SHEFFIELD AND ROTHERHAM CLEAN AIR ZONE FEASIBILITY STUDY

TRANSPORT MODELLING METHODOLOGY REPORT (T3)

21st June 2019

Sheffield City Council

Rotherham Metropolitan Borough Council

DOCUMENT CONTROL

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1. INTRODUCTION

1.1 Context

1.1.1 The UK Government has named Sheffield and Rotherham as one of 29 areas in England which contains locations where the annual average concentrations of Nitrogen Dioxide (NO_2) exceed statutory limits and are projected to continue to do so over and beyond the next 3-4 years.

1.1.2 The two Councils have therefore been tasked with developing a strategy which will help ensure that their Council areas become compliant with this statutory limit 'in the shortest possible time'.

1.2 Overview of this Document

1.2.1 This document is the Transport Model Methodology Report (T3), which explains in detail how the model will be used to assess the Sheffield and Rotherham CAZ options that have been developed. This report includes a description of:

- The approach taken to forecast traffic in 2021, including the demand growth assumptions used in the forecast, as well as the results of any reviews of local schemes/development plans that have been conducted, including an uncertainty log which provides a clear description of the planning status of local developments;
- How uncertainty was managed in the forecasting, including demand suppression and mode shift;
- How the transport modelling outputs will feed into the air quality modelling; and
- How the distribution of Euro standards within the fleet were forecast.

1.2.2 This report is part of the **Outline Business Case (OBC)** and has been updated with responses to feedback from JAQU. The current version of this report has been written before any scheme assessment has been undertaken. It will be updated and resubmitted as part of the **Full Business Case (FBC)**.

1.3 Model Background and Version

1.3.1 Several alternative strategic transport modelling options were considered by Sheffield City Council (SCC) and Rotherham Metropolitan Borough Council (RMBC) in advance of submitting our proposal to JAQU. The aim was to identify an approach which could deliver the required evidence base that would be as robust as possible, without jeopardising our ability to deliver the study within challenging timescales.

1.3.2 Ultimately it was decided to use the **Sheffield and Rotherham Transport Model (SRTM3B)** to undertake the CAZ modelling work as it was the **best model available** at the point when the modelling work was required.

1.3.3 A new model of the Sheffield City Region (SCRTM1) is currently being developed, which will provide a more up to date modelling platform to asses' schemes in Sheffield and Rotherham. However, that model was still not complete in time for the evidence gathering phase and was not completed in time for use on the development of the OBC. **Therefore, this new SCRTM1 model has not been used in the feasibility study and will not be used for the OBC.**

1.4 Structure of this Document

1.4.1 The remainder of this document is structured as follows

- Section 3 details the forecasting which has been undertaken in the traffic model including the management of uncertainty;
- Section 4 details the link to the Air Quality Model; and
- Section 5 details how the fleet has been forecast.

2. FORECASTING APPROACH

2.1 Introduction

2.1.1 This section describes how future year forecasting has been undertaken using the SRTM3B model. The standard forecasting procedures are the same as those developed for use with SRTM3A, for which forecasts have been produced in the following years:

- 2024; and
- 2034.

2.1.2 We have retained these forecasts years for use in the CAZ study because these are the years for which Sheffield and Rotherham have developed modelling for the Sheffield Local Plan and Uncertainty Logs exist describing the likelihood of future developments and transport schemes being complete (noting that some further checks and amends were made for the CAZ Study).

2.1.3 To obtain the CAZ forecast year of 2021 linear interpolation has been undertaken using the modelled outputs from the 2017 Base and the 2024 forecast.

2.1.4 The remainder of this section describes how the 2024 forecast year was created. It does not consider the 2034 forecast year as this will not be used for the CAZ study.

2.2 Approach to Using the Uncertainty Logs

Supply Side

2.2.1 The "baseline" forecasts made use of the scheme information provided in the Uncertainty Logs as provided by SCC, RMBC and HE (supplied November 2017). In summary, the information contained in the Uncertainty Logs was incorporated into the Baseline models as follows:

- Only Major/Significant highway improvement schemes modelled;
- Major Public Transport schemes modelled (eg. BRT North, Tram-train, additional Supertram vehicles);
- No bus route / timetable changes were modelled since these are not considered to be material;
- Category 1 & 2 Schemes (as defined by DFT as near certain – TAG Unit M4) from the 2024 Sheffield and Rotherham Uncertainty Logs were coded in Baseline Scenario;
- Major committed schemes on the Strategic Road Network (SRN) within the modelled area were coded in 2024 Baseline Scenario; and
- Update of values of time, vehicle operating costs, and PT fares to future year values

2.2.2 Category 3 & 4 (with are hypothetical) Supply Side Schemes from the 2024 Sheffield and Rotherham Uncertainty Logs are not included in the "baseline" forecasts.

Demand Side

2.2.3 The principle behind the Baseline Development Assumptions is to include all development sites within the model boundary covering the Sheffield and Rotherham districts that already have planning permission and are considered "near certain" or "more than likely" to be in place by 2024. This information was obtained from uncertainty logs provided by Sheffield City Council and Rotherham Metropolitan Borough Council.

2.2.4 Trips associated with the Category 1 and 2 sites described above are added to the base year matrices, and the overall growth in trips is controlled to match forecast growth from the National Trip End Model Version 7 (via the TEMPRO program) for cars and forecasts from the National Transport Model for goods vehicles.

2.2.5 This approach enables us to account for differential growth between zones resulting from the location of individual developments whilst maintaining consistency with the overall expectations of population and economic growth in the area.

2.2.6 The cut-off decisions made as to which developments contained in the Uncertainty Log should be explicitly modelled were a little different for the forecast years from those made in updating the base models. As there were many small sites in the Uncertainty Log, a low cut-off had to be set to model the impact of the many small sites. The cut-off was therefore only applied to residential developments and set to 20 dwellings, which is equivalent to approximately 70 daily arrivals. The cut-off removed 1100 dwellings, or 2.5% of all dwellings in the Uncertainty Log.

2.3 Forecast Year Baseline Transport Networks

2.3.1 Modelled changes to the Strategic Road Network and key changes to the local road network are summarised in Table 1 and 0 respectively.

Table 1. Modelled Network Changes – Strategic Road Network

PROJECT TITLE	DESCRIPTION
M1 J28-31 Managed Motorways	Hard shoulder permanently converted to an extra lane and variable speed limits.
M1 J32-J35a Managed Motorways	Hard shoulder permanently converted to an extra lane and variable speed limits.
M1 J31-J32 Extra Lane	Widening from three to four lanes.
IKEA*	M1 J34 Junctions improvements.

Table 2. Modelled Network Changes – Local Road Network

PROJECT TITLE	DESCRIPTION
A630 Sheffield Parkway improvement	Widening to three lanes from two between M1 Junction 33 and Catcliffe.
BRT North	New link road from Meadowhall to A6178 Sheffield Road and signalisation of junctions.
Sheffield Retail Quarter	Changes to road layout in Sheffield city centre arising from development.
Bridgehouse Junction	Improvements to junction lay out
Waverley	Signalisation of two roundabouts and reinstating Highfield Lane Orgreave Road.
IKEA	A6138 junctions Improvements.
SAV Tram-Train	Tram-Train connection Sheffield city centre, Meadowhall, Rotherham Central and Parkgate.

2.4 Forecast Year Baseline Development Assumptions

2.4.1 The baseline scenario includes all developments identified in the Uncertainty Log as either Category 1 or 2 – “near certain” or “more than likely”. Table 3 shows the level of residential and commercial developments modelled explicitly in the 2024 baseline forecasts (relative to the 2017 base model) for the Rotherham and Sheffield districts.

Table 3. Baseline Scenario – Residential and Commercial Development

DISTRICT	RESIDENTIAL (DWELLINGS)	COMMERCIAL (FLOORSPACE)
Rotherham	3,900	276,000
Sheffield	18,800	688,000

2.4.2 Trip end estimates for demand generated by each of the sites contained in the Uncertainty Log are prepared using trip rates taken from the industry standard TRICS database for appropriate development types.

2.4.3 The total scale of the development in units of 12-hour arrivals included in the Baseline Scenario for the 2024 forecast year is summarised in Table 4. The figure below the table summarises the same trip end information by mode and hourly time period.

Table 4. 12-hour Trip Ends by Land Use Type

LAND USE TYPE	2024 12H ARRIVALS
A1 Shops	88,000
B1 Business	50,000
B2 General Industry	7,000
C3 Dwelling Houses	53,000

Table 5. Development Trips by Mode and Time Period

PERIOD	2024 CAR	2024 PT	2024 WALK/ CYCLE
Morning peak hour	12,200	2,600	4,600
Average Inter peak hour	11,600	2,800	6,000
Evening peak hour	13,800	3,100	6,300

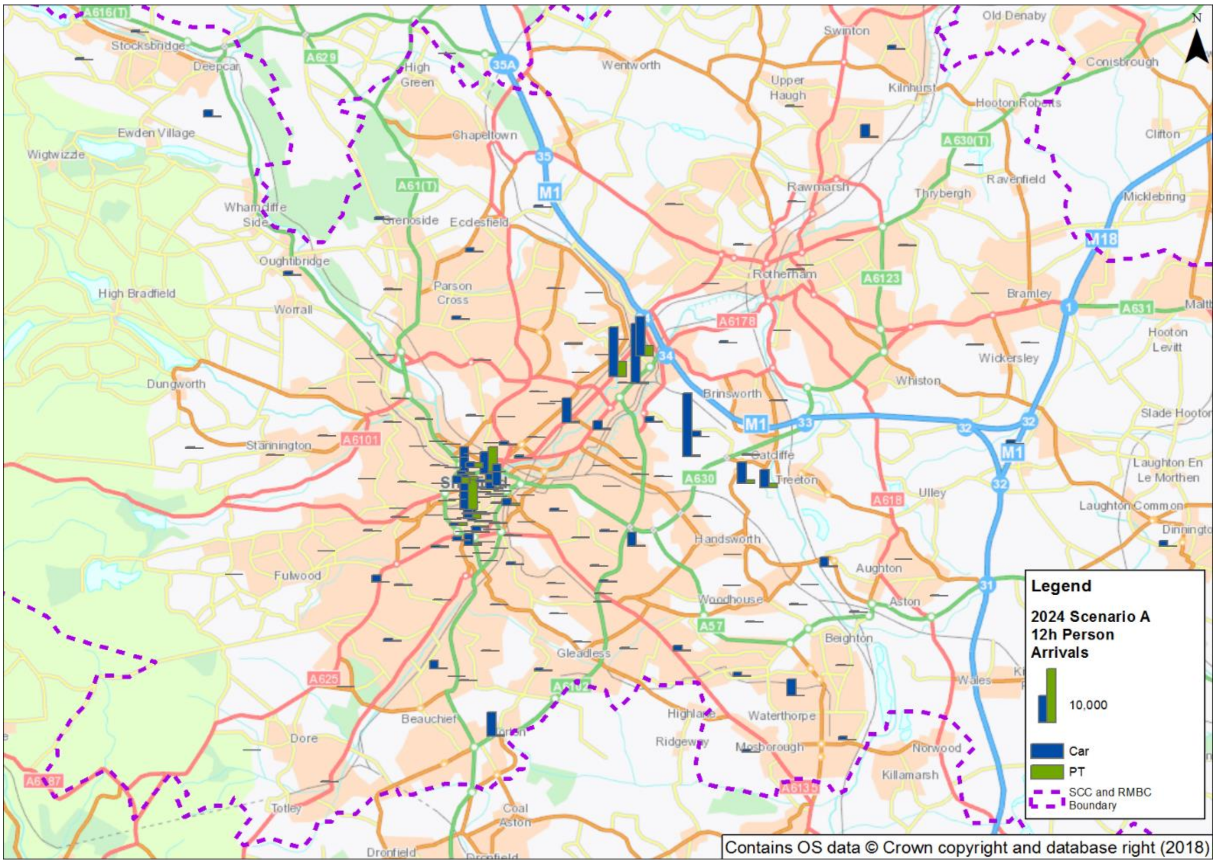

Figure 1. 12-hour Car and PT person trip end arrivals for developments in 2024 Baseline Scenario

3. LINK TO THE AIR QUALITY MODELLING

3.1 Introduction

3.1.1 This section details how the transport model links to the air quality modelling. For the purpose of the initial CAZ appraisal the SRTM3B model was linked to ENEVAL[1] (SYSTRA in-house Environmental Evaluation Software).

3.1.2 ENEVAL version 11 is consistent with the latest version of the DEFRA Emissions Factor Toolkit (EFT v8.0.1b) and links to the same data sources. The programme is based on the same data sources as the latest EFT and is a C# compiled executable which links to a SQL database. It calculates both link and junction emissions. The latter being done by calculating queue length at junctions and applying the same formulae at the lowest speed for which they hold.

3.1.3 The reason for using ENEVAL rather than the EFT is that because it is in a database environment it can deal with more data than the EFT. It also has an inbuilt ability to undertake emissions calculations at junctions and finally has more flexibility in allowing the user to adjust the fleets in sensitivity testing.

3.1.4 The ENEVAL software takes traffic directly from the model (in the form of user class inputs) it then converts these first into fuel types by road type and then disaggregates to the more detailed fleet type (Euro Class and Vehicle Size)

3.1.1 Finally, the programme calculates the emissions (including NOX, PM10, HC and CO2) for each link based on the speeds and the traffic flow. It also calculates emissions for each junction and the outputs placed in a table in the SQL database. For the CAZ work the most important output is the fraction of NO2 (f-NO2), which Road transport is the major source of pf-NO2 emissions and different vehicle types emit different proportions of NOx as NO2. This is therefore calculated after ENEVAL using the DEFRA / Bureau Veritas spreadsheet tool.

3.1.2 The SATURN highway assignment models in SRTM3A included an output which was set up for input directly into ENEVAL. This has been updated to be more detailed in SRTM3B as detailed in the sections below.

3.1.3 The outputs from the ENEVAL process are then input into the South Yorkshire Airviro model, which undertakes the air quality dispersal modelling. More details on this can be found in the AQ2 Air Quality Modelling Methodology Report.

3.2 Traffic Disaggregation in SRTM3B

3.2.1 The SRTM3B SATURN assignment models contain 5 user classes and one preload, which are:

- Three Car User Classes (Business, Commute, Other);
- LGV;
- HGV; and
- Bus Preloads.

3.2.2 Traffic flows for these user classes are output to a text file along with link lengths and average speeds (including average junction delay) for each time period in the correct format for input into ENEVAL.

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[1] This is Systra's own Emissions Evaluation software. More details can be found in the ENEVAL user manual.

3.2.3 An update was incorporated into the SRTM3B model to enable differential affects to be tested between CAZ-Compliant and Non-Compliant vehicles in the assignment models. This was undertaken by expanding the user classes from 6 to 12 in the assignment model, where 1 to 5 are the CAZ-compliant vehicle types for Car Business, Car Commute, Car Other, LGV and OGV and 6-10 are the non-compliant equivalents.

3.2.4 The setup of the assignment model is otherwise the same as in the base year with each non-compliant user class having the same parameters as it's CAZ-compliant equivalent.

3.2.5 The VDM model was updated to work with a CAZ cordon. It distinguishes between compliant and non-compliant cars, as the costs (and hence mode split responses) will differ between these two sub-groups of motorists. The costs from the assignment model for trips through the cordon in the VDM. For trips with con-compliant vehicles to/from/within the cordon, the charge is applied in the VDM model, thus overwriting any costs read from the assignment model.

3.2.6 The matrices for assignment were split using a combination of ANPR data from 2017 combined with data from the emission factor toolkit. The former allowed the compliant / non-compliant splits to be determined at four different key geographic areas (Sheffield, Rotherham, Parkway and the M1 Motorway) in the base year. Changes over time from EFT were then applied to these to obtain forecast year compliant / non-compliant splits. These are shown in the tables below.

3.2.7 The table below also show the compliant split proportions including for bus, coach, 'black cabs' and car-based Private Hire Vehicles (PHV), which are included in the traffic assignment model as preloads. These are presented for the Base Year and the 2024 Forecast Year.

Table 6. CAZ-Compliant Splits in the Modelled Area (by geography)

	SHEFFIELD		ROTHERHAM		PARKWAY		MOTORWAY	
	2017	2024	2017	2024	2017	2024	2017	2024
User Classes								
Car Commute	54%	72%	52%	71%	57%	75%	55%	73%
Car Business	54%	72%	52%	71%	57%	75%	55%	73%
Car Other	54%	72%	52%	71%	57%	75%	55%	73%
LGV	15%	60%	14%	60%	17%	61%	15%	60%
OGV	46%	67%	45%	66%	48%	68%	47%	68%

3.3 Post Model Process – Taxis

3.3.1 Within ENEVAL there are default Taxi splits based on the non-London road types within EFT. However, for Sheffield we know from the ANPR data the numbers of black cabs and private hire vehicles (PHV's) at each of the camera sites. So rather than allow ENEVAL to split these based on default splits a process has been created to add these into the ENEVAL input file as a separate user class.

3.3.2 The taxis in SRTM3B are included in the car user class. So the process involves using proportions from the ANPR data for black cabs and PHV's separately based on the links geographical location and adding these in as 2 new preload fields. The two tables below, Table 6 and Table 7 respectively, below show proportions of black cabs and PHV's grouped into different geographies.

Table 7. Black Cabs as a Proportion of Total Car Vehicle Flows

DATA SOURCE	MORNING PEAK	INTER-PEAK	EVENING PEAK	OFF PEAK
Sheffield Suburban	0.6%	0.8%	0.8%	2.2%
Sheffield Central	1.4%	1.9%	2.3%	4.4%
Rotherham	0.3%	0.8%	0.6%	0.8%
Motorway	0.1%	0.2%	0.2%	0.4%
Parkway	0.1%	0.1%	0.2%	0.3%
Buffer Network	0.7%	1.0%	1.0%	2.3%
External	0.7%	1.0%	1.0%	2.3%

Table 8. PHV as a Proportion of Total Car Vehicle Flows

DATA SOURCE	MORNING PEAK	INTER-PEAK	EVENING PEAK	OFF PEAK
Sheffield Suburban	1.7%	2.2%	1.4%	3.4%
Sheffield Central	2.5%	3.5%	2.2%	4.8%
Rotherham	3.2%	3.9%	2.9%	4.8%
Motorway	0.8%	0.9%	0.7%	1.4%
Parkway	0.5%	0.6%	0.4%	0.9%
Buffer Network	2.0%	2.6%	1.7%	3.6%
External	2.0%	2.6%	1.7%	3.6%

3.3.3 As there is no data to split taxi travel by purpose. The three car purposes are combined before the black cab and PHV extraction factors are applied. Once these have been abstracted the remaining car flows are re-split into the three purposes based on the initial proportional splits.

3.3.4 In forecasting, the absolute taxi values are kept constant and subtracted from the car flows on that link. For the very unlikely event that this makes a link have zero flow a check has been included to set the car value for that link to zero.

3.4 Post Model Process – HGV's

3.4.1 Furthermore, from a combination of the ANPR data and the DFT rolling count data we know the proportion of rigid and articulated HGV at certain key points on the Sheffield and Rotherham road network. So, as with taxi rather than allowing ENEVAL to apply the default splits (based on those in EFT), we will separate out the HGV user class into two before it is put into ENEVAL.

3.4.2 Before any splitting between rigid and articulated HGVs takes place, coaches are extracted from the HGV user class. A general proportion of 5.04% of HGVs were considered coaches, a proportion is based on the DFT rolling count data.

3.4.3 The different geographies are as follows:

- Motorways: 30% Rigid/70% Artic;
- The A57 east of the M1: 40%Rigid/60%Artic;
- The A616: 45% Rigid/55% Artic;
- The A57 between M1 and the A630: 65% Rigid/35%Artic;
- All other roads in Rotherham: 70% Rigid/30%Artic;
- Any route which crosses the Sheffield/Rotherham boundary: 75% Rigid/25%Artic; and
- All other roads in Sheffield: 80% Rigid/20%Artic.

3.4.4 Each link in the model is given a flag as to which of these geographies it is in and when the ENEVAL input file is being constructed the post-SRTM3B process applies the relevant split for that link.

3.4.5 In total the ENEVAL input file therefore contains 10 vehicle type flows, which are:

- Car Business;
- Car Commute;
- Car Other
- LGV
- Rigid HGV;
- Articulated HGV;
- Black Cab;
- PHV;
- Bus; and
- Coaches.

3.5 ENEVAL in operation

3.5.1 The version of ENEVAL used with SRTM3B has been updated to be specific to Sheffield and Rotherham, in particular by incorporating fuel, engine size and euro composition splits which are specific to the area, rather than the default non-London proportions from the EFT.

3.5.2 In operation ENEVAL spreadsheet undertakes the following steps:

1) Splits the user classes into fuel types based on data from the ANPR analysis;

2) Further splits the vehicle types by vehicle size and euro class (these splits are also based on the Sheffield and Rotherham ANPR data);

3) Undertakes emissions calculations on each link using link speed (excluding junction delay) and link distances (excluding junction queue lengths);

4) Applies fuel and mileage scaling factors, which take into account changing efficiency in fuel over time and reduced efficiency of vehicles as they become older;

5) Undertakes Junction Based emissions calculations (using the queue length as the distance over which the emissions are produced); and

6) Outputs the data to the SQL database.

3.6 ENEVAL Outputs

3.6.1 The ENEVAL outputs which are stored in SQL are also linked to output mapping processes. Figure 2 below shows the initial ENEVAL run using SRTM3B outputs and shows NOX emissions (as an example) on each link in the modelled area. Similar maps, difference plots and grid based maps can be produced for each of the modelled scenarios as required.

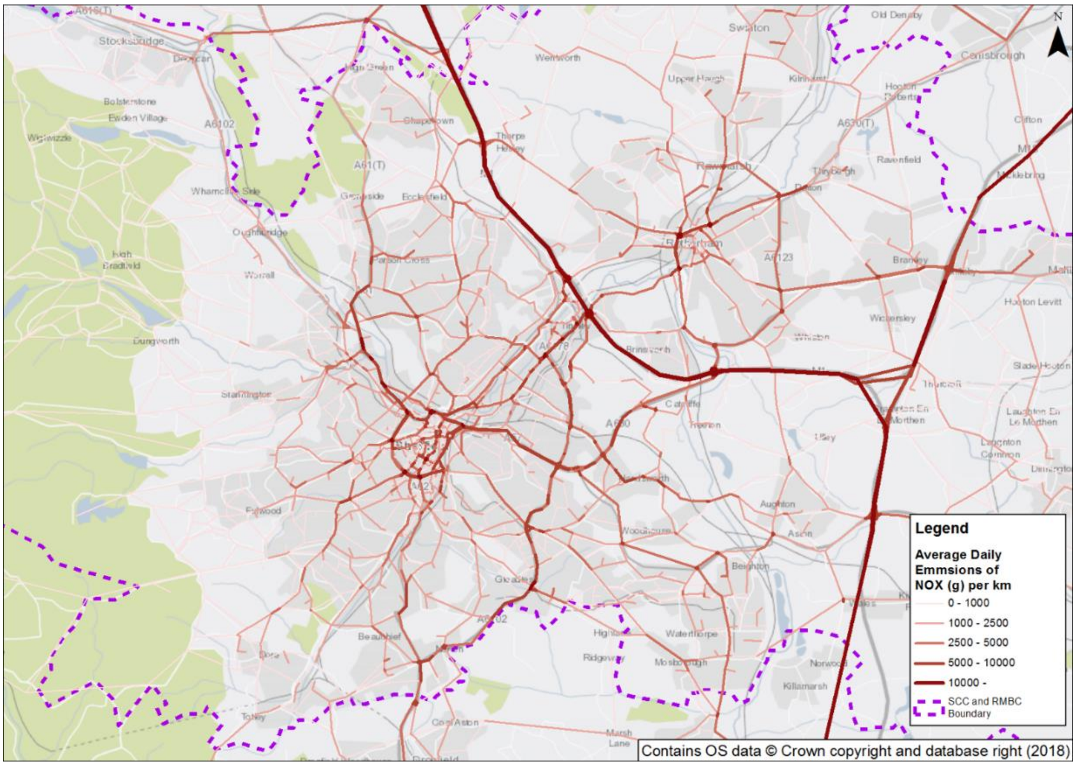

Figure 2. 24hr NO_X emissions from initial SRTM3B ENEVAL run

3.6.2 The outputs from the ENEVAL process then feed into the f-NO_2 tool and the Airviro Air Quality Model (which is where the air quality dispersion modelling is done is done)

4. FORECASTING FLEET

4.1 Overview

4.1.1 This section of the report explains how the fleet composition was forecast. The baseline fleet composition was developed through interrogation of the ANPR site data and applied to the model flows within the fleet splitting table in the ENEVAL[2] software.

4.1.2 The fleet forecasting has been undertaken line with the latest version of EFT, but with additional consideration to the latest trends in diesel car sales[3]. The way this is done is that the fleet developed for the base year (2017) has proportional changes applied to each individual vehicle type. These proportions are calculated from the fleet by year tables within the EFT and then applied to the relevant tables within ENEVAL.

4.1.3 Where old fleet types leave the overall fleet proportion and new types enter the fleet in EFT, we have included these in our forecasting process to come on line within the same time scales. The changing nature of vehicle size in the composition is also taken into consideration in the same way by simply using the proportional changes from EFT and applying them to the base 2017 fleet for Sheffield and Rotherham.

4.1.4 More detail and the results of this forecasting process can be found in the **T4 Local Plan Transport Model Forecasting Report**

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[2] This is Systra's Environmental Analysis module which is attached to the outputs of SRTM3B. It is consistent with the latest version (8.0.1b) of the Emissions Factor Toolkit.

[3] See OBC Modelling Clarification document, 21st June 2019