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

Local Plan Transport Modelling Methodology Report (T3)

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1 Introduction

1.1.1 This report describes the approach taken to forecast road traffic for the Greater Manchester Clean Air Plan Feasibility Project. The purpose of the report is to describe the development of the future year highway networks and trip matrices and to set out the assumptions on which the forecasts are made.

1.1.2 Initially, the future year models were developed for forecast year of 2021, which represents the expected opening year of the CAP measures. In the course of the study, however, it was decided develop additional models for 2023 and 2025. The purpose of these models was to assist in confirming the year of compliance (with regards to NO2 concentrations) and to help with modelling the phased introduction of a GM-wide CAZ C.

1.1.3 The incremental approach to development of the models is reflected in the structure of this report, which is divided into six sections, as follows:

- Section 2 provides an overview of the CAP project and the models being used in the study
- Section 3 describes the road traffic model
- Section 4 describes the development of the 2021 highway networks
- Section 5 describes the production of the 2021 demand matrices
- Section 6 describes the production of the 2023 and 2025 models

1.1.4 The report should be read in association with the transport model validation (T2) report, which describes the development of the base year highway model, and the transport model forecasting report, (T4), which provides details of the baseline and scenario forecasts, as described in section 2.6.

2 Background

2.1 Overview

2.1.1 In July 2017 the Government published the UK plan for tackling roadside nitrogen dioxide (NO2) concentrations. This set out how the Government would bring UK concentrations of NO2 within the statutory annual limit of 40 micrograms per cubic metre (µg/m3) in the shortest possible time. The plan sets out a number of national and local measures that need to be taken.

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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 NO2 concentrations as soon as possible. A variety of measures are being considered in the study, including the introduction of Clean Air Zones (CAZs), that could include charging as a measure to help achieve compliance. Other measures that are being considered include:

- Improvements to Public Transport, including retrofitting/upgrades to the bus fleet
- Traffic management measures to reduce congestion
- Incentives for taxis to improve the fleet mix
- Measures to support increased walking and cycling.

2.1.3 The CAP study is being undertaken using guidance produced by Defra'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.

2.2 The Modelling Process

2.2.1 At the highest level, the modelling process for producing the GM view on air quality consists of:

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

2.2.2 For future years the forecasts include:

- National changes to the vehicle fleet mix and engine technology, so the air quality improves over time
- Future road and travel demand changes

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2.3 CAZ Interventions

2.3.1 Four different classes of CAZ interventions being considered by Greater Manchester, as illustrated below in Table 2- 1.

Table 2- 1: Clean Air Zone Classes

CAZ Class	Vehicles Included
A	Buses, coaches and taxis
B	Buses, coaches, taxis and heavy goods vehicles (HGVs)
C	Buses, coaches, taxis, HGVs and light goods vehicles (LGVs)
D	Buses, coaches, taxis, HGVs, LGVs and cars

2.3.2 The minimum emission standards for vehicles entering the CAZ's are shown in Table 2- 2.

Table 2- 2: CAZ Emission Standards

Vehicle Type	Euro Standard
Cars/Taxis	Euro 4 (petrol), Euro 6 (diesel)
Light Goods Vehicles	Euro 4 (petrol), Euro 6 (diesel)
Heavy Goods Vehicles	Euro VI
Buses	Euro VI

2.4 Data Sources

2.4.1 The following data is being used in the study:

- Traffic speed and flow data from the highway model
- Information about the vehicle fleet composition in Greater Manchester from Automatic Number Plate Recognition surveys (ANPR) undertaken in 2016
- Road traffic emission factors and national fleet composition data from version 8.0 of DEFRA's Emission Factor Toolkit (EFT)
- 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 for 2015

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2.5 Model Specifications

2.5.1 The modelling system that is being used in the study consists of four components:

- An option sifting tool, which has been developed to allow measures to be tested in a quick and efficient way prior to any detailed assessments being undertaken using the highway and air quality models
- The highway model, 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 DEFRA's emission factor toolkit 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.
- 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.

2.6 Documentation

2.6.1 This report is part of a suite of documents that have been produced to describe the modelling deliverables for the CAP study. Other documents in the series include:

- The 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 base year road traffic model was validated against real-world data
- The Local Plan Air Quality Modelling Methodology Report (AQ2), which provides an overview of the air quality modelling process
- The Local Plan Transport Model Forecasting Report (T4), which describes the overall transport modelling process, and which will include details of the baseline and scenario forecasts and a summary of the key findings for the project, once the modelling is completed.

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3 Overview of the Highway Modelling

3.1 Introduction

3.1.1 The highway modelling is being undertaken for a base year of 2016 and a forecast year of 2021, which represents the anticipated opening year of the final package of CAP measures. Additional models have also been developed for 2023 and 2025, to assist in confirming the year of compliance and to help with modelling the phased introduction of a GM-wide CAZ C.

3.1.2 The modelling is being carried out using TfGM's county-wide Saturn model. 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.

3.2 Model Availability

3.2.1 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.

3.3 Overview of the Trafford Park Saturn Model

3.3.1 The Trafford Park Saturn model was developed for a base year of 2013 and forecast years for 2020 and 2035. Separate versions of the model are available for the weekday morning peak, evening peak and average inter-peak hours.

3.3.2 The 2020 highway networks were created by updating the 2013 networks to include all committed highway schemes that it was considered would have an impact on network performance. The most significant schemes that were included in the model are described below in Table 3- 1.

3.3.3 The TPL uncertainty log considered all developments within a reasonable walk of a stop on the new Metrolink line, defined as 800m. Trip growth rates in other parts of the model were based traffic growth forecasts derived from version 6.2 of the Department for Transport' National Trip End Model (NTEM). The modelling undertaken as part of this project has used the existing Trafford Park model uncertainty log, which has not been updated or refreshed.

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3.3.4 The 2020 forecast year matrices for the Trafford Park Saturn model were built in two stages:

- First, development trips were added to the base TPL matrices
- 'Background' growth was then applied to the matrices in a way that ensured that the outturn growth matched NTEM growth forecasts at local authority a district level for zones within Greater Manchester, with the exception Manchester, Salford and Trafford which were combined, as the route of the Metrolink line roughly follows the boundaries of these three districts.

3.3.5 Further information about the Trafford Park Metrolink model is available in References 3 and 4. The Trafford Park uncertainty log is provided in Appendix A of this report.

Table 3- 1: Trafford Park Model 2020 Do-Minimum Highway Scheme Assumptions

Scheme	
1	Western Gateway Infrastructure Scheme (Super WGIS): • New dual carriageway linking the A57 at Barton Aerodrome to Trafford Way and a new bridge over the Manchester Ship Canal east of the M60 • Improvements to the Ellesmere Circle roundabout north of Trafford Boulevard • New links to the M60 at junction 11 • Redesign of the anti-clockwise off-slip at junction 10 of the M60 and a new link road to the junction 10 roundabout from the Part WGIS scheme
2	M60 Junction 8 to M62 Junction 20 Smart Motorways: • Variable speed limits M60 Jn 8-18 • Hard Shoulder running M62 Jn 18-20
3	A6 to Manchester Airport Relief Road, including Airport City Infrastructure (A6MARR/SEMMMS): • 10km of new single and dual carriageway from the A6 near Hazel Grove (south east Stockport), via the 4 kilometres of existing A555 to Manchester Airport and the link road to the M56
4	A556 Knutsford to Bowdon Improvement: • New dual carriageway linking junction 19 of the M6 with the M56 at junction 7
5	Metrolink extension to Ashton-under-Lyne
6	Metrolink extension to Oldham and Rochdale Town centres
7	Metrolink Phase 3B (Chorlton - Manchester Airport)
8	Metrolink Second City Crossing
9	Bus Priority Package (A580, Oxford Rd and Rochdale Rd)
10	Bus lanes on Barton Dock Road

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4 2021 Do-Minimum CAP Network Development

4.1 Introduction

4.1.1 The do minimum models represent what is likely to happen in the absence of the final package of CAP interventions. The 2021 do-minimum model was formed by updating the 2020 do-minimum Trafford Park model as described below.

4.2 Updates to Values of Time and Distance

4.2.1 The values of time and distance, (PPM and PPK), used during the assignments were updated to 2021 values using the latest values of time, GDP growth rates and vehicle operating costs recommended by the DfT for use in the economic appraisals of transport projects in England, based on values derived from the WebTAG data book, July 2017.

4.2.2 The 2021 values of time (pence per minute – PPM) and distance (pence per kilometre – PPK) are shown below in Table 4- 1.

Table 4- 1: 2021 Generalised Cost Parameters (2010 Prices)

Period	User Class	PPM (Pence/Min)	PPK (Pence/km)
AM Peak Hour	Compliant/Non-Compliant Cars	20.50	7.64
	Compliant/Non-Compliant LGVs	22.29	14.36
	Compliant/Non-Compliant OGVs	22.88	54.32
	Compliant/Non-Compliant Taxis	28.21	14.12
Inter-Peak Hour	Compliant/Non-Compliant Cars	19.22	6.96
	Compliant/Non-Compliant LGVs	22.29	13.64
	Compliant/Non-Compliant OGVs	22.88	48.30
	Compliant/Non-Compliant Taxis	28.21	12.81
PM Peak Hour	Compliant/Non-Compliant Cars	19.93	7.11
	Compliant/Non-Compliant LGVs	22.29	14.18
	Compliant/Non-Compliant OGVs	22.88	52.98
	Compliant/Non-Compliant Taxis	28.21	13.80

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4.3 Bus Data

4.3.1 The bus routing data was updated to include up-to-date information about local bus flows based on 2015 services, as coded into the 2016 Saturn networks.

4.3.2 The fleet mix of the bus services (i.e. the percentages of buses that are compliant with different emission standards) was adjusted assuming that the age profile for each service (i.e. the percentage of buses that are x years old) would be unchanged in the future. Adopting this approach, for example, if 5% of the buses for a given service in 2015 were 3 years old (or had been retrofitted to have the emission standard equivalent to a 3 year old bus), then it was assumed that 5% of buses for that service would also be 3 years old in 2021, and would therefore meet the equivalent emission standard for 2018. This allowed an estimate of the proportion of vehicles meeting different Euro standards in the forecast year to be made, based on their age.

5 2021 Do-Minimum Trip Matrix Updates

5.1 Matrix Factoring

5.1.1 The CAP matrix building procedure is illustrated below in Figure 5- 1.

5.1.2 The starting point for the matrix building procedure was the 5 user class demand matrices developed for use with the 2020 Trafford Park model. The 2021 do-minimum matrices were built in three stages:

- First, updated 2020 matrices were formed by applying cell based traffic growth factors calculated from the 2013 and 2020 Trafford Park model matrices to the 2013 post matrix estimation matrices developed in the course of the base year CAP model update. (The aim of this step was to propagate the changes brought about by the matrix estimation process into the 2020 Trafford Park model matrices. The production and calibration of the 2016 highway matrices is described in the T2 Report).
- Next, the adjusted matrices were factored from 2020 to 2021.
- Finally, the matrices were disaggregated to 8 user classes to allow the different vehicle types that might be affected by a charging CAZ to be separately identified in the updated model.

5.1.3 The 2020 car matrices were factored to 2021 using traffic growth factors calculated from the DfT's TEMPro/NTEM Version 7.2 datasets. The growth factors were applied at local authority district level within Greater Manchester, by journey purpose, using Saturn's matrix furnessing procedure. Adjustment factors were also applied at this stage to compensate for differences between trip end forecasts derived from version 6.2 of the national trip end model (which had been used for development of Trafford Park highway model) and those derived from version 7.2 of the NTEM, representing the latest version of the dataset.

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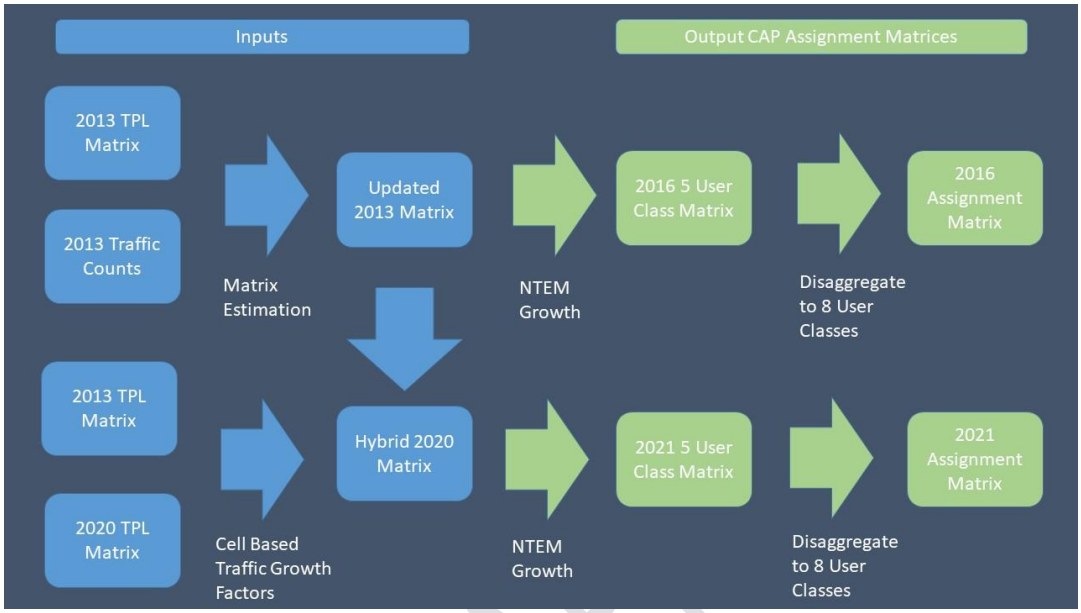
5.1.4 The commercial vehicle matrices adjusted by applying blanket traffic growth factors to the LGV and OGV matrices calculated from the National Transport Model (NTM) for the North West Region between 2020 and 2021.

Figure 5- 1: CAP Matrix Building Procedure



5.2 Matrix Segmentation

5.2.1 The number of user classes in the demand matrices used with the model was expanded to allow the different vehicle types that might be affected by a charging CAZ to be separately identified in the updated CAP model. The disaggregated matrices represented 8 user classes comprising:

- Compliant Car trips
- Non-Compliant Car trips
- Compliant LGV trips
- Non-Compliant LGV trips
- Compliant OGV trips
- Non-Compliant OGV trips
- Compliant (all purpose) Taxi trips
- Non-Compliant (all purpose) Taxi trips

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5.2.2 The matrices were formed in two stages:

- First, taxi matrices were created by applying blanket factors to the car matrices (for trips with an origin or destination inside Greater Manchester) based on the number of taxi trips as a proportion of total car trips calculated from ANPR data collected in 2016 at sites within the county. The estimated taxi trips were then subtracted from the car matrices to avoid any 'double counting'.
- Next, the matrices were disaggregated into compliant and non-compliant vehicle types using information about the local fleet mix also obtained from the ANPR data.

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

5.2.4 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.

5.2.5 The projection approach keeps the vehicle age profile constant for any the 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.

5.2.6 In addition, JAQU guidance on the change in petrol to diesel splits for cars into future years was applied. This involved using JAQU assumptions on the proportions of vehicles that would switch to diesel, and using the ANPR trip frequency information to convert a journey based change (vehicle kilometre equivalent).

5.2.7 Details of the local fleet composition data used in the process (for both 2016 and 2021) are given below in Table 5- 1 and Table 5- 2.

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Table 5- 1: Fleet Composition By Euro Standard for 2016 and 2021

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

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Table 5- 2: Percentage Petrol/Diesel Car Splits By Year

Year	Cars Including Taxis		Cars Excluding Taxis	
	Petrol	Diesel	Petrol	Diesel
2016	50.7%	49.3%	54.1%	45.9%
2021	47.8%	52.2%	51.2%	48.8%

Demand Matrix Growth

5.2.8 Table 5- 3 compares traffic growth between 2016 and 2021 from the demand matrices with NTEM Version 7.2 growth by time period for all purpose car trips. The comparisons are presented at local authority district level within the county, although the figures for Manchester, Salford and Trafford have been combined as was the case during the development of the Trafford Park highway model demand matrices.

5.2.9 The results show that there is a good agreement between the demand matrix growth and the background growth calculated from NTEM, although the overall modelled growth in the inter-peak period is slightly higher than the NTEM forecast. This is due to spatial changes in the distribution of trips in the base year matrices brought about by the matrix estimation process described earlier, but also reflects the impacts of the variable demand modelling that was carried out for the Trafford Park model, and the adjustments that were made to its reference case matrices to reflect changes in generalised cost between the base and forecast year.

5.2.10 Table 5- 4 shows trip totals from the 2016 base and 2021 do-minimum forecast demand matrices broken down by user class for trips with an origin or destination inside Greater Manchester. (This information is also presented graphically in Figure 6- 2). The table shows that 46% of cars trips in 2016 are made in compliant vehicles, with only 2% of LGV trips being compliant, reflecting the increased 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.

5.2.11 The equivalent figures for 2021 show that 78% of car trips are made by compliant vehicles in the forecast year, as older more polluting vehicles are replaced by newer/cleaner models as the age profile of the vehicle fleet changes over time. Approximately 74% of vehicles in total are forecast to be compliant in the 2021 do-minimum model.

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Table 5- 3: Comparisons of Modelled Versus NTEM Growth for Car Trips between 2016 and 2021 (All Purposes, Car Driver plus Passenger, Origins Plus Destinations)

District(s)	AM Peak		Inter-Peak		PM Peak	
	Modelled	NTEM	Modelled	NTEM	Modelled	NTEM
Bolton	1.08	1.06	1.08	1.06	1.07	1.05
Bury	1.06	1.05	1.07	1.05	1.05	1.05
Manchester/ Salford/ Trafford	1.06	1.07	1.08	1.07	1.07	1.07
Oldham	1.06	1.06	1.07	1.06	1.05	1.05
Rochdale	1.07	1.06	1.07	1.06	1.07	1.06
Stockport	1.06	1.05	1.06	1.05	1.05	1.04
Tameside	1.07	1.06	1.08	1.06	1.06	1.05
Wigan	1.07	1.06	1.08	1.06	1.06	1.06
GM	1.06	1.06	1.08	1.06	1.06	1.06

Table 5- 4: 2016 and 2021 Do-Minimum Matrix Totals (PCUs)

Vehicle Type	2016 Base					
	AM Peak		Inter-Peak		PM Peak	
	Trips	%	Trips	%	Trips	%
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		259,801		325,449	
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		40,844		35,468	
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		20,850		9,396	
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		18,955		23,745	

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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		340,450		394,058	
Vehicle Type	**2021 Do-Minimum Forecast**					
	AM Peak		**Inter-Peak**		**PM Peak**	
	Trips	**%**	**Trips**	**%**	**Trips**	**%**
Compliant Car	265,956	78.2%	220,025	78.2%	271,873	78.2%
Non-Compliant Car	74,141	21.8%	61,337	21.8%	75,791	21.8%
All Car	340,097		281,362		347,664	
Compliant LGV	29,042	57.8%	28,071	57.8%	24,386	57.8%
Non-Compliant LGV	21,204	42.2%	20,495	42.2%	17,804	42.2%
All LGV	50,246		48,565		42,190	
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		21,604		9,738	
Compliant Taxi	14,392	58.0%	11,907	58.0%	14,712	58.0%
Non-Compliant Taxi	10,422	42.0%	8,622	42.0%	10,654	42.0%
All Taxi	24,814		20,529		25,366	
All Compliant	323,552	74.4%	275,363	74.0%	317,895	74.8%
All Non-Compliant	111,523	25.6%	96,697	26.0%	107,063	25.2%
All Vehicle	435,075		372,060		424,958	

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6 Development of the 2023 and 2025 Models

6.1 Introduction

6.1.1 The 2023 and 2025 models were developed to assist in confirming the year of compliance (with regards to NO2 concentrations) and to help with modelling the phased introduction of a GM-wide CAZ C. The development of the do-minimum models is described in the following sections:

- Section 6.2 summarises the development of the forecast year networks
- Section 6.3 summarises the development of the demand matrices

6.1.2 For brevity, both models are referred to as the future year models in the remainder of the text.

6.2 Network Development

6.2.1 The future year networks were formed by updating the 2021 CAP networks to:

- Update the values of time and distance used during the assignments
- Update the fleet mix of the bus routing data
- Include highway schemes that are due to be constructed between 2021 and 2025

6.2.2 The future year values of time and distance are shown below in Table 6- 1.

6.2.3 The procedure for updating the bus routing data was the same as that adopted for the 2021 networks, based on the assumption that the age profile of each service would remain unchanged in the future.

6.2.4 The schemes for inclusion in the future year networks are shown below in Table 6- 2. The schemes were identified by comparing the road schemes that were included in the 2021 CAP highway model with schemes that were included in the 2025 model developed by TfGM for the appraisal of the Metrolink extension to Manchester Airport Terminal 2. Schemes that were considered to be near certain, more than likely or reasonably foreseeable that were included in the Airport model but which had not been included in the 2021 CAP model were added into the updated 2025 CAP networks.

6.2.5 It was decided as part of this process to also include all of the 2025 schemes in the 2023 networks, to ensure that both networks were topologically the same. This approach was adopted to avoid having to update the road width and street canyon files that had been developed for use with the 2025 dispersion model, which would have been time-consuming and could have delayed the project. This will, however, need to be addressed before the preparation of the Full Business Case.

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Table 6- 1: 2023 and 2025 Generalised Cost Parameters (2010 Prices)

Period	User Class	2023		2025	
		PPM	PPK	PPM	PPK
AM Peak Hour	Cars	21.15	7.58	21.88	7.54
	LGVs	22.86	14.37	23.51	14.38
	OGVs	23.61	55.78	24.43	57.23
	Taxis	29.10	14.04	30.11	13.97
Inter-Peak Hour	Cars	19.83	6.89	20.52	6.83
	LGVs	22.86	13.64	23.51	13.65
	OGVs	23.61	49.59	24.43	50.89
	Taxis	29.10	12.71	30.11	12.62
PM Peak Hour	Cars	20.56	7.03	21.27	6.96
	LGVs	22.86	14.18	23.51	14.19
	OGVs	23.61	54.40	24.43	55.82
	Taxis	29.10	13.70	30.11	13.61
Notes: The same PPM/PPK values are used for both compliant and non-compliant vehicle types.					

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Table 6- 2: 2025 Highway Scheme Assumptions

1	M60 J13 and A572 Leigh Rd improvements
2	Manchester Airport Rainbow Works
3	M60 Junction 24-27 and Junction 1-4 Managed Motorway
4	MSIRR Regent Road/Water Street improvements
5	Stockport Town Centre Access Plan
6	A6 to Manchester Airport Relief Road, including Airport City Infrastructure and Poynton Bypass
7	Metrolink to Trafford Centre
8	A49 Wigan Gateway
9	A58 Wigan Gateway
10	Bolton Salford Quality Bus Network
11	MSIRR Great Ancoats Street improvements
12	M62 Junction 19 improvements (South Heywood)
13	M56 Junction 5 to 8 Smart Motorway improvement
14	M62 Junction 10-12 Smart Motorway improvement
15	Simister Island
16	Denton Island
17	Carrington A1 Link

6.3 Matrix Development

6.3.1 The car matrix building procedure is illustrated below in Figure 6- 1.

6.3.2 The starting point for the matrix build was the 2021 demand matrices described in section 5. The updated matrices were built in three stages

- First, cell based demand changes were calculated using information form the 2014 and 2025 highway matrices developed for use with the most recent version of the Greater Manchester Variable Demand Model (GMVDM). Demand changes for intervening years were then calculated by interpolation, and added to the 5 user class versions of the 2021 do-minimum CAP matrices
- Next, adjustment factors were applied to ensure that the outturn growth matched NTEM 7.2 growth forecasts. The adjustment factors were applied at local authority district level within Greater Manchester, by journey purpose, using Saturn's matrix furnessing procedure.

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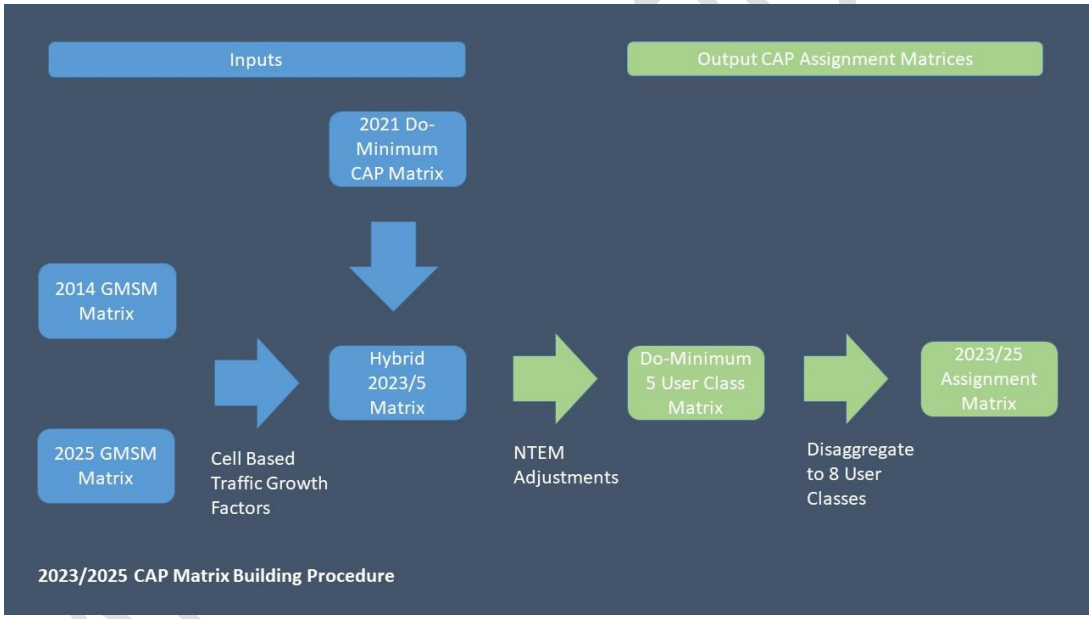
- Finally, the matrices were disaggregated to 8 user classes so that the different vehicle types represented in the CAP model could be separately identified.

6.3.3 The commercial vehicle matrices were formed by applying blanket traffic growth factors to the 2021 LGV and OGV matrices, as calculated from the National Transport model (NTM) for the North West Region.

6.3.4 The main advantage of using the GMVDM matrices to calculate the demand changes described above was that these matrices included early estimates of GMSF (Greater Manchester Spatial Framework) growth, which were not available at the time that the 2021 CAP matrices were developed. It needs to be born in mind, however, that the GMSF is still open to consultation and will be subject to uncertainty. Overall traffic growth has also been constrained to NTEM forecasts.

Figure 6- 1: 2023/2025 CAP Matrix Building Procedure



Matrix Segmentation

6.3.5 The 8 user class assignment matrices (representing compliant and non-compliant car, LGV, OGV and Taxi trips) were formed using the same approach as that adopted for use with the 2021 matrices, as described in Section 5. This involved two steps:

- First, taxi matrices were created by applying blanket factors to the all purpose car matrices as described earlier
- Next, the matrices were disaggregated into compliant and non-compliant vehicle types using information about the local fleet composition obtained from ANPR data, suitably adjusted to reflect the forecast change in the fleet mix over time.

6.3.6 Details of the fleet composition data used in the process are shown below in Table 6- 3 and Table 6- 4

Demand Summaries

6.3.7 Table 6- 5 and Table 6- 6 compare traffic growth between 2021 and 2023/2025 from the CAP demand matrices with NTEM growth by time period for all purpose car trips. The results show that the NTEM targets have been achieved in all cases.

6.3.8 Table 6- 7shows trip totals from the 2023 and 2025 do-minimum matrices broken down by user class for trips with an origin or destination inside Greater Manchester. (The proportions of compliant vehicles are also shown in Figure 6- 2, for years 2016, 2021, 2023 and 2025). The results show that 85% of cars trips in 2023 are forecast to be made in compliant vehicles, with approximately two thirds of LGV trips in 2023 being compliant. The equivalent figures for do-minimum OGV and taxi trips in 2023 are 82% and 78% respectively, with approximately 83% of vehicles overall being compliant.

6.3.9 The corresponding figures for 2025 show that 92% of car trips are made in compliant vehicles in this forecast year, with approximately 90% of vehicles in total being compliant in the do-minimum model.

Figure 6- 2: Proportions of Compliant Vehicles by Year

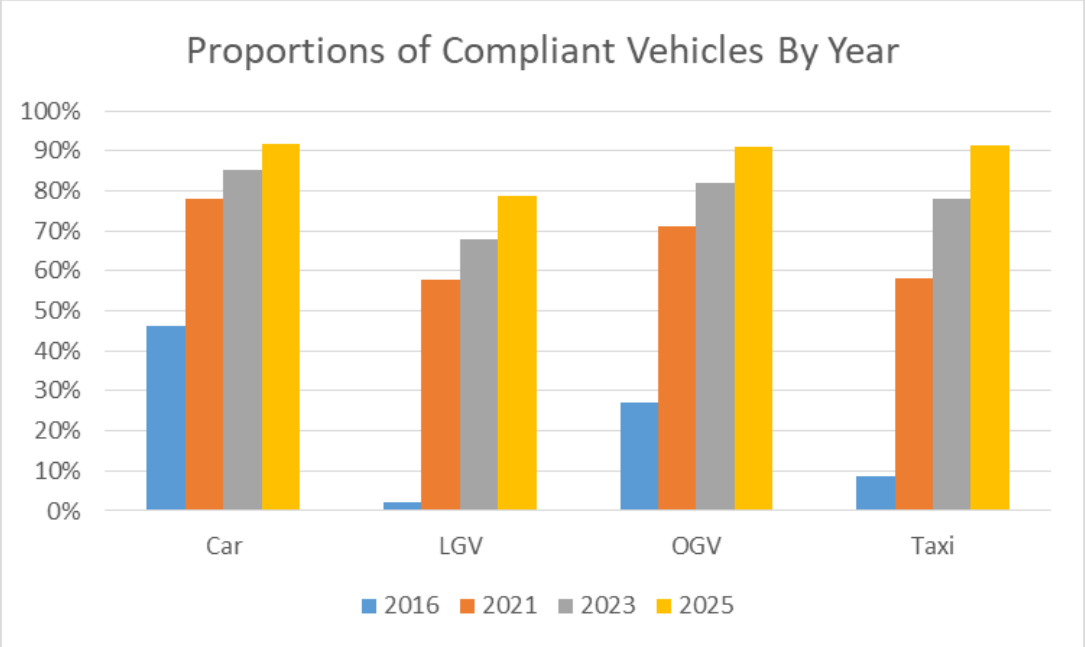


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Table 6- 3: 2023 and 2025 Fleet Composition By Euro Standard

Euro Standard	2023 Do-Minimum								2025 Do-Minimum Forecast							
	Petrol Car	Diesel Car	Petrol Taxi	Diesel Taxi	Petrol LGV	Diesel LGV	Diesel HGV	Diesel Bus	Petrol Car	Diesel Car	Petrol Taxi	Diesel Taxi	Petrol LGV	Diesel LGV	Diesel HGV	Diesel Bus
Pre-Euro	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	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%	0.0%	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%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Euro 3	0.9%	0.7%	0.3%	0.2%	0.0%	0.3%	0.9%	0.6%	0.7%	0.6%	0.3%	0.1%	0.0%	0.3%	0.4%	0.4%
Euro 4	12.4%	4.4%	4.1%	1.3%	0.0%	6.8%	1.9%	3.8%	4.4%	1.8%	2.6%	0.4%	0.0%	1.5%	1.2%	1.1%
Euro 5	33.5%	21.8%	22.2%	20.8%	0.0%	24.9%	14.8%	11.6%	27.4%	13.6%	8.4%	8.3%	0.0%	19.3%	7.1%	5.5%
Euro 6	12.5%	11.6%	19.1%	20.2%	0.0%	10.1%	82.1%	83.9%	14.5%	11.1%	15.2%	13.4%	0.0%	11.0%	91.2%	93.0%
Euro 6c	40.4%	23.2%	54.3%	36.0%	0.0%	27.3%	0.0%	0.0%	52.9%	18.3%	73.4%	33.1%	0.0%	17.8%	0.0%	0.0%
Euro 6d	0.0%	38.2%	0.0%	21.6%	0.0%	30.4%	0.0%	0.0%	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 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

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Table 6- 4: 2023 and 2025 Percentage Petrol/Diesel Car Splits

Year	Cars Including Taxis		Cars Excluding Taxis	
	Petrol	Diesel	Petrol	Diesel
2023	48.6%	51.4%	52.0%	48.0%
2025	50.2%	49.8%	53.6%	46.4%

Table 6- 5: Comparisons of Modelled Versus NTEM Growth for Car Trips between 2021 and 2023 (All Purposes, Car Driver Plus Passenger, Origins Plus Destinations)

District(s)	AM Peak		Inter-Peak		PM Peak	
	Modelled	NTEM	Modelled	NTEM	Modelled	NTEM
Bolton	1.01	1.01	1.01	1.01	1.01	1.01
Bury	1.01	1.01	1.01	1.01	1.01	1.01
Manchester/ Salford/ Trafford	1.02	1.02	1.02	1.02	1.02	1.02
Oldham	1.01	1.01	1.01	1.01	1.01	1.01
Rochdale	1.01	1.01	1.01	1.01	1.01	1.01
Stockport	1.01	1.01	1.01	1.01	1.01	1.01
Tameside	1.01	1.01	1.02	1.02	1.01	1.01
Wigan	1.01	1.01	1.01	1.01	1.01	1.01
GM	1.01	1.01	1.01	1.01	1.01	1.01

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Table 6- 6: Comparisons of Modelled Versus NTEM Growth for Car Trips between 2021 and 2025 (All Purposes, Car Driver Plus Passenger, Origins Plus Destinations)

District(s)	AM Peak		Inter-Peak		PM Peak	
	Modelled	NTEM	Modelled	NTEM	Modelled	NTEM
Bolton	1.02	1.02	1.03	1.03	1.02	1.02
Bury	1.02	1.02	1.03	1.03	1.02	1.02
Manchester/ Salford/ Trafford	1.03	1.03	1.03	1.03	1.03	1.03
Oldham	1.02	1.02	1.03	1.03	1.02	1.02
Rochdale	1.02	1.02	1.02	1.02	1.02	1.02
Stockport	1.02	1.02	1.02	1.03	1.02	1.02
Tameside	1.03	1.03	1.03	1.03	1.03	1.03
Wigan	1.02	1.02	1.03	1.03	1.02	1.02
GM	1.03	1.03	1.03	1.03	1.03	1.03

Table 6- 7: 2023 and 2025 Do-Minimum Matrix Totals (PCUs)

Vehicle Type	2023					
	AM Peak		Inter-Peak		PM Peak	
	Trips	%	Trips	%	Trips	%
Compliant Car	294,699	85.4%	244,172	85.4%	301,401	85.4%
Non-Compliant Car	50,380	14.6%	41,740	14.6%	51,526	14.6%
All Car	345,079		285,912		352,927	
Compliant LGV	35,634	67.9%	34,462	67.9%	29,920	67.9%
Non-Compliant LGV	16,844	32.1%	16,288	32.1%	14,142	32.1%
All LGV	52,478		50,750		44,062	
Compliant OGV	16,580	82.1%	17,979	82.1%	8,100	82.1%
Non-Compliant OGV	3,613	17.9%	3,918	17.9%	1,765	17.9%
All OGV	20,194		21,897		9,864	
Compliant Taxi	19,579	78.1%	16,235	78.1%	20,027	78.1%
Non-Compliant Taxi	5,485	21.9%	4,546	21.9%	5,610	21.9%
All Taxi	25,064		20,780		25,636	

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All Compliant	366,493	82.8%	312,848	82.5%	359,447	83.1%
All Non-Compliant	76,322	17.2%	66,493	17.5%	73,042	16.9%
All Vehicle	442,814		379,340		432,489	
Vehicle Type	**2025**					
	AM Peak		**Inter-Peak**		**PM Peak**	
	Trips	**%**	**Trips**	**Trips**	**%**	**Trips**
Compliant Car	320,490	91.6%	265,995	91.6%	327,666	91.6%
Non-Compliant Car	29,389	8.4%	24,391	8.4%	30,048	8.4%
All Car	349,879		290,386		357,714	
Compliant LGV	43,169	78.9%	41,769	78.9%	36,244	78.9%
Non-Compliant LGV	11,542	21.1%	11,167	21.1%	9,690	21.1%
All LGV	54,711		52,935		45,934	
Compliant OGV	18,669	91.2%	20,240	91.2%	9,114	91.2%
Non-Compliant OGV	1,799	8.8%	1,951	8.8%	878	8.8%
All OGV	20,469		22,191		9,992	
Compliant Taxi	23,267	91.5%	19,315	91.5%	23,763	91.5%
Non-Compliant Taxi	2,158	8.5%	1,790	8.5%	2,203	8.5%
All Taxi	25,425		21,105		25,967	
All Compliant	405,595	90.0%	347,319	89.8%	396,787	90.3%
All Non-Compliant	44,889	10.0%	39,299	10.2%	42,819	9.7%
All Vehicle	450,483		386,617		439,607	

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References

1. JAQU Inception Package Guidance
   Huddle, October 2017
2. JAQU Transport and Air Quality Evidence
   Huddle, October 2017
3. Trafford Park Metrolink Highway Model Validation Report
   HFAS Report 1806, November 2014
4. Metrolink Trafford Park Line Forecasting Report
   SYSTRA, October 2014

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Glossary of Terms and Abbreviations

	Term or Abbreviation	Explanation
A	ADMS-Urban	Atmospheric Dispersion Modelling System developed by Cambridge Environmental Research Consultants (CERC) to model the dispersion of pollutants from industrial, domestic and road transport sources in urban areas.
	ANPR	Automatic Number Plate Recognition; mass surveillance technique that uses optical character recognition to read the registration plates of vehicles.
B		
C	CAP	Clean Air Plan
	CAZ	Clean Air Zone
D	DfT	Department for Transport
	DEFRA	Department of Environment, Food & Rural Affairs
E	EFT	Emission Factor Toolkit; software developed by DEFRA to assist with calculating road vehicle pollutant emission rates for NOx, PM10, PM2.5 and CO_2 for specified years, road types, vehicle speeds and composition.
	EMIGMA	Emissions Inventory for Greater Manchester; software developed by TfGM to calculate mass road traffic emissions using information about traffic speeds and flows from the county-wide Saturn model and road traffic emission factors and fleet composition data from the EFT.
F		
G	GMSF	Greater Manchester Spatial Framework; Greater Manchester's Plan for the development of Homes, Jobs and the Environment up to 2037.
	GM	Greater Manchester.
	GMBusRoutes	Bus route mapping system which is used to build and check bus service routes within Greater Manchester.
H	HFAS	Highways Forecasting and Analytical Services
I		
J	JAQU	Joint Air Quality Unit; Unit established in 2016 by Defra and the Department for Transport to coordinate delivery of the Government's plans for achieving NO2 compliance
K		

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	Term or Abbreviation	Explanation
L	LGV	Light Goods Vehicle.
M	ME	Matrix Estimation.
N	NTM	National Transport Model; a transport model developed by the DfT to evaluate the national consequences of alternative national transport policies
	NTEM	National Trip End Model; a model developed by the DfT to forecast the growth in trip origin-destinations (or productions-attractions) for use in transport modelling.
O	OD	Origin-Destination.
	OGV	Other Goods Vehicle (i.e. a medium or heavy goods vehicle).
P	PPM/PPK	Monetary values expressed in units of Pence Per Minute and Pence Per Kilometre used in SATURN to convert times and distances into generalised costs for assignment purposes.
	PCU	Passenger Car Unit, a standard unit of traffic used in modelling work; a car or LGV is generally 1 PCU, an OGV is 1.9 PCUs and a bus is 2 PCUs.
Q		
R		
S	Saturn	Simulation and Assignment of Traffic to Urban Road Networks; a commonly used road traffic modelling suite developed by the Institute for Transport Studies at Leeds University which allows the detailed modelling of junctions and their associated delays.
T	TEMPRO	Trip End Model Presentation Program; software developed by the DfT to allow analysis of trip-end, car ownership and population data from the National Trip End Model (NTEM).
U	Updated Matrix	The trip matrix that has been subjected to matrix estimation.
V		
W	WebTAG	Department for Transport website providing guidance on the conduct of transport studies.
X		
Y		
Z		

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Appendix A – Trafford Park Metrolink Uncertainty Log

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