage A or Stages A to C. Also the Cost response models were developed post OBC, prior to this behavioural responses were based on other methods and sources including SP survey results from other cities, investigating a CAZ, such as Bristol.

Do Something Modelling updates post-OBC

4.2.4 Updates to the Do Something modelling for with Consultation Option are reported in Section 4. A table summarising the methodology and assumptions has been supplied separately as "Summary of method and assumptions at Consultation package Oct 2019.docx".

4.2.5 Note that the results presented herein, have under-represented the effect on the Clean Taxi Funds, which allow for upgrade to both a compliant diesel Hackney Carriage and an EV. However, analysis of the impact on NOx emissions has been undertaken and is very marginal so unlikely to materially alter the conclusions as reported. This will be updated and finalized for FBC submission.

4.3 Behavioural Response to Measures

4.3.1 The Behavioural Response to most measures has been assessed using the vehicle cost models to determine expected behavioural responses to the Clean Air Plan. These responses are then modelled using a spreadsheet based "Demand Sifting Tool" developed as part of option sifting and assessment. The tool applies the following behavioural responses to understand the changing use of compliant vehicle journeys due to the Clean Air Plan:

- Paying the charge and continuing to travel into/within the zone;
- Cancelling the journey;
- Upgrading the vehicle by replacing the trip with a journey in a compliant vehicle (also includes, as appropriate, uptake to zero emissions vehicle journeys); or
- Changing model, which includes a switch to other highway models, the use of active modes, or opting to use Public Transport.

4.3.2 A more detailed methodology is provided in **Appendix A.** A brief description of the process for feeding the outputs from the demand sifting tool into the SATURN modelling is provided below.

4.4 Modelling of Measures in SATURN

4.4.1 The CAP option which is being taken forward for consultation includes the following measures:

- A category C CAZ covering the whole of Greater Manchester in 2021, with temporary exemptions to 2023 for LGVs, minibuses, GM-licensed wheelchair accessible hackney cabs and private hire vehicles, and GM-registered coaches;
- Measures to promote sustainable journeys and invest in electric vehicle charging infrastructure for taxis and a try-before-you-buy electric taxi scheme;
- Funds to upgrade the bus fleet;
- Funds for Taxi, PHV, LGV and HGV operators to upgrade their vehicles, plus Loan/Finance measures.

4.4.2 The nature of the proposals means that some but not all vehicles will face a daily charge for travelling in parts of Greater Manchester. Re-routing responses to the CAZ charges are represented in the SATURN model by coding monetary charges (tolls) for non-compliant vehicles into the highway networks, which may differ by vehicle type (e.g. cars, LGVs, OGVs and Taxis). The tolls are defined as charges per cordon crossing link and have been divided equally between inbound and outbound sites on the proposed charging cordons. Note, however, that charges are not coded into the SATURN model for GM-wide Clean Air Zones, as it assumed that there will be no re-routing responses for these measures as motorists cannot change their routes to avoid paying the charge, so that drivers of non-compliant vehicles will either choose to pay the toll or make a different behavioural response, as described below. Analysis has been carried out to assess the risk of traffic re-routing at the boundary, reported in Note 13: GM CAP Traffic Impact on Neighbouring Authorities.

4.4.3 The DST has been developed to assist in modelling the behavioural responses to the CAP measures based on guidance provided by JAQU concerning the proportions of drivers of affected vehicles who would pay the charge, cancel their journey or upgrade to a compliant vehicle etc. These responses are implemented in the study by using the output demand change matrices from the sifting tool to adjust the do-minimum demands in the SATURN model at a sector level to create do-something forecasts. The updated do-something matrices are then assigned to the highway networks to assess the demand changes on specific links in the SATURN model and the impact on emissions using EMIGMA.

4.4.4 The CAZ charges for the Consultation Option are shown below in Table 5**.**

Table 5: Option for Consultation CAZ Charges (Non-Compliant Vehicles)

	2021					2023 + 2025				
Vehicle type	**Car**	**LGV / minibus**	**HGV**	**Bus / coach**	**Taxi**	**Car**	**LGV / minibus**	**HGV**	**Bus / coach**	**Taxi**
Charge	NA	NA(1)	£60	£60(2)	£7.50 (3)	NA	£10	£60	£60(2)	£7.50

Note:

1. LGVs and minibuses are exempt from the charge until 2023.
2. Modelling assumes all buses upgrade due to the CAZ. GM-registered coach operators are exempt from the charge until 2023.
3. Wheelchair accessible taxis are exempt from the charge until 2023.

4.5 Modelling the Take Up of Electric Taxis and Upgrades to the Bus Fleet

4.5.1 The 'Option for Consultation' package to deliver air quality compliance includes measures to promote the increased take up of electric taxis and upgrades to the bus fleet, which are essential components of the overall CAP package.

4.5.2 The impacts of measures to promote the increased uptake of electric taxis were modelled using the taxi cost model to assess the behavioural responses to the CAZ and the introduction of incentives for operators to upgrade their vehicles. This estimated that approximately 15% of taxi and private hire car drivers who operate a compliant vehicle would either purchase an electric vehicle or choose to lease an electric vehicle. The air quality impacts of this were modelled post assignment by reducing the compliant taxi flows that were output from the SATURN model (and that were input to EMIGMA) by 15%, assuming that electric vehicles generate zero emissions at the exhaust.

4.5.3 The impacts of upgrades to the bus fleet were modelled by adjusting the bus fleet mix that was input to EMIGMA assuming that all buses in the do-something models would be compliant with Euro 6 emission standards. It was assumed that bus service levels would remain unchanged as part of this process.

4.6 Sustainable Journeys

4.6.1 The consultation package includes proposals to encourage sustainable journeys to reduce travel by car. These include:

- Measures to support walking and cycling;
- Measures to promote flexible working;
- Workplace travel plans; and
- Measures to reduce the cost of commuting by public transport.

4.6.2 The impacts of the sustainable journey proposals have been included in the modelling by estimating the forecast reduction in highway trips that could be achieved from the proposals and subtracting these out of the assignment matrices that are used with the do-something SATURN models.

4.6.3 Estimates of the annual numbers of car trips that could be removed from the highway networks were provided by TfGM's Sustainable Journeys team, based on analysis of evaluation results for the LSTF travel choices programme. Separate estimates of the trip reductions were provided for workplace and school trips, for each of the forecast years. These reductions were subtracted out of the hourly assignment matrices used with the SATURN models in such a way that the outputs from the SATURN models reproduced the annual target reductions following the application of the annualisation factors that are used in the economic appraisal and to convert hourly emissions to annual totals in EMIGMA. Further details of the methodology for modelling sustainable journeys are available in Reference 5.

4.7 Air Quality Modelling

4.7.1 The air quality modelling was undertaken using TfGM's EMIGMA software, which provides estimates of mass emissions for vehicles travelling on roads represented in the SATURN model.

4.7.2 Inputs to the process comprise:

- Traffic speed and flow data from the SATURN model;
- Fleet weighted road traffic emission factors, by vehicle type, for vehicles travelling at different speeds;
- Information about the proportions of petrol and diesel powered vehicles (by road type) in the vehicle fleet, which are used to disaggregate the assigned flows from the traffic model by method of propulsion; and
- Road traffic annualisation factors to convert hourly emissions for the time periods represented in the SATURN model to annual totals.

4.7.3 The road traffic emission factors for input to the process have been derived using information from version 9.1a of DEFRA's Emission Factor Toolkit (EFT) for NOx, PM10 and PM2.5 emissions. (The fraction of NOx emitted by vehicles as NO_2 is also estimated using information from the EFT, separately by vehicle type).

4.7.4 Information about the fleet composition in the base year for use in the study has been derived from national data for motorways and from ANPR surveys on the local road network in Greater Manchester for other roads, which have been used to derive estimates of the age profile of the vehicle fleet on the local road network. Information about the age profile of the bus fleet has been obtained (by service) using data collected during TfGM's (bus service) Punctuality and Reliability Monitoring Survey (PRMS), for 2019 and from data collected from bus operators for the GM CAP.

4.7.5 The projected fleet mix for buses and other road traffic in the forecast year is estimated using the methodology provided by JAQU via huddle, based on an assumption that the age profile of the vehicle fleet remains unchanged over time.

4.7.6 The main outputs from the EMIGMA modelling comprise estimates of mass road traffic emissions (broken down by vehicle type in tonnes per year) for the links in the SATURN model. Emissions from these sources can be reported separately, or grouped to provide summary totals for all sources combined.

4.7.7 The outputs from EMIGMA are converted to air quality concentrations using the ADMS Urban dispersion modelling software. This process combines the road traffic emissions from EMIGMA with emissions from non-traffic sources from Defra data to calculate modelled concentrations at ‘receptor points’ corresponding to sites close to the road network. The process includes urban topology and other data such as wind speed and direction to provide estimates of pollution concentrations (measured in µg/m3) to be compared with national and local targets to assess compliance.

5 Baseline Traffic Forecasts

5.1 Introduction

5.1.1 This section presents results from the do-minimum road traffic modelling, which represents what is forecast to happen in the absence of the CAP scheme proposals. Information is provided describing:

- The modelled fleet mix;
- The do-minimum demand matrices;
- Vehicle km totals from the do-minimum assignments; and
- Modelled road traffic emissions.

5.2 Fleet Mix Proportions

5.2.1 Information about the vehicle fleet composition in Greater Manchester has been derived from Automatic Number Plate Recognition surveys (ANPR) undertaken in 2016. The analysis used Greater Manchester Police vehicle class information to identify vehicle and fuel type, plus cross referencing with local authority licensing data for taxis (hackney carriage and private hire).

5.2.2 The fleet mix projection was estimated by identifying the date of registration from the licence plate number. These were then matched against the date of enforcement of the relevant Euro standard, to develop the Euro standard for that vehicle type.

5.2.3 The projection approach keeps the vehicle age profile constant for any given future year (e.g. 2021), and then re-calculates the Euro standard at this point in time. The approach conserves the age distribution of the vehicle population for each vehicle class/fuel type, to produce the fleet mix for the future year based on this constant distribution.

5.2.4 Changes in petrol to diesel splits for cars and taxis in future years were modelled using guidance provided by JAQU to model changes in the ratios of petrol and diesel powered vehicles in the base and forecast years from national data. These were then applied to the local base year ratio (calculated from ANPR data) to obtain local forecast splits for each vehicle category.

5.2.5 Details of the local fleet composition data from the process are given below in Table 6 and

5.2.6 Euro Standard	Petrol Car	Diesel Car	Petrol Taxi	Diesel Taxi	Petrol LGV	Diesel LGV	Diesel HGV	Diesel Bus
2016								
Pre-Euro	0.3%	0.2%	0.0%	0.0%	0.0%	0.2%	0.1%	0.0%
Euro 1	0.5%	0.4%	0.3%	0.1%	0.0%	0.2%	0.4%	0.4%
Euro 2	2.6%	1.2%	0.8%	0.3%	0.0%	0.2%	1.8%	2.9%
Euro 3	22.5 %	9.7%	7.4%	4.1%	0.0%	15.3 %	10.9 %	8.9%
Euro 4	33.7 %	27.1 %	37.1 %	38.0 %	0.0%	26.4 %	15.8 %	28.0 %
Euro 5	31.9 %	47.8 %	54.3 %	52.5 %	0.0%	55.6 %	44.1 %	44.9 %
Euro 6	8.5%	13.5 %	0.0%	5.1%	0.0%	2.1%	27.0 %	15.0 %
Euro 6c	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 6d	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All	100.0 %	100.0 %	100.0 %	100.0 %	0.0%	100.0 %	100.0 %	100.0 %
2021								
Pre-Euro	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 1	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Euro 2	0.4%	0.4%	0.3%	0.0%	0.0%	0.2%	0.3%	0.3%
Euro 3	2.8%	1.4%	0.8%	0.3%	0.0%	0.3%	1.9%	2.9%
Euro 4	22.5 %	9.7%	7.4%	4.1%	0.0%	15.3 %	3.7%	2.9%
Euro 5	33.7 %	27.1 %	37.1 %	38.0 %	0.0%	26.4 %	22.9 %	34.0 %
Euro 6	11.3 %	14.4 %	30.5 %	25.7 %	0.0%	16.2 %	71.1 %	59.9 %
Euro 6c	29.1 %	33.4 %	23.9 %	26.8 %	0.0%	39.5 %	0.0%	0.0%

5.2.6 Euro Standard	Petrol Car	Diesel Car	Petrol Taxi	Diesel Taxi	Petrol LGV	Diesel LGV	Diesel HGV	Diesel Bus
Euro 6d	0.0%	13.5 %	0.0%	5.1%	0.0%	2.1%	0.0%	0.0%
All	100.0 %	100.0 %	100.0 %	100.0 %	0.0%	100.0 %	100.0 %	100.0 %
2023								
Pre-Euro	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 1	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 2	0.2%	0.2%	0.0%	0.0%	0.0%	0.1%	0.2%	0.0%
Euro 3	0.9%	0.7%	0.3%	0.2%	0.0%	0.3%	0.9%	0.6%
Euro 4	12.4 %	4.4%	4.1%	1.3%	0.0%	6.8%	1.9%	3.8%
Euro 5	33.5 %	21.8 %	22.2 %	20.8 %	0.0%	24.9 %	14.8 %	11.6 %
Euro 6	12.5 %	11.6 %	19.1 %	20.2 %	0.0%	10.1 %	82.1 %	83.9 %
Euro 6c	40.4 %	23.2 %	54.3 %	36.0 %	0.0%	27.3 %	0.0%	0.0%
Euro 6d	0.0%	38.2 %	0.0%	21.6 %	0.0%	30.4 %	0.0%	0.0%
All	100.0 %	100.0 %	100.0 %	100.0 %	0.0%	100.0 %	100.0 %	100.0 %
2025								
Pre-Euro	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 2	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Euro 3	0.7%	0.6%	0.3%	0.1%	0.0%	0.3%	0.4%	0.4%
Euro 4	4.4%	1.8%	2.6%	0.4%	0.0%	1.5%	1.2%	1.1%
Euro 5	27.4 %	13.6 %	8.4%	8.3%	0.0%	19.3 %	7.1%	5.5%

5.2.6 Euro Standard	Petrol Car	Diesel Car	Petrol Taxi	Diesel Taxi	Petrol LGV	Diesel LGV	Diesel HGV	Diesel Bus
Euro 6	14.5 %	11.1 %	15.2 %	13.4 %	0.0%	11.0 %	91.2 %	93.0 %
Euro 6c	52.9 %	18.3 %	73.4 %	33.1 %	0.0%	17.8 %	0.0%	0.0%
Euro 6d	0.0%	54.6 %	0.0%	44.6 %	0.0%	50.1 %	0.0%	0.0%
All	100.0 %	100.0 %	100.0 %	100.0 %	0.0%	100.0 %	100.0 %	100.0 %

5.2.7 Table 7. An alternative summary showing the proportions of compliant vehicles by year is shown in Figure 2.

Table 6: Fleet Composition by Vehicle Type, Euro Standard and Year, Do Minimum

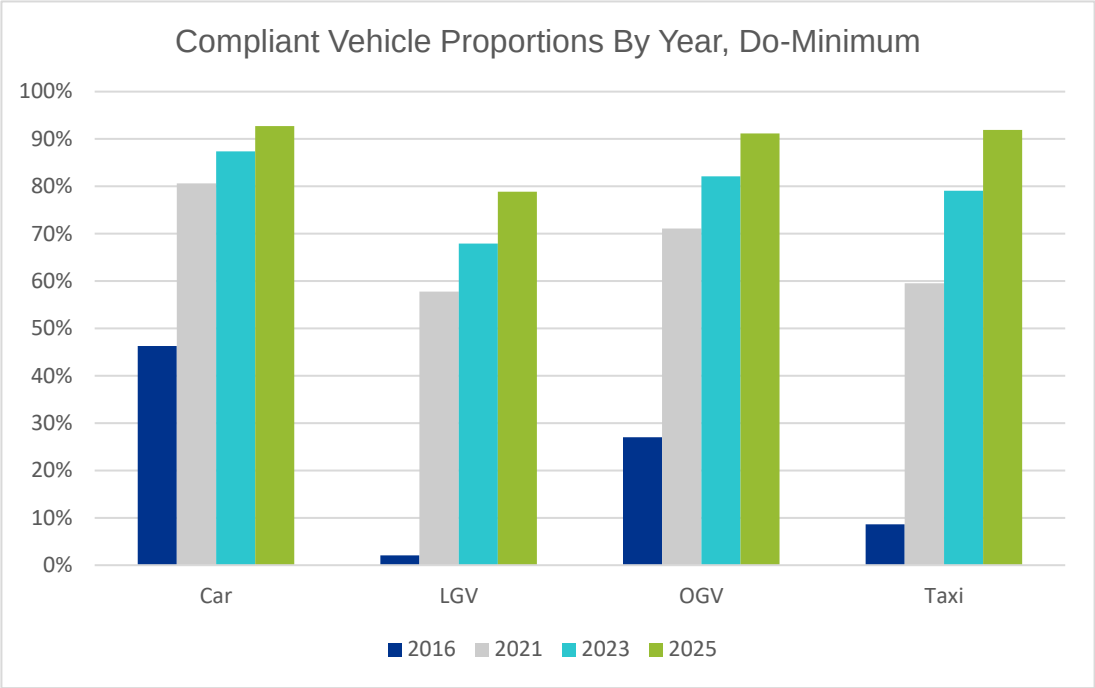
Euro Standard	Petrol Car	Diesel Car	Petrol Taxi	Diesel Taxi	Petrol LGV	Diesel LGV	Diesel HGV	Diesel Bus
2016								
Pre-Euro	0.3%	0.2%	0.0%	0.0%	0.0%	0.2%	0.1%	0.0%
Euro 1	0.5%	0.4%	0.3%	0.1%	0.0%	0.2%	0.4%	0.4%
Euro 2	2.6%	1.2%	0.8%	0.3%	0.0%	0.2%	1.8%	2.9%
Euro 3	22.5%	9.7%	7.4%	4.1%	0.0%	15.3%	10.9%	8.9%
Euro 4	33.7%	27.1%	37.1%	38.0%	0.0%	26.4%	15.8%	28.0%
Euro 5	31.9%	47.8%	54.3%	52.5%	0.0%	55.6%	44.1%	44.9%
Euro 6	8.5%	13.5%	0.0%	5.1%	0.0%	2.1%	27.0%	15.0%
Euro 6c	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 6d	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All	100.0%	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%	100.0%
2021								
Pre-Euro	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 1	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Euro 2	0.4%	0.4%	0.3%	0.0%	0.0%	0.2%	0.3%	0.3%
Euro 3	2.8%	1.4%	0.8%	0.3%	0.0%	0.3%	1.9%	2.9%
Euro 4	22.5%	9.7%	7.4%	4.1%	0.0%	15.3%	3.7%	2.9%
Euro 5	33.7%	27.1%	37.1%	38.0%	0.0%	26.4%	22.9%	34.0%
Euro 6	11.3%	14.4%	30.5%	25.7%	0.0%	16.2%	71.1%	59.9%
Euro 6c	29.1%	33.4%	23.9%	26.8%	0.0%	39.5%	0.0%	0.0%
Euro 6d	0.0%	13.5%	0.0%	5.1%	0.0%	2.1%	0.0%	0.0%
All	100.0%	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%	100.0%
2023								
Pre-Euro	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 1	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 2	0.2%	0.2%	0.0%	0.0%	0.0%	0.1%	0.2%	0.0%

Euro Standard	Petrol Car	Diesel Car	Petrol Taxi	Diesel Taxi	Petrol LGV	Diesel LGV	Diesel HGV	Diesel Bus
Euro 3	0.9%	0.7%	0.3%	0.2%	0.0%	0.3%	0.9%	0.6%
Euro 4	12.4%	4.4%	4.1%	1.3%	0.0%	6.8%	1.9%	3.8%
Euro 5	33.5%	21.8%	22.2%	20.8%	0.0%	24.9%	14.8%	11.6%
Euro 6	12.5%	11.6%	19.1%	20.2%	0.0%	10.1%	82.1%	83.9%
Euro 6c	40.4%	23.2%	54.3%	36.0%	0.0%	27.3%	0.0%	0.0%
Euro 6d	0.0%	38.2%	0.0%	21.6%	0.0%	30.4%	0.0%	0.0%
All	100.0%	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%	100.0%
2025								
Pre-Euro	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Euro 2	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Euro 3	0.7%	0.6%	0.3%	0.1%	0.0%	0.3%	0.4%	0.4%
Euro 4	4.4%	1.8%	2.6%	0.4%	0.0%	1.5%	1.2%	1.1%
Euro 5	27.4%	13.6%	8.4%	8.3%	0.0%	19.3%	7.1%	5.5%
Euro 6	14.5%	11.1%	15.2%	13.4%	0.0%	11.0%	91.2%	93.0%
Euro 6c	52.9%	18.3%	73.4%	33.1%	0.0%	17.8%	0.0%	0.0%
Euro 6d	0.0%	54.6%	0.0%	44.6%	0.0%	50.1%	0.0%	0.0%
All	100.0%	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%	100.0%

Table 7: Percentage Petrol/Diesel Car Splits By Year, Do Minimum

Year	Cars		Taxis	
	Diesel	Petrol	Diesel	Diesel
2016	50.7%	49.3%	4.0%	96.0%
2021	54.7%	45.3%	4.7%	95.3%
2023	56.0%	44.0%	6.2%	93.8%
2025	57.7%	42.3%	8.2%	91.8%

Figure 2: Compliant Vehicle Proportions By Year, Do Minimum



5.3 Demand Forecasts

5.3.1 Table 8 shows trip totals from the 2016 base and forecast year demand matrices broken down by user class for trips with an origin or destination inside Greater Manchester. The table shows that 46% of car trips in 2016 are made in compliant vehicles, with only 2% of LGV trips being compliant, reflecting the greater use of diesel fuel for these vehicle types. The equivalent figures for OGV and taxi trips in the base year are 27% and 9% respectively, with approximately 39% of vehicles overall being compliant.

5.3.2 The equivalent figures for the 2021 do-minimum model (shown in Table 9) show that 81% of car trips are made by compliant vehicles in this year, as older more polluting vehicles are replaced by newer/cleaner models as the age profile of the vehicle fleet evolves over time. Approximately 76% of vehicles in total are forecast to be compliant in the 2021 do-minimum modelling.

5.3.3 Approximately 85% of vehicles are forecast to be compliant in 2023, with 91% of vehicles achieving compliance by 2025. The numbers of trips (with an internal origin or destination) in the assignment matrices are forecast to grow by between 7 and 9 percent between 2016 and 2021 and by between 11 and 13 percent between 2016 and 2025. The development of the demand matrices is described in Documents **T2** and **T3** (References 3 and 4).

Table 8: Highway Assignment Matrix Totals (PCUs, Trips With an Origin or Destination Inside Greater Manchester), 2016 Base

Vehicle Type	AM Peak		Inter-Peak		PM Peak	
	Trips	%	Trips	%	Trips	%
Cars						
Compliant Car	147,060	46.3%	120,288	46.3%	150,683	46.3%
Non-Compliant Car	170,564	53.7%	139,513	53.7%	174,766	53.7%
All Car	317,624	100%	259,801	100%	325,449	100%
LGV						
Compliant LGV	887	2.1%	858	2.1%	745	2.1%
Non-Compliant LGV	41,358	97.9%	39,986	97.9%	34,723	97.9%
All LGV	42,246	100%	40,844	100%	35,468	100%
HGV						
Compliant OGV	5,189	27.0%	5,630	27.0%	2,537	27.0%
Non-Compliant OGV	14,030	73.0%	15,221	73.0%	6,859	73.0%
All OGV	19,218	100%	20,850	100%	9,396	100%
Taxi (Hackney/PHV)						
Compliant Taxi	1,993	8.6%	1,630	8.6%	2,042	8.6%
Non-Compliant Taxi	21,181	91.4%	17,325	91.4%	21,703	91.4%
All Taxi	23,174	100%	18,955	100%	23,745	100%
All						
All Compliant	155,129	38.6%	128,405	37.7%	156,007	39.6%
All Non-Compliant	247,133	61.4%	212,045	62.3%	238,051	60.4%
All Vehicle	402,262	100%	340,450	100%	394,058	100%

Table 9: Highway Assignment Matrix Totals (PCUs, Trips With an Origin or Destination Inside Greater Manchester), 2021 Do Minimum

Vehicle Type	AM Peak		Inter-Peak		PM Peak	
	Trips	%	Trips	%	Trips	%
Car						
Compliant Car	274,118	80.6%	226,778	80.6%	280,217	80.6%
Non-Compliant Car	65,979	19.4%	54,584	19.4%	67,447	19.4%
All Car	340,097	100.0%	281,362	100.0%	347,664	100.0%
LGV						
Compliant LGV	27,706	57.8%	26,779	57.8%	23,264	57.8%
Non-Compliant LGV	20,228	42.2%	19,552	42.2%	16,985	42.2%
All LGV	47,934	100.0%	46,331	100.0%	40,249	100.0%
HGV						
Compliant OGV	14,162	71.1%	15,360	71.1%	6,923	71.1%
Non-Compliant OGV	5,756	28.9%	6,243	28.9%	2,814	28.9%
All OGV	19,918	100.0%	21,604	100.0%	9,738	100.0%
Taxi (Hackney/PHV)						
Compliant Taxi	14,764	59.5%	12,215	59.5%	15,093	59.5%
Non-Compliant Taxi	10,050	40.5%	8,314	40.5%	10,273	40.5%
All Taxi	24,814	100.0%	20,529	100.0%	25,366	100.0%
All						
All Compliant	330,750	76.4%	281,132	76.0%	325,497	76.9%
All Non-Compliant	102,013	23.6%	88,693	24.0%	97,519	23.1%
All Vehicle	432,763	100.0%	369,825	100.0%	423,017	100.0%

Table 10: Highway Assignment Matrix Totals (PCUs, Trips With an Origin or Destination Inside Greater Manchester), 2023 Do Minimum

Vehicle type	AM Peak		Inter-Peak		PM Peak	
	Trips	%	Trips	%	Trips	%
Car						
Compliant Car	301,599	87.4%	249,888	87.4%	308,458	87.4%
Non-Compliant Car	43,480	12.6%	36,025	12.6%	44,469	12.6%
All Car	345,079	100.0%	285,913	100.0%	352,927	100.0%
LGV						
Compliant LGV	33,994	67.9%	32,874	67.9%	28,542	67.9%
Non-Compliant LGV	16,071	32.1%	15,542	32.1%	13,493	32.1%
All LGV	50,064	100.0%	48,416	100.0%	42,036	100.0%
HGV						
Compliant OGV	16,579	82.1%	17,978	82.1%	8,099	82.1%
Non-Compliant OGV	3,615	17.9%	3,920	17.9%	1,766	17.9%
All OGV	20,194	100.0%	21,897	100.0%	9,864	100.0%
Taxi (Hackneys/PHV)						
Compliant Taxi	19,826	79.1%	16,438	79.1%	20,278	79.1%
Non-Compliant Taxi	5,238	20.9%	4,343	20.9%	5,358	20.9%
All Taxi	25,064	100.0%	20,781	100.0%	25,636	100.0%
All						
All Compliant	371,998	84.5%	317,178	84.1%	365,377	84.9%
All Non-Compliant	68,404	15.5%	59,829	15.9%	65,086	15.1%
All Vehicle	440,401	100.0%	377,007	100.0%	430,463	100.0%

Table 11: Highway Assignment Matrix Totals (PCUs, Trips With an Origin or Destination Inside Greater Manchester), 2025 Do Minimum

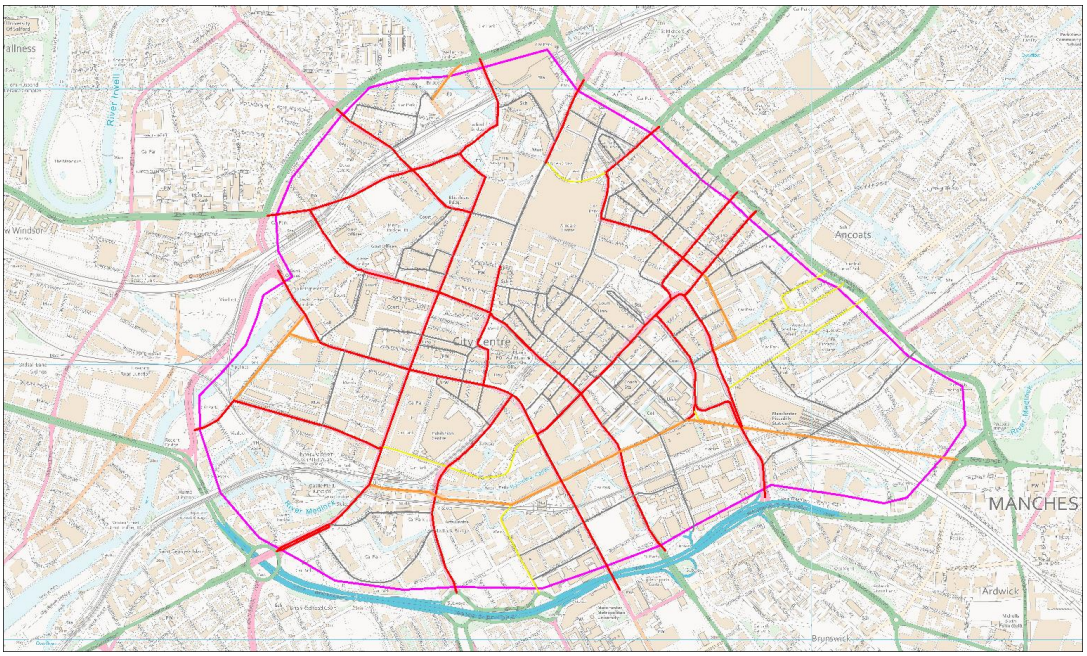
Vehicle type	AM Peak		Inter-Peak		PM Peak	
	Trips	%	Trips	%	Trips	%
Car						
Compliant Car	324,338	92.7%	269,188	92.7%	331,601	92.7%
Non-Compliant Car	25,541	7.3%	21,198	7.3%	26,113	7.3%
All Car	349,879	100.0%	290,386	100.0%	357,714	100.0%
LGV						
Compliant LGV	41,182	78.9%	39,845	78.9%	34,575	78.9%
Non-Compliant LGV	11,013	21.1%	10,656	21.1%	9,246	21.1%
All LGV	52,195	100.0%	50,501	100.0%	43,822	100.0%
HGV						
Compliant OGV	18,667	91.2%	20,238	91.2%	9,112	91.2%
Non-Compliant OGV	1,801	8.8%	1,953	8.8%	879	8.8%
All OGV	20,469	100.0%	22,191	100.0%	9,992	100.0%
Taxi (Hackney/PHV)						
Compliant Taxi	23,365	91.9%	19,396	91.9%	23,864	91.9%
Non-Compliant Taxi	2,059	8.1%	1,710	8.1%	2,103	8.1%
All Taxi	25,425	100.0%	21,105	100.0%	25,967	100.0%
All						
All Compliant	407,553	91.0%	348,668	90.8%	399,153	91.2%
All Non-Compliant	40,415	9.0%	35,516	9.2%	38,342	8.8%
All Vehicle	447,968	100.0%	384,184	100.0%	437,495	100.0%

5.4 Forecast Traffic Volumes

5.4.1

5.4.2 Table 12 shows modelled do-minimum annual vehicle km totals for roads in the Regional Centre and the whole of Greater Manchester from the SATURN and EMIGMA modelling, broken down by compliant and non-compliant vehicle types. (The location of the Regional Centre cordon is shown in Figure 3).

Figure 3: Regional Centre Cordon



5.4.3 The results show that traffic flows in the Regional Centre are forecast to remain stable between 2021 and 2025. This is broadly in line with observed trends for highway trips in the City Centre, where traffic flows have been stationary or falling since 2010. Vehicle kilometres across the County as-a-whole are forecast to increase by approximately 5% between 2021 and 2025, which is slightly higher than the growth in the numbers of trips shown in Table 11. This is caused by a small increase in average trip lengths in the SATURN model, which often happens due to re-routing responses in the highway assignment caused by lower vehicle operating costs and higher values of time in forecast years

5.4.4 The breakdown of vehicle kilometres by compliant and non-compliant vehicle types matches that in the demand matrices (shown in Table 9, Table 10 and Table 11), as expected.

Table 12: Modelled Do-Minimum Vehicle KM Totals by Year for Compliant and Non-Compliant Vehicle Types (Millions)

Vehicle Type	2021 DM	% Total	2023 DM	% Total	2025 DM	% Total
Regional Centre						
Compliant Car	46	80.6%	49	87.4%	52	92.7%
Non-Compliant Car	11	19.4%	7	12.6%	4	7.3%
All Car	56		56		56	
Compliant LGV	6	57.8%	7	67.9%	8	78.9%
Non-Compliant LGV	4	42.2%	3	32.1%	2	21.1%
All LGV	10		10		10	
Compliant OGV	1	71.1%	1	82.1%	1	91.2%
Non-Compliant OGV	0	28.9%	0	17.9%	0	8.8%
All OGV	1		1		1	
Compliant Taxi	2	59.5%	3	79.1%	4	91.9%
Non-Compliant Taxi	2	40.5%	1	20.9%	0	8.1%
All Taxi	4		4		4	
Bus	5		5		5	
Total	76		76		77	
Greater Manchester						
Compliant Car	10,574	80.5%	11,788	87.3%	12,801	92.7%
Non-Compliant Car	2,563	19.5%	1,708	12.7%	1,014	7.3%
All Car	13,138		13,496		13,816	
Compliant LGV	1,487	57.8%	1,821	67.9%	2,202	78.9%
Non-Compliant LGV	1,086	42.2%	861	32.1%	588	21.1%
All LGV	2,573		2,682		2,790	
Compliant OGV	726	71.1%	849	82.1%	955	91.2%
Non-Compliant OGV	295	28.9%	185	17.9%	92	8.8%
All OGV	1,021		1,034		1,048	
Compliant Taxi	508	59.6%	686	79.2%	816	92.0%
Non-Compliant Taxi	345	40.4%	180	20.8%	71	8.0%
All Taxi	853		867		887	
Bus	104		104		104	
Total	17,688		18,183		18,644	

Notes:

Totals may not sum due to rounding

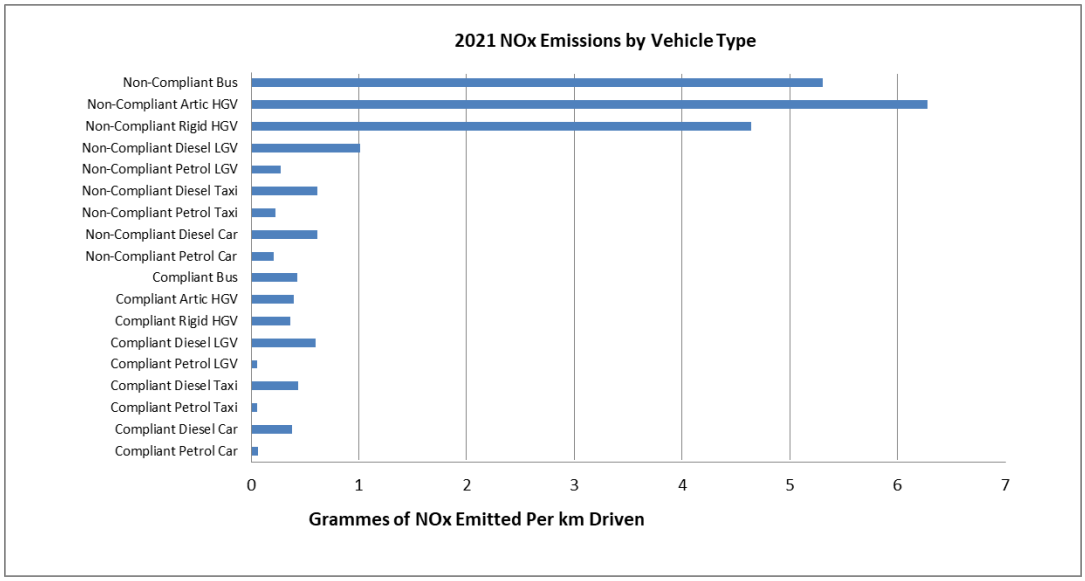
The location of the Regional Centre cordon is shown in Figure 3

5.5 Road Traffic Emissions

5.5.1 This section presents summary details of do-minimum road traffic emissions from the air quality modelling. The results should be viewed in the context that road traffic emissions represented approximately two thirds of total NOx emissions in Greater Manchester in 2014, as described in Reference 6.

5.5.2 Figure 2 shows NOx emission rates (in grammes per km travelled) for different vehicle types travelling at average speeds from the 2021 EMIGMA modelling. In general, the figure shows that non-compliant vehicles have higher emissions than equivalent compliant vehicle types, and that diesel vehicles have higher emission rates than petrol powered vehicles. It can also be seen that non-compliant HGVs and buses have much higher emission rates than other vehicle types, and will therefore have a disproportionate impact on air quality levels relative to their overall contribution to the total traffic flow.

Figure 2: 2021 NOx Emissions from Different Vehicle Types at Average Speeds



5.5.3 The figures in the columns headed '% Total' show the fraction of total emissions for the corresponding road and vehicle type. Non-compliant cars travelling on motorways, for example, generate approximately 11% of total road traffic emissions in the County in 2016. Traffic travelling on motorways generates 40% of total NOx emissions in 2016, with emissions from non-compliant LGVs representing approximately 23% of the county-wide total. Emissions from non-compliant cars represent approximately 19% of total road traffic emissions in 2021, with emissions from non-compliant Light Goods Vehicles representing just over 16% of the total. Emissions from non-compliant vehicles as-a-whole (excluding buses) represent approximately 51% of total road traffic NOx emissions in 2021, although they represent only about 25% of the total vehicle fleet.

5.5.4 Figure 3 shows modelled NOx emissions within Greater Manchester by year, illustrating how emissions from road traffic are forecast to decline between 2016 and 2025 due to improvements in vehicle emission standards over time. (This occurs despite the forecast increase in demand over this period).

5.5.5 The breakdown of GM road traffic NOx emissions by vehicle type for 2021 is shown in Figure 4. The figure shows emissions from private cars represent approximately 45% of the total in this year, with emissions from LGVs and HGVs representing 29% and 15% of the total respectively. Emissions from buses represent 7% of the total.

5.5.6 Table 13 provides a more detailed breakdown of the information described above, showing modelled road traffic NOx emissions by year for compliant and non-compliant vehicle types travelling on roads in Greater Manchester, from the do-minimum EMIGMA modelling.

5.5.7 The figures in the columns headed '% Total' show the fraction of total emissions for the corresponding road and vehicle type. Non-compliant cars travelling on motorways, for example, generate approximately 11% of total road traffic emissions in the County in 2016. Traffic travelling on motorways generates 40% of total NOx emissions in 2016, with emissions from non-compliant LGVs representing approximately 23% of the county-wide total. Emissions from non-compliant cars represent approximately 19% of total road traffic emissions in 2021, with emissions from non-compliant Light Goods Vehicles representing just over 16% of the total. Emissions from non-compliant vehicles as-a-whole (excluding buses) represent approximately 51% of total road traffic NOx emissions in 2021, although they represent only about 25% of the total vehicle fleet.

Figure 3: Modelled Road Traffic NOx Emissions By Year

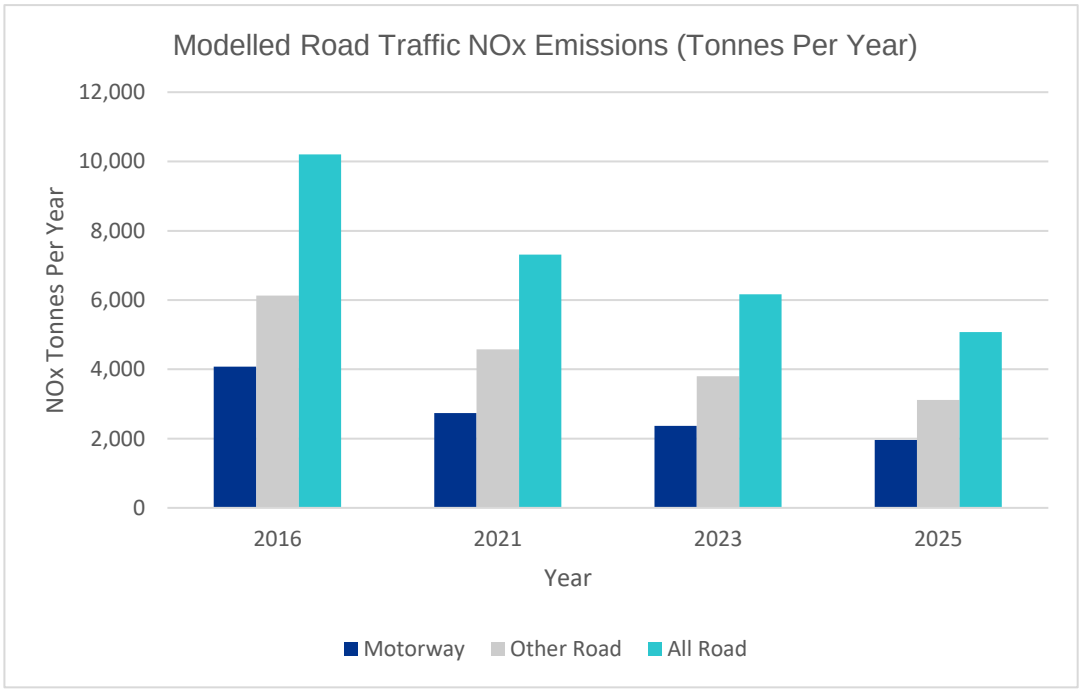


Figure 4: 2021 Road Traffic Emission Sources

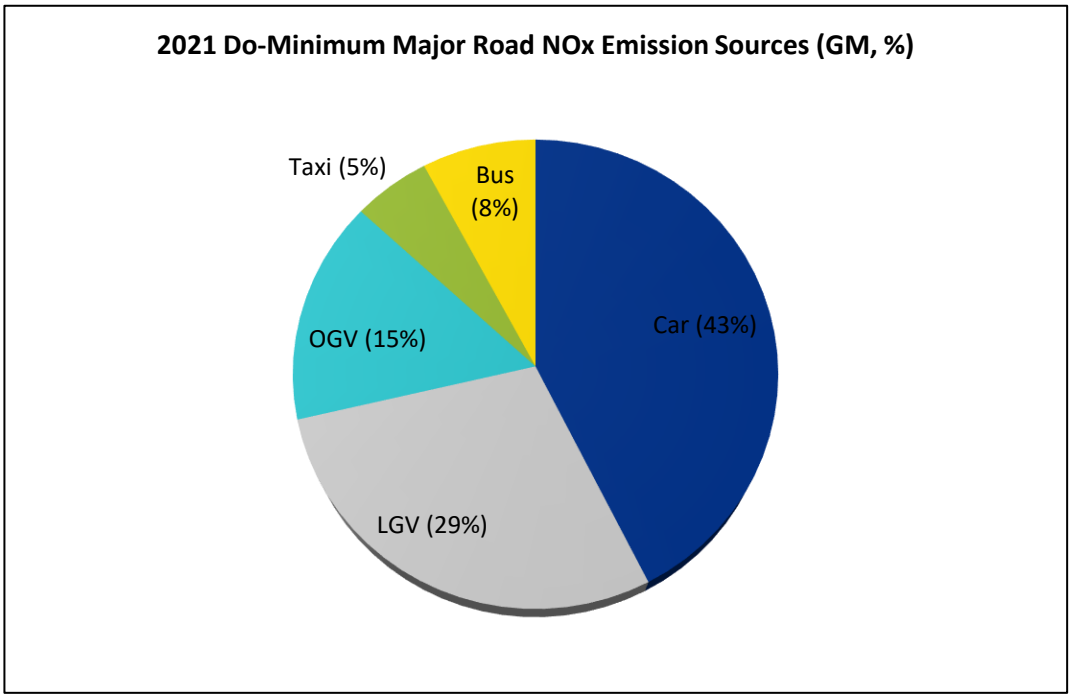


Table 13: Modelled Road Traffic NOx Emission Totals By Year, Vehicle and Road Type (Millions of Tonnes Per Year)

Vehicle Type	2016						2021					
	M'way	%	Other Road	%	All Road	%	M'way	%	Other Road	%	All Road	%
Compliant Car	322	3.2%	424	4.2%	746	7.3%	624	8.5%	1,103	15.1%	1,727	23.6%
Non-Compliant Car	1,097	10.8%	2,000	19.6%	3,097	30.4%	479	6.6%	901	12.3%	1,381	18.9%
All Car	1,419	13.9%	2,424	23.8%	3,843	37.7%	1,104	15.1%	2,004	27.4%	3,108	42.5%
Compliant LGV	24	0.2%	24	0.2%	48	0.5%	422	5.8%	496	6.8%	918	12.6%
Non-Compliant LGV	1,172	11.5%	1,212	11.9%	2,384	23.4%	589	8.1%	600	8.2%	1,189	16.3%
All LGV	1,196	11.7%	1,235	12.1%	2,432	23.9%	1,010	13.8%	1,097	15.0%	2,107	28.8%
Compliant OGV	22	0.2%	38	0.4%	60	0.6%	62	0.8%	110	1.5%	172	2.4%
Non-Compliant OGV	1,315	12.9%	1,263	12.4%	2,577	25.3%	450	6.2%	506	6.9%	956	13.1%
All OGV	1,337	13.1%	1,301	12.8%	2,638	25.9%	512	7.0%	617	8.4%	1,128	15.4%
Compliant Taxi	5	0.1%	14	0.1%	20	0.2%	54	0.7%	137	1.9%	190	2.6%
Non-Compliant Taxi	112	1.1%	290	2.9%	403	4.0%	57	0.8%	142	1.9%	199	2.7%
All Taxi	117	1.2%	305	3.0%	422	4.1%	111	1.5%	279	3.8%	389	5.3%
Bus	0	0.0%	850	8.3%	850	8.3%	0	0.0%	573	7.8%	573	7.8%
Total	4,070	40.0%	6,115	60.0%	10,185	100.0%	2,736	37.5%	4,569	62.5%	7,306	100.0%

Vehicle Type	2023						2025					
	M'way	%	Other Road	%	All Road	%	M'way	%	Other Road	%	All Road	%
Compliant Car	681	11.1%	1,058	14.5%	1,739	28.3%	698	13.8%	1,078	21.2%	1,776	35.0%
Non-Compliant Car	334	5.4%	607	8.3%	941	15.3%	200	3.9%	353	7.0%	553	10.9%
All Car	1,015	16.5%	1,665	22.8%	2,680	43.5%	898	17.7%	1,431	28.2%	2,329	45.9%
Compliant LGV	419	6.8%	448	6.1%	867	14.1%	432	8.5%	480	9.5%	912	18.0%
Non-Compliant LGV	486	7.9%	499	6.8%	985	16.0%	333	6.6%	355	7.0%	688	13.6%
All LGV	905	14.7%	947	13.0%	1,852	30.1%	765	15.1%	836	16.5%	1,600	31.6%
Compliant OGV	74	1.2%	131	1.8%	205	3.3%	84	1.7%	149	2.9%	234	4.6%
Non-Compliant OGV	276	4.5%	317	4.3%	593	9.6%	134	2.6%	158	3.1%	291	5.7%
All OGV	350	5.7%	448	6.1%	798	13.0%	218	4.3%	307	6.1%	525	10.4%
Compliant Taxi	64	1.0%	157	2.2%	221	3.6%	65	1.3%	157	3.1%	222	4.4%
Non-Compliant Taxi	30	0.5%	74	1.0%	104	1.7%	12	0.2%	29	0.6%	41	0.8%
All Taxi	94	1.5%	231	3.2%	325	5.3%	77	1.5%	186	3.7%	262	5.2%
Bus	0	0.0%	500	6.8%	500	8.1%	0	0.0%	355	7.0%	355	7.0%
Total	2,364	38.4%	3,791	51.9%	6,155	100.0%	1,958	38.6%	3,114	61.4%	5,072	100.0%

6 Scenario Forecasts

6.1 Introduction

6.1.1 This section presents results from the do-something modelling for the 'Option for Consultation'.

6.2 Assessment Scenarios

6.2.1 Many options have been tested throughout the option development process to first test that the approach adopted was giving sensible results and then to investigate the potential impacts of combinations of different measures.

6.2.2 Options have been tested using the DST throughout the option development process. During each stage, additional functionality has been applied to the DST. Since the completion of the OBC, the DST was further enhanced to include:

- Application of a switch mode behavioural response to allow the switching between vehicle modes;
- Functionality to enable the application of separate behavioural responses for Hackney and PHVs. This also replaced the previous assumption that 100% of hackneys upgraded, which are now represented by behavioural responses from the taxi cost model; and
- Inputs updated to allow integration of behavioural responses identified by the vehicle cost models.

6.3 Compliance level achieved across Greater Manchester

6.3.1 The performance of the package has been assessed at a high level by examining the splits of compliant/non-compliant vehicle types for trips with an origin or destination inside Greater Manchester and the total change in traffic volumes from the do-minimum for each of the forecast years. (It should be noted that these results relate to trip totals from the SATURN model demand matrices, and cannot therefore reflect the extent to which the package reduces the number of non-compliant sites, or how it impacts on air quality concentrations. They do, however, provide an indication of the performance of the package with respect to improvements to vehicle emission standards).

6.3.2 Table 14**,**Table 15 and Table 16 present the results of the analysis for 2021, 2023 and 2025 respectively. (The figures in the columns labelled '% Change in Traffic' show changes in traffic volumes relative to the do-minimum for the AM peak, PM peak and inter-peak hours. These figures differ slightly by time period due to the modelling of sustainable journey trips, (described above), where the impacts are more pronounced in the peaks, albeit at modest levels).

Table 14: Option Performance in 2021

Mode	Do-Minimum		Option for Consultation				
	Compliant	Non-Compliant	Compliant	Non-Compliant	% Change in Traffic		
					AM Peak	Inter-Peak	PM Peak
Car	81%	19%	81%	19%	-0.2%	-0.1%	-0.1%
LGV	58%	42%	58%	42%	0.0%	0.0%	0.0%
HGV	71%	29%	99%	1%	0.0%	0.0%	0.0%
Taxi	59%	41%	88%	12%	0.0%	0.0%	0.0%

Table 15: Option Performance in 2023

Mode	Do-Minimum		Option for Consultation				
	Compliant	Non-Compliant	Compliant	Non-Compliant	% Change in Traffic		
					AM Peak	Inter-Peak	PM Peak
Car	87%	13%	87%	13%	-0.1%	0.0%	-0.1%
LGV	68%	32%	95%	5%	-1.0%	-1.0%	-1.0%
HGV	82%	18%	99%	1%	0.0%	0.0%	0.0%
Taxi	79%	21%	96%	4%	0.0%	0.0%	0.0%

Table 16: Option Performance in 2025

Mode	Do-Minimum		Option for Consultation				
	Compliant	Non-Compliant	Compliant	Non-Compliant	% Change in Traffic		
					AM Peak	Inter-Peak	PM Peak
Car	93%	7%	93%	7%	-0.3%	-0.2%	-0.3%
LGV	79%	21%	97%	3%	0.0%	0.0%	0.0%
HGV	91%	9%	100%	0%	0.0%	0.0%	0.0%
Taxi	92%	8%	98%	2%	0.0%	0.0%	0.0%

6.3.3 The figures in Table 14 show that the introduction of the Category B CAZ in 2021 is forecast to increase the percentage of compliant HGV trips from approximately 70% of the total in the do-minimum to 99% of total trips in the do-something. The percentage of compliant Taxi trips is forecast to increase from 60% of the total for the do-minimum to 88% of the total for the do-something. The proportions of compliant car and LGV trips have not changed in 2021 as the category B CAZ does not have an impact on these vehicle types. Note that this may understate the true level of compliance, as vehicle owners upgrade in advance of the end date of the exemption, and access the Funds and/or Loan Finance schemes to help them upgrade. Overall, there is a small reduction in total car trips of between 0.1% and 0.2%, associated with the mode shift impacts of the sustainable journey measures.

6.3.4 Table 15 shows the impacts of the removal of the temporary exemptions for LGVs, minibuses, GM-registered coaches and GM-licensed wheelchair accessible taxis in 2023. The table shows that the percentage of compliant LGV trips is forecast to increase from 68% of the total for the do-minimum to 95% of the total for the do-something. The percentage of compliant car trips is forecast to increase from 81% of all car trips in 2021 to 87% of all trips in 2023 due to expected changes in the Euro standards of the fleet over time. The modelled reduction in car trips in 2023 (relative to the do-minimum) is slightly lower than that for 2021, due to some non-compliant LGV drivers opting to change mode to car following the extension of the CAZ, as modelled in the DST.

6.3.5 The results for 2025 (shown in Table 16) are similar to those for 2023, albeit with increased proportions of compliant trips as the vehicle fleet changes over time. The sustainable journey measures deliver small reductions in total car trips relative to the do-minimum of between 0.2% and 0.3% in 2025.

6.4 Highway Model Convergence

6.4.1 WebTAG notes the importance of achieving appropriate levels of network convergence in transport models used for appraisal purposes, in order to provide stable and consistent model results. The DMRB also stresses that it is important that the levels of convergence achieved in the do-minimum and do-something assignments are similar, and that they are sufficiently robust to ensure that differences in the results are not confused with oscillation effects or assignment ‘noise’.

6.4.2 The WebTAG criteria for an acceptable level of network convergence are that:

- the Delta and %GAP statistics should be less than 0.1% on the final assignment iteration; and
- more than 98% of links should have a flow that changes by less than 1% on the final 4 iterations.

6.4.3 Table 17 shows the above values for the three time periods, for the do-minimum and do-something models, for each of the forecast years and modelled scenarios. The table indicates that the models were satisfactorily converged for all tests, with Delta and GAP values well below 0.1% and the percentage of links with flows changing by less than 1% meeting the criteria for all model runs.

Table 17: Forecast Highway Assignment Convergence Statistics

Criterion	Target	2021			2023			2025		
		AM Peak	Inter-Peak	PM Peak	AM Peak	Inter-Peak	PM Peak	AM Peak	Inter-Peak	PM Peak
Do Minimum										
Delta	< 0.1%	0.028%	0.020%	0.028%	0.040%	0.022%	0.028%	0.028%	0.022%	0.032%
%GAP	< 0.1%	0.026%	0.019%	0.030%	0.029%	0.022%	0.040%	0.039%	0.026%	0.038%
% of links with < 1% flow change on final iteration	> 98%	98.4%	98.6%	98.3%	98.1%	98.6%	98.3%	98.2%	98.1%	98.4%
Final iteration -1		98.1%	98.3%	98.4%	98.4%	98.4%	98.1%	98.1%	98.0%	98.3%
Final iteration -2		98.1%	98.1%	98.2%	98.2%	98.2%	98.4%	98.1%	98.0%	98.1%
Final iteration -3		98.1%	98.2%	98.5%	98.1%	98.2%	98.4%	98.1%	98.1%	98.2%
Option for Consultation										
Delta	< 0.1%	0.021%	0.016%	0.024%	0.021%	0.019%	0.030%	0.029%	0.021%	0.030%
%GAP	< 0.1%	0.035%	0.022%	0.031%	0.031%	0.022%	0.043%	0.041%	0.026%	0.041%
% of links with < 1% flow change on final iteration	> 98%	98.2%	98.5%	98.4%	98.7%	98.3%	98.4%	98.5%	98.2%	98.4%
Final iteration -1		98.1%	98.5%	98.5%	98.3%	98.2%	98.3%	98.6%	98.2%	98.1%
Final iteration -2		98.6%	98.4%	98.4%	98.3%	98.3%	98.2%	98.0%	98.2%	98.1%
Final iteration -3		98.2%	98.5%	98.4%	98.5%	98.0%	98.5%	98.3%	98.0%	98.2%

6.5 Forecast Traffic Flows

6.5.1 Table 18 shows modelled annual vehicle km totals by year from the do-minimum and do-something models, broken down by vehicle type, for the Regional Centre and the county-as-a-whole. (The figures in the columns labelled '% Total' for compliant and non-compliant vehicles show the fraction of the total mileage for the for the corresponding vehicle type. Travel in non-compliant cars, for example, represents approximately 80% of total car travel in the Regional Centre in the 2021 do-minimum model. The figures in the columns labelled '% Change' show the percentage change in the do-something flow relative to the do-minimum figure for each of the vehicle types).

6.5.2 The results show that the models provide stable assignments, with only modest differences between the do-minimum and do-something flows at an aggregate level. Overall, there is a small reduction in the do-something vehicle km's in the Regional Centre in each of the forecast years, mainly due to small reductions in car flows and the impacts of the measures to promote sustainable journeys as described in Section 4. In percentage terms, the reductions in car flows are generally smaller outside of the Regional Centre, where the sustainable journey measures have less of an impact and are more spread out.

6.5.3 Vehicle km totals for compliant taxi trips within the Regional Centre are forecast to increase from approximately 60% of total taxi travel in the 2021 do-minimum model to approximately 88% of the total in the do-something forecast as drivers upgrade their vehicles in response to the CAZ. The changes in taxi flows across the county-as-whole follow a similar pattern with the increase in compliant trips being offset by a corresponding reduction in non-compliant trips, so that the overall taxi mileage remains unchanged.

6.5.4 The proportion of compliant HGV trips across the county-as-a -whole are forecast to increase from 71% of the HGV total in the 2021 do-minimum to approximately 92% of total HGV travel in the do-something forecast following the introduction of the CAZ. (The proportions of compliant HGV trips within the Regional Centre are slightly greater than those for the county-as-whole as the county wide figure includes 'through trips' made entirely on the motorway network, where non-compliant vehicles are not subject to a penalty charge, and are not therefore affected by the CAZ).

6.5.5 The proportion of compliant LGV mileage is forecast to increase from 58% of the LGV total in 2021 to approximately 93% of the do-something county-wide total in 2023, when their exemption from the CAZ ends. This is compared to a figure of 68% for the do-minimum forecast, which represents what is likely to happen without the CAZ.

Table 18: Annual Vehicle KM Totals By Year for Compliant and Non-Compliant Vehicle Types (Millions)

Vehicle Type	2021					2023					2025				
	DM	% Total	DS	% Total	% Change	DM	% Total	DS	% Total	% Change	DM	% Total	DS	% Total	% Change
Regional Centre															
Compliant Car	46	80.6%	45	80.6%	-0.6%	49	87.4%	49	87.4%	-0.6%	52	92.7%	52	92.7%	-1.0%
Non-Compliant Car	11	19.4%	11	19.4%	-0.4%	7	12.6%	7	12.6%	-1.0%	4	7.3%	4	7.3%	-0.9%
All Car	56		56		-0.5%	56		56		-0.6%	56		56		-1.0%
Compliant LGV	6	57.8%	6	57.8%	0.3%	7	67.9%	9	95.2%	39.0%	8	78.9%	10	96.6%	22.7%
Non-Compliant LGV	4	42.2%	4	42.2%	0.3%	3	32.1%	0	4.8%	-85.3%	2	21.1%	0	3.4%	-84.0%
All LGV	10		10		0.3%	10		10		-0.9%	10		10		0.2%
Compliant OGV	1	71.1%	1	99.2%	39.9%	1	82.1%	1	99.1%	20.6%	1	91.2%	1	99.8%	9.6%
Non-Compliant OGV	0	28.9%	0	0.8%	-97.3%	0	17.9%	0	0.9%	-94.9%	0	8.8%	0	0.2%	-97.9%
All OGV	1		1		0.3%	1		1		0.0%	1		1		0.1%
Compliant Taxi	2	59.5%	4	88.0%	48.2%	3	79.1%	4	96.1%	21.6%	4	91.9%	4	98.3%	7.2%
Non-Compliant Taxi	2	40.5%	0	12.0%	-70.3%	1	20.9%	0	3.9%	-81.3%	0	8.1%	0	1.7%	-79.2%
All Taxi	4		4		0.2%	4		4		0.1%	4		4		0.2%
Bus	5		5		0.1%	5		5		0.1%	5		5		0.1%
Total	76		76		-0.3%	76		76		-0.6%	77		76		-0.7%

Vehicle Type	2021					2023					2025				
	DM	% Total	DS	% Total	% Change	DM	% Total	DS	% Total	% Change	DM	% Total	DS	% Total	% Change
Greater Manchester															
Compliant Car	10,574	80.5%	10,566	80.5%	-0.1%	11,788	87.3%	11,790	87.3%	0.0%	12,801	92.7%	12,783	92.7%	-0.1%
Non-Compliant Car	2,563	19.5%	2,561	19.5%	-0.1%	1,708	12.7%	1,708	12.7%	0.0%	1,014	7.3%	1,013	7.3%	-0.1%
All Car	13,138		13,127		-0.1%	13,496		13,498		0.0%	13,816		13,796		-0.1%
Compliant LGV	1,487	57.8%	1,487	57.8%	0.0%	1,821	67.9%	2,456	92.5%	34.8%	2,202	78.9%	2,645	94.8%	20.2%
Non-Compliant LGV	1,086	42.2%	1,086	42.2%	0.0%	861	32.1%	200	7.5%	-76.7%	588	21.1%	145	5.2%	-75.4%
All LGV	2,573		2,573		0.0%	2,682		2,656		-1.0%	2,790		2,790		0.0%
Compliant OGV	726	71.1%	940	92.2%	29.6%	849	82.1%	981	94.8%	15.6%	955	91.2%	1,023	97.6%	7.1%
Non-Compliant OGV	295	28.9%	80	7.8%	-72.9%	185	17.9%	53	5.2%	-71.1%	92	8.8%	25	2.4%	-73.2%
All OGV	1,021		1,020		0.0%	1,034		1,034		0.1%	1,048		1,048		0.0%
Compliant Taxi	508	59.6%	751	88.0%	47.9%	686	79.2%	833	96.0%	21.4%	816	92.0%	872	98.3%	6.9%
Non-Compliant Taxi	345	40.4%	102	12.0%	-70.3%	180	20.8%	35	4.0%	-80.9%	71	8.0%	15	1.7%	-78.8%
All Taxi	853		853		0.1%	867		867		0.1%	887		887		0.0%
Bus	104		104		0.0%	104		104		0.0%	104		104		0.0%
Total	17,688		17,678		-0.1%	18,183		18,160		-0.1%	18,644		18,626		-0.1%
Notes: Totals may not sum due to rounding.															

6.6 Road Traffic Emission Forecasts

6.6.1 Table shows forecast road traffic emissions with percentage changes relative to the do-minimums for the Full Consultation Package for each of the forecast years, separately for the Regional Centre, the area inside the M60 and the whole of GM.

6.6.2 The results show that NOx emissions in the Regional Centre are forecast to be reduced by approximately 44% relative to the do-minimum total in 2021, and by approximately 48% in 2023 when the temporary exemptions end. NOx emissions from buses (which represent approximately 60% of total road traffic emissions within the Regional Centre in the 2021 do-minimum model) are forecast to fall by approximately 44% in 2021 following the introduction of Package, with corresponding reductions of approximately 48% and 39% relative to the do-minimum forecasts in 2023 and 2025 respectively.

6.6.3 The results for the county-as-a-whole show that the Package could deliver reductions in road traffic NOx emissions relative to the do-minimums of approximately 17% in 2021, 22% in 2023 and 17% in 2025. These percentage changes are smaller than those for the Regional Centre mainly due to the increased significance of bus emissions in the central area, which is more congested and has higher bus flows, which exhibit steep rises in emission rates, especially at low speeds.

Table 19: Forecast Road Traffic Emissions with Percentage Changes from the Do-Minimums (Tonnes Per Year)

Vehicle Type	2021			2023			2025		
	DM	DS	% Change	DM	DS	% Change	DM	DS	% Change
Regional Centre									
Car	17	16	-0.5%	13	13	-0.8%	11	11	-0.9%
LGV	9	9	0.3%	7	5	-26.8%	7	5	-22.7%
HGV	4	1	-62.5%	3	2	-50.7%	2	1	-33.9%
Taxi	2	2	-23.2%	2	1	-23.8%	2	1	-19.8%
Bus	44	14	-68.3%	42	14	-67.6%	32	14	-57.2%
Total	75	42	-43.7%	68	35	-47.8%	53	33	-38.9%
Inside M60									
Car	568	566	-0.2%	476	475	-0.2%	408	406	-0.4%
LGV	329	329	0.0%	285	209	-26.5%	249	192	-22.7%
HGV	166	47	-71.9%	122	48	-60.6%	83	46	-45.1%
Taxi	81	62	-23.3%	67	51	-23.8%	53	43	-20.0%
Bus	244	50	-79.6%	223	50	-77.7%	159	49	-69.0%
Total	1,388	1,054	-24.1%	1,172	832	-29.0%	952	736	-22.7%
Greater Manchester									
Car	3,108	3,105	-0.1%	2,680	2,681	0.0%	2,329	2,325	-0.2%
LGV	2,107	2,107	0.0%	1,852	1,401	-24.3%	1,600	1,267	-20.8%
HGV	1,128	436	-61.3%	798	379	-52.5%	525	313	-40.3%
Taxi	389	298	-23.4%	325	248	-23.7%	262	210	-19.9%
Bus	573	110	-80.8%	500	110	-78.0%	355	110	-69.0%
Total	7,306	6,057	-17.1%	6,155	4,819	-21.7%	5,072	4,226	-16.7%

7 Sensitivity Testing

7.1 A number of sensitivity tests are to be carried out on the 'Option for Consultation' to assess the impact of uncertainty on the modelling carried out to date. All tests will be carried out utilising the 2023 forecast year model, the first year in which LGVs are subject to a charge.

7.2 At OBC a number of initial sensitivity tests were undertaken on the following areas:

- Fuel Costs;
- Traffic Growth;
- Charge Levels;
- Fleet Age;
- Emissions at Low Speeds; and
- Electric Vehicle Uptake.

7.3 Further Details of the tests carried out at OBC and their outcomes are provided in **Appendix C**. Note these are to be updated with the preferred option for Full Business Case, following Consultation on the 'Option for Consultation' package of measures.

8 Summary and Conclusions

8.1.1 This document has presented the overall transport modelling process adopted during the development of the GM CAP both in showing how the Do Minimum scenario has been developed and how the impacts of measures to improve NOx emissions are expected to impact traffic volumes through behavioural change driven by measures such as a charging clean air zone or measures such as the Local Authorities within GM committing to ensure their vehicle fleets are compliant as part of the CAP.

8.1.2 From a review of the natural progression of the fleet mix it can be seen that over time the proportion of compliant vehicles is expected to dramatically increase to the point where over 90% of vehicles are forecast to be compliant by the final modelled year (2025) naturally.

8.1.3 However, it is clear that implementation of measures to improve NOx emissions are likely to lead to a much higher proportion of compliant vehicles across LGVs, HGVs and Taxis, over and above natural turnover in the fleet (i.e. the do-minimum).

8.1.4 GM's preferred CAP option which is being taken forward for consultation comprises:

- A category C CAZ covering the whole of Greater Manchester in 2021, with temporary exemptions to 2023 for LGVs, minibuses, GM-licensed wheelchair accessible hackney cabs and private hire vehicles, and GM-registered coaches;
- Measures to promote sustainable journeys and invest in electric vehicle charging infrastructure for taxis and a try-before-you-buy electric taxi scheme;
- Funds to upgrade the bus fleet;
- Funds for Taxi, PHV, LGV and HGV operators to upgrade their vehicles, plus Loan/Finance measuresThe analysis presented in this report indicates that the package could deliver reductions in road traffic NOx emissions across the county relative to the do-minimums of approximately 17% in 2021, 22% in 2023 and 17% in 2025.

8.1.5 The air quality impacts of these reductions are described in the AQ3 report, which should be read alongside this report.

References

1. JAQU Inception Package Guidance
   Huddle, October 2017
2. JAQU Transport and Air Quality Evidence
   Huddle, October 2017
3. Greater Manchester Clean Air Plan
   Local Plan Transport Validation report (T2)
   March 2019
4. Greater Manchester Clean Air Plan
   Local Plan Transport Modelling Methodology Report (T3)
   March 2019
5. Greater Manchester Clean Air Plan
   Note 32 - Modelling the Impacts of Sustainable Journey Measures for the GM CAP
   October 2019
6. Greater Manchester Emissions Inventory 2014 Update
   HFAS Report 1894
   April 2016

Appendix A – Behavioural Response Cost Models and Demand Sifting Tool

(see separate document)

Appendix B – Boundaries considered for charging clean air zones in Greater Manchester

(see separate document)

Appendix C – GM Clean Air Plan Highways Modelling Sensitivity Tests

(to be updated following consultation – in advance of this the analysis undertaken for the OBC is the most current information on sensitivity testing)

Appendix D – Demand Sifting Tool Operating Manual

(see separate document)