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

Note 25: Modelling the Impacts of Sustainable Journey Measures for the GM CAP

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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.

1 Introduction

1.1 Overview

1.1.1 The purpose of this note is to describe the methodology for incorporating the impacts of measures to promote sustainable journeys within the CAP highway and emissions modelling. The Sustainable Journeys measure was not included in the quantitative modelling of air quality in the Outline Business Case (OBC), because the assessment methodology was not available at this stage of appraisal. This Note describes the result of a sensitivity test applying behavioural response assumptions to the Do Minimum scenario used in the OBC for 2023. The purpose of this test is to determine the possible impact of this measure on traffic, NOx emissions and NO_2 concentrations. 2023 has been used as it provides the best insight into conditions close to the current modelled year of compliance with-action of 2024, and is targeted year for maximum impact by the measure.

1.1.2 Whilst there are a wide range of potential interventions considered as part of the Sustainable Journeys project, only two types of intervention have been modelled comprising:

- Workplace initiatives; and
- School initiatives

1.1.3 The interventions are modelled separately, with the combined impacts being calculated by running the processes in a linked sequence, with the outputs from one run feeding into the next.

1.2 Structure of the Note

1.2.1 The note is structured as follows:

- Section 2 describes the modelling of workplace initiatives
- Section 3 describes the modelling of school initiatives
- Section 4 compares aggregate estimates of NOx emissions for the procedures with the 2023 do-minimum forecast
- Section 5 discusses the potential impacts on NO_2 concentrations and compliance
- Section 6 provides overall conclusions

2 Workplace Iniitiatives

2.1 Introduction

2.1.1 Workplace initiatives involve engaging with businesses to offer personal travel advice to reduce commuting by car. Components of packages might include:

- Workplace travel plans
- Measures to support walking and cycling
- Measures to promote flexible working
- Car/bicycle sharing schemes
- Measures to reduce the cost of commuting by public transport

2.1.2 The highway impacts of the initiatives have been modelled using information supplied by TfGM's Sustainable Journeys team, who have carried out an analysis of evaluation results for the LSTF travel choices programme to provide estimates of trip reductions that could be achieved by workplace interventions. These provide estimates of the numbers of car trips that could be removed from the highway network as a result of the packages, which would involve engaging with approximately 200 workplaces in the County. Further details of the analysis carried out by the sustainable journeys team are available in Appendix 1.

2.1.3 The estimates of the numbers of car trips that could be removed from the highway network have been used to adjust the assignment matrices that are used with the CAP Saturn model to reduce car demand. The outputs from the Saturn model have then been input to TfGM's EMIGMA software to measure the impacts of the initiatives on mass emission totals.

2.2 Methodology

2.2.1 The modelling has incorporated the locations of the Local Exceedances project to target some of the interventions of the most persistent sites of exceedance predicted by the Clean Air Plan modelling. These locations can be refined in the future with reference to the effectiveness of the GM CAP on local air quality monitoring, if necessary.

2.2.2 Separate estimates of the numbers of car trips that could be removed from the highway network have been produced for 2021, 2023 and 2025, for three areas comprising:

- Parts of Manchester, Salford and Trafford inside the Regional Centre (as illustrated in **Figure 2.1**)
- The district of Bury
- Other districts within GM

2.2.3 These estimates were used to adjust the highway assignment matrices that are used with the Saturn model to reduce the numbers of car trips in each of the modelled periods.

2.2.4 The reduced car demand matrices (which incorporate the reductions in car travel) were built in four stages:

i. First, the Sustainable Journeys team provided estimates of daily trip reductions which could be achieved by the initiatives;

ii. Next, the daily trip reductions were allocated to the time periods represented in the Saturn model;

iii. Next, the hourly trip reductions were split into trips originating and ending in the modelled areas. This was done using origin and destination proportions derived using the DfT's Trip End Presentation Program (TEMPRO, Reference 2), separately by area and time period. (This approach was adopted to ensure that the numbers of trips with an origin or destination in the modelled areas were 'sensible', since it might be expected that commuting trips would be 'directional', and that there would for example, be more commuting trips to the Regional Centre in the morning peak hour – compared to the number of trips from the area – and that there would be more trips from the Regional Centre in the evening peak area – compared to the numbers arriving); and

iv. Finally, the calculated origin and destination trip reductions were applied to the Saturn matrices, separately by time period.

2.2.5 Futher details of these steps are provided below.

2.3 Converting Daily Trip Reductions to Hourly Totals

2.3.1 The estimated numbers of car trips that could be removed from the highway network are shown below in **Table 2.1**. These figures represent daily totals for weekdays, for inbound and outbound journeys combined, based on information provided by the Sustainable Journeys team.

Table 2.1 Summary Workplace Trip Reductions (24 Hour Average Weekday)

Analysis Area/District	Modelled Year		
	2021	2023	2025
Manchester (Regional Centre)	1,726	3,609	3,609
Salford/Trafford (Regional Centre)	431	902	902
Bury	785	1,177	1,177
Other GM	981	2,157	2,157
Total	**3,923**	**7,845**	**7,845**

Notes:

- The Regional Centre area comprises 6 traffic zones in Trafford, 31 zones in Manchester and 17 zones in the district of Salford.
- The Regional Centre area as a whole comprises 54 zones
- Bury comprises 59 zones, representing the local authority district
- Other GM represents the rest of the County, comprising 792 zones

2.3.2 To maintain compatibility with the Saturn model it is necessary to convert the daily trip totals shown above to hourly totals for each of the modelled areas.

2.3.3 The CAP Saturn model represents 3 time periods comprising:

- a weekday morning peak hour 0800-0900
- an evening peak hour 1700-1800
- an average inter-peak hour for the 1000-1530 time period

2.3.4 The assignment matrices that are used with the model represent 8 user classes:

- 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

2.3.5 The daily journey to work trips were allocated to the modelled hours using information about trip purpose by start time for weekday commuting trips from the National Travel Survey, as shown in **Table 2.2**. The figures in the table indicate that approximately 13% of commuting trips are made in the morning peak hour (0800-0900), with approximately 14% of trips being made in the evening peak hour (1700-1800). Two thirds of commuting trips are made in the morning peak period (0700-1000), with approximately 30% of trips being made in the evening peak period (1600-1900). Approximately 17% of commuting trips are made in the inter-peak period 1000-1600, with 20% of trips being made in other parts of the day (0000-0700 plus 1900-2359).

Table 2.2 Trip purpose by trip start time (Monday to Friday, England, 2014/2018

Start time	Commuting (Percentage)
0000 - 0059	-
0100 - 0159	-
0200 - 0259	-
0300 - 0359	-
0400 - 0459	1
0500 - 0559	3
0600 - 0659	8
0700 - 0759	16
0800 - 0859	13
0900 - 0959	4
1000 - 1059	2
1100 - 1159	2
1200 - 1259	2
1300 - 1359	3
1400 - 1459	3
1500 - 1559	5
1600 - 1659	9
1700 - 1759	14
1800 - 1859	7
1900 - 1959	2
2000 - 2059	2
2100 - 2159	1
2200 - 2259	1
2300 - 2359	1
Source: Table NTS0503, National Travel Survey (Reference 2)	

2.4 Allocating Trips to Origin and Destination Zones

2.4.1 The numbers of trips beginning and ending in the traffic zones in the modelled areas were estimated using origin and destination proportions for home based work trips derived using the DfT's Trip End Presentation Program (TEMPRO, Reference 3), as shown in **Table 2.3**.

2.4.2 The results are in line with expectations, with smaller proportions of commuting car trips beginning in the Regional Centre in the morning peak period and a higher proportion of trips ending in the area. The proportions for the PM peak are transposed, with a higher proportion of trips beginning in the Regional and a lower proportion of trips ending in the area. The proportions for the inter-peak period are more balanced, although there is a greater flow in the outbound direction, with 55% of commuting trips originating in the area and 45% of trips destinating in the area.

2.4.3 The origin and destination proportions for Bury show that approximately 55% of commuting car trips begin in the area in the morning peak period, with approximately 45% of trips ending in the area. The results for the PM peak period are transposed, with 46% of commuting car trips beginning in the district and 54% of trips ending in the district. The proportions in the inter-peak period are very similar, with 49% of trips beginning in the area and 51% of trips ending in the area.

2.4.4 The origin and destination proportions for the rest of GM are very similar in all time periods, with equal numbers of trips beginning and ending in the area.

2.4.5 The proportions described above were applied to the hourly trips referred to in Section 2.3 to determine the number of trips beginning and ending in the modelled areas for each time period. The total trip ends were then allocated equally to the traffic zones comprising the areas. If, for example, it was estimated that the workplace initiatives could reduce the number of morning peak hour commuting car trips in the Regional Centre by 1000, then it was assumed that this would be equivalent to a reduction of 239 trips beginning in the area and 761 trips ending in the area. If there were 31 traffic zones in the Manchester component of the Regional Centre, then it was assumed that there would be a reduction of 7.7 trips with an origin in each of these zones and 24.5 trips with a destination in the zones.

Table 2.3 Home Based Work Car Driver Origin and Destination Proportions

Area	Modelled Period	Origin %	Destination %
Regional Centre	AM Peak	23.9%	76.1%
	Inter-Peak	54.7%	45.3%
	PM Peak	73.0%	27.0%
Bury	AM Peak	54.5%	45.5%
	Inter-Peak	49.1%	50.9%
	PM Peak	46.2%	53.8%
Other GM	AM Peak	50.6%	49.4%
	Inter-Peak	49.8%	50.2%
	PM Peak	49.5%	50.5%
Source: TemPro version 7.2 weekday car driver plus passenger Home Based Work Trip ends by time period (2023)			

2.5 Trip Distribution

2.5.1 The trip reductions described above were included in the demand matrices by applying row and column adjustment factors which could be applied to the input matrix totals for the process. The factors were calculated and applied separately for each zone in turn, in such a way that the matrix totals were derived from the current version of the matrix in the internal memory. The internal matrix row and column totals were calculated by summing the trip end totals for the compliant and non-compliant car matrices, with the trip reductions being applied on a cell by cell basis pro-rata to the compliant and non-compliant trip proportions for each cell.

2.5.2 This approach assumes that the sustainable journey trips will have the same spatial distribution as existing trips to the modelled areas. This is a simplification, but it was thought that it could be justified in view of the relatively small numbers of trips involved and the complexities of applying more sophisticated methods which would not necessarily increase the accuracies of the results. A slightly different approach was, however, adopted when modelling school trips, as described in Section 3.

2.6 Trip Scaling Factors

2.6.1 There is a slight complication which occurs when subtracting the sustainable trip reductions from the assignment matrices, which must be taken into account in the matrix manipulations. The problem occurs when the annualisation factors are applied within EMIGMA to convert hourly flows from the Saturn model into period and then annual totals for input to the dispersion model, which can mean that target trip reductions are inconsistent with the annualised vehicle mileage changes within EMIGMA unless some form of adjustment is made.

2.6.2 The problem is most easily understood for school (escort) trips which are only made during specific hours of the day, (when pupils are travelling to or from school), and would not be made on weekends or school/bank holidays. Within EMIGMA, however, traffic flows are modelled for all hours of the year by applying annualisation factors to the hourly flows from the Saturn model to ensure that the correct total annual flows are used in its calculations. (Similar issues also apply for the workplace initiatives, which have only been modelled for weekdays in this piece of work).

2.6.3 The potential inconsistencies between the sustainable journey and EMIGMA flows were tackled by applying empirical adjustment factors to the target trip reductions supplied by the sustainable journeys team to ensure that the calculated annual trip reductions match the target values once the EMIGMA annualisation factors have been applied.

2.6.4 The results of the process for adjusting the trip reductions are illustrated in **Table 2.4**, which compares the annual trip reductions for 2023 following the application of EMIGMA annualisation factors with the target values provided by the sustainable journeys team. The checks illustrate that the output trip reduction reproduces the target value very well, with an absolute difference of approximately 1,800 trips and a percentage difference of 0.1%. This level of accuracy is considered to be acceptable (equivalent to approximately 0.15% of weekday commute car trips with an origin or destination inside GM), especially as the target trip reductions themselves are approximations, which will be subject to innaccuracies.

Table 2.4 Comparisons of Target versus Modelled Trip Reductions (2023, Annual Totals, Compliant plus Non-Compliant Cars)

Measure	Target Trip Reduction	Modelled Trip Reduction	Difference	% Difference
Commute	1,984,785	1,986,634	1,849	0.1%

Notes:

- 2023 commute trips comprise 7,845 trips per day, based on engagement with 200 businesses
- Forecasts represent weekday flows only, based on 253 weekdays per year (excluding bank holidays)

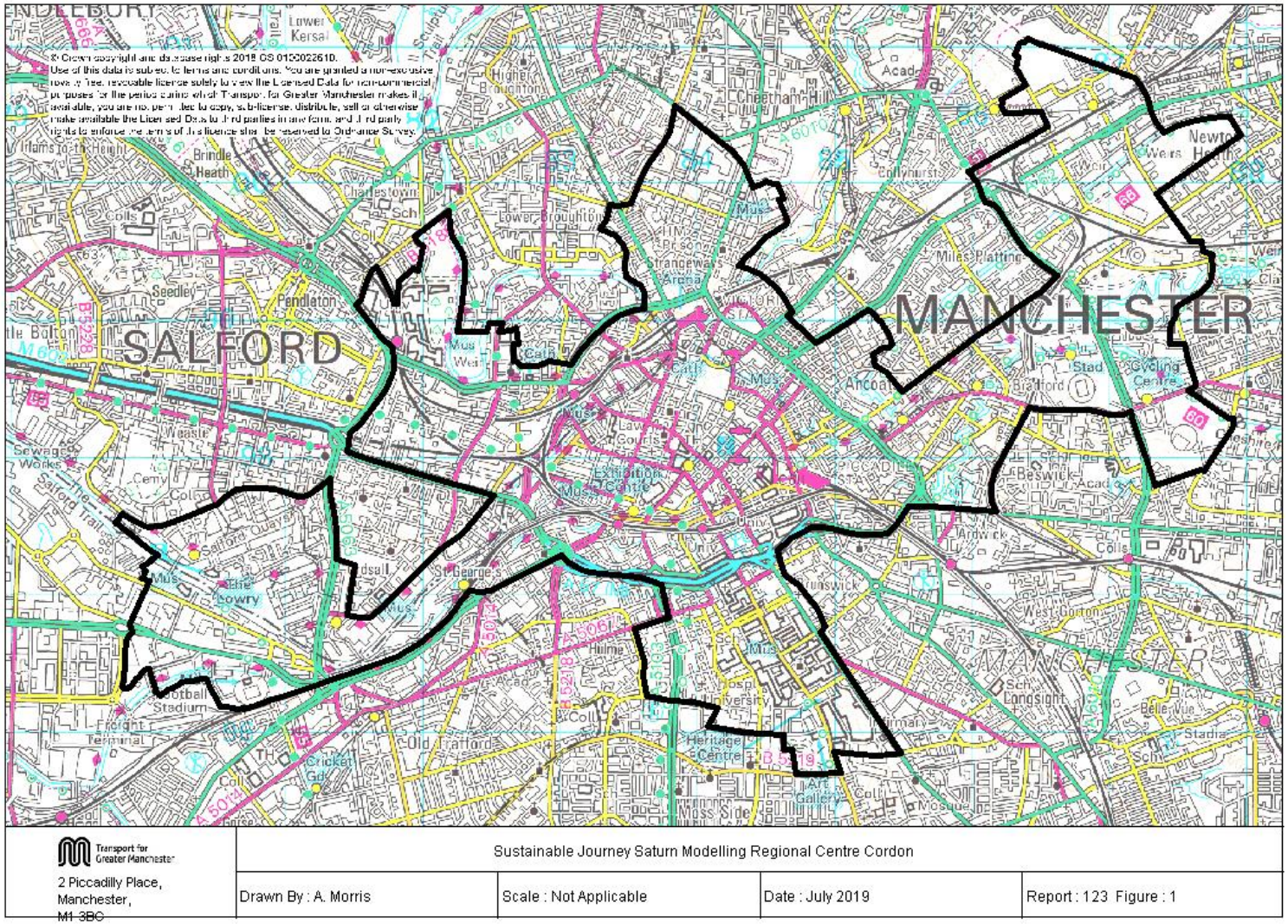


Figure 2.1 Regional Centre Area

3 School Initiatives

3.1 Introduction

3.1.1 A total of 71 schools have been identified for engagement, as illustrated in **Figure 3.1**.

3.2 Methodology

3.2.1 The procedure for modelling school trips was as follows:

- Estimates of the numbers of car trips that could be removed from the highway network as a result of the CAP School Engagement programme were supplied by the Sustainable journeys team, as shown (in aggregate) in **Table 3.1**. (Journeys were assumed to represent 'tours' (return journeys) comprising escort trips which would involve journeys from home to school and from school to home in the morning peak period, with equivalent journeys in the inter-peak period).

- 'Target' schools were allocated to zones in the traffic model to allow the start and end points of the school end of the trip to be accurately modelled

- Next, trips were distributed between the zones in the Saturn model and subtracted out of the input car matrices. (It was assumed that there would be 190 schools days per year. Trip scaling factors were applied at this stage - as described in section 2 - to ensure that the modelled flows were self-consistent).

- The updated matrices were assigned to the highway networks and the networks converged

- Traffic speeds and flows from the converged networks were then input EMIGMA to calculate the air quality impacts of the interventions.

3.2.2 The procedure for distributing trips between zones was similar to that described earlier for workplace trips. The only difference was that when modelling school trips it was assumed that the trip lengths of drop-of journeys would be shorter than the trip lengths for other purposes. This was reflected in the assignments by assuming that school trips would have a maximum trip length of 5km, so that the trip reductions would only apply to OD pairs involving journeys of less than this amount. (This was a somewhat arbitrary figure, but was one which was considered would produce more realistic assignments compared to doing nothing and assuming that the drop off trips would have the same trip length distributions as other car trips to and from the school zones).

3.2.3 The results of the process for adjusting the trip reductions (described above in Step 3) are shown in **Table 3.2**, which compares the annual trip reductions following the application of EMIGMA annualisation factors with the target trip reductions provided by the sustainable journeys team. The checks illustrate that the output change reproduces the target total to within a handful of trips.

Table 3-1 Estimated School Trip Reductions (Vehicles, Average School Day)

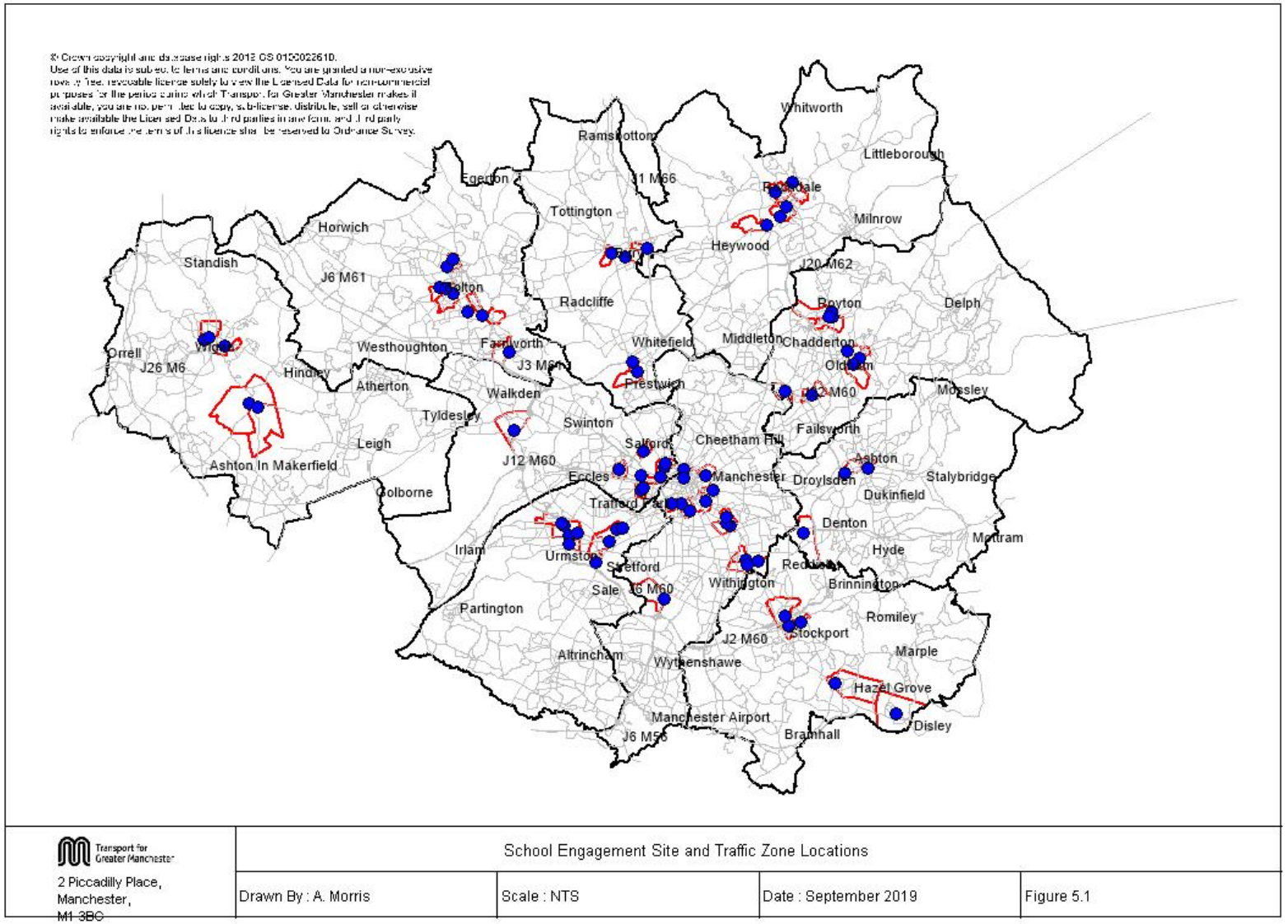
School Type	No, Schools	AM Peak Period Impact (Trips Removed)	Inter-Peak Period Impact (Trips Removed)
State- funded Primary	52	1,956	1,956
Statefunded Secondary	11	809	809
Other (Independent, Special schools etc.)	8	163	163
Total	**71**	**2,928**	**2,928**

Table 3-2 Comparisons of Target versus Modelled School Trip Reductions (2023, Annual Totals, Compliant plus Non-Compliant Cars)

Measure	Target Trip Reduction	Modelled Trip Reduction	Difference	% Difference
School	1,112,640	1,113,028	388	0.0%

Notes:

- School trips comprise 5,856 trips per day based on engagement with 71 schools and 190 school days per year.



Transport for Greater Manchester 2 Piccadilly Place, Manchester, M1 3BG	School Engagement Site and Traffic Zone Locations			
	Drawn By : A. Morris	Scale : NTS	Date : September 2019	Figure 5.1

Figure 3.1 School Engagement Locations and Associated Highway Zone Boundaries (in red)

4 Emission Impacts

4.1 Introduction

4.1.1 This section presents results of the EMIGMA analysis for the workplace and school initiatives, for 2023.

4.2 Overview

4.2.1 The EMIGMA software provides estimates of mass emissions for vehicles traveling on the roads represented in the Saturn model.

4.2.2 Inputs to the software comprise:

- Traffic speed and flow data from the Saturn model
- Fleet weighted road traffic emission factors, by vehicle type, for vehicles travelling at different speeds
- Information about the proportions of petrol and diesel powered vehicles (by road type) in the vehicle fleet, which are used to disaggregate the assigned flows from the traffic model by method of propulsion
- Road traffic annualisation factors to convert hourly emissions from the time periods represented in the Saturn model to annual totals.

4.2.3 The road traffic emission factors for input to the process are derived using information from DEFRA's Emission Factor Toolkit (EFT) for NOx, PM_{10}, $PM_{2.5}$ and CO_2 emissions. (The fraction of NOx emitted by vehicles as primary-NO_2 is also estimated using information from the EFT, separately by vehicle type).

4.2.4 The main outputs from the EMIGMA modelling comprise estimates of mass road traffic emissions (broken down by vehicle type in tonnes per year) for the links in the Saturn network. Emissions from these sources can be reported separately, or grouped to provide summary totals for all sources combined. The outputs from the procedures also provide inputs to TfGM's atmospheric dispersion model, ADMS Urban, which provides estimates of pollution concentrations (measured in $\mu g/m^3$) at selected sites, to allow concentrations to be compared with national and local targets for improving air quality.

4.3 Workplace Initiatives

4.3.1 The results for the workplace initiatives are presented in **Table 4.1**, which shows modelled changes in annual mass NOx emission totals for 2023 from the EMIGMA modelling relative to the do-minimum.

4.3.2 Changes in mass NOx emissions are reported for roads in the Regional Centre and for Greater Manchester as a whole, for all vehicles combined. The location of the Regional Centre cordon is shown in **Figure 2.1**.

Table 4-1 2023 Forecast NOx Emissions With Percentage Changes from the Do-Minimum for Workplace Initiatives (Tonnes Per Year)

Location	DM	DS	Change (T/a)
Regional Centre	198	197	-1
GM	6,384	6,381	-3

4.3.3 The table shows that there is a small reduction in mass NOx emissions for this test of approximately 0.2% for roads inside the Regional Centre and 0.1% across the county-as-a-whole.

4.4 School Initiatives

4.4.1 Summaries of the EMIGMA outputs for the school initiatives are presented in **Table 4.2**, which shows changes in mass NOx emissions for roads within traffic zones containing school sites and for Greater Manchester as a whole, for all vehicles combined. The location of the school sites and associated traffic zones are shown in **Figure 3.1**.

Table 4-2 2023 Forecast NOx Emissions With Percentage Changes from the Do-Minimum for School Initiatives (Tonnes Per Year)

Location	DM	DS	Change (T/a)
School Zones	554.8	554.7	-0.1
GM	6384.2	6383.2	-1.0

4.4.2 The table shows that there are only small reductions in mass NOx emissions for this test, (relative to the 2023 do-minimum), however these are average changes over many roads, and specific road link impacts are masked.

4.5 Workplace and School Initiatives Combined

4.5.1 **Table 4.3** shows changes in mass emission totals for Greater Manchester as a whole for the workplace and school initiatives combined, calculated by first adjusting the demand matrices for the workplace measures, followed by a second set of adjustments for the school measures.

4.5.2 The shows that there is a small reduction in mass NOx emissions within the county of approximately 4 tonnes, (0.1%), in the modelled year. (There are small differences between the impacts of the combined measures - as compared to summing the impacts of the individual measures - due to interactions between vehicle flows and and small changes in the assignments generated during the network convergence process).

Table 4-3 2023 Forecast NOx Emissions With Percentage Changes from the Do-Minimum for Workplace and School Initiatives Combined (Tonnes Per Year)

Location	DM	DS	Change (T/a)
GM	6,384	6,379	-4

4.5.3 Whilst this appears at County or zonal level to be insignificant, because the emissions creating specific exceedances are highly localised this may be masking the local scale effectiveness of the measure. Therefore, the emissions were run through the dispersion modelling process to understand the potential for improvements in predicted NO_2 concentrations.

5 Air Quality Impacts

5.1 Air Quality Impacts

5.1.1 The revised vehicle emissions for the Do Minimum with the Sustainable Journeys measure in 2023 were then used in the dispersion modelling process to produce NO_2 concentrations. The AQ modelling process is identical to that used in the OBC modelling, as set out in AQ2 and AQ3.

5.1.2 However, as a result of the analysis carried out for the Local Exceedances project, there have been amendments to two of the worst case exceedances for the Full Business Case. The maximum exceedance in Tameside has been reclassified as being associated with the Highways England, so is excluded. The road network representation at the maximum exceedance in Oldham, beside the A62, has been improved in the dispersion modelling, which has reduced the predicted NO_2 concentrations. The Do Minimum modelling had not yet been updated at the time of this Sustainable Journeys Note modelling, so the results for this scenario remain as per the OBC. Also, sites predicted to be below 38 ug/m^3 in 2021 have been excluded from the modelling process for these tests to reduce run times.

5.1.3 A summary of the results of this Sustainable Journeys sensitivity test are presented in **Table 5.1**, alongside the Do Minimum results.The results show that the Sustainable Journeys test reduces the number of predicted exceedances in 2023 compared with the Do Minimum scenario by three sites.

Table 5-1: Number of modelled sites by scale of NO_2 exceedance

Scheme Option	Compliant sites		Non-compliant sites			
	Very compliant (below 35 µg/m³)	Compliant but marginal (35 to 40 µg/m³)	Non-compliant (>40 to 45 µg/m³)	Very non-compliant (>45 to 50 µg/m³)	Extremely non-compliant (>50 µg/m³)	Total non-compliant (>40 µg/m³)
2021						
Do Minimum 2023	2262	236	57	10	0	**67**
Sustainable Journeys test 2023	2270	170	55	9	0	**64**

5.1.4 Greater Manchester aims to deliver compliance in the shortest possible time in a way that takes into account the need to minimise human exposure. **Table 5-1** demonstrates the benefits being delivered in terms of reduced concentrations even at sites remaining in exceedance in that year. This also shows that the number of sites close to exceedance reduces considerably with the Sustainable Journeys measure. Furthermore, this measure will contribute to increase the confidence of potential improvements in air quality predicted as part of the GM CAP and delivery of compliance with the Air Quality Directive.

6 Summary and Conclusions

6.1.1 This note presents the results of sensitivity testing carried out to investigate the impact of the Sustainable Journeys measure in isolation in 2023. This measure has not previously been modelled as part of the OBC package modelling.

6.1.2 The sensitivity test described in this note applied behavioural responses for passenger car trips associated with Targeted Workplace and Schools Engagement to a Do Minimum scenario in 2023. The key findings of this test are:

- The measures improves air quality in the vicinity of the locations where sustainable journeys measures are targeted. These locations can be further refined as part of the FBC process as key locations are refined.
- The measure can assist in reducing exposure to residents in GM, especially in the vicinity of schools where children are exposed to poor air quality, inside the regional centre, and in the overall delivery of compliance in GM.

References

1. DRAFT Sustainable Journeys NOx Impact Estimation Methodology, August 2019

2. National Travel Survey - Table NTS0503
   Trip Purpose by Trip Start Time (Monday to Friday) England, 2013/17
   https://www.gov.uk/government/statistical-data-sets/nts04-purpose-of-trips

3. Trip End Model Presentation Program (TEMPro) Version 7.2
   https://www.gov.uk/government/publications/tempro-downloads

APPENDIX 1: DRAFT Sustainable Journeys NOx Impact Estimation Methodology

DRAFT Sustainable Journeys NOx Impact Estimation Methodology, August 2019

This note summarises the method for estimating the number of car trips removed from the road network as a result of the Sustainable Journeys (SJ) proposed workplace and school CAP interventions.

It should be noted that the interventions delivered by SJ seek to encourage behaviour change towards sustainable travel choices. It is accepted that an individual may encounter numerous, unique obstacles before they are able and willing to change mode away from single-occupancy car journeys. Whilst SJ initiatives do result in mode shift, behaviour changes are also monitored via changes in awareness, understanding and willingness to change. It is also noted that there can be a time delay in between an individual participating in a SJ intervention, the resultant change in behaviour and eventual mode shift.

The GM CAP appraisal will be undertaken via traffic model and emissions dispersion model. This means that *only* the change in volume of car journeys resulting from Sustainable Journeys' interventions will be included within this exercise to inform the quantitative appraisal. This will primarily arise from mode shift away from car use. In reality this may also include transfer to compliant vehicles and the effects of journey retiming, which may improve congestion and thus emissions – however it is not possible to quantify this affect at this time. The wider benefits of the SJ interventions will not be included in this part of the appraisal, which a conservative approach under estimating the potential impacts on journeys and emissions.

For each element below, the impact of the SJ interventions are car journeys that are removed from the network. If the SJ interventions were not delivered, those car journeys would continue to be made.

This methodology has also been informed by the Local Exceedances Package. The Local Exceedances Package is based on modelling included within the OBC. It should be noted that SJ interventions were not included in the model for the OBC. The Local Exceedances are localities that are identified to have NOx exceedances even in the Do Something Scenario. The Local Exceedances Package seeks to address those exceedances, and as a result SJ proposes to focus its interventions in the Districts where the Local Exceedances occur in 2023 following the implementation of the CAZ – primarily in the Regional Centre (Manchester and Salford) and Bury – but intend to also offer the interventions in the remaining seven Districts.

1. Workplace Methodology

Workplace Engagement

The impact of SJs interventions varies from workplace to workplace, due to each business having unique characteristics in terms of location, accessibility, working practices, attitudes and enthusiasm.

All businesses which are currently engaged at some level with are included within SJ's Business Travel Network (BTN). Existing BTN businesses may also deliver benefits to the CAP, but the methodology below focuses on only the new businesses engaged for CAP specifically (i.e. new audiences targeted to deliver emissions compliance). The BTN currently comprises of 695

workplaces, across 786 different locations. The average number of employees on the existing BTN falls between 418 employees per workplace (lower estimate) and 458 (higher estimate).
The ONS UK Business Workbook 2018[1] has been interrogated to demonstrate that there are 105,255 enterprises within GM, located across 123,715 Local units (i.e. individual locations). This includes 1,980 enterprises with over 100 employees. There are estimated to be 1.4 million working people in Greater Manchester[2]. Table 1 below summarises the conversion of all GM located enterprises onto TfGM's BTN.

Table 1: Comparison of BTN workplaces and total Greater Manchester Enterprises

	GM Total	BTN	BTN %
Enterprises/Workplaces	105,255	695	1%
local units	123,715	786	1%
Employees (lower estimate)	1,400,000	327,233	23%
Employees (Higher estimate)	1,400,000	358,507	26%

The table above demonstrates that there is still significant potential for workplace engagement, given that only 1% of total workplaces have been engaged with.
Further interrogation of the data has been carried out to identify the employee size of the workplaces yet to be included on the BTN, as presented in Table 2.

Table 2: Comparison of BTN workplaces and GM enterprises, by District and Employment Size Band

District	Employment Size Band							
	0-4	5-9	10-19	20-49	50-99	100-249	250+	Total
BTN local Units								
Bolton	2	0	3	1	6	8	29	*49*
Bury	6	0	8	20	3	9	13	*59*
Manchester	38	8	18	27	28	67	86	*272*
Oldham	1	0	2	1	4	9	10	*27*
Rochdale	2	3	1	16	7	7	13	*49*
Salford	14	1	10	6	20	20	26	*97*
Stockport	21	2	4	8	9	15	23	*82*
Tameside	0	0	1	0	5	9	10	*25*
Trafford	7	3	4	9	6	26	24	*79*
Wigan	1	1	4	7	5	15	14	*47*
GM total	*92*	*18*	*55*	*95*	*93*	*185*	*248*	*786*
GM local Units								
Bolton	7,635	1,560	925	570	205	110	50	*11,055*
Bury	7,125	1,350	615	350	110	60	25	*9,635*
Manchester	20,290	3,560	2,340	1,580	640	365	195	*28,970*
Oldham	5,920	1,160	620	435	145	80	35	*8,395*
Rochdale	6,650	1,390	640	420	165	75	25	*9,365*
Salford	8,580	1,425	830	625	235	130	50	*11,875*

[1] https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/datasets/ukbusinessactivitysizeandlocation
[2] http://www.neweconomymanchester.com/media/1474/ne-key-facts-dec-15-web.pdf

Stockport	9,530	1,740	995	620	245	90	65	*13,285*
Tameside	5,125	1,070	560	440	130	65	20	*7,410*
Trafford	9,500	1,585	1,035	735	275	135	60	*13,325*
Wigan	7,065	1,525	875	600	170	120	45	*10,400*
GM total	*87,420*	*16,365*	*9,435*	*6,375*	*2,320*	*1,230*	*570*	*123,715*
BTN % of GM								
Bolton	0%	0%	0%	0%	3%	7%	58%	*0%*
Bury	0%	0%	1%	6%	3%	15%	52%	*1%*
Manchester	0%	0%	1%	2%	4%	18%	44%	*1%*
Oldham	0%	0%	0%	0%	3%	11%	29%	*0%*
Rochdale	0%	0%	0%	4%	4%	9%	52%	*1%*
Salford	0%	0%	1%	1%	9%	15%	52%	*1%*
Stockport	0%	0%	0%	1%	4%	17%	35%	*1%*
Tameside	0%	0%	0%	0%	4%	14%	50%	*0%*
Trafford	0%	0%	0%	1%	2%	19%	40%	*1%*
Wigan	0%	0%	0%	1%	3%	13%	31%	*0%*
GM total	*0%*	*0%*	*1%*	*1%*	*4%*	*15%*	*44%*	*1%*

The table demonstrates that only 44% workplaces of 250+ employees have been engaged with in the Manchester District, and only 18% of workplaces of 100-249 employees. Similar levels of activity are also demonstrated in Salford. This means there is still significant potential for engaging with large workplaces who can deliver significant network impact in the Regional Centre. There is potential for large workplaces (assuming 100+ employees) to be included on the BTN in all 10 districts of Greater Manchester. With reference to the districts with Local Exceedances, only 26% of all workplaces of 100+ employees have been engaged with in the three Districts of Manchester, Salford and Bury, and less than 1% of workplaces of all sizes.

The OBC cost plan assumed for engagement with 200 businesses over 10 years. It is intended to "front-load" the workplace programme in order to deliver the maximum benefits as quickly as possible. It is proposed to profile this engagement across the project period as follows.

Table 3: Proposed Workplace Engagement Profiling

	2020/21	2021/22	2022/23	2023/24	Location total
Regional Centre	25	30	30	30	115
Bury	10	10	5	5	30
Other GM	10	15	15	15	55
Annual Total	45	55	50	50	
Annual Cumulative	45	100	150	200	

Based on the Local Exceedances project aims, it is proposed to focus workplace activity upon the Regional Centre, with a secondary focus on Bury, whilst also providing the ability to deliver benefits across Greater Manchester.

Trip Reduction

The number of trips removed from the GM Highway network as a result of the SJ Workplace interventions has been estimated using the evaluation results of the LSTF Travel Choices programme.

The LSTF evaluation saw a decrease in the number of people who travel by car 5+ days a week from 48% to 37%, and was a result of workplaces receiving support from TfGM. TfGM has since improved the offer to workplaces and developed new initiates which should further encourage behaviour change, however for the purposed of the GM CAP it has been assumed that there would be no variation in the rate of behaviour change.

The LSTF evaluation has been used to estimate the equivalent number of daily journeys for:

- Employees who travel by car for 5 days per week
- Employees who travel by car for 3 days per week
- Employees who travel by non-car modes

The LSTF Evaluation found that of those respondents who reported a change in car use, there was a net positive shift away from car use – 38% working from home more and 63% using public transport, walking or cycling. It is understood that any transfer to active modes may also result in improved health benefits which may be included within the Business Case appraisal, this data may be provided in due course.

This allows for an estimation of the total number of trips removed from the network. As a result, it is estimated up to 7,845 car trips would be removed from the network each day (depending upon average number of employees) once 200 businesses have been engaged for the CAP.

The 2011 Census demonstrates that average trip length for a commuter journey in GM is 11.2km per trip. Therefore, this would be is equivalent of 87,707 car-km removed from the network each day (depending upon average number of employees) once 200 businesses have been engaged.

It has been assumed that the higher estimate of workplace size has been used to determine the cumulative volume of removed trips from each District per modelled year, and is detailed in Table 4.

Table 4: Summary of Workplace Impact

District	Modelled Year		
	2021	2023	2025
Manchester (regional Centre)	1,726	3,609	3,609
Salford (regional Centre)	431	902	902
Bury	785	1,177	1,177
Other GM	981	2,157	2,157
Total	3,923	7,845	7,845

2. Schools Methodology

A worksheet containing a list of all schools in GM has been prepared using the January 2016 School Census. The 2016 FTE pupil count is also included within the worksheet. Average mode share has been derived from the National Travel Survey 2017 for trips to and from school, for ages 5-10 years and 10-16 years. This allows for an estimation of vehicle trips to and from each school in GM.

Phase 1 of SJ's Schools Engagement programme has delivered its first year of interventions, but evaluation data is not yet available to compare against this base year survey dataset. Similar school engagement programmes have reduced car mode share to schools between 3-6%. Therefore, in absence of the SJ Schools Evaluation data, a 6% reduction in car mode share has been assumed.

The national average mode share has been modified to reflect the impact of the proposed schools engagement programme, and allows for an estimation of the number of car trips removed from the highway network for each school location.

There are four journey associated with a single pupil's daily attendance – inbound drop-off, outbound drop-off, inbound pick-up, outbound pick-up. It has been assumed that for all car journeys removed as a result of the school programme, the journeys are return journeys (A-B-A) rather than linked trips (A-B-C). It may reasonably be assumed that those people undertaking linked journeys by car do not have a suitable alternative mode, and therefore could not be removed from the network. This worksheet can be used to estimate how many car trips will be removed as a result of the CAP Schools Engagement programme. It is recommended that schools are selected which are located close to the identified exceedance points. A total of 75 schools have been targeted, comprising 53 state-funded Primary Schools, 13 state-funded Secondary schools and 9 'other' school types. The school selection has been based on the following assumptions:

- More than 20 FTE pupils
- within 400m of an exceedance point in the 2021 Do Min scenario; or
- within 1.2km of an exceedance point in the 2023 Do Something scenario (i.e. the Local Exceedances scenario)

The impact is summarised in Table 5.

Table 5: Summary of Schools Impact

	No. of Schools	AM Total Impact (journeys removed)	IP Total Impact (journeys removed)
State-funded primary	52	1,956	1,956
State-funded secondary	11	809	809
Other Schools (independent, special schools, etc)	8	164	164
SUM	71	2,928	2,928

It should be noted that this is indicative of the type of impact possible. School participation will be voluntary and as a result, the schools recruited may differ from those included above. However, school selection will be prioritised upon contributing towards achieving NOx compliance.