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

Local Plan Air Quality Modelling Report (AQ2)

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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 The Greater Manchester Urban Area Zone is one of 37 zones across the UK where, based on the Department for the Environment, Food and Rural Affairs (Defra) modelling for 2015, annual mean nitrogen dioxide (NO_2) concentrations exceeded the statutory Limit Values set by the European Union (EU) based on the World Health Organisation's air quality guidelines. These EU Limit Values were directly transposed into UK law as part of the Air Quality Standards Regulation 2010, and subsequently the Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019. Of the ten Local Authorities within Greater Manchester (GM), seven are predicted to include road links which exceed the EU limits beyond 2020.

1.1.2 In order to address these exceedances, Defra and the Department for Transport (DfT) has set out an approach to introduce targeted local measures to bring NO_2 concentrations within legal limits, in their Clean Air Zone Framework[1] and the National Plan[2]. The Joint Air Quality Unit (JAQU), comprising teams from Defra and the DfT, has been set up specifically to deliver the National Plan to improve air quality and comply with the EU Limit Value (EU LV) and the equivalent UK Air Quality Objective (AQO). The JAQU guidance documents set out the assessment process and typical measures that an authority should consider to deliver compliance with the NO_2 annual mean AQO of 40 µg/m^3.

1.1.3 Many local authorities across the UK (including eight within GM) have been instructed by JAQU to undertake detailed feasibility studies and develop plans for the implementation of appropriate measures to deliver compliance with the AQO in the 'shortest possible time'. According to the Supreme Court ruling the feasibility study must consider all options which are 'technically feasible' to be delivered in the shortest possible time and at least as quickly as a charged-based Clean Air Zone (CAZ) could. Local authorities need to consider a range of measures, including a charge-based CAZ as required by Government and set out in the JAQU guidance. The charge-based CAZ scenario is to be used as the reference case in terms of timescales and cost, against which other alternative measures are considered. It is the Government's preference that a charge-based CAZ is only implemented if other measures cannot deliver compliance in similar timescales while providing the same value for money.

1.1.4 TfGM is acting on behalf of the Greater Manchester Combined Authority (GMCA) and the ten Greater Manchester Local Authorities to undertake the feasibility study and develop the Greater Manchester Clean Air Plan (GM CAP) to meet the air quality challenge.

1.1.5 As required by JAQU, this AQ2 document sets out the air quality modelling methodology that is and will be used to underpin any air quality modelling for the baseline (2016, 2021, 2023 & 2025) scenario and for the various measures that are proposed to be assessed more thoroughly in order to understand the potential, as a stand-alone measure or part of a package of measures, to achieve the AQO.

1.1.6 This 'Consultation Option' scenario AQ2 document updates the version submitted as part of the Strategic Outline Case (SOC) submission in May 2018, and supports the reporting in the Outline Business Case (OBC) March 2019. Detailed information on the vehicle emission sources at key sites of exceedance in provided in the associated AQ3 technical report.

2 Existing Information and the Source of the Problem

2.1.1 JAQU reported the outputs of the Pollution Climate Mapping (PCM) model in July 2017. This identified that road links operated by local authorities (as opposed to the Strategic Road Network operated by Highways England which are identified separately) in eight of the ten Greater Manchester Local Authorities are projected to be in exceedance of the NO_2 annual mean EU Limit Value of 40 µg/m^3 (the EU Limit Value) in 2020, and five in 2021.

2.1.2 The road links identified are the primary focus of the GM Clean Air Plan and are detailed in Table 1 and Figure 1. These show that whilst on many links, cars (including taxis) and vans are responsible for the vast majority of emissions, there are links with notable contributions from HGVs (Manchester, Tameside & Salford). The main link with a meaningful contribution from buses is in Bury. The data indicates that a range of measures may be necessary to tackle GM's NO_2 concentrations due to the diverse spatial context and differing sources.

Table 1: PCM Model Results for Links in Exceedance of the AQO in 2021

Local authority	Road Name	Census ID	PCM NO_2 concentration (µg/m^3)		
			2015	2020	2021
Bolton MBC	A666	7431	53	43	41
Bury MBC	A58	38354	53	44	41
Manchester CC	A57M	46068	51	43	40
Manchester CC	A57	56370	55	44	42
Manchester CC	A635	70273	53	43	40
Manchester CC	A57M	75243	50	41	39
Manchester CC	A5103	37809	53	44	41
Oldham MBC	A62	36632	49	41	38
Salford CC	A57	36585	51	41	39
Stockport MBC	A34	26352	51	43	40
Stockport MBC	A34	38735	52	43	41
Tameside MBC	A635	99618	56	45	42
Trafford MBC	A56	58022	48	41	38

2.1.3 Table 1 shows that the PCM model predicts significant reductions in NO_2 concentrations between 2015 and 2021, typically by 20% to 25%. Previous versions of Defra's Local Air Quality Management suite of tools, which will form the basis for this feasibility study, have predicted significant year on year reductions which have not been observed in roadside NO_2 monitoring trends, as can be seen in Figure 3. It is therefore possible that the modelling process for the 2020 year may also be optimistic and measured concentrations could prove to be greater than those predicted.

2.1.4 Figure 1 shows the PCM exceedance links spatially, along with the vehicle emissions source apportionment. Figure 2 summarises the local authority NO_2 monitoring and Air Quality Management Area (AQMA) within GM. Further monitoring was deployed in 2018 at the PCM exceedance sites but is not yet suitable for use in the modelling process.

Figure 1: Source Apportionment for GM PCM Exceedance Links Identified in the National Plan for 2021 (based on July '17 information)

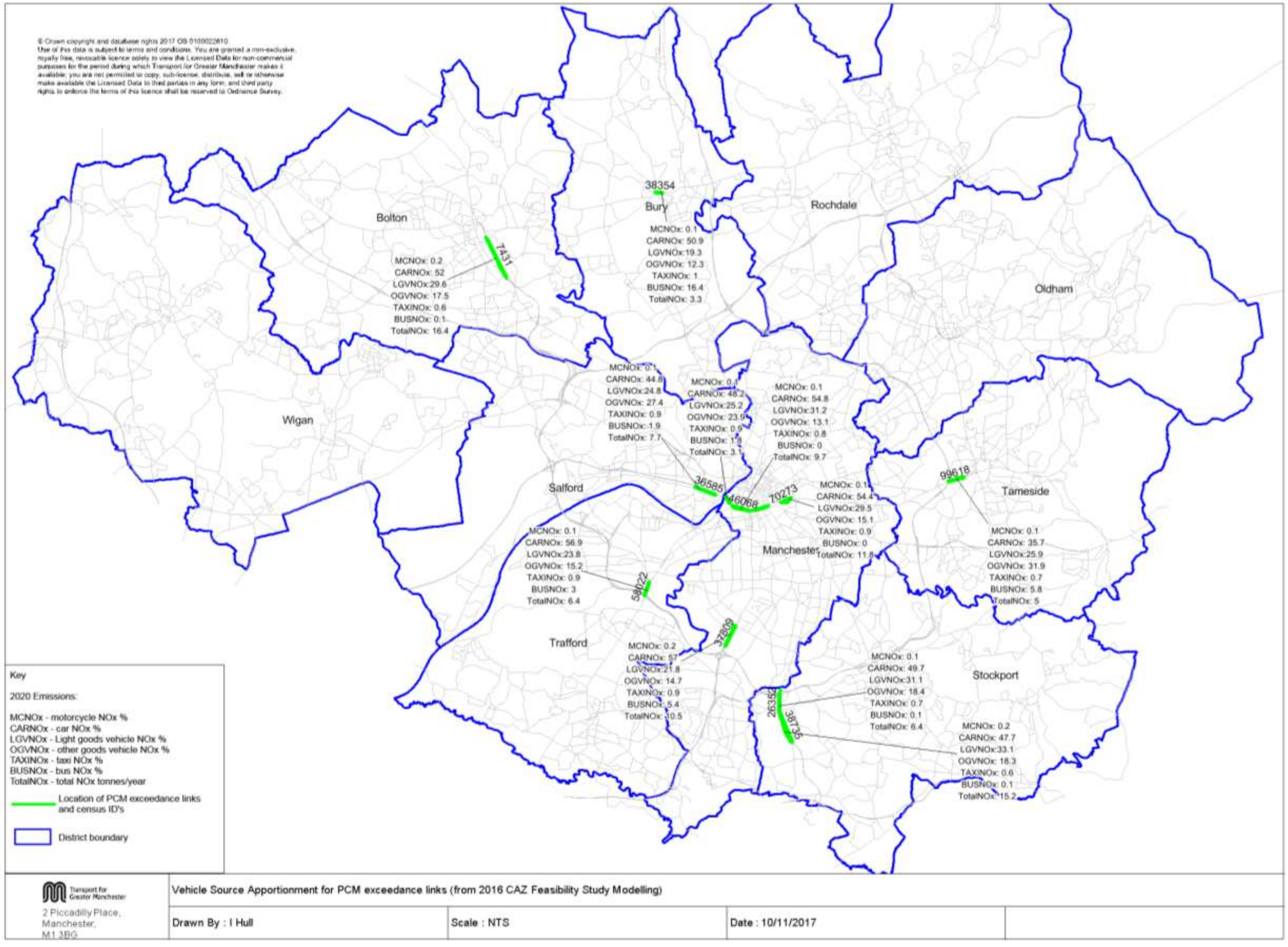
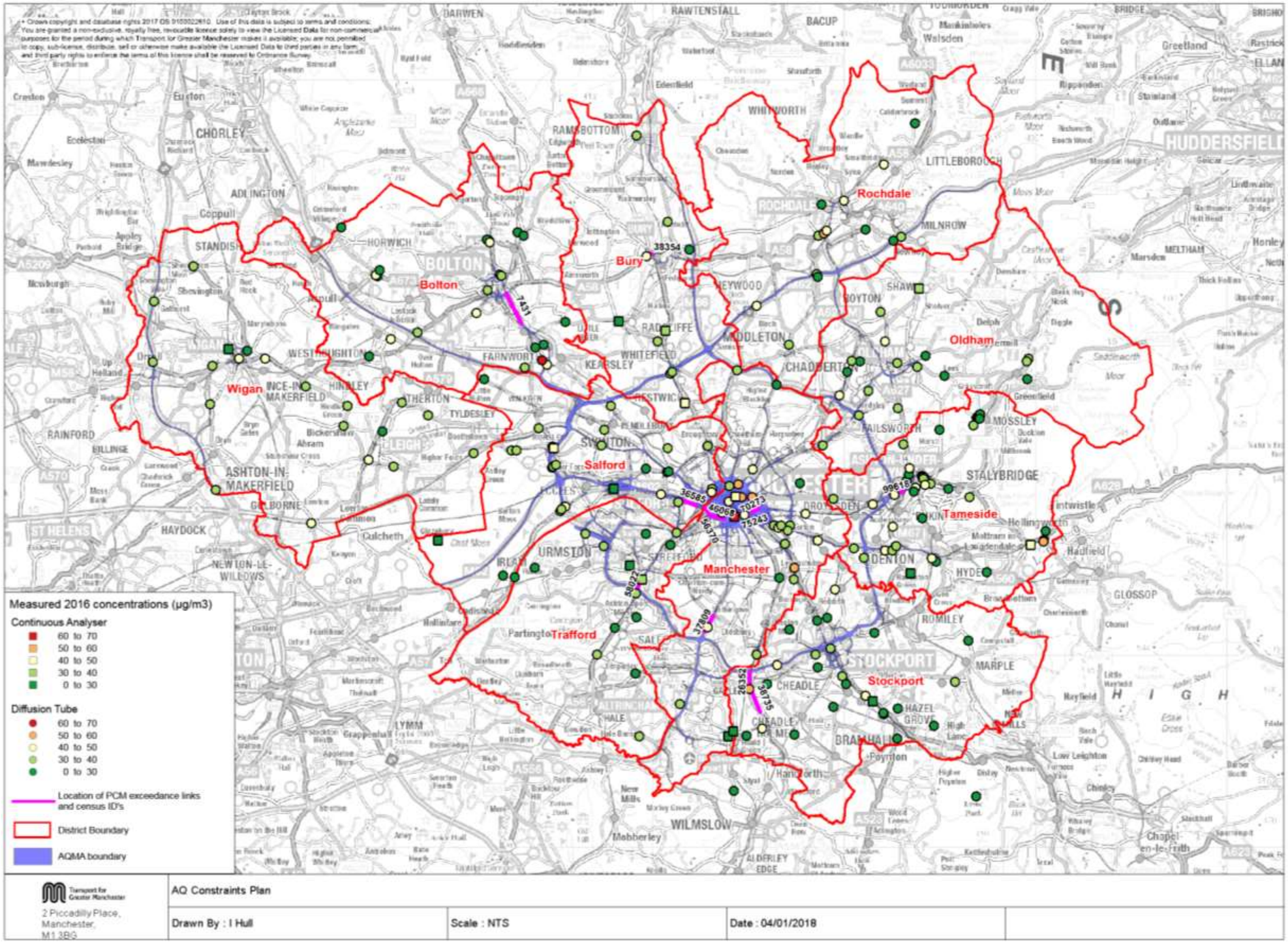


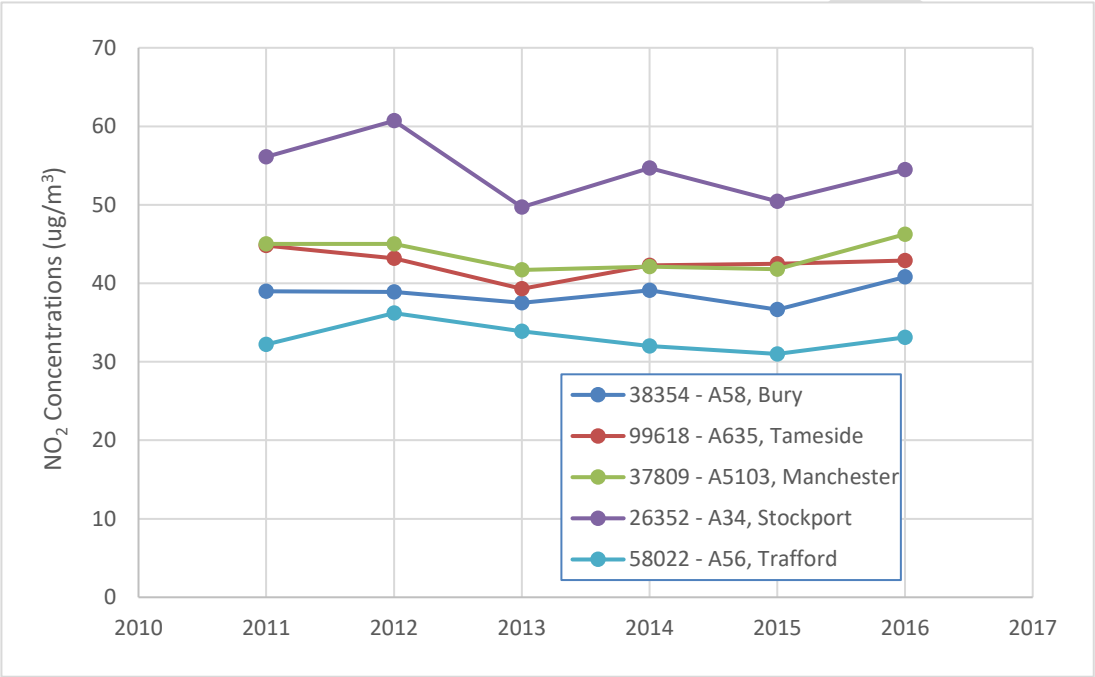
Figure 2: GM Air Quality Constraints Plan



2.1.5 In broad terms, local air quality monitoring and previous modelling for GM supports the conclusions of the PCM model, that there are widespread exceedances of the AQO.

2.1.6 Monitoring data adjacent to PCM exceedance links has been reviewed, and the sites where monitoring is within ~10m of the kerb, and therefore reasonable to compare with the PCM outputs (which are equivalent to 4m from the kerb) is summarised in Figure 3.

Figure 3: GM NO_2 Monitoring Trends at the PCM Exceedance Links



2.1.7 The local monitoring and trend analysis indicates that air quality in these locations is likely to be in exceedance of the NO2 annual mean AQO of 40 ug/m^3 in 2020, although the A56 site is not, however as monitoring is within ~10m of the kerb and the PCM outputs are equivalent to 4m from the kerb the NO_2 values do not fully align. Overall, measured concentrations at these sites appear stable over the last 5 years, with the decreases that would have been predicted by modelling based on the LAQM suite of tools not apparent.

3 Air Quality Modelling

3.1.1 As part of the Evidence Methodology submission, JAQU require the submission of supporting documentation detailing the methodology, including AQ2, 'The Air Quality Methodology', which this report represents.

3.1.2 The Evidence Package sets out that the feasibility study needs to provide robust evidence on the impact of measures, informed by local traffic and air quality models and it contains the minimum technical criteria to supplement the guidance in Defra's Local Air Quality Management Technical Guidance (TG16)[3]. These primarily cover:

- air quality monitoring;
- emission estimation; and
- dispersion modelling.

3.1.3 Each of these are discussed in the following sections. The study area is defined as all links within the traffic model.

3.1.4 Since the production of the modelling for the OBC, there have been a number of updates to best practice tools and datasets. These have led to updates to the modelling of projected future year traffic and vehicle emissions. There have been no updates to the 2016 Base model applied.

3.1.5 However, 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. These methodological updates are described in the relevant sections herein.

Air Quality Monitoring

3.1.6 GM already has an extensive monitoring network of continuous monitors supplemented by diffusion tubes as shown in Figure 2. However, not all of the PCM links discussed in section 1 are covered by the existing monitoring locations. Therefore, additional diffusion tube monitoring is being undertaken, although this cannot be available for the 2016 model verification year.

3.1.7 The use of diffusion tubes is a simple way to screen air quality, and gives a general indication of average pollution concentrations usually over the period of a year, with each tube exposed for period of approximately 4 weeks. They are a type of passive sampler, as they do not involve the pumping of any air; instead the flow is controlled natural diffusion. The diffusion tubes are supplied by Staffordshire Scientific Services. The tubes are prepared using 20% trimethanolamine (TEA) in water.

3.1.8 Diffusion tube monitoring is being carried out at several locations along the exceeding PCM links in Greater Manchester, as well as on major links within 200m of these PCM links, where there could also be exceedances. The diffusion tubes have been positioned on opposite sides of the road to allow for wind direction variability and street canyons where viable.

3.1.9 Technical Guidance Note: Local Air Quality Management (LAQM).TG(16) issued by Defra requires diffusion tubes results to be adjusted for bias against a continuously monitoring NOx analyser and therefore for this study triplicate co-location surveys are being undertaken at the automatic monitoring sites in Trafford (Trafford A56), Stockport (Stockport Hazel Grove), and Bury (Bury Radcliffe). However, GM has used the National NO_2 Diffusion Tube Survey bias adjustment factor for Staffordshire Scientific Services.

3.1.10 Details of all GM monitoring used in the model verification process for 2016 is included in AQ3.

Traffic and Vehicle Emissions Estimation

3.1.11 Traffic data are provided as detailed in the Transport Modelling Reports (T1/2/3/4) for the base year (2016) and the future year (2021/2023/2025) do-minimum and do-somethings for each scenario.

3.1.12 Speed data from the Saturn assignment model periods have been used. Modelled 2016 journey times from the Saturn model have been validated against Trafficmaster data collected during the period September 2013 to August 2014 for a selection of radial/orbital and motorway routes within the county, as described in the Transport Model Validation Report (T2). However, it is recognised that this is a regional transport model, and urban link speeds are an area of uncertainty.

3.1.13 ANPR analysis using Greater Manchester Police (GMP) vehicle class information was used to identify vehicle type and fuel, plus cross referencing with local authority licensing information on buses, and taxis (hackney carriage and private hire).

3.1.14 Fleet projection was undertaken before EFT v8.0.1a, v9.1a or v9.1b were released, which added fleet projection functionality options. Fleet mix projection is based on identifying the date of registration from the licence plate number. These are matched against the date of enforcement of the relevant Euro standard, to develop the Euro standard for that vehicle type. Licence plates from GMP cannot be issued onwards due to Data Protection, and therefore direct matching with the DVLA database was not possible.

3.1.15 The projection 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 approach conserves the age distribution of the vehicle population for each class/fuel, to produce the fleet mix for the future year based on this constant distribution. Details of the derived Euro and fuel fleets splits are provided in T3 for each year.

3.1.16 EFT version 9.1a is being used with the appropriate Euro fleet splits in the Advanced Options to derive emission rates in g/km for non-motorway and motorway type roads for speeds between 5kph and 115kph (at 5 kph intervals) for NOx, PM_{10}, $PM_{2.5}$ and f-NO_2. These derived emission factors are then fed into the EMIGMA model, which is described in more detail in T3, to derive total emissions for each pollutant by link for each modelled scenario. These total emissions were then input into the dispersion model. The outputs of the dispersion model for NOx and f-NO_2 at every monitoring site and receptor will be used to calculate the f-NO_2 ratio for every output location.

3.1.17 Additional project specific ANPR surveys have been undertaken in 2019 at areas of predicted exceedance, and a review of the data against assumptions of age and the projection methodology has been carried out. The results of this analysis are described in the accompanying note 'Note 5 - GM ANPR Surveys: Summary of Initial Findings'. The analysis shows that there are not major differences between observed levels of compliance in the overall GM fleet between the 2016 and 2019 surveys, with the projection methodology described herein applied to the datasets. It did highlight that the passenger car fuel split projections in EFT v8 for increasing diesel uptake were not being realised, and the documented switch to petrol and hybrid battery electric from post 'diesel-gate' car sales was evident. The petrol/diesel fleet mix projections were updated in EFT v9.1a, and these were used in the fleet mix projection process ans compliant/non-compliant fleet splits which is described in more detail in the T2/3 documents and 'Note 15: Implications of the EFT update for the GM CAP'.

ADMS Dispersion Parameters

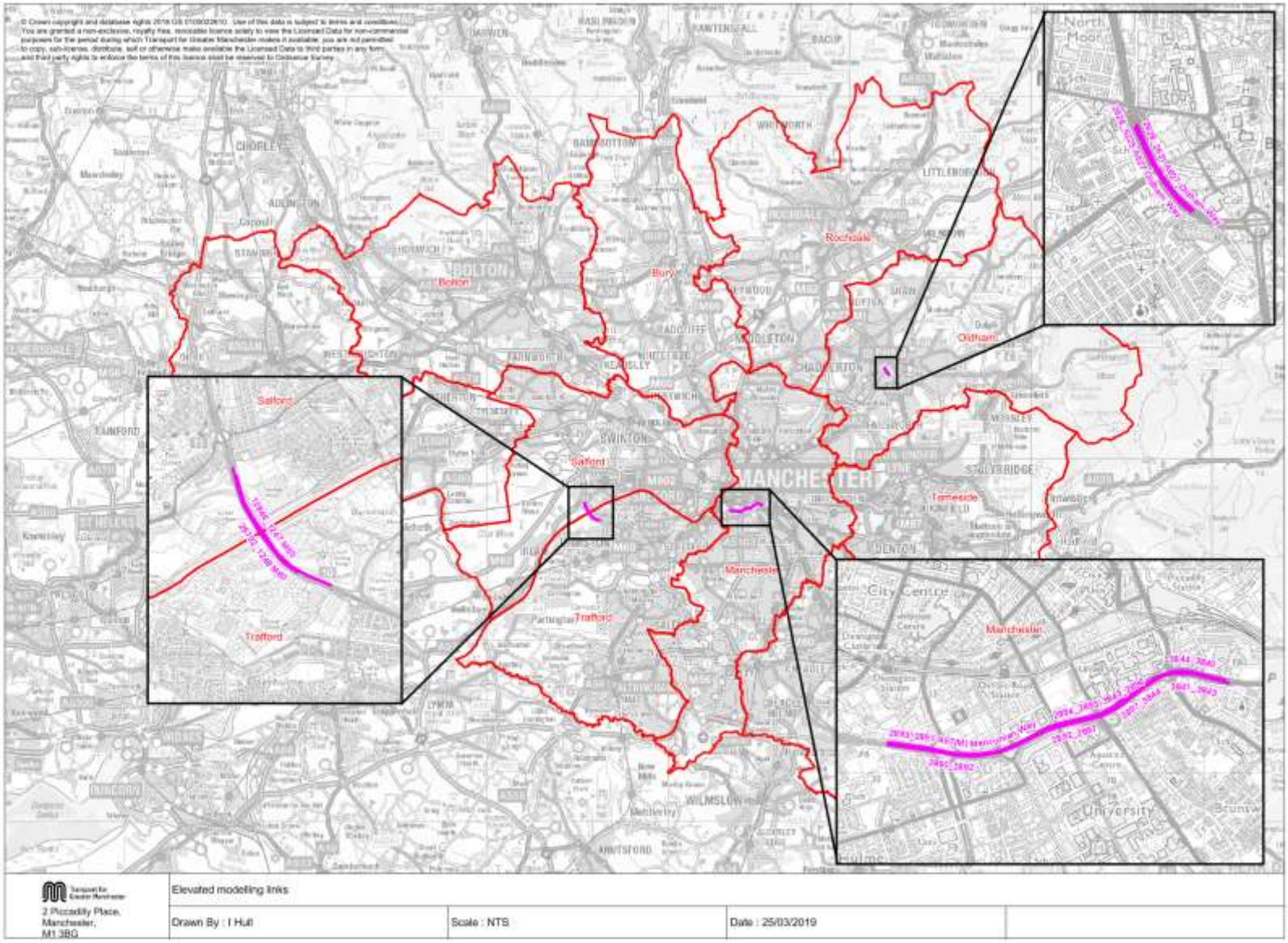
3.1.18 The emission rates for each modelled scenario in EFT will be input into the ADMS-Urban air quality dispersion model (v4.0.1.0), along with hourly meteorological data from Manchester Airport meteorological station for 2016. The meteorological hourly data set includes all key parameters such as wind speed, direction, temperature etc.

3.1.19 Canyon effects are included in the modelling, and the performance of the model was reviewed spatially, see AQ3 for further information on the application of the canyons module.

3.1.20 Significant elevated sections have been included in the model. There are no significant tunnels. Elevated roads included in the modelling are described below, and shown in Figure 4:

- A627, Oldham Way, Oldham
- A57(M), Mancunian Way, Manchester
- M60 Junction 10-11, Salford/Trafford

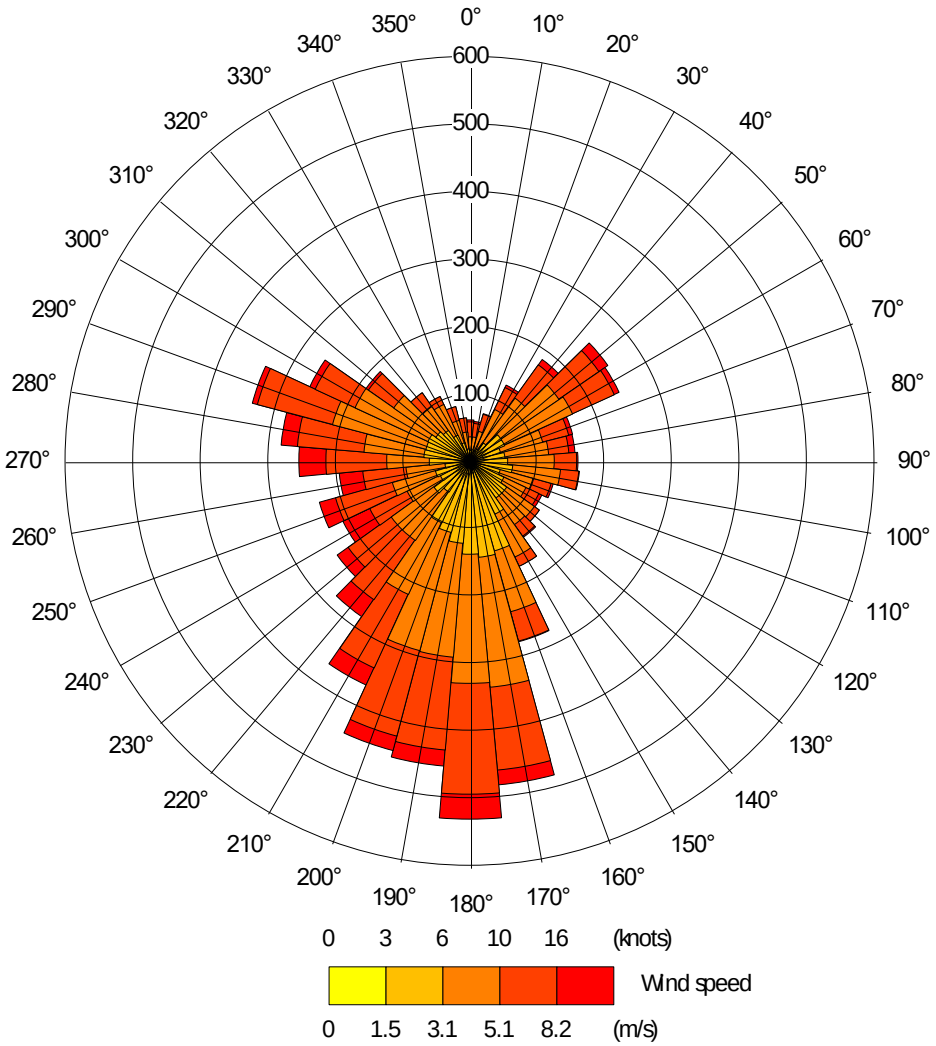
Figure 4: Location of modelled elevated road links



3.1.21 Gradient effects have not been taken into account directly, but local verification has been applied to Mottram. Further refinement of gradients at key points of exceedance may be reviewed during the Final Business Case stage if necessary.

3.1.22 Meteorological data was obtained from Manchester airport, as an hourly sequential dataset was obtained for 2016. Data with null values of 00 was set to -999, which ADMS excludes, this equated to 4% of the dataset. Overall valid data capture was 93%. The data is presented in Figure 5.

Figure 5: Manchester Airport Windrose (2016)



3.1.23 The following model dispersion parameters were applied:

- Minimum Monin-Obukhov length = 30m
- Model domain surface roughness = 0.5m
- Met site surface roughness = 0.3m

3.1.24 The ADMS-Urban modelling will only be used to account for the road contribution to total receptor concentrations, therefore background concentrations (see below) will be added to derive total concentrations.

Defra Background Map Data & NOx Chemistry

3.1.25 Defra 2015 based background maps have been adjusted based on JAQU guidance, by comparing the total NOx and NO_2 with measured values at background monitoring sites for the base year. These adjustment background factors have been applied to the Defra maps for all assessment years.

3.1.26 The NOx background maps have then been processed for each year to have the road contributions sector removed, to avoid double counting, with the exception of the minor road component, and the NO_2 recalculated using the NO_2-Adjustment-for-NOx-Sector-Removal-Tool (v6.0).

3.1.27 The conversion of modelled road NOx to NO_2 has been undertaken using the Defra NOx to NO_2 calculator (v6.1). The dispersion model has used link specific f-NO_2 emissions, modelled as NO2. The modelled annual mean Road NOx and f-NO_2 and background concentrations for each output point then put into the calculator so that a location specific f-NO_2 is applied and NO_2 concentrations calculated.

3.1.28 Since the submission of the original Target Determination datasets, JAQU have released a number of updates to the EFT (v9.0, v9.1a and v9.1b), background maps and NOxtoNO_2 tools.

3.1.29 JAQU's assessment is that the fleet projections in EFT v9.1a represent the best evidence currently available at a national level regarding the future of the vehicle fleet. JAQU have advised that second wave authorities still developing modelling, including GM, can use the updated EFT v9.1a in modelling provided this does not result in any delay to delivery against Ministerial Direction deadlines.

3.1.30 It should be noted that, because JAQU deemed it necessary to provide NO_2 Plan LAs with the latest DfT fleet projections as soon as possible, background maps have not been updated such that they are consistent with these fleet projections (and it is for this reason that EFT v9.1a has not been made publicly available). The latest (2017 base year) background maps are available on the LAQM website, and these maps are consistent with the fleet figures in EFT v9.0, but not v9.1a which accommodates more recent vehicle petrol/diesel split projections which are critical to CAZ modelling. JAQU's assessment is that it is acceptable for NO2 plan LAs to use EFT v9.1a in conjunction with the 2017 base year background maps to calculate total roadside NO_2 concentrations, provided that this is noted as an inconsistency in modelling methodology reports and the analytical assurance statement.

3.1.31 The GM modelling uses the 2015 projection background mapping because the 2017 version wasn't published when the GM modelling commenced. JAQU have confirmed that the guidance with respect to the use of inconsistent background maps/tools with the EFTv9.1 holds for all reference years, including the 2015 version. Furthermore, the 2017 projection background mapping was not produced for a 2016 year dataset, so could not be incorporated into any verification which would have been necessary for its usage in the GM CAP process.

3.1.32 The GM CAP OBC forecasts that compliance cannot be achieved until 2024 in the region. The relatively long forecasting window compared to other cities means that the impact of the trends underpinning the JAQU tools on the reliability of GM's modelling is potentially greater than for many cities developing plans.

Model Verification

3.1.33 The dispersion modelling outputs have been converted to NO_2 and then compared to the monitoring data. The verification process has been applied following guidance in LAQM.TG(16) to adjust Road NOx, with a further adjustment applied to Road NO_2. Full details of the methodology and model performance are provided in AQ3.

Receptors

3.1.34 Receptor locations include upwind and downwind points 4m from carriageway edge (where the public can access). Additional receptors were added in, in line with JAQU guidance for the links identified through the Target Determination process. Receptors were placed at 2m in height. Any receptors within 25m of major junction were be removed. Receptors were also be placed at monitoring site locations to enable calibration and verification of the model.

3.1.35 Additional worst case receptors have also been added for LAQM purposes (e.g. residential, hospitals, schools and care homes), at locations excluded by the PCM process (i.e. close to junctions or on roads excluded from the PCM model). Initial modelling results have been used to identify roads where Target Determination receptors in 2021 are >35ug/m^3. Receptors at junctions of these roads have then been manually selected, based on building usage in Ordnance Survey Address Base+ datasets.

3.1.36 Overall, this resulted in approximately 17,000 receptor points being used for analysis of the OBC phase.

3.1.37 In order to speed up model processing for the Consultation Option phase of assessment, only those sites that were predicted to be >38 ug/m3 in the OBC Do Minimum 2021 have been utilised. This reduces the number of output points reported from ~17,000 to ~2,500.

References

1. Clean Air Zone Framework Principles for Setting Up Clean Air Zones in England, Defra & DfT, May 2017
2. Air quality plan for nitrogen dioxide (NO_2) in UK (2017): UK plan for tackling roadside nitrogen dioxide concentrations, Detailed plan Defra & DfT, July 2017
3. Local Air Quality Management Technical Guidance (TG16) https://laqm.defra.gov.uk/technical-guidance/ Defra, 2018