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

# Note 24: Updates to the Modelling Tools post OBC Submission

## CONFIDENTIAL DRAFT



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# 1 Introduction

1.1 This note documents the updates to the modelling tools since the OBC was submitted in Spring 2019.

1.2 The note covers updates to each of the elements of the modelling process including:

- Do Minimum SATURN Model;
- Demand Sifting Tool;
- Updates to EMIGMA;
- Dispersion model updates; and
- AQ Modelling DM Updates.

# 2 DM Updates to the strategic highway model (GM Saturn)

## 2.1 Overview of Updates

2.1.1 The updates to the forecast year Saturn models since the submission of the OBC in March 2019 comprise:

- Updates to the bus service data based on more recently available 2019 service patterns;
- Updates to the demand matrices in line with changes to the projected splits of petrol, diesel and electric cars\taxis in version 9.1a of the EFT and the latest DfT figures for the projected fleet split (by vkms);
- Updates to the values of time and distance, (PPM and PPK), used during the assignments using the latest values of time, GDP growth rates and vehicle operating costs derived from the WebTAG data book, May 2019.

## 2.2 Updates to the Bus Service Data

2.2.1 The bus services in the OBC Saturn model were based on 2016 service patterns and frequencies. The bus services in the updated models have been refreshed to include more recent 2019 data.

2.2.2 The updates to the bus routing data have resulted in an overall reduction in bus mileage across the County of approximately 11% compared with the OBC modelling, as operators have reduced services and stopped running some less profitable routes.

2.2.3 The bus services in the forecast year models for 2021, 2023 and 2025 are based on the 2019 services and patterns. The fleet mix, however, is projected forward using the OBC fleet roll-over methodology. This has resulted in an older bus fleet in future years than was projected in the OBC modelling, because bus operators have not invested in newer vehicles as frequently since 2016 as in preceding years. This has the effect of increasing future bus emissions on a per vehicle basis.

## 2.3 Updates to the Demand Matrices

2.3.1 The updates to demand matrices involved adjustments to the compliant and non-compliant car\taxi matrices to maintain consistency with the updated petrol\diesel splits in version 9.1.a of the EFT. The updated forecasts produced a small increase in the proportions of petrol vehicles and a corresponding reduction in the proportions of diesel vehicles compared to our earlier forecasts.

2.3.2 At the same time as adjusting the car demand matrices a correction was made to the traffic growth factors that were applied to the LGV matrices, which had incorrect growth applied in the OBC forecasts. This correction reduced the numbers of LGV trips by approximately 5% in each of the forecast years.

2.3.3 The reduction in LGV flows following the correction to the demand matrices reduced total NOx emissions from LGVs in the 2021 OBC do-minimum model by approximately 5% and total NOx emissions from all vehicle types approximately 1%.

## 2.4 Updates to the Values of Time and Distance

2.4.1 The future year generalised cost parameters for the updated models are shown in **Table 2.1**, below.

**Table 2-1: Future Year Generalised Cost Parameters (2010 Prices)**

| Period | User Class | 2021 | | 2023 | | 2025 | |
|---|---|---|---|---|---|---|---|
| | | PPM | PPK | PPM | PPK | PPM | PPK |
| AM Peak Hour | Compliant Cars | 20.32 | 8.10 | 20.77 | 7.89 | 21.33 | 7.70 |
| | Non-Compliant Cars | 20.32 | 7.65 | 20.77 | 7.52 | 21.33 | 7.42 |
| | Compliant LGV | 22.09 | 15.29 | 22.44 | 15.15 | 22.91 | 15.03 |
| | Non-Compliant LGV | 22.09 | 15.29 | 22.44 | 15.15 | 22.91 | 15.03 |
| | Compliant OGVs | 22.68 | 50.30 | 23.18 | 50.93 | 23.81 | 51.47 |
| | Non-Compliant OGVs | 22.68 | 50.30 | 23.18 | 50.93 | 23.81 | 51.47 |
| | Compliant Taxis | 27.96 | 14.18 | 28.57 | 14.06 | 29.35 | 13.94 |
| | Non-Compliant Taxis | 27.96 | 14.13 | 28.57 | 14.02 | 29.35 | 13.90 |
| Inter-Peak Hour | Compliant Cars | 19.05 | 7.62 | 19.47 | 7.05 | 20.00 | 6.87 |
| | Non-Compliant Cars | 19.05 | 6.92 | 19.47 | 6.78 | 20.00 | 6.67 |
| | Compliant LGV | 22.09 | 14.24 | 22.44 | 14.11 | 22.91 | 14.00 |
| | Non-Compliant LGV | 22.09 | 14.24 | 22.44 | 14.11 | 22.91 | 14.00 |
| | Compliant OGVs | 22.68 | 44.41 | 23.18 | 44.97 | 23.81 | 45.45 |
| | Non-Compliant OGVs | 22.68 | 44.41 | 23.18 | 44.97 | 23.81 | 45.45 |
| | Compliant Taxis | 27.96 | 12.77 | 28.57 | 12.63 | 29.35 | 12.50 |
| | Non-Compliant Taxis | 27.96 | 12.73 | 28.57 | 12.60 | 29.35 | 12.47 |
| PM Peak Hour | Compliant Cars | 19.75 | 7.58 | 20.19 | 7.35 | 20.74 | 7.14 |
| | Non-Compliant Cars | 19.75 | 7.15 | 20.19 | 6.99 | 20.74 | 6.87 |
| | Compliant LGV | 22.09 | 15.11 | 22.44 | 14.97 | 22.91 | 14.86 |
| | Non-Compliant LGV | 22.09 | 15.11 | 22.44 | 14.97 | 22.91 | 14.86 |
| | Compliant OGVs | 22.68 | 49.30 | 23.18 | 49.91 | 23.81 | 50.45 |
| | Non-Compliant OGVs | 22.68 | 49.30 | 23.18 | 49.91 | 23.81 | 50.45 |
| | Compliant Taxis | 27.96 | 13.92 | 28.57 | 13.77 | 29.35 | 13.63 |
| | Non-Compliant Taxis | 27.96 | 13.86 | 28.57 | 13.73 | 29.35 | 13.60 |

# 3 DM Updates to Demand Sifting Tool

## 3.1 Overview of Updates

3.1.1 Since the submission of the OBC in March 2019, several updates and enhancements have been applied the Demand Sifting Tool (DST). These enhancements have improved the linkage with the wider modelling tools, whilst providing enhanced functionality. These include the following changes, which are discussed further below:

- Disaggregation of Taxi behavioural responses to apply separate responses to PHV and Hackneys;
- Enable the DST to assess the impacts of change mode behavioural responses;
- Enhanced linkages between the do minimum demand in the DST and GM SATURN model; and
- Update to DST demand to reflect refined Do Minimum matrices following GM SATURN do minimum model updates. This also included the update of PPM/PPK values which were updated during the SATURN model update.

## 3.2 Disaggregation of Taxi Behavioural Responses

3.2.1 For the OBC, the behavioural responses for taxis assumed that all hackney carriages are upgraded to compliant, with a taxi behavioural response applied to determine the response for PHVs. Following review of more recent behavioural responses from the Sheffield SP surveys, plus the development of a cost response model, a more detailed set of responses were developed for Hackney Carriages, and PHVs separately.

3.2.2 As a result, additional changes to the DST were applied to disaggregate the do minimum taxi demand separately into PHV and Hackneys. This included the following:

- Do minimum taxi demand was split within the DST into Hackneys and PHVs. Also, separately splitting these by compliant and non-compliant;
- The assumption of 100% hackney upgrades was removed from the DST;
- The inclusion of separate behavioural responses for Hackneys and PHVs was applied within the DST; and
- The resultant changes in demand after application of the behavioural responses was then combined back into compliant and non-compliant taxi matrices (User class 7 and User class 8) for input back into the strategic highway model.

## 3.3 Capturing Change Mode Behavioural Responses

3.3.1 At OBC stage, the DST did not include the functionality to allow the changing of demand between modes as a result of the behavioural changes. Previously it was assumed that LGVs would change mode to active or PT i.e. walking or public transport, but due to the unrealistic nature of this action the DST was refined in order to allow for more accurate mode changes. The refined change mode are as follows:

- HGVs downgrading to LGVs;
- LGVs switching to either a car or a HGV trip
- Hackneys switching to PHVs
- PHVs switching to Hackneys; and
- Cars switching to active modes or public transport.

The DST underwent a number of structural changes to allow the switching between modes, which were then sense checked by checking the quantum of change in outturn flows by user class through to the SATURN model to review the impacts of the changes.

### 3.4 Electric Vehicle Upgrade Behavioural Response

3.4.1 For taxis (PHV/Hackneys), the behavioural responses include an upgrade to an electric vehicle (EV). Within the DST, this forecasts an upgrade to a compliant vehicle, which is then incorporated within the highway model. To account for the air quality impacts associated with this change to electric, the outputs of the DST were reviewed to identify the percentage of the compliant matrices that would become EV. This output was then provided as an input to the EMIGMA model.

### 3.5 Enhanced linkages between the SATURN model and DST

3.5.1 The original do minimum (DM) matrices used for the DST was recreated from the outputs from the SATURN model, following updates made to the SATURN model. This was to ensure the consistent representation of do minimum demand in both models.

3.5.2 Further updated assumptions include a refinement to the Pence Per Minute (PPM) and Pence Per Kilometre (PPK) to reflect a more realistic cost for vehicles. Other updated assumptions include the change to vehicle proportions as mentioned in the previous section.

## 4 Update to EMIGMA Model

### 4.1 Overview

4.1.1 Road traffic emissions for the Greater Manchester Clean Air Plan (GM CAP) have been calculated using TfGM's in-house EMIGMA software (EMissions Inventory for Greater MAnchester). The software uses information about traffic speeds and flows from the highway model in association with fleet-weighted emission rates (factors) derived from the EFT to calculate mass road traffic emissions in the County, broken down by vehicle type, as previously submitted to the T-IRP.

4.1.2 The road traffic emission factors (for input to EMIGMA) for the OBC were derived using EFT version 8.0 by selecting the 'Advanced/Euro Composition' options. The appropriate Euro fleet splits were then entered in the 'UserEuro' worksheet to obtain emission rates in g/km for motorway and non-motorway road types, for speeds between 5kph and 115kph (at 5kph intervals), for NOx and $NO_2$ to calculate f-$NO_2$, $PM_{10}$ and $PM_{2.5}$.

4.1.3 The Euro fleet splits for the base year (2016) were derived using ANPR data supplied by Greater Manchester Police. The fleet mix for forecast years is estimated using a 'roll-over' model to adjust base year vehicle composition for the projected fleet. The approach keeps the vehicle age constant for any given future year (e.g. 2021), and then re-calculates the Euro standard at this point in time. The method conserves the age distribution of the vehicle population for each vehicle/fuel type, to produce the fleet mix for the future year based on this constant distribution the fleet mix. An ANPR survey taken during 2019 was used to cross-check the rate of fleet renewal which demonstrated that the approach used in 2016 and projected forwards was robust. Therefore, the 2016 GMP ANPR analysis has not been altered.

4.1.4 Petrol/diesel splits for forecast years were estimated using JAQU guidance, making use of information about the ratios of petrol and diesel powered vehicles in the base year (calculated from ANPR data) and assumptions that vehicle splits by fuel type would change at the same rate as the national fleet. (Further details of these procedures are available in Note 15: Implications of the EFT update for the GM CAP).

4.2 Updates to the Emission Factor Toolkit

4.2.1 The road traffic emission rates and petrol\diesel splits for input to EMIGMA have been updated using information from version 9.1.a of the EFT, released May 2019. 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 the 2023 do-minimum OBC forecast by approximately 2%. This varies, however, depending on the vehicle mix on each road. There is also a secondary effect as petrol cars have lower f-$NO_2$ than diesel cars, which further reduces final $NO_2$ concentrations.

## 5 Updates to Dispersion Model

5.1 There have been no alterations to the dispersion modelling process since OBC.

## 6 Update to AQ Modelling

6.1 There have been no alterations to the air quality modelling (Defra background maps or NOx to $NO_2$ tool or verification) process since the OBC, as previously agreed with JAQU (see Note 15 section 3).

## 7 Summary

7.1 Overall, these updates are considered to better reflect best practice and the more recent evidence which has evolved since the production of the OBC modelling process.