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

Local Plan Air Quality Modelling Report (AQ2)

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Version Status:	DRAFT FOR APPROVAL	**Prepared by:**	Transport for Greater Manchester on behalf of the 10 Local Authorities of Greater Manchester
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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. Of the ten Local Authorities within GM, seven are predicted 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 EU Limit Value of 40 µg/m^3.

1.1.3 Many local authorities across the UK (including the 8 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 EU Limit Value 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 charge-based clean air zone could. Local authorities need to consider a range of measures, including a charge-based Clean Air Zone (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 a plan to meet the air quality challenge. This 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) 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 EU Limit Value.

1.1.5 This 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 OBC AQ3 technical report.

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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 seven 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. 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 EU Limit Value 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

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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 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 used in the OBC modelling process and has not been finalised at the time of writing.

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

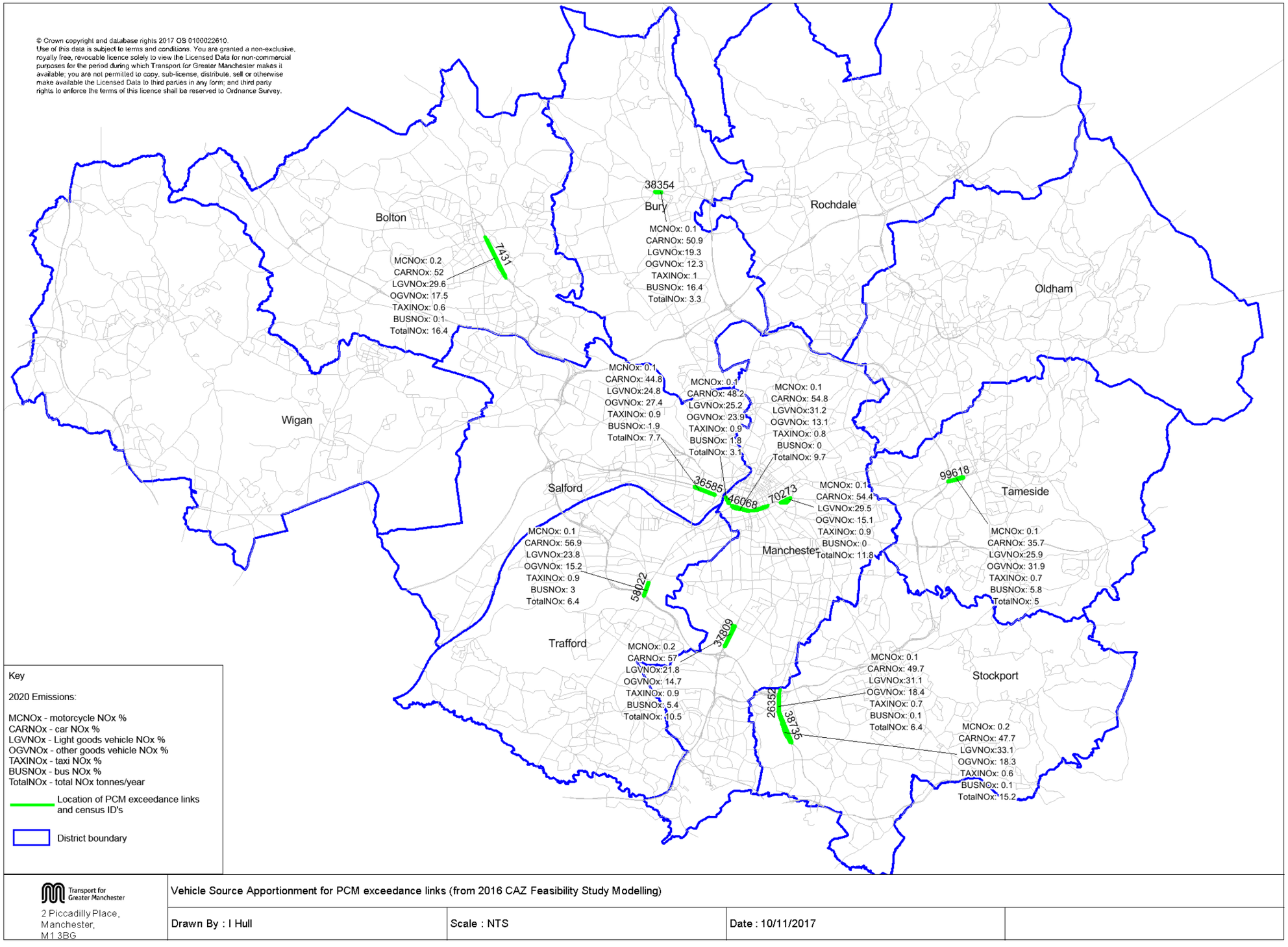
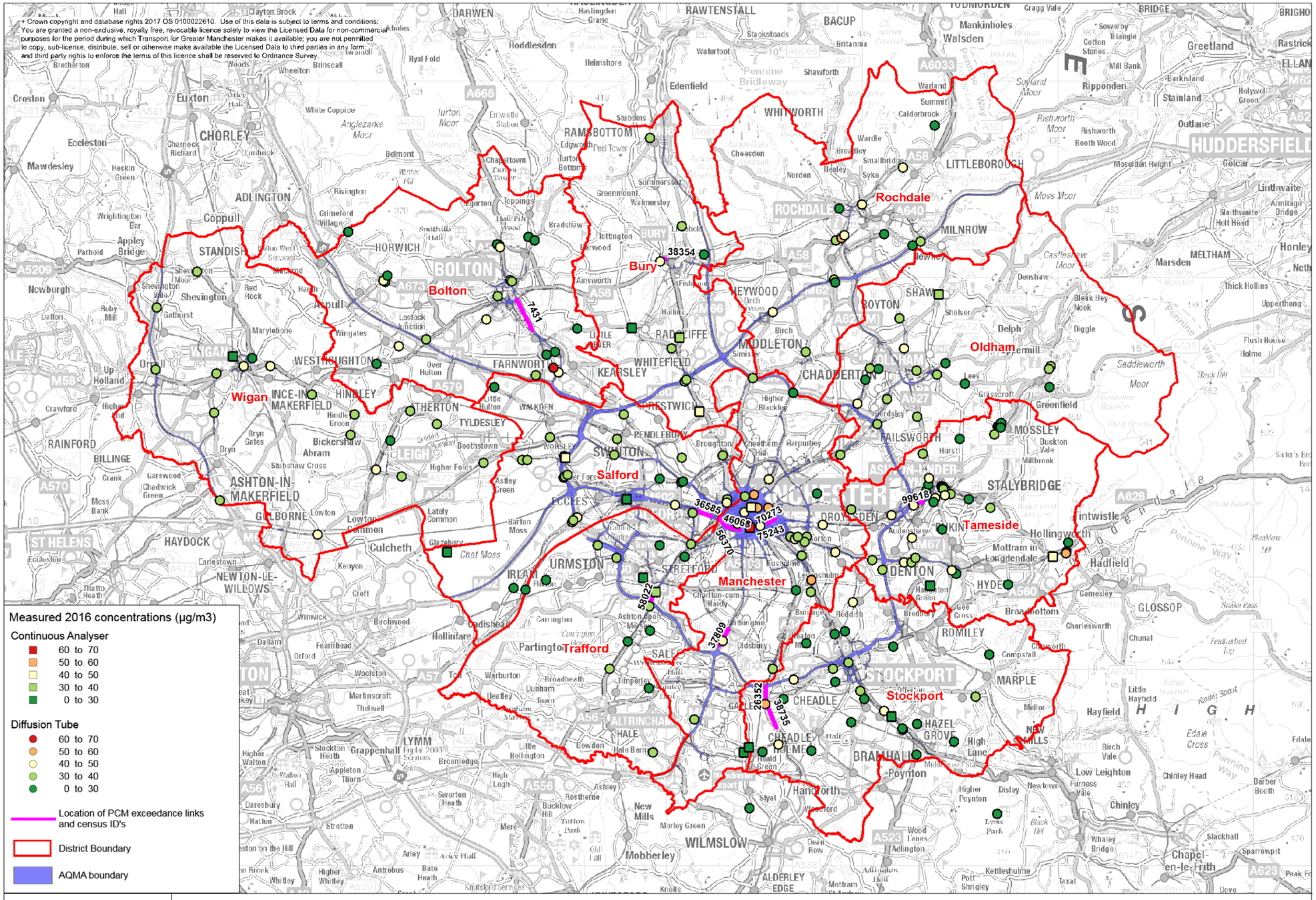


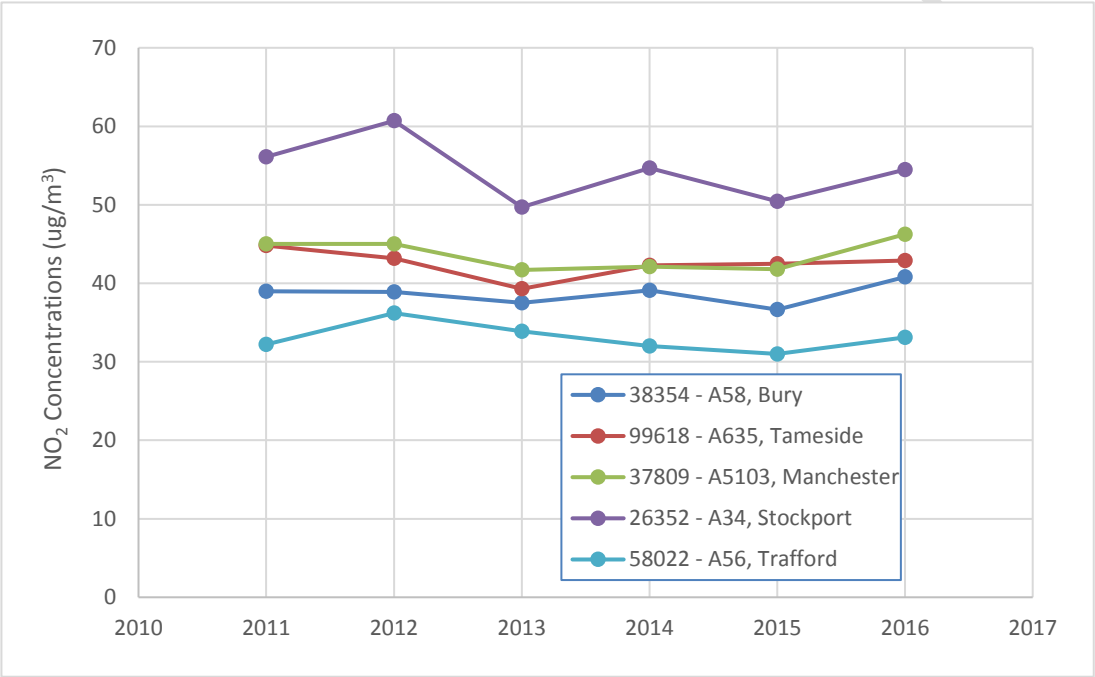
Figure 2: GM Air Quality Constraints Plan



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 EU Limit Value.

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 NO_2 annual mean objective 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 eqiuvalent 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.

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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.

Air Quality Monitoring

3.1.4 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.

3.1.5 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 will be supplied by Staffordshire Highways Laboratory. The tubes will be prepared using 20% trimethylamine (TEA) in water.

3.1.6 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.

3.1.7 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).

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

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Emissions Estimation

3.1.9 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. 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.

3.1.10 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).

3.1.11 Fleet projection was undertaken before EFT8.0.1a was released. 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 is not possible.

3.1.12 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.

3.1.13 Additional project specific ANPR surveys have been undertaken at areas of predicted exceedance, and the data will be reviewed against assumptions of age and projection methodology during the FBC appraisal phase.

3.1.14 EFT version 8.0 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.

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ADMS Dispersion Parameters

3.1.15 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.

3.1.16 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.

3.1.17 Significant elevated sections have been included in the model. Tthere 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

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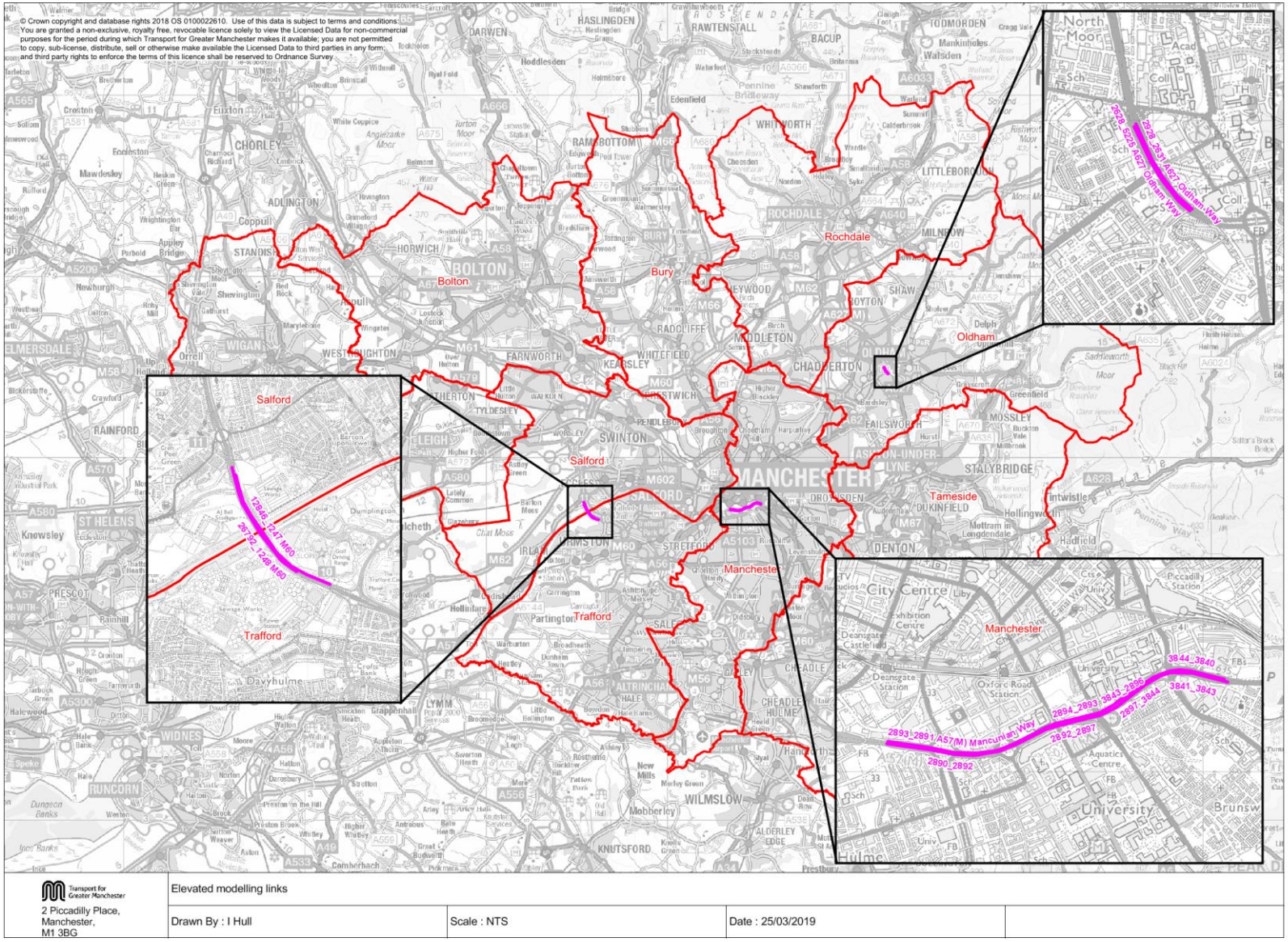
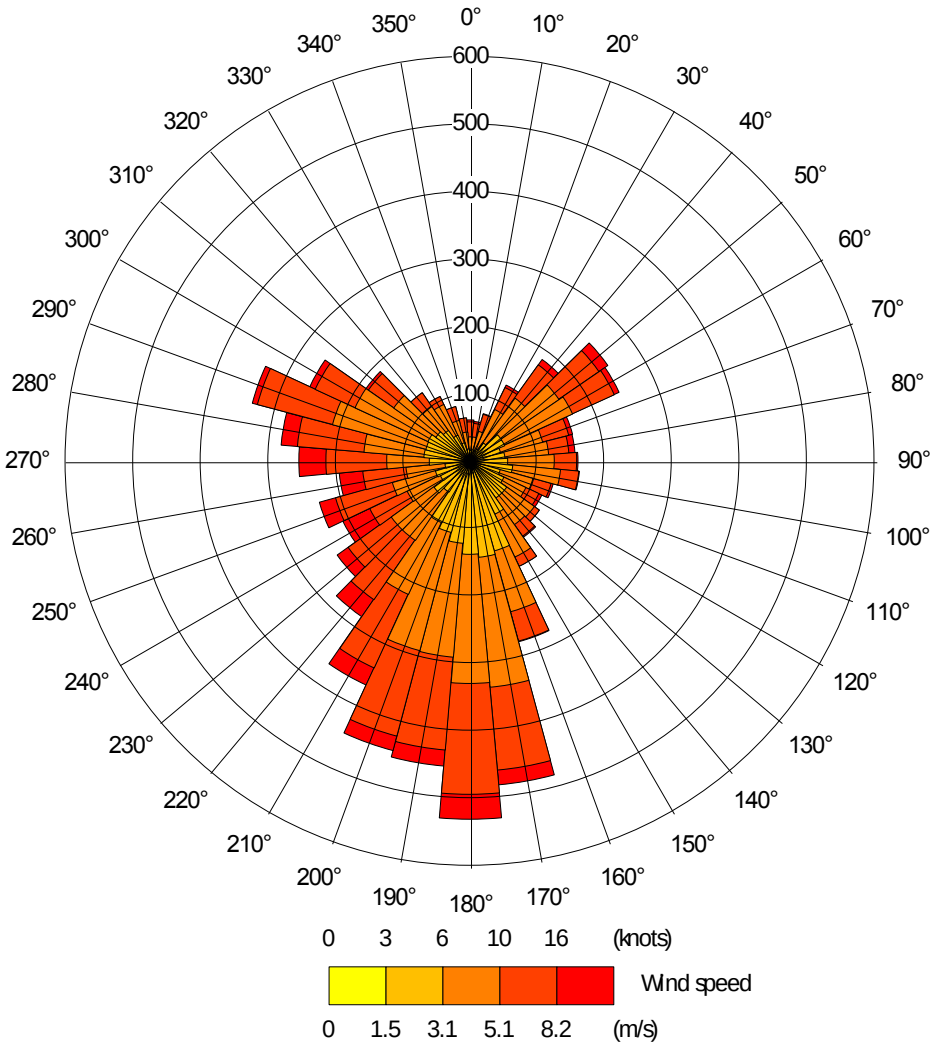
Figure 4: Location of modelled elevated road links



3.1.18 Gradient effects have not be 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.

3.1.19 Meteorological data was obtained from Manchester airport, as an hourly sequential dataset was obtained for 2016. Data with null values of 0^0 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)



3.1.20 The following model dispersion parameters were applied:

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

3.1.21 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.

Background Data

3.1.22 Defra 2015 based background maps will be adjusted based on JAQU guidance, by comparing the total NOx and NO_2 with measured values at background monitoring sites for the base year. This adjustment background factor will be applied to the Defra maps for all assessment years.

3.1.23 The NOx background maps will then be 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).

NOx Chemistry

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

Model Verification

3.1.25 The dispersion modelling outputs will be converted to NO_2 and then compared to the monitoring data. The verification process will be 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

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

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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, 2016

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