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

Analysis of Distributional Impacts

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1 Executive Summary

1.1 Overview

As set out in the Options Appraisal Report, two clean air options are proposed within the Greater Manchester Clean Air Plan (GM CAP), Option 5(i)/(ii)[1] and Option 8. Option 5(i)/(ii) is broadly framed around a CAZ D scenario (including buses, coaches, taxis, Private Hire Vehicles (PHVs), Heavy Goods Vehicles (HGVs), Light Goods Vehicles (LGVs) and private cars), whereas Option 8 is framed around a CAZ C scenario (the same as CAZ D but without private cars), both with variations on the standard CAZ classes and with proposed sunset periods.

This report presents the results of the distributional impacts analysis of Option 5(i)/(ii) and Option 8. For the purpose of the analysis, the ten council districts of Greater Manchester were divided into 1,673 Lower Layer Super Output Areas (LSOAs), as illustrated in Figure 4 (Appendix A). LSOAs are small geographical areas referred to by the Office for National Statistics (ONS) and were used as the default spatial framework for the analysis of distributional impacts[2].

The analysis is structured around the key social and economic groups considered most likely to be impacted by the proposed clean air measures. The analysis aims to establish whether one group is being unfairly disadvantaged or advantaged by the options being proposed

Within this report, consideration has been given to children, the elderly, the disabled, low income households, women, and the Black, Asian and Minority Ethnic (BAME) community. In addition, two business groups were considered: Small and medium sized enterprises (SMEs) and LGVs. Impacts on each group was considered, where relevant, under the following three variables: air quality, affordability and accessibility.

The distributional analysis of air quality impacts looks at changes in emissions across the study area focussing on low-income households, under 16s and over 65s. An assessment of health and environmental damage costs is also provided. Next the report examines affordability distributional impacts, including personal affordability, user benefits[3] and business affordability, focussing on low income households, the disabled population, SMEs and the use of LGVs. Finally, the accessibility distributional impacts analysis considers changes to the ability and ease of individuals or

[1] Modelling was undertaken separately for Option 5(i), Option 5(ii) and Option 8. In some instances, the results of the analysis are comparable for both Option 5(i) and Option 5(ii). And the options are considered as one – Option 5(i)/(ii).

[2] Where LSOA data was not available (i.e. for business counts), data for Middle Layer Super Output Areas (MSOAs) was used (Figure 3 in Appendix A).

[3] User benefits capture the experience of people commuting to a place of work or education and undertaking journeys for social or leisure purposes via private vehicle. Benefits are associated with improved journey times and the reduction in cost of operating a car.

businesses to get to places of work, social networks and public amenities focusing on low income households, children, the elderly, the disabled population, women and the BAME community.

The results of the analysis are summarised here and explained in detail in the main body of the report. The assessment of distributional impacts presented here is not considered exhaustive; recommendations for further work are presented in Appendix B.

1.2 Assessment criteria

The following scale, as recommended by TAG Unit A4.2, is used in the reporting of the distributional impacts. In cases where the methodology has deviated from the guidance, potential impacts are described qualitatively.

Table 1- 1 Distributional Impact Assessment Criteria

Assessment		Impact Description
✓✓✓	Large beneficial	Beneficial and the population impacted is significantly greater than the proportion of the group in the total population
✓✓	Moderate beneficial	Beneficial and the population impacted is broadly in line[4] with the proportion of the group in the total population
✓	Slight beneficial	Beneficial and the population impacted is smaller than the proportion of the group in the total population
-	Neutral	There are no significant benefits or dis-benefits experienced by the group for the specified impact
✘	Slight adverse	Adverse and the population impacted is smaller than the proportion of the population of the group in the total population
✘✘	Moderate adverse	Adverse and the population impacted is broadly in line with the proportion of the population of the group in the total population
✘✘✘	Large adverse	Adverse and the population impacted is significantly greater than the proportion of the group in the total population

It is important to note that a large beneficial impact does not represent the areas receiving the greatest air quality/affordability/accessibility benefits. For example, from an air quality perspective, benefits would be expected to be greatest in areas where the emissions reduction is highest. Instead, the WebTAG methodology determines whether the impacts are representative of an even distribution if all groups received the same share of the benefit. As such, care must be taken when interpreting the results of the analysis.

[4] For the assessment of air quality and affordability, 'broadly in line' refers to a +/- 2% threshold between the percentage of net winners/losers and the share of the resident population in each group. For the assessment of affordability, this threshold is increased to +/- 5% in line with the TAG Unit A4.2 guidance.

1.3 Key findings

1.3.1 Key findings for social groups for each impact variable

An overview of findings for key social groups and each impact variable is presented in Table 1- 2.

To identify social groups that could be disproportionately impacted by the GM CAP, the population within the study area was divided into quintiles. For example, to assess income deprivation, LSOA populations were first divided into five equal parts depending on the level of income: the first quintile contains the top fifth of the population on the scale (i.e. the 20% of the population with high levels of deprivation), the second quintile represents the second fifth (from 20% to 40%) and the fifth quintile represents the 20% of the population with the lowest level of income deprivation. Once the LSOA populations have been divided into quintiles, it is then possible to see which groups receive the highest share of the benefits.

It is noted that Greater Manchester has a higher proportion of low income households relative to the national profile for England and Wales, with 35% of Greater Manchester living in LSOAs that are in the most income-deprived quintile.

Table 1- 2 Overview of impacts on key social groups

Social group	Impact Variable	Comment
Low income households	Air quality	For low income households, results are comparable for Option 5(i)/(ii) and Option 8, although Option 8 provides slightly better opportunities for enhancement than Option 5(i)/(ii). For Option 5(i)/(ii), moderate benefits are experienced evenly across all quintiles. For Option 8, moderate benefits are experienced across the majority of the population, with large benefits experienced by the 20-40% most income-deprived households (quintile 2).
	Personal Affordability	When the distribution of impacts on low income households is compared to the distribution across England and Wales, impacts for Option 5(i)/(ii) and Option 8 are distributed *unevenly.* When compared to the distribution across Greater Manchester, distributional impacts on low income households are distributed *unevenly* for Option 5(i)/(ii) and *evenly* for Option 8. The analysis also shows that under Option 5(i)/(ii), the burden of costs associated with upgrading private cars to compliant vehicles across Greater Manchester would fall disproportionately on low income households, including the high proportion of low income households (quintile 1), located just outside of the IRR. Under Option 8, the use of non-compliant private cars would not incur a charge, therefore there is likely to be a significantly lower affordability impact on low income households under this option.
	User benefits	For both Option 5(i)/(ii) and Option 8, when the distribution of low income households is compared to the distribution across Greater Manchester, moderate beneficial user benefits are evenly distributed across all quintiles. When compared to the distribution across England and Wales, those in quintile 1 experience a slightly lower share of the benefits (slight beneficial impacts).
	Accessibility	When compared to the distribution of low income households across Greater Manchester, under Option 5(i)/(ii) moderate beneficial impacts are anticipated to be experienced evenly across all income groups. When compared to the distribution across England and Wales, the benefits for Option 5(i)/(ii) are greatest (large beneficial) in quintile 2. Similarly, for Option 8 large benefits are anticipated in the areas with the greatest income deprivation (quintiles 1 and 2). For both Option 5(i)/(ii) and Option 8, the areas with the greatest improvements in journey times are located within the IRR and in the key centres of Bolton, Rochdale and Oldham.

Social group	Impact Variable	Comment
Children	Air quality	For children (under 16s), results are comparable for Option 5(i)/(ii) and Option 8, although Option 5(i)/(ii) provides slightly better opportunities for enhancement than Option 8. For Option 5(i)/(ii), benefits are experienced by all under 16s, although the spread of benefits is uneven. Large benefits are experienced in quintile 1 and quintile 3, slight benefits in quintile 2, and moderate benefits in quintile 4 and quintile 5. For Option 8, benefits are experienced by all under 16s, with large benefits experienced by areas with the highest concentration of under 16s compared to other areas (quintile 1). In general, air quality impacts on children are likely to be more beneficial outside of the Manchester IRR boundary. Despite there being high emissions reductions in this zone, this area contains less than 1% of total population of under 16's and only a small number of facilities of importance to children (three nurseries, four parks/open space and no junior/secondary schools). Within the M60 and the rest of Greater Manchester the overall impacts on children are more apparent with residents located in close proximity to the major road networks (M6, M60, M61, M62, M602, M66, M56) likely to experience the greatest air quality benefits.
	Accessibility	Beneficial impacts are experienced *unevenly* across all quintiles for Option 5(i)/(ii) and Option 8. For Option 5(i)/(ii), large beneficial impacts are experienced by quintiles 1 and 3, moderate beneficial impacts are experienced by quintiles 4 and 5 and slight beneficial impacts are experienced by quintile 3. For Option 8, moderate beneficial impacts are experienced by quintiles 3, 4 and 5 (least children) large beneficial impacts are experienced by quintile 1 (most children) and slight beneficial impacts are experienced by quintile 2. For Option 5(i)/(ii) and Option 8, large beneficial impacts are experienced in quintile 1 (most children). Overall, journey time benefits are highest within the IRR. This has little impact on children as the IRR contains a very low proportion of under 16's and no schools. There are no special educational needs schools within areas with increased journey times.
Elderly	Air quality	For the elderly population, results are comparable for Option 5(i)/(ii) and Option 8, although the benefits are more evenly spread for Option 8. For Option 5(i)/(ii), the areas with relatively low levels of elderly residents (quintile 4) receive the greatest share of the benefits. For Option 8, moderate benefits are experienced evenly across all quintiles.

Social group	Impact Variable	Comment
		The analysis shows that LSOAs within the M60 (and the IRR) are expected to receive the highest changes in emissions. In general, high concentrations of elderly residents are located outside of M60/IRR, towards the outskirts of Greater Manchester. The relatively small proportion of elderly people living within the IRR would be expected to experience largely beneficial impacts with over 70% (490 elderly residents) located in areas of high emissions reductions. It is likely that given the distribution of the elderly population, benefits are more likely to be experienced through improved accessibility and affordability of local transport services as a result of the GM CAP rather than reductions in emissions.
	Accessibility	Under Option 5(i)/(ii), the impacts across the elderly population are anticipated to be uneven with large beneficial impacts expected in quintile 4 and slight beneficial impacts in quintile 2. Quintiles 1, 3 and 5 experience moderate beneficial impacts. Overall the impacts are anticipated to be moderate beneficial. Under Option 8, moderate beneficial impacts are distributed evenly across the elderly population. In general, the areas with the highest proportion of elderly residents (located towards the outskirts of Greater Manchester rather than in the M60/IRR) also have the lowest availability of public transport options. The age profile of community transport vehicles used by elderly residents is also typically older and hence more likely to be non-compliant. In the event that community transport operators (e.g. Local Link) cannot afford to upgrade vehicles, there could be a reduction in the availability of services. This would result in significant adverse impacts on users who are reliant on this form of transport.
Disabled people	Accessibility	For both Option 5(i)/(ii) and Option 8, the distribution of beneficial impacts is anticipated to be uneven with the areas containing the highest proportion of disabled people (quintile 1) receiving the largest benefits. Disabled people with reduced mobility may be unable to make use of conventional public transport services or active transport modes (walking and cycling) and may be more reliant on private cars for personal journeys than people who do not have reduced mobility. As car owners only experience a travel cost under Option 5(i)/(ii) the impact on accessibility on disabled people would be greater under this option than it would be under Option 8 (a CAZ C which excludes private cars).

Social group	Impact Variable	Comment
		Data from the Department for Transport (DfT) shows that, in England, the proportion of personal trips undertaken by taxi is on average three times higher for adults with mobility difficulties than those without (DfT, 2017a). Wheelchair adapted vehicles that are used solely for the transport of disabled people, and hence are registered as disabled passenger vehicles, are exempted from the clean air charge for those travelling within the IRR. However, a proportion of community transport vehicles operating within Greater Manchester may not be registered as disabled passenger vehicles as they are also used to transport people who do not have a disability. Since WAVs are more expensive than standard vehicles, these types of adapted vehicles tend to be kept or leased by their owners for longer periods than non-adapted vehicles, making them more likely to be non-compliant. If the cost of upgrading vehicles is too high, this could have a disproportionate impact on this group.
	Personal affordability	The high concentration of LSOAs with relatively high levels of health deprivation located within the M60 suggests that for Option 5(i)/(ii), in which private cars are charged for entering the IRR, there may be a disproportionate adverse impact on this group. For this option, exemptions for blue badge holders, wheelchair adapted vehicles and specialist vehicles would provide some mitigation. In Option 8, the impact on those with a disability is likely to be significantly less than that for Option 5(i)/(ii) as there would be no affordability impacts linked to the use of private vehicles. Affordability impacts would only be experienced in cases where disabled people are dependent on non-compliant community transport vehicles. Exemptions for blue badge holders, wheelchair adapted vehicles and specialist vehicles would provide some mitigation of impacts on this group.
Women	Accessibility	Under Option 5(i)/(ii) accessibility benefits are distributed unevenly, with the areas containing the lowest proportion of women (quintile 5) receiving large beneficial impacts. Quintile 2, which contains a relatively high proportion of women receives slight beneficial impacts. Quintiles 1,3 and 4 all receive moderate beneficial impacts. Analysis of distributional impacts on women was screened out under Option 8. Evidence shows that women are less likely to use public transport than men (Section 3.9) and as such, any changes in the availability of taxis and/or PHV or increases in fares would have a slightly disproportionate and differential adverse impact on women.
Ethnicity (BAME)	Accessibility	In general, areas with high concentrations of BAME populations correlate with areas of improved accessibility. For both Option 5(i)/(ii) and Option 8, moderate beneficial impacts are anticipated to be evenly across all quintiles.

Social group	Impact Variable	Comment
		Any increase in the cost of travel by private vehicle could have a differential adverse accessibility impact on ethnic minorities due to their perceived negative experience of alternative travel options (Section 3.10). However, as private vehicles do not incur a travel cost under Option 8, this differential adverse impact would only be experienced under Option 5(i)/(ii).

Table 1-2 shows that all social groups are likely to experience moderate beneficial air quality, personal affordability and accessibility impacts, with the following exceptions:

- Under Option 5(i)/(ii), adverse impacts fall disproportionately on residents of the IRR who otherwise have no choice other than to comply with CAP charges for private car travel. These impacts could be mitigated in part through the implementation of 'sunset periods' (time-limited discounts) for IRR residents. Under Option 8, the use of non-compliant private cars would not incur a charge, therefore there is likely to be a significantly lower affordability impact on low income households under this option.
- There is potential for disabled people to experience an adverse personal affordability impact due to the increased costs associated with upgrading wheelchair accessible vehicles and the potential for increased costs of community transport services. However, the exemptions for blue badge holders, wheelchair adapted vehicles and specialist vehicles would provide some mitigation.
- Under Option 5(i)/(ii) there is potential for disabled people with reduced mobility to incur a greater share of the costs than those without reduced mobility. Disabled people with reduced mobility may be unable to make use of conventional public transport services or active transport modes (walking and cycling) and may be more reliant on private cars for personal journeys than people who do not have reduced mobility. As car owners only experience a travel cost under Option 5(i)/(ii) the impact on accessibility on disabled people would be greater under this option than it would be under Option 8 (a CAZ C which excludes private cars).
- Although accessibility benefits for the BAME community are more evenly spread across quintiles for Option 8 than for Option 5(i)/(ii), it is noted that for Option 5(i)/(ii), any increase in the cost of travel by private vehicle could have a differential adverse accessibility impact on ethnic minorities due to their perceived negative experience of alternative travel options.

1.3.2 Key findings for business groups

Two business groups were considered: SMEs and LGVs. Due to the challenges associated with the quantitative approach prescribed by JAQU, a qualitative assessment was completed (see section 6.2.2), which highlights the potential for the following adverse business affordability impacts:

SMEs

The qualitative analysis of business affordability distributional impacts for SMEs is summarised as follows:

- The business profile of Greater Manchester (83.9% micro, 12.9% small, 3.2% medium and 0.4% large) is broadly in line with the national average for each business type (84.6% micro, 12.4% small, 2.6% medium and 0.4% large). Within the IRR, there is a slight shift away from micro businesses compared to the national and regional trend, and a slightly larger proportion of small, medium and large businesses. Larger businesses would be expected to be more resilient to a new clean air charge than SMEs since they have greater resources and can better adapt to increasing costs. However, it is assumed that levels of resilience are homogenous across the study area and that all SMEs would be vulnerable to potential affordability impacts resulting from the GM CAP.
- It is noted that although businesses in the IRR might have a slightly elevated level of economic resilience to the GM CAP than the national and regional average, approximately 10% of all SMEs within Greater Manchester are concentrated within the IRR and therefore overall this area is likely to experience a disproportionate business affordability impact compared to the Greater Manchester region as a whole.
- It is assumed that almost all Greater Manchester SMEs are reliant on the transportation of goods and services on the road network, meaning that impacts could directly affect suppliers travelling from outside of Greater Manchester, potentially resulting in indirect effects on the businesses located within. Similarly, increased costs could be generated if the business relies on HGVs, or if the LGV fleets are owned by individuals rather than registered to the company. For employee-owned vans, the rate of fleet turnover is typically slower, meaning these vehicles are likely to account for a higher proportion of non-compliant vehicles in 2021. Businesses are less likely to own HGV vehicles but may rely on HGV services, which could become more expensive if the providers choose to pass on any costs to the customer.
- Overall, impacts on SMEs are expected to be similar for Option 5(i)/(ii) and Option 8. It is assumed that all businesses across Greater Manchester are reliant on commercial vehicles, all of which face the same charges under each clean air option. In cases where businesses are dependent on the use of personal cars, it is anticipated that Option 5(i)/(ii) is likely to result in greater adverse impacts on business affordability than Option 8. There is also a risk under the conditions of Option 5(i)/(ii) that SME workers within the IRR could choose to move to employment outside of the IRR to avoid a charge, potentially resulting in lost productivity and an increase in recruitment costs.
- In acknowledgement of the potential affordability impacts on SMEs, ‘sunset periods’ (time-limited discounts) have been considered for small and micro businesses under all options (Refer to the Options Appraisal Report). Similarly, for Option 5(i)/(ii), sunset periods have been considered for IRR residents.

LGVs

The qualitative analysis of business and personal affordability distributional impacts for LGVs is summarised as follows:

- It is assumed that business sectors that are more heavily reliant on LGVs and HGVs, such as Retail, Wholesale and Transport and Storage, would be more heavily impacted by the GM CAP than those that are not reliant on good vehicles. Within the IRR, 37% of the SMEs are either Retail, Wholesale or Transport and Storage. Across the entirety of Greater Manchester, this figure is 21%.
- Across Greater Manchester, only 1% of LGVs are currently compliant (euro rating of four or above for petrol and six or above for diesel). The majority of businesses with an LGV fleet would therefore be expected to incur additional vehicle replacement costs between 2021 and 2023. However, some vehicle replacement and improvement in compliance levels are expected by 2023 as part of routine fleet upgrade, with an average reduction of 17% for non-compliant LGVs and 33% for non-compliant HGVs across Greater Manchester in this time.
- Figure 51 (in Appendix A) shows that there are areas of high concentrations of LGV registrations just outside the IRR suggesting this area could also be disproportionately impacted by the GM CAP.
- Although LGV affordability impacts are considered as business costs rather than social costs, there is potential for LGVs to also be used for leisure/personal purposes. In these instances, the impact could shift from a business affordability issue to a personal affordability issue.

Overall, the analysis shows that based on current and forecasted compliance levels, there is potential for adverse affordability impacts for those using and relying on LGVs. The magnitude of this impact would depend on the frequency of journeys and the behavioural response to the GM CAP.

1.3.3 Health and environmental benefits

This report also includes details of an assessment of the health and environmental benefits. A summary of this assessment for the Greater Manchester area is presented as follows:

- For Option 5(ii), the total monetised health and environmental benefit across Greater Manchester is estimated at around £17.9 million. This is slightly higher than the total monetised benefit of £17.8 million for Option 5(i). Option 8 delivers the lowest benefits of all options at £14.9 million across Greater Manchester.
- Within the IRR, the total monetised health and environmental benefit is estimated at £480,000 for Option 5(ii). The benefit within the IRR for Option 5(i) is slightly higher than Option 5(ii) at £430,000. The total benefit within the IRR for Option 8 is the lowest of all three options at approximately £350,000.

1.4 Summary of baseline socio-economic data

A selection of key socio-economic characteristics of Greater Manchester is provided as follows:

- Greater Manchester has an economy larger than that of Wales or Northern Ireland with a GVA of £56 billion.
- Greater Manchester contains 348 of the 3,284 top 10% most deprived LSOAs in England. This equates to just over one fifth of Greater Manchester's LSOAs in the 10% most deprived in the country.
- Within Manchester City Council, 18 LSOAs are within the top 1% most deprived nationally. Within the IRR, 53% of the LSOAs fall within the top 30% most deprived in the country.
- There are considerably more people in their 20s living in Greater Manchester than the national average (24% compared to 13%). In all age groups beyond the age of 39, the proportion of people in Greater Manchester is lower than the national average. Almost 7%5 of the Greater Manchester population is over the age of 75, which is broadly in line with the national average of 8%6.
- Within the M60 there are 23 hospitals/hospices, including Manchester's Children's Hospital.
- The average life expectancy (LE) of residents in Greater Manchester is lower than the national average. Average male LE in Greater Manchester is 81.3 compared to 83.1 for England. For females, LE in Greater Manchester is 77.8, lower than the England average of 79.5.
- There are 3,981 people in Greater Manchester in contact with mental health services for every 100,000 of the population, compared to 2,176 nationally.
- Approximately 28% of trips within Greater Manchester have a length of less than 1km. One third of these journeys are made by car.
- 73% of all journeys made within Greater Manchester stay within the council in which they originated, 19% move between councils and only 8% travel outside of Greater Manchester.
- Travelling to work by car/van is the largest mode of transport in Greater Manchester (68%) and within the M60 (52%). Over half (51%) of residents within the IRR walk to work (51%).
- Within Greater Manchester, 31% of households have no car/van and 43% have one car/van per household. Within the M60, 40% have no car/van and 42% have one car/van per household. Within the IRR, 59% of households do not have access to a car/van.

[5] 6.9% to two significant figures.

[6] 8.2% to two significant figures.

- In 2017, 86% of the total taxis (excluding PHVs) within the Greater Manchester region were accessible to wheelchair users, which is significantly higher than the average for England (58%). Only 1% of the total PHVs in Greater Manchester are wheelchair accessible vehicles (WAVs).
- There are approximately 124,000 businesses in Greater Manchester. The majority of businesses have fewer than ten employees. Within the IRR, 96.8% of the businesses are either micro or small.
- Outside of London, Greater Manchester is the UK's main centre for Business, Financial and Professional Services. The Wholesale and Retail Trade is currently the largest employer in Greater Manchester.
- Greater Manchester has the largest Creative and Digital Clusters in the UK, employing 63,500 people and generating GVA of £3.1 billion each year. Key assets include MediaCity UK (home of the BBC and ITV) and The Sharp Project.
- In 2016, there were approximately 78 start-ups per 10,000 population in Manchester7, a large increase from an approximate 60 start-ups per 10,000 in 2015.
- There are approximately 1.5 million international visitors to Greater Manchester each year making it the third most popular city in the UK for international visits after London and Edinburgh. According to STEAM (Tourism Economic Activity Monitor), Greater Manchester's tourism sector is worth £7.9 billion and supports 94,000 jobs.

1.5 Mitigation and enhancement

In line with TAG unit A4-2, where the distributional impacts analysis shows evidence of an intervention having particularly high benefits or dis-benefits to a certain group, enhancement and mitigation ought to be considered.

The findings of the Distributional Analysis indicate that, for Option 5(i)/(ii), the burden of costs associated with upgrading private cars to compliant vehicles across Greater Manchester falls disproportionately on low income households. This would be true of any CAP in any city because low income households are more likely to have older (non-compliant) cars and are less able to afford to upgrade to a compliance vehicle. What is unique about Greater Manchester is that the region has relatively high levels of income deprivation with just over one fifth of Greater Manchester's LSOAs in the 10% most deprived in the country.

This highlights the importance of the proposed Clean Air Credits, an incentive upgrade scheme for private car owners. The credits would be awarded at the point of scrappage of a vehicle at an approved location and would be used to finance a cleaner car or alternative more sustainable means of travel.

[7] This is defined as the primary urban areas (PUA) within Manchester, so it is a measure of the 'built-up' areas of a city rather than individual council districts. The Local authorities included in 'Manchester' PUA are Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside and Trafford. Wigan is therefore not included in this statistic and is captured separately.

As set out in the Options Appraisal Report, the following discounts and exemptions have been considered:

- Exemptions and discounts to limit the impact on disabled people and those with accessibility needs – for blue badge holders and adapted vehicles.
- 'Sunset periods' (time-limited discounts) for residents of the zone, who otherwise have no choice other than to comply.
- 'Sunset periods' (time-limited discounts) to limit the impact on local small/micro businesses, not-for-profit organisations, charities and schools.
- Bespoke time-limited discounts for those with outstanding lease or pcp contracts.
- Collaborative working with bus companies and taxi operators to help them comply and avoid unnecessary charges, and the offer of paying an annual Clean Air Levy for non-compliant GM-registered Hackney cabs or PHVs, at a discounted rate to the daily charge.

It is recommended that further work be undertaken to ensure sufficient mitigation is proposed to reduce impacts on social and economic groups, and that any potential to enhance beneficial distributional impacts be fully explored.

2 Introduction

2.1 Overview

The city region of Greater Manchester is home to more than 2.7 million people (Office for National Statistics, 2016a). The ten councils of Greater Manchester make up the Greater Manchester Combined Authority (GMCA), which is run jointly by the leaders of the ten councils and the Mayor of Greater Manchester. The ten council boundaries are displayed in Figure 1 of the Map Book, provided in Appendix A.

As set out in the Options Appraisal Report, two clean air options are proposed within the Greater Manchester Clean Air Plan, Option 5(i)/(ii) and Option 8. Option 5(i)/(ii) is broadly framed around a CAZ D scenario (including buses, coaches, taxis, PHVs, HGVs, LGVs and private cars), whereas Option 8 is framed around a CAZ C scenario (the same as CAZ D but without private cars), both with variations on the standard CAZ classes and with proposed sunset periods.

This report presents the results of the distributional impacts analysis of these two options. For the purpose of the analysis, the ten council districts of Greater Manchester were divided into 1,673 LSOAs, as illustrated in Figure 4 (Appendix A). LSOAs are small geographical areas referred to by the ONS and were used as the default spatial framework for the analysis of distributional impacts[8].

Where LSOA data was not available (i.e. for business counts), data for MSOAs was used (Figure 3 in Appendix A).

The analysis is structured around the key social and economic groups considered most likely to be impacted by the proposed clean air measures. The analysis aims to establish whether one group is being unfairly disadvantaged or advantaged by the options being proposed

Within this report, consideration has been given to children, the elderly, the disabled, low income households, women, and the BAME community. In addition, two business groups were considered: SMEs and LGVs. Impacts on each group was considered, where relevant, under the following three variables: air quality, affordability and accessibility.

The distributional analysis of air quality impacts looks at changes in emissions across the study area focussing on low-income households, under 16s and over 65s. An assessment of health and environmental damage costs is also provided. Next the report examines affordability distributional impacts, including personal affordability, user benefits and business affordability, focussing on low income households, the disabled population, SMEs and the use of LGVs. Finally, the accessibility distributional impacts analysis considers changes to the ability and ease of individuals or businesses to get to places of work, social networks and public amenities focusing on low income households, children, the elderly, the disabled population, women and the BAME community.

The results of the analysis are summarised here and explained in detail in the main body of the report. The assessment of distributional impacts presented here is not considered exhaustive; recommendations for further work are presented in Appendix B.

2.2 Strategic context

The Greater Manchester Strategy, ‘Our People, Our Place,’ was written by the ten Greater Manchester councils (Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside, Trafford and Wigan), the Mayor, the National Health Service (NHS), police, the fire service and several businesses, community and social enterprises and members of the public (GMCA, 2017a). The strategy consists of ten priorities which address education and skills, health, wellbeing, environment, work and economic growth. The strategy outlines plans for a fully integrated transport system,

[8] Where LSOA data was not available (i.e. for business counts), data for Middle Layer Super Output Areas (MSOAs) was used (Figure 3 in Appendix A).

reduced congestion and improved air quality. It is supported by several documents including the 2040 Transport Strategy, the Greater Manchester Spatial Framework (GMSF), the Low Emissions Strategy and the Air Quality Action Plan (AQAP), all designed to aid in the implementation of the overarching strategy.

The Low Emissions Strategy (GMCA, 2016) recognises both the health and economic impacts of poor air quality and aims to identify key actions which can be developed in more detail in the AQAP (GMCA, 2018b), Local Transport Plan (GMCA, 2017d) and other accompanying sub-strategies. Priority areas identified as having the biggest impact on emissions include: stimulating the uptake of Ultra-Low-Emission Vehicles, reducing emissions from buses on key urban corridors, changing travel behaviour (particularly driver only trips and travel to work) and the investigation of Clean Air Zones (CAZ).

The Low Emissions Strategy also focuses on areas within the Air Quality Management Area (AQMA). The AQMA reflects the areas of Manchester where NO_2 limits are exceeded. This reflects the locations of major motorways, major roads and urban centres.

3 Baseline

3.1 Study area

Baseline data collection focused on three key study areas:

1) Greater Manchester – The areas covered by the ten councils (Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside, Trafford and Wigan). This area has an economy larger than that of Wales or Northern Ireland.
2) Within the M60 – The geographical area within the M60 cordon. This area includes the IRR but also extends to include the towns of Prestwich, Failsworth, Stretford and Eccles.
3) Within the IRR – The geographic area within the IRR which covers the city centre of Manchester. This extends to Manchester Victoria station in the North, the Ring Road to the East and the A57 Mancunian Way leading onto Trinity Way to the South and East respectively. The Quays area of Salford is also situated within the IRR and is recognised as a key area for future economic growth within the city of Manchester.

Table 3- 1 provides an overview of the baseline data provided and at which spatial level the data was available. The baseline data presented here is not necessarily used for the purposes of the assessment, rather this data is intended to set the socio-economic context of Greater Manchester.

Table 3- 1: Baseline data presented at each spatial level

Topics	Key study areas (M60, IRR)	Greater Manchester	Regional / National
Travel to education	×	✓	×
Special needs schools	×	✓	×
Youth centres	×	✓	×
Children's hospitals	×	✓	×
Community transport	×	✓	×
Isolation/Loneliness	×	✓	✓
Blue Badges	×	✓	×
Wheelchair accessible taxis	×	✓	×
Overview	✓	✓	×
Car/van availability	✓	✓	×
Employment and the gender pay gap	×	×	✓
Modes of transport	×	×	✓
Religion	✓	✓	×
Ethnicity	×	✓	×
Health	×	✓	✓
Economic context	×	✓	✓
Economic activity	✓	×	×
Business counts	✓	✓	×
SMEs	✓	✓	×
Business turnover	✓	✓	✓
Growth of enterprises and business innovation	×	✓	×
Business sectors	✓	✓	×
Visitor economy	×	✓	×
Night time economy	×	✓	✓
LGVs and HGVs	×	✓	×

Topics	Key study areas (M60, IRR)	Greater Manchester	Regional / National
Taxis	×	✓	×
Land use	✓	✓	✓
Shift workers	×	×	✓
Travel to work patterns	✓	✓	×
Access to a vehicle	✓	✓	✓
Vehicle compliance	✓	✓	×
Accessibility levels	×	✓	×
Bus and cycle routes	✓	✓	×
Coaches	×	✓	×

3.2 Social groups

The baseline is structured around the key social and economic groups considered most likely to be impacted by the proposed clean air measures. Within this report, consideration is given to children, the elderly, the disabled, low income households, women, and the BAME population. Baseline data is also provided on the economic context and the potential impacts on businesses, LGV and HGVs and those in employment (including shift workers and taxi drivers). This report also outlines key health indicators and the baseline health of the Greater Manchester population.

3.3 Key receptors

Baseline data for social groups is supplemented with data on key receptors within the study area. This allows the distributional impacts analysis to look further than that of the resident population. For example, the overall proportion of children in the impact area may not be high, but if there is a school located within the area, it is assumed that children will be travelling within this area and this facility should therefore be considered within the assessment. Table 3- 2 gives the number of key receptors within the study area.

Table 3- 2: Key receptors within the key study areas (education and social receptors)

	Within Greater Manchester	Within the M60	Within the IRR
Junior schools	947	264	0
Secondary schools	228	72	0
University Buildings	64	55	17

	Within Greater Manchester	Within the M60	Within the IRR
Nursery/Crèche	642	206	3
Playgrounds/play areas	339	84	0
Parks/open space	835	215	4
Religious Centres	541	186	6

There are approximately 2,000 educational establishments within Greater Manchester, with approximately 600 of these located within the M60 and approximately 20 located within the IRR. This includes, schools, universities and nurseries/crèches. These are also shown in Figure 14 (Appendix A). Locations of playgrounds, parks and open space are shown in Figure 15 (Appendix A).

Table 3- 3 shows the number of medical and health care receptors in the key study area.

Table 3- 3: Key receptors within the key study areas (medical and health care receptors)

	Within Greater Manchester	Within the M60	Within the IRR
Hospitals/hospice	134	23	0
Care homes	1,080	238	0
Dentists	271	48	2
GPs/Clinics	379	176	12

As shown in Table 3- 3, there are a total of 134 hospitals/hospices within Greater Manchester, 23 of which are located within the M60 cordon. These are also shown in Figure 16 (Appendix A). There are no hospitals or hospices located within the IRR. For those located within the M60, the hospitals promote use of public transport due to the congested nature of the city and high demand for parking at the hospitals. The hospitals do not provide unique transport services for users however they recommend community transport providers within the city such as Ring and Ride, Local Link and Transport for Sick Children.

Additional health care receptors were considered, such as stroke centres and mobile cancer care units, but insufficient relevant information was available. The locations of care/nursing homes are shown in Figure 17 (Appendix A).

Table 3- 4 shows the number of micro, small, medium and large businesses within the key study areas.

Table 3- 4: Key receptors within the key study areas (economic receptors) (Nomis, 2018)

Business Type	Greater Manchester		Within the M60		Within the IRR	
	Count	%	Count	%	Count	%
Micro (0-9 employees)	104,000	83.9%	38,600	83.0%	10,500	81.4%
Small (10-49 employees)	15,805	12.9%	6,100	13.1%	1,900	14.7%
Medium (50-249 employees)	3,555	3.2%	1,500	3.2%	500	3.9%
Large (250+ employees)	500	0.4%	200	0.4%	100	0.8%
Total	124,000	100%	46,500	100%	12,900	100%

As shown in Table 3- 4, within Greater Manchester there are over 104,000 micro businesses, employing less than 10 employees per business. Within the IRR, micro businesses still dominate with over 10,500 total businesses in the city centre. Similarly, there are over 15,800 small businesses within Greater Manchester, 6,100 of which are located within the M60 and 1,900 within the IRR. Further information on SMEs is provided in section 3.12.4.

The business profile of Greater Manchester is broadly in line with the national averages for each business type: 84.6% micro, 12.4% small, 2.6% medium and 0.4% large. The greatest deviation from this profile is within the IRR, where there is a slight shift away from micro businesses, and a larger proportion of small, medium and large businesses.

3.4 Population demographics

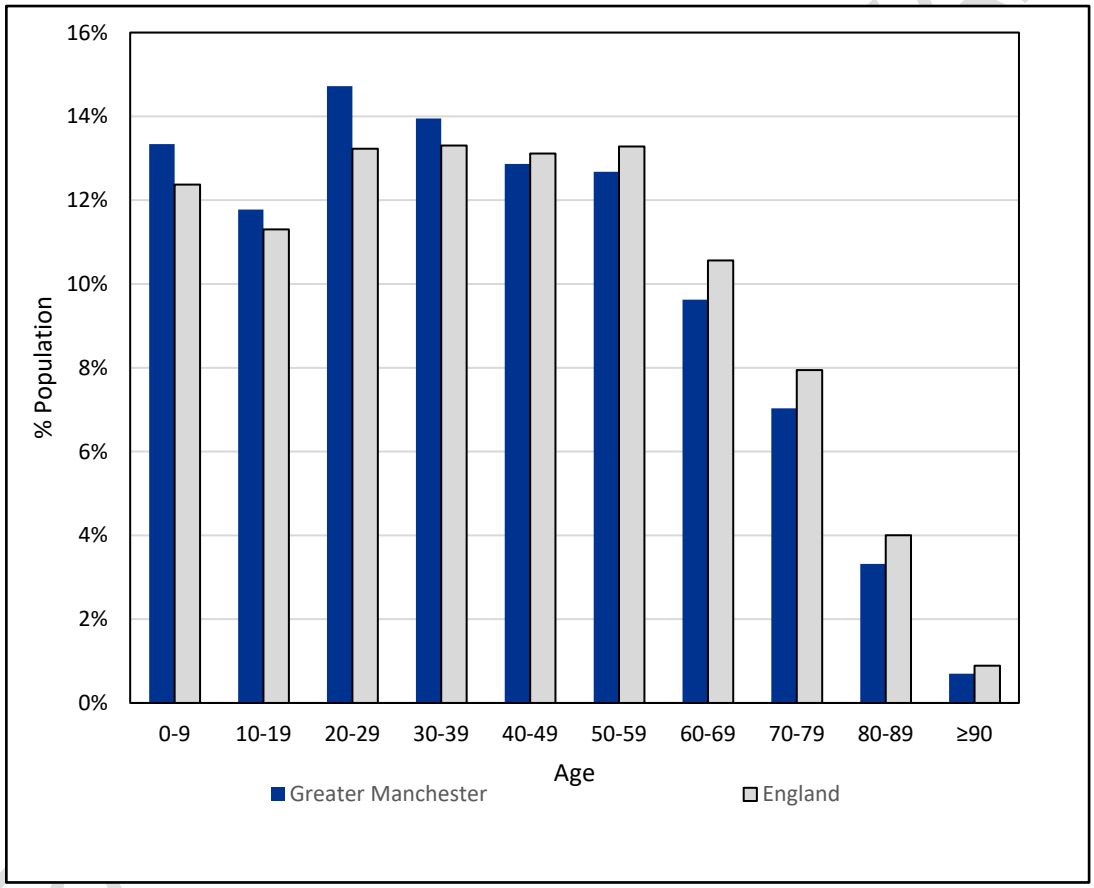
3.4.1 Population density

Population density per hectare across the study area is presented in Figure 27 (Appendix A). As can be seen from the figure, most of the LSOA within the IRR have a relatively high population density, with several pockets of very high population density (more than 125 people per hectare). Outside of the IRR, population density is higher in the vicinity of the major urban centres, such Oldham and Bolton. In general, population density is relatively low at the furthest edges of the Greater Manchester boundary.

3.4.2 Age profile

Image 3- 1 shows that the population is evenly spread across the different age bands from 20 to 59 for Greater Manchester and England. There are more people in their 20s living in Greater Manchester than the national average (15% compared to 13%). This is also true of the 0-9, 10-19 and the 30-39 age bands, although the difference for these four bands is not more than a couple of percentage points. In all age bands beyond the age of 39, the proportion of people in Greater Manchester is lower than the national average (ONS, 2017e).

Image 3- 1: Age profile of Greater Manchester and England (ONS, 2017e)



3.5 Children

3.5.1 Greater Manchester overview

Within Greater Manchester, there are approximately 565,000 people under the age of 16 (ONS, 2016a). This equates to 20% of the population of Greater Manchester. Table 3- 5 shows the distribution of children under the age of 16 across Greater Manchester compared to England and Wales.

3.5.2 Travel to education

Table 3- 5 shows that in the North West region, more children walk to school (42%) than are driven by an adult (35%).

Table 3- 5: Mode of transport to travel to schools in the North West (DfT, 2017c)

Area	Mode of transport to travel to school			
	Walk	Car	Bus	Other
North West	42%	35%	14%	1%
England	45%	34%	12%	1%

Children, or people with children, may place greater value on the availability of routes closer to home, lower priced fares and higher frequency services than other groups. Increased costs because of a transport intervention could affect the ability of children to travel to school. Image 3- 2 shows that the main mode of travel to education within Greater Manchester between 2013-2015 is by foot followed by passenger in a car/van.

Image 3- 2: Method of travel to school (TfGM Travel Diary Surveys, 2013-2015)

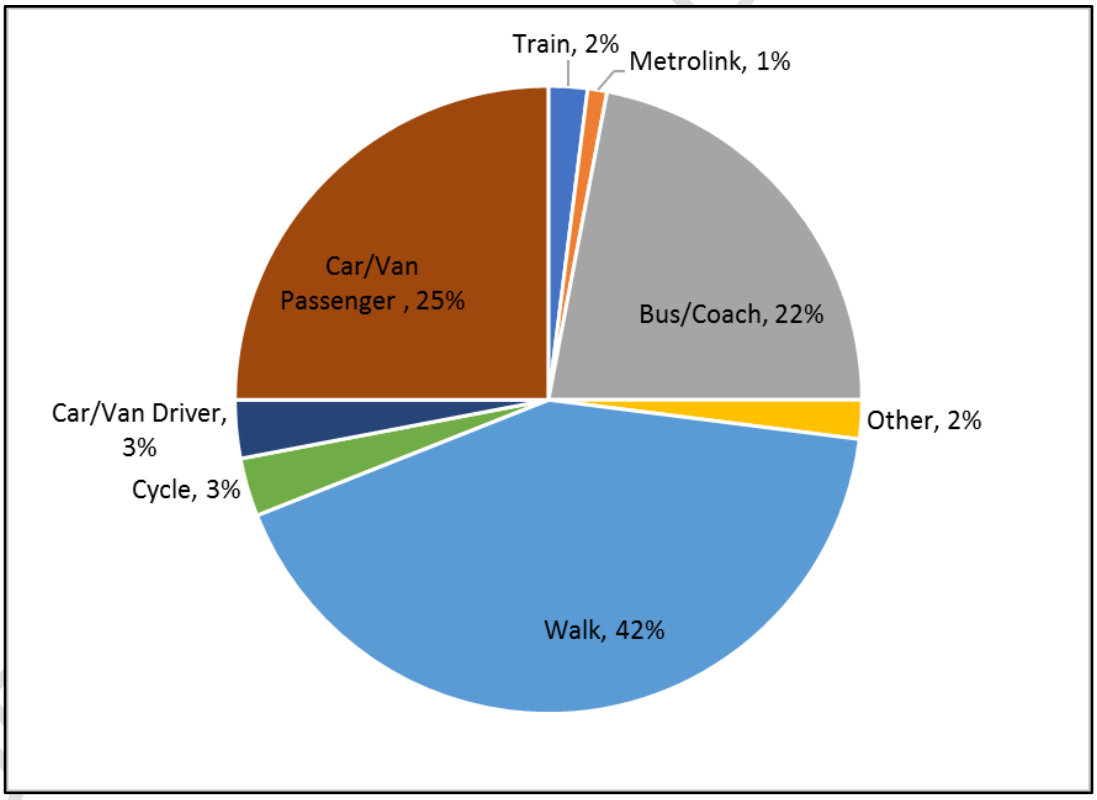


Table 3- 6 shows how the method of travel to education differs between age bands in Greater Manchester. For those in secondary school, college and university, bus or coach is the predominant mode of travel (TfGM, 2017). TfGM fund a Yellow School Bus program to help pupils aged 11 to 16 get to and from several Greater Manchester secondary schools. The cost of a ticket on these services is £1.35 for a single and £2.30 for a return. Weekly tickets can be bought for £7.30. For those aged between five and ten, the predominant form of transport is by foot, followed by passenger in a car/van (TfGM, 2017).

Table 3- 6: Main mode of travel to education by age range (TfGM Travel Diary Surveys, 2013-2015)

Main mode of travel to Education	Age Band					
	5 to 10	11 to 16	17 to 18	19 to 21	22 to 25	26+
Walk	53.5%	29.5%	22.0%	18.8%	18.1%	12.5%
Cycle	0.8%	1.6%	2.4%	10.7%	22.3%	8.3%
Car/Van Driver	0.0%	0.0%	3.1%	10.8%	10.9%	31.0%
Car/Van Passenger	32.7%	18.5%	11.8%	6.5%	8.2%	5.0%
Train	0.1%	0.6%	5.4%	10.5%	6.6%	8.0%
Metrolink	0.7%	2.3%	2.6%	3.2%	0.0%	1.5%
Bus/Coach	11.1%	45.0%	50.7%	36.2%	33.0%	28.4%
Study mainly at home	0.0%	0.0%	0.0%	0.8%	0.9%	1.0%
Other	1.1%	2.5%	2.0%	2.5%	0.0%	3.4%

3.5.3 Special needs schools

Within the Manchester City Council area there are 14 schools for those with special educational needs. Eleven of these are located within the M60 cordon. A further three are located outside of the M60 boundary within Greater Manchester. Of these schools, one organises daily transport to and from the school for its students. The remaining schools rely on the Greater Manchester Travel Co-ordination Unit. This unit is responsible for providing unique travel solutions to children who need extra assistance. They look after 1,100 children per day, using over 250 routes and various travel solutions (Manchester City Council, 2018a). There are no special needs schools located within the IRR.

3.5.4 Youth centres

There are three main youth centres within the Manchester city council region, two of which are located within the M60. A further eight youth clubs are listed on the Manchester City Council website. Whilst most do not provide transport to and from the youth centre, it is assumed that a number of these own or rent minibuses or community transport vehicles for events and activities. Often youth groups such as these are funded either partially or fully by charitable donations. They are therefore unlikely to have cash reserves available to upgrade fleet or afford increasing costs which may be associated with clean air measures.

3.5.5 Children's hospitals

Greater Manchester is home to Royal Manchester Children's Hospital. This is located on Oxford Road to the south of the IRR. The hospital is easily accessible from several public transport links within the city centre. There is also a free park and ride service in which people can park at dedicated sites and take a free shuttle bus to the hospital. For those with special requirements, there are a range of accessible transport options.

Transport for Sick Children is a registered charity which helps children living within Greater Manchester access essential health care. This includes help for families living in deprivation and those unable to drive. The charity receives funding from the NHS, Clinical Commissioning Groups, small community groups and individuals.

3.6 Elderly

3.6.1 Greater Manchester overview

Within Greater Manchester, there are approximately 411,000 people over the age of 65 (ONS, 2016a). This equates to 15% of the population of Greater Manchester. This is lower than the average for England and Wales of 17.2%. Older people are less likely to drive and more likely to be dependent on public or community transport that offers door to door usage, or lifts from family and friends.

By 2021, Greater Manchester's population is predicted to increase by 3%. The number of people aged over 70 is predicted to increase by 12.5% during the same period.

3.6.2 Community Transport

Greater Manchester offers a wide range of services to help older people and disabled people get access to transport to get around the city. Key services include 'Ring and Ride', a door to door accessible minibus service for people of all ages who find it hard to use public transport and 'Local Link', which offers low-cost flexible transport solutions in areas where public transport is limited or unavailable. Ring and Ride costs up to £3 for those with an over-60 pass, and Local Link costs £2.60 for a single adult journey. Other services include Manchester Community Transport, the largest non-publicly funded community transport operator in Greater Manchester.

3.6.3 Isolation/Loneliness

Age UK identify loneliness as one of the major factors older people worry about (Age UK, 2015). Personal circumstances such as poor health, living alone and lack of support can all contribute to feelings of loneliness which has a secondary effect on a person's wellbeing (ONS, 2015). A study of three English Cities, including parts of Manchester, identified that 16% of older people reported being severely lonely (Scharf et al., 2002). Another study found that 10% of the population aged over 65 are lonely all or most of the time (Victor C., 2011).

According to the 2011 Census, within Greater Manchester there approximately 211,000 households containing someone aged 65 and over; 64% of these are one-person households. This equates to 12% of the population of the study area living alone.

According to mid-year population estimates, 191,768 people in Greater Manchester are over the age of 75, which constitutes 6.9% of the Greater Manchester population.

3.7 Disability

Under the Equality Act (2010), disability refers to people who have a physical or mental impairment that has a 'substantial' and 'long-term' negative effect on their ability to do normal daily activities. It is recognised that people with disability are less likely to drive and more likely to be dependent on public transport (including taxis and PHVs), community transport that offers door to door usage, or lifts from family and friends.

3.7.1 Greater Manchester overview

Within the study area there are approximately 521,000 people with a long-term health problem or disability (Nomis, 2011d). This equates to approximately 19% of the population of the study area. Amongst these, approximately 264,000 state that their disability limits their day to day activities a lot, and 258,000 state that their disability limits their day to day activities a little (Nomis, 2011d).

3.7.2 Blue Badges

'Blue Badges' are parking badges for disabled people issued by local authorities to individuals and organisations concerned with the care of disabled people. Once a Blue Badge is issued, it remains valid for three years.

In 2017, Greater Manchester issued a total of 47,212 Blue Badges (DfT, 2018). This equated to 49% of the total Blue Badges issued in the North West (DfT, 2018).

Evidence from the London Ultra Low Emission Zone (ULEZ) project suggests that the average age of a blue badge registered petrol vehicle entering the London Congestion Charge Zone was eight years (Jacobs, 2014). In 2011, the average age of a blue badge diesel vehicle was five years.

3.7.3 Wheelchair accessible taxis

As stated above, disabled drivers occasionally require specific vehicles adjusted to their needs. For those who don't drive, there is an increased dependence on wheelchair accessible forms of public transport including taxis and PHVs. PHVs are any vehicle that seats up to eight passengers and are available to hire with a driver. These must be booked with a licensed private hire operator.

Overall, in 2017, 86% of the total taxis within the Greater Manchester region were accessible to wheelchair users, this is higher than the average for England (58%). Only 1% of the total PHVs in Greater Manchester were wheelchair accessible. Since WAVs are more expensive than standard vehicles, these types of adapted vehicles tend to be kept or leased by their owners for longer than non-adapted vehicles.

3.8 Low Income Households

The Index of Multiple Deprivation (IMD) provides a measure of relative deprivation across England. The deprivation ranking refers to the population weighted average of the combined ranks for the LSOAs in each district.

Income deprivation is one of seven domains of deprivation. Measures of income deprivation are concerned with people on low incomes who are in receipt of benefits and tax credits (DfT, 2015). It is not an absolute measure of household income and therefore it does not reflect household income in a given area, nor does it cover the distribution of that income across its resident population. Whilst it effectively captures concentrations of low income households it does not identify areas of affluence. For example, an area with a relatively small proportion of people on low incomes may also have relatively few or no people on high incomes (DfT, 2015).

3.8.1 Greater Manchester overview

Greater Manchester contains 348 of the 3,284 top 10% most deprived LSOA's in England. This equates to just over one fifth of Greater Manchester's LSOAs in the 10% most deprived in the country. Within Manchester city council, 18 LSOAs are within the top 1% most deprived nationally. Within the IRR, 53% of the LSOAs fall within the top 30% most deprived in the country.

Two figures have been produced to show the distribution of income deprivation across Greater Manchester; Figure 5 (Appendix A) maps income deprivation based on the distribution of income deprivation across the whole of England and Wales. Figure 6 (Appendix A) is reflective of the distribution of income deprivation across Greater Manchester.

Figure 5 (Appendix A) shows that the greatest levels of deprivation are focused around Manchester city centre, and districts located to the centre and north of GM including: Rochdale, Bury, Wigan, Oldham and Salford. These areas fall within the first quintile of income deprivation on a national scale. To the south of Greater Manchester, Wythenshawe and the residential area near Manchester Airport are also shown to display high levels of income deprivation within the first quintile.

Figure 6 (Appendix A) shows that the greatest levels of deprivation are concentrated around Manchester city centre/Salford and districts to the north of Greater Manchester including: Bolton, Rochdale and Oldham. Pockets of deprivation are also evident in Wythenshawe and Wigan. The greatest levels of deprivation within Manchester city centre are located between the IRR and M60 with areas within the IRR itself displaying relatively low levels of income deprivation.

3.8.2 Car/van availability

Table 3- 7 shows household car/van availability in Greater Manchester. This data includes company cars and vans that are available for private use. It does not include motorbikes, scooters or any cars or vans belonging to visitors. The table shows that within Greater Manchester, most households (43%) have one car or van per household. Within the M60, most households have either no car/van (40%) or one car/van per household (42%). Once within the IRR, most households have no car/van (59%) (Nomis, 2011a).

Table 3- 7: Household car/van availability in Greater Manchester (Nomis, 2011a)

	Greater Manchester		Within M60		Within IRR	
	Total number of households	**% of households**	**Total number of households**	**% of households**	**Total number of households**	**% of households**
No cars or vans in household	345,000	31%	134,000	40%	7,500	59%
1 car of van in household	482,000	43%	139,000	42%	4,500	35%
2 car or van in household	245,000	22%	50,000	15%	700	5%
3 car or van in household	44,000	4%	8,000	2%	69	1%
4+ car or van in household	12,000	1%	2,000	1%	14	0%

3.9 Gender

This section looks at gender differences that could potentially drive distributional effects on men or on women, i.e. where differences in travel patterns between men and women could result in differential impacts between the two groups. For example, personal safety on public transport is more of a concern for women than for men, particularly when travelling at night (TfL, 2016; Sustrans, 2018).

The total number of women within the study area is approximately 1,400,000; this equates to approximately 20,000 more women than men (ONS, 2016a). Figure 10 (Appendix A) shows the distribution of the female population across the study area compared to the distribution of females across England and Wales.

3.9.1 Employment and the gender pay gap

Table 3- 8 presents the gender pay gap for all occupations in the UK in 2017. In every occupation category women, were on average paid less per hour for the same occupation than men. This difference was greatest in 'Chief Executive and Senior Official' occupations where women are paid on average £12.24 per hour less than men. The occupation with the closest average hourly pay was found in the 'Caring, Leisure and Other Service' occupations, where women earn on average 39p less than their male counterparts (Nomis, 2017a).

Table 3- 8: Difference in median gross hourly pay between men and women, UK (Nomis, 2017a)

Occupation	Median gross hourly pay (excluding overtime)		
	Male (£)	Female (£)	Gender Pay Gap
Chief Executives and Senior Officials	47.40	35.16	12.24
Managers and Directors	23.18	19.99	3.19
Other Managers & Proprietors	14.65	13.57	1.08
Professional Occupations	21.29	19.08	2.21
Associate Professional and Technical Occupations	16.48	14.11	2.37
Administrative and Secretarial Occupations	11.51	10.49	1.02
Skilled Trades Occupations	12.15	8.84	3.31
Caring, Leisure and Other Service Occupations	9.41	9.02	0.39
Sales and Customer Service Occupations	8.76	8.29	0.47
Process, Plant and Machine Operatives	10.50	8.49	2.01
Elementary Occupations	8.63	7.83	0.80

The TfGM Gender Pay Gap report found that there was a difference of 11.3% in the hourly average rate of pay between men and women (TfGM, 2018). This suggests that Manchester and other large cities in the UK may experience a similar pattern to the UK, with men on average earning more than women across different occupations. As men on average are earning more, this may influence their choice of transport around the city. They may choose to use more expensive modes of transport compared to women, e.g. a taxi instead of a bus.

Table 3- 9 shows that both men and women chose to drive on most trips. However, more women tend to be passengers than men. Marginally more women chose to walk (26.9%) on trips compared to men (25.3%), whereas more men choose to cycle (2.5%) than women (0.9%).

Table 3- 9: Average number of trips by mode of transport for men and women in the UK (DfT, 2017b)

Main mode	Average trips per person per year			
	Male	Percent	Female	Percent
Walk	240	25.3%	269	26.9%
Bicycle	24	2.5%	9	0.9%
Car/van driver	412	43.5%	369	36.9%
Car/van passenger	162	17.1%	245	24.5%
Other private transport	7	0.8%	5	0.5%
Local and non-local buses	34	3.6%	43	4.3%
Rail	24	2.5%	18	1.8%
Taxi/minicab	8	0.8%	10	1.0%
Other public transport	4	0.4%	4	0.4%

3.9.2 Modes of transport

The National Transport Survey found that in 2017, women made six times more trips than men, but men travelled 16% further. In general, the survey found that women make more trips for shopping and the 'school run', which tend to be relatively short, whereas men make more commuting trips. For trips made by car, men made a higher share of trips as driver (44%) compared to women (37%) (DfT, 2017i).

DfT data from 2017 shows that women are slightly more likely to use taxis and PHVs than men (DfT, 2017). Due to concerns over safety, it is anticipated that women travelling into the city centre during anti-social hours for work or social purposes are likely to use taxis.

Transport for London (TfL) conducted a study of late night travel options looking at the use of un-booked minicabs (i.e. those minicabs that are not pre-booked) and perceptions towards un-booked minicabs. It was identified that one of the main reasons women chose this method of transport was due to a lack of available alternatives (TfL, 2016). The use of buses as an alternative transport mode has been steadily decreasing while the number of women choosing to walk from venues to their next destination has increased. In large urban area such as Manchester, walking is also likely to be a popular method of transport. Safety concerns were also highlighted as a key factor in discouraging women from un-booked minicabs.

3.9.3 Religion

Figures from the 2011 Census show that 73% of the population of Greater Manchester have some religious affiliation. The main religions/beliefs in Greater Manchester are Christian (62%) and Muslim (9%), followed by Jewish (1%) and Hindu (1%). Within the IRR, the main religions/beliefs are Christian (73%) followed by no religion (17%), those who have not stated a religion (6%) and Muslim (3%) (Nomis, 2011b).

As illustrated in Figure 18 (Appendix A), there are 541 religious sites across Greater Manchester. This includes registered places of worship, church halls and religious communities. 186 of these are located within the M60 boundary and six are registered within the IRR. Key religious centres within Greater Manchester include the Jewish community located in Broughton, Salford, which is now the second largest Orthodox Jewish community in the UK. This is situated within the M60 to the North of Manchester centre.

Muslim communities are centred around the areas of Rusholme and Fallowfield towards the South of the city centre. This includes Manchester Islamic Centre located just outside the IRR between the main university campuses in Manchester. This centre holds over 30 religious and educational programs and conferences annually, attracting visitors from across Manchester and the UK. Similarly, this area is home to several Mosques including Shahjalal Mosque and Islamic Centre, Manchester Central Mosque and Shahporan Mosque.

To the north of the city centre, Manchester Buddhist centre is home to a large Triratna Buddhist community with a small residential community. Manchester city centre is also home to Manchester Reform Synagogue, attracting a large Jewish community.

3.10 Ethnicity

The Black, Asian and Minority Ethnic (BAME) community encompasses all those of non-white decent. For the purposes of this study, BAME communities are defined as those who identify as Asian, Black or Minority Ethnic.

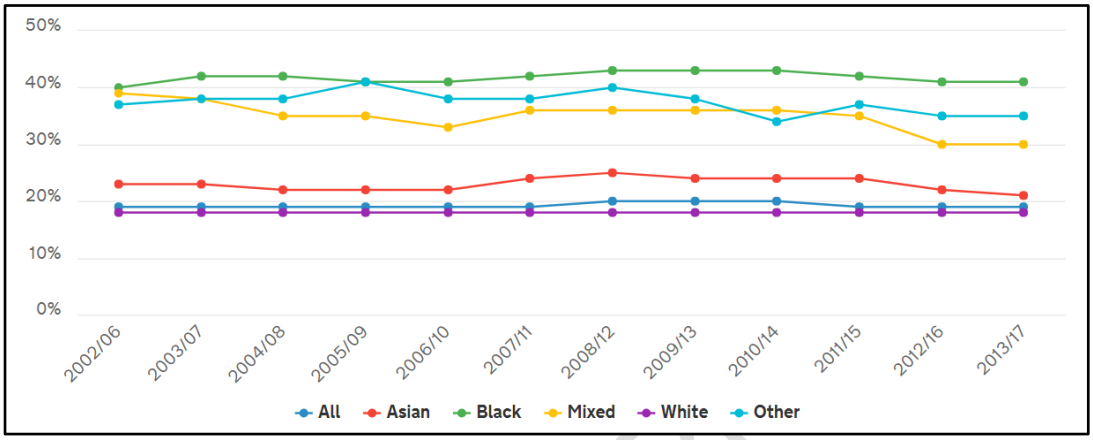
Within Greater Manchester, high concentrations of BAME communities reside around the main centres of Bolton, Bury, Rochdale, Oldham and Ashton-Under-Lyne. Similarly, within the centre of Manchester, there are large numbers of BAME residents located to the north towards Broughton and to the south and south east in Old Trafford, Hulme and Ardwick. The distribution of BAME residents compared to the distribution across England and Wales is shown in Figure 11 (Appendix A).

Overall, the proportion of White residents in Greater Manchester has decreased from 81% in 2001 to 67% in 2011. This compares to a national average in 2011 of 85%, and an average of 90% for the North West region.

3.10.1 Access to a car/van by ethnic group

Image 3- 3 shows the percentage of people aged 17 and over with no access to a car or van, by ethnicity, between 2002 and 2017.

Image 3- 3: Percentage of people aged 17 and over with no access to a car or van, by ethnicity over time (DfT, 2017)



The graph shows that in every period from 2002/6 to 2013/17, White people were more likely to live in a household with access to a car or van than any other ethnic group. The graph also shows that Black people were most likely to have no access to a car or van out of all ethnic groups (at 41%), followed by people from the Other ethnic group (at 35%), people with Mixed ethnicity (at 30%), Asian people (at 21%), and White people (at 18%). For most groups, this figure has remained broadly similar since the 2002/06 figure.

3.10.2 Travel patterns by ethnic groups

The list below provides a brief overview of travel trends from the National Travel Survey (2017):

- In the period from 2013 to 2017, White people travelled the greatest distance and made the most trips and Black people travelled the smallest distance and made the fewest trips (DfT, 2017i).
- 79% of the distance travelled by White people was by car or van, compared to 54% of the distance travelled by Black people (DfT, 2017i)
- Black people were most likely to have no access to a car or van out of all ethnic groups (41%), followed by people from the Other ethnic group (35%), people with Mixed ethnicity (30%), Asian people (21%), and White people (18%) (DfT, 2017i).
- Between 2013 to 2017, White people made the highest percentage of trips by car or van out of all ethnic groups (64%), while Black people made the lowest percentage of trips by car or van (40%) (DfT, 2017i).
- Black people made the highest percentage of trips by local bus out of all ethnic groups (21%) (DfT, 2017i).

3.11 Health

3.11.1 Health in the UK

Daily physical activity is hugely important for maintaining health (Department of Health, 2011), and inactivity directly contributes towards one in six deaths in the UK (Lee et al., 2012). It is estimated that physical inactivity costs the UK approximately £7.4 billion per year when the impact on NHS, social care, sickness absence from work and other factors are considered (PHE, 2016). The costs to business of absenteeism and presenteeism (working whilst sick can cause productivity loss and further poor health) are significant. In 2014, the cost of absences was approximately £14 billion (Confederation of British Industry/Pfizer, 2013), of which approximately £5 billion can be attributed to physical inactivity (Sustrans, 2017). The costs of presenteeism may be even more (Centre for Mental Health, 2011).

High traffic volumes and speeds can reduce opportunities for positive contacts with other residents in a neighbourhood, contributing towards increased social isolation and reduced community cohesion (Appleyard, 1981; Hart and Parkhurst, 2011). Individuals who are socially isolated are more likely to make use of public services due to lack of support networks and have increased likelihood of developing certain health conditions such as depression and dementia (Social Finance, 2015). They are also more likely to be physically inactive (Social Finance, 2015), which is again linked to increased likelihood of developing certain diseases as discussed above. People experiencing high levels of social isolation have significantly higher mortality levels than those with low or average levels of isolation (Steptoe et al., 2013). It has been estimated that better community cohesion could save the UK around £530 million per year (Public Health England (PHE), 2017).

3.11.2 Health in Greater Manchester

Greater Manchester has significant health inequalities across the region (GMCA, 2017b). For example, in Manchester city council, LE is 8.1 years lower for men and 7.0 years lower for women in the most deprived areas than in the least deprived areas (PHE, 2018c). Similarly, figures show that there are 3.5 times as many premature deaths (deaths under the age of 75) in the most deprived parts of Manchester (primarily in the north east of the city and in parts of Wythenshawe) compared with the least deprived parts (Manchester City Council, 2018).

Table 3- 10 shows how Greater Manchester compares to the North West and England average across a broad range of health indicators. The table shows that overall, Greater Manchester performs worse than the England average for all indicators except statutory homelessness, diagnoses of dementia, diabetes and cancer, and the number of residents killed and seriously injured on the roads.

Table 3- 10: PHE health profile summary[9] (PHE, 2018)

	Year	England	North West	GMCA
LE at birth (Male)	2014 - 16	79.5	78.2	77.8
LE at birth (Female)	2014 - 16	83.1	81.7	81.3
Under 75 mortality rates: all causes	2014 - 16	334	394	415
Under 75 mortality rates: cardiovascular	2014 - 16	73.5	87.8	97.3
Under 75 mortality rates: cancer	2014 - 16	136.8	151.4	157.3
Suicide rate	2014 - 16	9.9	11	10.5
Killed and seriously injured on roads	2014 - 16	39.7	39.8	24.8
Hospital stays for self-harm	2016/17	185.3	231.2	207.1
Hip fractures in older people (aged 65+)	2016/17	575	612	631
Cancer diagnosed at early stage	2016	52.6	51.9	54.3
Diabetes diagnoses (aged 17+)	2017	77.1	81	-
Dementia diagnoses (aged 65+)	2018	67.5	72.2	76.3
Alcohol-specific hospital stays (under 18s)	2014/15 - 16/17	34.2	49.6	48
Alcohol-related harm hospital stays	2016/17	636	719	679
Smoking prevalence in adults (aged 18+)	2017	14.9	16.1	17.5
Physically active adults (aged 19+)	2016/17	66	65.1	64.6
Excess weight in adults (aged 18+)	2016/17	61.3	63.6	63.3
Under 18 conceptions	2016	18.8	22.3	22.3
Smoking status at time of delivery	2016/17	10.7	13.4	12.5
Breastfeeding initiation	2016/17	74.5	64.5	66.3[10]
Infant mortality rate	2014 - 16	3.9	4.5	4.7
Obese children (aged 10-11)	2016/17	20	20.8	21.6
Deprivation score (IMD 2015)	2015	21.8	-	-
Smoking prevalence: routine and manual occupations	2017	25.7	26	28.8
Children in low income families (under 16s)	2015	16.8	18.7	20.1
GCSEs achieved	2015/16	57.8	56.6	56.1
Employment rate (aged 16-64)	2016/17	74.4	71.8	70.6
Statutory homelessness	2016/17	0.8	1.1	0
Violent crime (violence offences)	2016/17	20	21.2	24.3
Excess winter deaths	2013-2016	17.9	18	17.7
New sexually transmitted infections	2017	794	718	802
New cases of tuberculosis	2014 - 16	10.9	8.4	13.8[11]

[9] Orange cells reflect health outcomes which are worse than the England average. Green cells reflect health outcomes which are better than the England average. White cells reflect areas in which there is no data available.

[10] This number is aggregated from all known lower geography values.

[11] This number is aggregated from all known lower geography values.

In 2016, the Health and Social Care Partnership produced the Devolution Difference, which aims to improve health and social care within the communities of Greater Manchester (GMCA, 2016b). Measures include:

- Helping 115,000 smokers quit over the next three years;
- Spending £74 m on child and adolescent mental health;
- Spending a further £50 m on adult mental health services; and
- Spotting and treating dementia quicker.

Greater Manchester also runs a programme for dementia care called 'Dementia United'. Current estimates suggest that by 2021, there will be 34,973 people living with dementia in Greater Manchester. Nearly, a third of these people have severe symptoms requiring 24-hour care. Currently Greater Manchester spends £221m a per year on dementia across health and social care. In 2016, the dementia diagnosis rate was 87.13%. Predictions suggest spending on dementia would rise to £320m a year with more accurate diagnosis (GMCA, 2015).

Similarly, there are 3,981 people in Greater Manchester in contact with mental health services for every 100,000 of the population, compared to 2,176 nationally. This is often tied into a wider set of issues for families for example, 18% of secondary care patients in Manchester city council are not in stable accommodation. Currently, people with chronic mental health illnesses in Greater Manchester are likely to die 15 years earlier than people in other areas (Greater Manchester Health and Social Care Partnership, 2016). Greater Manchester's Mental Health Strategy works to address issues identified across the region.

Table 3- 11 outlines how Greater Manchester compares to the England average for respiratory and heart disease related health outcomes. The table shows that overall, Greater Manchester performs worse than the England average. In 2016/17, prevalence of COPD amongst Greater Manchester residents was 2.3%, higher than the England prevalence rate of 1.9%. Similarly, the total number of COPD admissions in Greater Manchester is 2.84 (per 1,000 population), higher than the average for England of 2.15 (PHE, 2018).

Table 3- 11: Respiratory and heart disease related health outcomes (PHE, 2018).

	England	Greater Manchester
Under 75 mortality rates from respiratory disease (per 100,000 population)	33.8	47.5
COPD prevalence	1.9%	2.3%
COPD admissions (per 1,000 population)	2.15	2.84
Deaths from COPD (per 100,000 population)	52.2	72.1
Hospital admissions for asthma (under 19) (per 100,000 population)	202.8	301.5
Under 75 mortality rate from heart disease (per 100,000 population)	39.4	56.2

3.12 Economy

Business size is a key factor that would determine how businesses are affected by charges associated with the implementation of clean air measures. Businesses with lower number of employees, especially micro, small and medium size enterprises have less capacity to adapt to financial pressures linked to clean air measures. Larger businesses tend to be more resilient since they have more resources and can spread any costs incurred over a larger customer base. Smaller businesses tend to be less resilient to a shifting economic landscape due to limited options to diversify or increase productivity and fewer cash reserves.

The following section describes the economic context of the study area, including the location and sector of operation of small medium enterprises (SMEs), employment statistics and travel to work patterns. SMEs are micro, small and medium sized enterprises (SMEs) which employ fewer than 250 persons. SME's represent 99% of all businesses in the European Union (EU) (European Commission, 2018).

3.12.1 Economic context

The Greater Manchester economy generates £56 billion of Gross Value Added (GVA) on an annual basis. This is higher than the GVA of the North East (£46 billion), West Yorkshire (£46 billion), and accounts for nearly 40% of the total GVA in the North West (ONS, 2017a). The Greater Manchester Forecasting Model (GMFM), produced by Oxford Economics, benchmarks the anticipated level of growth of the Greater Manchester economy (GMCA, 2017c). This forecast shows GVA growing at 1.7% per annum up to 2035.

3.12.2 Economic activity

Table 3- 12 presents the economic activity of people in the three key study areas (Nomis, 2011g). Levels of unemployment and retirement are lowest within the IRR at 2% and 1% respectively.

Table 3- 12: Economic activity (Nomis, 2011g)

Study areas	Economically active (%)	Part-time employment (%)	Full-time employment (%)	Unemployed (%)	Retired (%)
Within the IRR	60%	3%	36%	2%	1%
Within the M60	65%	11%	35%	5%	9%
Greater Manchester	68%	13%	38%	5%	13%

3.12.3 Business counts

As set out in Table 3- 4, there are approximately 124,000 businesses in Greater Manchester. Table 3- 4 presents the number of businesses within Greater Manchester, the M60 and the IRR by size. Most of businesses within the three study areas are micro i.e. they have fewer than ten employees. As you move inside the IRR the proportion of medium and large businesses increase. However, within the IRR, the majority (96.1%) of the businesses are either micro or small (Nomis, 2018).

3.12.4 SMEs

Table 3- 13 presents the number of SMEs by industry in the key study areas. The largest number of SMEs within the M60 are professional, scientific & technical businesses (17%), closely followed by retail (16%). The industries that are most likely to be reliant upon LGVs and HGVs are retail, wholesale and transport & storage, constituting 25% of businesses with the M60 and 37% of businesses within the IRR. Within the IRR, most SMEs are within the retail industry (33%), then the professional, scientific & technical industry (22%). Of the total businesses within Greater Manchester 87% are SMEs, this decreases to 84.7% within the M60 and 78.8% within the IRR (Nomis, 2017b).

Table 3- 13: SMEs by industry in key study areas (Nomis, 2017b)

Industry	Greater Manchester		Within the M60		Within the IRR	
	Count	%	Count	%	Count	%
Agriculture, forestry & fishing	695	1%	50	0%	5	0%

Industry	Greater Manchester		Within the M60		Within the IRR	
	Count	%	Count	%	Count	%
Mining, quarrying & utilities	465	0%	170	0%	40	0%
Manufacturing	5,640	6%	1,420	4%	150	2%
Construction	10,885	11%	2,870	8%	435	5%
Motor trades	2,985	3%	710	2%	35	0%
Wholesale	4,995	5%	1,945	5%	225	2%
Retail	11,105	11%	5,785	16%	3,065	33%
Transport & storage	5,285	5%	1,445	4%	140	2%
Accommodation & food services	5,545	6%	1,970	5%	495	5%
Information & communication	6,595	7%	2,710	7%	580	6%
Financial & insurance	3,280	3%	1,910	5%	260	3%
Property	3,875	4%	1,770	5%	420	5%
Professional, scientific & technical	16,725	17%	6,290	17%	2,000	22%
Business administration & support services	8,825	9%	2,950	8%	600	7%
Public administration & defence	15	0%	0	0%	0	0%
Education	1,545	2%	580	2%	105	1%
Health	5,630	6%	1,950	5%	180	2%
Arts, entertainment, recreation & other services	5,985	6%	1,870	5%	405	4%
Total	**100,090**	**100%**	**36,410**	**100%**	**9,150**	**100%**

3.12.5 Business Turnover

Table 3- 14 shows the number of businesses within each turnover size band. Across all key study areas, the majority of businesses (25-30%) sit within the £50,000-£199,000 a year turnover band. Within the IRR, approximately 19% of businesses are in the lowest turnover bracket of £0-£49,000 a year. Figure 25 (Appendix A) shows the locations of SMEs with a turnover of less than £200,000 per annum. The map shows that some of these businesses are located within the IRR. There is also a high concentration of SMEs with

this level of annual turnover within the Trafford Park retail area. Figure 26 (Appendix A) shows the locations of SMEs with a turnover of greater than £1 million per annum. The map also shows high concentrations of businesses in this category within the IRR.

Table 3- 14: Greater Manchester business counts by turnover size band (Nomis, 2017b)

Turnover band	Greater Manchester		Within M60		Within IRR	
0 to 49 (thousand £)	16,475	16%	6,785	19%	1,730	19%
50 to 99 (thousand £)	26,060	26%	9,200	25%	2380	26%
100 to 199 (thousand £)	29,960	30%	10,345	28%	2,400	26%
200 to 499 (thousand £)	11,720	12%	4,150	11%	1,005	11%
500 to 999 (thousand £)	6,995	7%	2,570	7%	705	8%
1,000 to 1,999 (thousand £)	3,965	4%	1,510	4%	395	4%
2,000 to 4,999 (thousand £)	2,955	3%	1,145	3%	335	4%
5,000 to 9,999 (thousand £)	1,165	1%	410	1%	110	1%
10,000 to 49,999 (thousand £)	925	1%	350	1%	105	1%
50,000+ (thousand £)	285	0%	95	0%	40	0%

3.12.6 Growth of enterprises and business innovation

Greater Manchester has two enterprise zones. One zone is located near Manchester Airport - Airport City Manchester. It totals 5 million sq. ft. once completed, will be filled with offices, hotels, advanced manufacturing, logistics facilities, hybrid and ancillary retail space. It has a total development value of £1billion (Airport City, 2018). This enterprise zone is expected to be popular with start-ups who will attract foreign customers due to the close location to Manchester Airport.

The second enterprise zone is located within the M60 – the Corridor Manchester Enterprise Zone. This comprises Manchester Science Park and Citylabs campuses. Health Innovation Manchester (a partnership with academia, industry and the NHS) plan to expand Citylabs to create a world-leading precision medicine campus. The project could support 1,500 jobs whilst also adding almost £150m to Manchester's economy over a decade (Health Innovation Manchester, 2018).

The Business Growth Hub supports different businesses at all stages of their journey, partially funded by the European Regional Development Fund. It currently supports 8,642 businesses across Greater Manchester with £166.9million secured in funding (Business Growth Hub, 2018).

In total, there are 2,043 companies providing environmental goods and services in Greater Manchester (Green Growth, 2018). Between 2012 and 2013, the green technology and service sectors in Greater Manchester assisted 13,594 businesses and created and safeguarded 8,314 jobs (Green Growth, 2018). In the same period, the low carbon and environmental goods services employed 38,000 people.

3.12.7 Business sectors

The location of key business sectors is also a key consideration when assessing the impact of clean air measures. It is assumed that business sectors that are heavily reliant on LGVs and HGVs, such as retail, wholesale and transport & storage, are likely to be more greatly impacted by clean air measures.

Outside of London, Greater Manchester is the UK's main centre for business, financial and professional services. This sector employs 324,000 and is expected to account for up to half of net additional job creation in Greater Manchester in the period to 2035 (totalling +88,800). The wholesale and retail trade is currently the largest employer in Greater Manchester. Similarly, the study area has the largest creative and digital clusters in the UK, employing 63,500 people and generating GVA of £3.1 billion each year. Key assets include MediaCity UK (home of the BBC and ITV) and The Sharp Project.

Within the M60 boundary, employees are evenly split across three industries: professional, scientific & technical (12.1%), business administration & support services (12.6%), and health (11.5%). Once inside the IRR, the professional, scientific and technical industry and the business administration and support sectors employ the greatest number of people (Nomis, 2016).

3.12.8 Visitor Economy

There are approximately 1.5 million international visitors to Greater Manchester each year making it the third most popular city for international visits after London and Edinburgh. A 2014 leisure visitor survey found that 42% of visitors were on a staying visit while 58% were day visitors to Greater Manchester. Within Manchester city centre this changed to 45% staying and 55% visiting during the day (Marketing Manchester, 2014).

According to STEAM, Greater Manchester's tourism sector is worth £7.9 billion and supports 94,000 jobs (Marketing Manchester, 2016a). Top attractions in Greater Manchester include The Lowry, the Museum of Science and Industry, Manchester Art Gallery, the National Football Museum and Manchester Museum. Manchester airport is also a key transport hub that continues to grow year on year handling close to 28 million passengers in 2017, up 8.5% from 2016 figures (Manchester Airport Group, 2018).

Table 3- 15 presents the top visitor attractions in Greater Manchester and the visitor number at these attractions in 2016.

Table 3- 15: Top Visitor Attractions and their Visitor Numbers in Greater Manchester (Marketing Manchester, 2016a)

Visitor Attraction	Visitor Number	Parking available (paid / free)	Coach parking available
The Lowry Theatre	846,097	On street	No
HOME	837,621	Discounted Q-Park	No
Museum of Science and Industry	651,473	No	No
Manchester Art Gallery	593,168	NCP car park nearby	No – only drop off
National Football Museum	481,541	Discounted Q-Park	No
Manchester Museum	406,997	Paid	No
Bolton Museum, Aquarium and Archive	354,653	NCP	No
Runway Visitor Park	338,450	Paid	Yes - fee
The Whitworth	321,269	On street parking	No
Manchester United Museum and Tour Centre	313,812	Free	No
Dunham Massey	285,637	Paid (free for members)	No
IWM North	281,919	Paid	Yes - fee
The John Ryland's Library	242,892	On street/NCP	No
East Lancashire Railway & Bury Transport Museum	201,916	On street	Yes - restricted
Manchester Cathedral	176,704	Discounted Q-Park	No
Portland Basin Museum	114,207	Free	No
Gallery Oldham	110,491	On street	No
Salford Museum & Art Gallery	104,701	Paid	No
People's History Museum	93,404	On street	No- only drop off

Most of these attractions ask that coaches do not park outside the attraction to avoid congestion. They suggest parking around the venue or in coach parking which is provided across the city.

A 2014 survey found that within Greater Manchester there were a higher number of incidences where visitors travelled with their family or with groups of friends (Marketing Manchester, 2014). Many of those that said they were travelling with a group of friends said they were attending a theatre show. Theatres within the IRR include the Palace Theatre and the Royal Exchange Theatre.

Other attractions/venues that may attract visitors include:

- The Bridgewater Hall;
- Hilton Manchester;
- Radisson Blue Hotel;
- Manchester Opera House;
- Albert Hall;
- Manchester Conference Centre;
- The University of Manchester Conferences and Venues;
- Princess St. Hotel;
- Midland Hotel;
- Manchester Marriott Victoria & Albert Hotel; and
- Manchester Coach Station.

Conferences and business events generate business through the hiring of the venue and accommodation bookings for conference attendees. A study showed that in 2015 4.5million delegates were hosted in Greater Manchester, with 1.9million of these staying overnight. These delegates were likely staying in central Manchester hotels close to the large conference centres (Marketing Manchester, 2016b). At the end of 2017 there were 9,350 accommodation rooms in Manchester City Centre. This includes rooms in hotels, B&Bs, self-catering units and serviced apartments. These are the most likely to be used by delegates using the Manchester Conference Centre due to the close location. The accommodation room count is expected to grow to 10,540 in 2018 (Marketing Manchester, 2018).

Manchester City Council provides coach parking within the IRR to allow coaches to pick up and drop off visitors close to city centre attractions. There is coach parking for short stays (20mins), medium stays (4 hours) and long stays (including overnight). In 2018, there are currently 5 short stay stands with 9 parking bays; 9 medium stay stands with 36 parking bays; and 3 long stay and overnight stands (Visit Manchester, 2018).

3.12.9 Night Time Economy in Manchester

In June 2018, Andy Burnham appointed Greater Manchester's first-ever night-time economy adviser. The role of the advisor will be to champion Greater Manchester's thriving nightlife and set out plans to ensure people on a night out can have a safe and enjoyable time.

In addition to the leisure and retail aspects of the Night Time Economy, the ONS defines the Night Time Economy as industry sectors that operate in the evening or night, although they may also operate during the daytime. These sectors have been identified using the Standard Industrial Classification (SIC) and include various types of accommodation and food services, retail, leisure, agriculture, manufacturing, health and social care, passenger transport, freight, storage, call centres, publishing and motion picture industries.

Data has been published by the ONS detailing the Night Time Economy in London and Manchester from 2001 to 2017 (ONS, 2018b). This is user-requested data, rather than a regular statistical publication.

In total, 43 sectors with 3-digit SIC codes have been deemed to be within the Night Time Economy, and have been mapped to four Night Time Economy categories:

- Cultural and leisure activities;
- Activities which support night time cultural and leisure activities;
- 24-hour health and personal social services; and
- Activities which support wider social and economic activities.

ONS data for the Night Time Economy in Manchester includes information on:

- The number of workplaces in the Night Time Economy by Manchester metropolitan districts and by middle super output area (MSOA), 2001 to 2017;
- The number of employees in the Night Time Economy by Manchester metropolitan districts, 2001-2017; and
- The percentages and numbers of Night Time Economy employee jobs in Greater Manchester paid less than the UK Living Wage, 2017.

3.12.10 Night Time Employment

In 2017, there were 27,070 workplaces in the Night Time Economy in Greater Manchester, a 11% increase from 2016. This is equivalent to 414,400 employees in the Night Time Economy in Greater Manchester in 2017.

Table 3- 16 shows the number of workplaces in the Night Time Economy in Greater Manchester broken down by the Night Time Economy Sub-category. In Greater Manchester, cultural and leisure activities account for a slightly higher share of the total Night Time Economy (37%) than at a national level (35%), along with 24-hour health and personal social services (13% and 10%, respectively). In contrast, activities which support wider social and economic activities account for 38% of the Night Time Economy in Greater Manchester, compared with 43% at a UK level.

Table 3- 16: The number of workplaces in the Night Time Economy in Greater Manchester by Night Time Economy Category, 2016 and 2017 (ONS, 2018b)

Night Time Economy Category	2016	2017	Change 2016 to 2017	Share of Night Time Economy, 2017
Cultural and leisure activities	9,645	9,990	4%	37%
Activities which support night time cultural and leisure activities	3,320	3,315	0%	12%
24-hour health and personal social services	3,075	3,435	12%	13%
Activities which support wider social and economic activities	8,340	10,330	24%	38%
Total	**24,380**	**27,070**	**11%**	

The ONS also publishes data on the number and percentage of jobs in the Night Time Economy which are paid less than the UK Living Wage, which was £8.45 in 2017 (ONS, 2017d).

Across any industry or occupation, almost 22% of employee jobs in Greater Manchester were paid less than the UK Living Wage. Across all Night Time Economy categories, this figure was higher at 30%; however, there was a significant variation across the individual Night Time Economy categories. More than half (55%) of employee jobs in the cultural and leisure activities sector were paid below the UK Living Wage in 2017, while the proportion was just 17% for 24-hour health and personal social services; the proportion was 44% for activities which support night time cultural and leisure activities, and almost 19% for activities which support wider social and economic activities.

There is a difference between the proportion of full-time and part-time employee jobs which are paid less than the UK Living Wage; around 14% of all full-time employee jobs in Greater Manchester are paid less than the UK Living Wage, compared with around 44% of part-time employee jobs. Across the Night Time Economy categories, the proportion for part-time employee jobs ranges from almost 74% for the cultural leisure activities category to around 27% for 24-hour health and personal social services.

Table 3- 17: Percentage of Night Time Economy employee jobs in Greater Manchester paid less than the UK Living Wage, held by those aged 18 or over, part-time and full-time, 2017 (ONS, 2017d)

Night Time Economy Category	All employees, percentage of jobs		
	Total	Full-time	Part-time
Cultural and leisure activities	55.4	35.7	73.9
Activities which support night time cultural and leisure activities	44.0	24.2	67.8
24-hour health and personal social services	16.8	13.0	27.3
Activities which support wider social and economic activities	18.8	14.7	39.0
Any Night Time Economy Category	29.5	18.3	52.6
All other industries	17.7	11.6	38.2
Total any industry or occupation	21.8	13.7	44.4

The proportion of employee jobs paid less than the UK Living Wage in the Night Time Economy varies by gender, with approximately 26% of male employees in Greater Manchester earning less than the UK Living Wage compared with 33% of female employees. For male employees, there is a greater difference between the proportion of full-time (17%) and part-time (61%) employee jobs in the Night Time Economy sector paid less than the UK Living Wage, compared with females (20% and 49%, respectively).

Table 3- 18: Percentage of Night Time Economy employee jobs in Greater Manchester paid less than the UK Living Wage, male and female, full-time and part-time, 2017 (ONS, 2017d)

Night Time Economy Category	Males employees, percentage of jobs			Female employees, percentage of jobs		
	Total	Full-time	Part-time	Total	Full-time	Part-time
Cultural and leisure activities	47.2%	28.8%	73.9%	64.5%	48.0%	73.9%
Activities which support night time cultural and leisure activities	30.8%	17.2%	60.8%	58.8%	38.1%	71.9%
24-hour health and personal social services	12.0%	10.1%	-	18.6%	14.5%	26.8%
Activities which support wider social and economic activities	17.1%	15.1%	-	22.9%	-	40.0%

Night Time Economy Category	Males employees, percentage of jobs			Female employees, percentage of jobs		
	Total	Full-time	Part-time	Total	Full-time	Part-time
Any Night Time Economy Category	25.5%	16.5%	61.0%	32.9%	20.4%	49.3%
All other industries	14.6%	11.5%	39.7%	21.1%	11.8%	37.7%
Total any industry or occupation	18.1%	12.9%	49.4%	25.5%	14.8%	42.6%

3.12.11 LGVs and HGVs

Manchester is a net importer of goods, importing 58 million tonnes to the region per year (TfGM, 2017). On average 17,000 goods vehicles make trips into Greater Manchester town centres each day.

LGVs are goods vehicles whose gross vehicles weight does not exceed 3,5 tonnes. In the UK, of the almost 4 million LGVs that were registered at the end of 2017, the majority of LGVs are diesel fuelled (96.4%), with only 3.3% petrol fuelled (DfT, 2017f). Diesel engines are popularly used for commercial businesses because they have a longer life and better fuel efficiency. These benefits are partially offset by the higher cost of a diesel engine and the cost of the fuel itself.

HGVs are vehicles such as lorries, busses and coaches. Large goods vehicles such as HGVs contribute a disproportionately large amount of NO_x emissions. HGV emissions are markedly worse at lower speeds; therefore, the ‘last mile’ of deliveries which are often close to key population centres, contribute greatly to the total emissions of the journey. The Greater Manchester Transport Strategy recognises the effect of this and aims to ensure increasing sustainability of freight, minimising the impact on the environment and communities of Greater Manchester.

3.12.12 Taxis

Table 3- 19 shows the number of taxis and private hire vehicles (PHV) within Greater Manchester. The table shows there are a total of 2,146 registered taxis. Approximately 32million trips are made each year using taxis and PHVs in Greater Manchester (GMCA, 2018d). Taxis and PHVs provide invaluable transport services by operating at times and to places where public transport is not an option however they also raise key concerns over public safety, congestion, inadequate vehicle standards and illegal out of area operation.

Table 3- 19: Total number of Licensed Taxis and PHVs within Greater Manchester (DfT, 2017h)

Area	Total Taxi's	Taxi only licensed drivers	Total PHVs	PHV only licensed drivers	Total licensed vehicles
Greater Manchester	2,146	3,783	11,246	12,763	13,392

Recent developments in app-based taxi services and new business models has led to the rapid development of the taxi and PHV market, creating a significant opportunity for social and technological change. It is therefore recognised that any package of clean air measures could create a significant opportunity and have a large impact on owners and users of taxis.

3.12.13 Land Use

An overview of land use across the Greater Manchester region is provided as follows.

- Trafford Park, located within Trafford, is the largest Industrial Estate in Europe. The park is home to approximately 1,400 businesses (Trafford Council, 2018).
- The GMSF has allocated areas which will focus on employment, housing or mixed use. There are no allocation areas within the IRR. There are three within the M60 but the majority are located within Greater Manchester, with the largest pockets of allocated land located in Bury, Trafford and Bolton (GMCA, 2018a).
- The large allocation area in Bolton is the North Bolton Strategic Opportunity Area. An area identified for future housing development sites. There is the potential to deliver up to 3,000 homes in around 15 locations (GMCA, 2016c).
- In addition to the allocation sites there are general development area across Greater Manchester for housing. There are concentrations of new housing planned for just outside the IRR and a large area (1,560 total additions between 2017-2035) in the south west Greater Manchester in Trafford (GMCA, 2018c).
- The location of future office development is concentrated within the IRR (GMCA, 2018c).
- Figure 22 (Appendix A) shows projected housing development areas located within the Manchester city centre boundary which are considered to be suitable for future housing growth and hence expected to be proposed for development by 2040. Most of the committed housing allocated areas are focused to the east of Manchester city centre itself and comprise sites in excess of 1000 houses. Smaller areas of housing allocation are located to the south of Manchester city centre with several sites located in close proximity to Wythenshawe. It should be noted that a significant proportion of the allocated housing sites are not expected to be allocated housing sites until post-2021 and are therefore unlikely to be completed before implementation of the GM CAP.

- Figure 23 (Appendix A) shows projected employment growth in 2016-17 within the Manchester city centre boundary based upon B2 and B8 land uses only. The largest employment areas identified are focused around Manchester Airport with reference to the Airport City North and the Airport City South. These employment areas are significantly greater than the other employment areas forecast for Manchester city centre in 2016-17. The remaining employment areas are located in Wythenshawe to the north of Manchester Airport, and Manchester city centre itself. The employment areas currently under construction within the Manchester city centre boundary only consists of four sites, none of which are particularly significant in total size.
- The Greater Manchester Brownfield Land Register 2017 shows that the brownfield sites are widely spread across the area, with a large concentration of brownfield sites within the M60. There are particularly large brownfield sites to the north east of the IRR within the M60 including: Miles Platting Neighbourhood (71 hectares), Holt Town Waterfront (31 hectares) and New Cross Zones B&C (22 hectares).
- Within the IRR there are several smaller brownfield sites within Salford and Manchester council.
- Within the wider Greater Manchester, the largest brownfield site is located in Wigan, which is a total of 109 hectares.
- Greater Manchester has large areas of designated greenbelt land. In general, these areas tend to be in less developed areas, outside of the M60 boundary and on the outskirts of Greater Manchester. Within the M60, designated greenbelt land includes Clayton Vale, and Medlock Vale to the north east, Reddish Vale to the south east, Chorlton and Sale waterpark to the south and the area surrounding the River Irwell and Clifton in the north.

3.13 Employment

3.13.1 Greater Manchester overview

There are a total of 1,267,000 jobs held by employees in Greater Manchester - 864,000 of these are full time and 402,000 are part time (Nomis, 2016). This excludes self-employed, government supported trainees and HM forces. The GMFM (GMCA, 2017c) estimates the number of Greater Manchester residents in employment will rise by 100,400 between 2016 and 2036, equivalent to growth of 0.4% per year, similar to the average rate of increase in the UK (GMCA, 2017c).

3.13.2 Shift workers

In 2017, 4.8 million people were employed in shift work in the UK. This equates to 18.6% of total employment in the UK (ONS, 2017c). Of this 4.8 million, the percentage of male shift workers (57%) was higher than the percentage of female shift workers (43%). In the three months at the end of June 2014 there were 637,000 people employed in shift work in the North West. This equates to 20% of people over the age of 16 employed in shift work (ONS, 2014). Of these, 94,000 conduct evening, night or twilight shifts. This equates to 29% of the regions working population.

Within the UK, the industries with the highest number of shift workers include health and social work (3.4 million) wholesale, retail and repair of vehicles (3.6 million) and manufacturing (3 million). For those working evening or twilight shifts, health and social work and wholesale, retail and repair of vehicles remain the most prominent industries. There are also high numbers of night and twilight shift workers in the transport and storage industry (ONS, 2017c).

Table 3- 20: Shift workers as a percent of employment in each sector (ONS, 2017c)

Industry	All Employed in Sector	Percent of shift workers in sector	All in Shift Work
Agriculture, forestry and fishing	229,478	8.6%	19,755
Manufacturing	1,749,259	24.4%	426,985
Wholesale, retail, repair of vehicles	1,775,691	23.6%	419,528
Transport and storage	1,005,771	39.7%	399,713
Financial and insurance activities	543,582	7.4%	40,136
Real estate activities	134,948	2.1%	2,826
Health and social work	771,793	36.5%	282,007
Other service activities	315,144	8.7%	27,412

3.13.3 Travel to work patterns

According to the TFGM transport strategy evidence base, less than 9% of total trips originating within Greater Manchester travel to a destination outside of the region. Approximately 28% of trips within Greater Manchester have a length of less than 1km, and a third of these are made by car.

Table 3- 21 below shows the travel to work patterns of those within Greater Manchester, within the M60 and within the IRR. This table excludes those that work from home and those that use 'other' alternative modes of transport that are not covered in the table below. Travelling to work by car/van is the largest mode of transport in Greater Manchester (68%) and within the M60 (52%). However, once within the IRR most individuals walk to work (51%). Bus is the second most popular mode of transport within the M60 with 20% choosing this mode, this drops to 10% within the IRR.

Table 3- 21: Travel to work patterns within key study areas (Nomis, 2011c)[12]

Mode of transport	Greater Manchester		Within M60		Within IRR	
	Count	%	Count	%	Count	%
Taxi	10,437	1%	8,427	3%	33	0%
Car/van	744,287	68%	150,896	52%	1,920	22%
Walk	127,603	12%	44,235	15%	4,392	51%
Metro	16,106	1%	6,454	2%	370	4%
Train	31,552	3%	8,427	3%	806	9%
Bus/minibus	131,096	12%	59,521	20%	886	10%
Motorbike	6,838	1%	1,359	0%	11	0%
Bike	25,769	2%	11,085	4%	165	2%
Total	**1,093,688**	**100%**	**290,404**	**100%**	**8,583**	**100%**

There are distinct differences in the number of trips and journey purpose when comparing employment status. For those in employment, the main purpose of trips is commuting. For those out of employment, the main purpose is for shopping (Nomis, 2011c). Similar number of movements are made by those in employment and not in employment for sport and entertainment purposes. Table 3- 22 shows the modes of travel taken to work by those who work in the IRR.

Table 3- 22: Travel to work for those who work in the IRR (Nomis, 2011f)

Mode of transport	Live outside the region		Live outside the LA		Live outside the MSOA		Live outside workplace zones[13]		Live inside workplace zones	
	Count	%	Count	%	Count	%	Count	%	Count	%
Work from home	0	0%	0	0%	0	0%	0	0%	12	50%
Taxi	0	0%	1	0%	3	1%	0	0%	0	0%
Car/van driver	16	24%	346	41%	76	19%	4	10%	5	21%

[12] The method of travel used for the longest part, by distance, of the usual journey to work (Nomis, 2011c).

[13] A workplace zone is based entirely on 2011 Census data. The workplace population encompasses: employees, self-employed, people on a government-sponsored training scheme, people working from home, people on sick leave, maternity leave, holiday or temporarily laid off and full-time students who are working. A 'workplace' is defined as a place of work recorded by a worker on their census form (ONS, 2018).

Mode of transport	Live outside the region		Live outside the LA		Live outside the MSOA		Live outside workplace zones[13]		Live inside workplace zones	
	Count	%	Count	%	Count	%	Count	%	Count	%
Car/van passenger	0	0%	40	5%	11	3%	0	0%	0	0%
Walk	3	4%	62	7%	91	22%	36	90%	5	21%
Metro	3	4%	62	7%	5	1%	0	0%	0	0%
Train	41	61%	148	18%	17	4%	0	0%	1	0%
Bus/ minibus	4	6%	168	20%	193	46%	0	0%	0	0%
Motorbike	0	0%	2	0%	1	0%	0	0%	0	0%
Bike	0	0%	7	1%	13	3%	0	0%	0	0%
Other	0	0%	2	0%	0	0%	0	0%	1	0%
Total	**67**	**100%**	**838**	**100%**	**410**	**100%**	**40**	**100%**	**24**	**100%**

3.14 Vehicle compliance and availability

3.14.1 Overview

Since 1992, EU regulations have been imposed on new cars, with the aim of improving air quality - meaning a car must meet a certain Euro emissions standard when it is made. Euro 1 was introduced in 1992. The current standard is Euro 6, which was introduced in September 2014 for new type approvals and September 2015 for most vehicle sales and registrations. The regulations – which are designed to become more stringent over time – define acceptable limits for exhaust emissions of new light duty vehicles sold in EU and European Economic Area (EEA) member states (RAC, 2018).

Over the next two years, 16 of the UKs largest fleet operations are signing the Clean Van Commitment and investing an initial £40 million. The Clean Van Commitment will aim to deploy 2,400 electric vans by 2020 as well as a long-term pledge to deliver zero tailpipe emissions by 2028. Progress towards this aim is dependent on the availability of sufficient charging infrastructure and competitively priced electric vans (Business Growth Hub, 2018).

3.14.2 Vehicle composition

Table 3- 23 shows the vehicle composition by fuel type in Greater Manchester. The table shows that diesel buses make up 99% of total busses in Manchester. Similarly, 100% of HGVs, 97% of LGVs and 98% of minibuses are diesel vehicles. The table also shows that there are more petrol cars (63%) than diesel cars (35%), and 100% of all motorcycles, mopeds and scooters are petrol engines.

Table 3- 23: Vehicle composition by fuel type in Greater Manchester (DfT, 2017d)[14]

	Diesel		Petrol		Hybrid/Electric		Other	
4	2,700	99%	0	0%	0	0%	0	0%
Cars	404,000	35%	723,600	63%	11,000	1%	1,400	0%
HGVs	30,500	100%	0	0%	0	0%	0	0%
LGVs	108,700	97%	2,900	3%	200	0%	200	0%
Minibuses	2,800	98%	100	2%	0	0%	0	0%
Motorcycles/ Mopeds/ Scooters	0	0%	37,600	100%	0	0%	0	0%
Other	8,100	68%	1,000	9%	2,700	23%	100	1%

3.14.3 Euro compliance by vehicle type

Table 3- 24 shows the number of vehicles which meet the most up to date euro standard (Euro six). The table shows that in all modes, less than 25% of the total vehicles meet the latest engine standards. HGVs have the highest percentage of vehicles at euro six standard (24%). This is followed by buses with 15% of registered vehicles estimated at euro six and cars with 10%. Motorcycles, mopeds, scooters, LGVs and minibuses all have 5% or lower of the total registered vehicles in the highest euro class.

Table 3- 24: Total vehicles of euro status six in Greater Manchester (DfT, 2017d)

	Euro 6 status	Total registered vehicles	% of total vehicles Euro 6 or above.
Buses	400	2,700	15%
Cars	119,600	1,140,000	10%
HGVs	7,200	30,600	24%
LGVs	1,900	112,100	2%
Minibuses	200	2,900	5%
Motorcycles/ Mopeds/ Scooters	0	37,700	0%
Other	0	12,000	0%

[14] Note that there may be minor inconsistencies between data for Greater Manchester, compared to data presented elsewhere for council district areas and the LSOA-based areas, as sometimes the Driver and Vehicle Licensing Agency (DVLA) database only has partial postcodes recorded for vehicles, e.g. a vehicle could be recorded as M2 *** so it can be allocated to GM but not to an individual LSOA. These differences will not be material to any analysis undertaken (DVLA, 2018).

3.14.4 Euro compliance of cars and LGVs by LSOA

For the purposes of this study, compliant cars and LGVs are those with a euro rating of four or above for petrol and six or above for diesel. Table 3- 25 shows the number of compliant cars and LGVs, according to these thresholds, within the key study areas.

Table 3- 25: Euro compliance of vehicles in Greater Manchester (DVLA, 2018)

	Compliant cars		Non-compliant cars		Compliant LGVs		Non-compliant LGVs	
Greater Manchester	580,000	51%	560,000	49%	1,000	1%	110,000	99%
M60	131,000	50%	131,000	50%	400	2%	25,000	98%
IRR	2,300	54%	2,000	46%	100	9%	1,200	91%

The table shows that across the whole of Greater Manchester, approximately 50% of cars and 1% of LGVs are compliant. There is a similar story within the M60 with 50% compliant cars and only 2% compliant LGVs, however, the total number of overall cars and LGVs is significantly lower (262,000 cars and 25,400 LGVs). Within the IRR, this increases to 54% compliant cars and 9% compliant LGVs. The percentage of non-compliant cars and LGVs at LSOA level are shown in Figure 28 and Figure 29 in Appendix A respectively.

3.14.5 Access to a vehicle

Table 3- 26 shows that most households (42.7%) across Greater Manchester own one car or van per household. This is in line with the England average for number of households with one car or van (42.2%). In contrast, 30.6% of households have no access to a car or van, slightly higher than the England rate of 25.8%. Only 1.1% of households within Greater Manchester have access to four or more cars or vans per household. Figure 24 (Appendix A) shows the percentage of households with no access to a car or van across Greater Manchester.

Table 3- 26: Household car/van availability (Nomis, 2011a)

Household car/van availability	Greater Manchester		England	
	Count	%	Count	%
No cars or vans in household	350,000	30.6%	5,690,000	25.8%
1 car or van in household	480,000	42.7%	9,300,000	42.2%
2 cars or vans in household	250,000	21.8%	5,440,000	24.7%
3 cars or vans in household	40,000	3.9%	1,200,000	5.5%
4 or more cars or vans in household	10,000	1.1%	420,000	1.9%

3.14.6 Access to a vehicle at LSOA level

Table 3- 27 shows the number of households with no access to a car or van within the key study areas.

The table shows that approximately one third of the study area have no access to a car or van. Within the M60, this number increases to 40.1%, representing the increased accessibility by public transport within these areas (see section 3.15.1 - accessibility levels). The data also shows that within the IRR, 58.8% of households do not have access to a car or van, representing approximately 7,500 households.

Table 3- 27: Households with no access to a car/van (Nomis, 2011a)

	Number of households with no car/van availability	% of total
Greater Manchester	345,000	30.6%
M60	133,600	40.1%
IRR	7,500	58.8%

3.15 Public Transport

3.15.1 Accessibility Levels (GMAL)

Accessibility is of key importance in the operation of a transport system. Greater Manchester Accessibility Levels (GMAL) are a measure of the accessibility of a point to both the conventional public transport network (i.e. bus, Metrolink and rail) and Greater Manchester's Local Link. This measure considers walking times, number of services and average waiting times to show the density and availability of public transport provision at any location in the Greater Manchester area, as illustrated in Figure 21 (Appendix A). The map clearly shows areas of very high accessibility are concentrated within the city centre. Areas with very low accessibility are concentrated on the very outskirts of the Greater Manchester boundary.

3.15.2 Bus/Cycle Routes

Figure 19 and Figure 20 (Appendix A) show the locations of cycle and bus routes within Greater Manchester.

Table 3- 28 shows the total length of cycle routes within Greater Manchester, which is approximately 1,700km. The total length of bus routes within Greater Manchester is approximately 61,000km. Table 3- 28 shows the total distance of bus and cycle routes within the key study areas.

Table 3- 28: Total distance of bus and cycle routes within key study areas (TfGM, 2015; TfGM, 2018b)

Key study area	Approximate total distance of cycle routes (2015)	Approximate total distance of bus routes (2018)
Within IRR	27 km	1636 km
Within the M60	503 km	28,000 km
Greater Manchester	**1,700 km**	**61,000 km**

3.15.3 Bus/Coach operators

In total, in 2017, there are approximately 5,525 licensed buses and coaches in Greater Manchester (DfT, 2017e), being run by approximately 87 bus operators in Greater Manchester (TfGM Committee, 2018). This includes school bus operators, ring and ride services, community transport and local link bus companies, as well as regional and national bus and coach operators.

First Manchester is a bus operator in Greater Manchester which owns four depots located in Bolton, Manchester, Oldham and Rusholme. A second operator, 'Stagecoach' has 6 depots; two in Manchester and one in Stockport, Wigan, Aston-under-Lynne and Middleton. Stagecoach operates a fleet of 750 buses consisting of 144 hybrid electric buses and 144 buses with Euro 6 engines (Stagecoach, 2018). Finally, Arriva North West operate in Greater Manchester and have depots located in Manchester (Wythenshawe) and Bolton.

There are three bus stations within the IRR located in Shudehill, Piccadilly and on Chorlton Street (UK Bus Fleetlist, 2018). Manchester's largest bus station, Shudehill Interchange, is used by Arriva North West, First Greater Manchester, Manchester Community Transport, Megabus and Stagecoach Manchester.

3.16 Summary matrix

A summary of socio-economic indicators for the key study areas is presented in Table 3- 29. The data presented here indicates that there is considerable variability in the socio-economic context across Greater Manchester. For example, within the IRR, only 1% of the population is over the age of 75, whereas across all of Greater Manchester this figure is 7%.

Table 3- 29: Socio-economic characteristics of key study areas

Study Areas	Socio-economic indicator		
	Greater Manchester	**Within M60**	**IRR**
Key Study Areas			
Economically active, proportion of the total population (%)	68%	65%	60%
Over 75 years of age, proportion of the total population (%)	7%	5%	1%
Number of schools (nursery's, junior, secondary and specialist)	1,826	548	3
Number of hospitals	134	23	0
Number of religious centres	541	186	6
% of the population driving to work by car	38%	29%	13%
IMD Income deprivation decile	6	5	6
IMD Health deprivation and disability decile	5	5	8
% of households with one or more cars	69%	60%	41%
Number of SMEs (% of total businesses)	99.6%	99.5%	99.4%

4 Air Quality

4.1 Overview

This section presents the findings of the preliminary analysis of air quality, health and environmental distributional impacts for the proposed GM CAP. The analysis is based on outputs of TfGM's EMIGMA (Emissions Inventory for Greater Manchester) software, which provides the change in emissions in tonnes for oxides of nitrogen (NO_X) and particulate matter (PM_{10}) for a Do Minimum (DM) scenario (2021) compared the clean air options under analysis (Option 5(i)/(ii) and Option 8).

The findings reported here are intended as illustrative of the final analysis that will be completed for the preferred clean air option selected for Greater Manchester, once the final air dispersion modelling results are available. The aim here is to present an overview of the methodology and the approach to the analysis, and to present some indicative results.

In February 2016, the Joint Air Quality Unit (JAQU) was established by Defra and the Department for Transport (DfT) to coordinate delivery of the Government's plans for achieving NO_2 compliance. Part of the remit of JAQU is to support the implementation of CAZs or other measures selected by local authorities (UK Parliament, 2018).

As recommended by the JAQU, the method of appraisal follows the guidance set out in the DfT's Transport Analysis Guidance (TAG) Unit A4-2 'Distributional Impact Appraisal' (DfT, 2015). This follows three stages of screening, assessment and appraisal to identify groups which could be disproportionately impacted by a proposed scheme. This approach is supplemented with additional qualitative narrative relating to the potential impacts on specific groups in specific geographies.

Air quality impacts are assessed at Lower Super Output Area (LSOA) level[15], as dictated by the guidance.

The key findings of the assessment are presented as follows:

- The analysis shows that, using the WebTAG methodology, moderate beneficial air quality impacts are distributed evenly across all income groups for both Option 5(i)/(ii) and Option 8. For children and the elderly, however, air quality benefits are not evenly distributed. For these two groups, air quality impacts favour residents in quintiles 4 and 5 (those with the lowest proportion of children/elderly people), where the impact is large beneficial. Those in quintile 1 (with the highest proportion of children/elderly), who may be considered the most vulnerable, experience slight beneficial air quality impacts.
- Overall, the number of net winners for Option 5(i)/(ii) is approximately 2,750,000 residents compared to a slightly lower 2,720,000 for Option 8.
- For all options, there is a strong correlation between areas experiencing the highest reductions in emissions and the areas ranked with the highest level of deprivation. For those under the age of 16, it is anticipated that the air quality benefits are likely to be greater outside of the Manchester IRR boundary. Despite there being large reductions in emissions (NO_x and PM_{10}) within the IRR, this area contains less than 1% of the total population of under 16's and only a small number of facilities of importance to children.

[15] Output Areas and Lower Super Output Areas are geographical definitions used for the mapping of socio-economic characteristics. These cover different scales: for example, Lower Super Output Areas typically have a resident population of around 1,500 people.

- In general, the elderly population are located towards the outskirts of Greater Manchester outside of areas most likely to receive the highest air quality benefits (M60, IRR). For the elderly population located within the IRR, over 70% of the population is expected to benefit from the 10% highest emissions reductions of anywhere across the study area.
- No distributional impacts from air quality are anticipated for any of the following key social groups; women, minority ethnic groups, disabled people, SMEs or LGV owners.

4.2 Methodology

The appraisal of the air quality distributional impacts is a minimum requirement of JAQU.

A three-step approach, in line with TAG unit A4-2, has been applied to the distributional impacts appraisal as follows:

1) Screening: to consider the variety of impacts that the options may have and to prioritise particular impacts for further analysis so that only the most relevant issues for the scheme are appraised to ensure proportionality.
2) Assessment: to collect information on the geographical area likely to be affected by each option and how different social and business groups are distributed within that geographical area. To calculate the number of areas with improved air quality, GIS techniques have been used to calculate the change in concentration between the baseline scenario and the intervention for each LSOA in the study area.
3) Appraisal: to assess the extent of the impact of each option on the social or business groups identified.

To identify societal groups who could be 'disproportionately' impacted, the population within the study area was divided into quintiles, based on the distribution across England and Wales. For example, to assess income deprivation, the population was first divided into five equal parts depending on the level of income: the first quintile contains the top fifth of the population on the scale (i.e. the 20% of the population with high levels of deprivation), the second quintile represents the second fifth (from 20% to 40%) and the fifth quintile represents the 20% of the population with the lowest level of income deprivation. Once the population has been divided into quintiles, it is then possible to see which groups receive the highest share of the benefits.

It is acknowledged that a large beneficial impact, does not represent the areas receiving the greatest air quality benefits. For example, from an air quality perspective, benefits would be expected to be greatest in areas where the emissions reduction is highest. Instead, the WebTAG methodology determines whether the impacts are representative of an even distribution if all groups received the same share of the benefit. As such, care must be taken when interpreting the results of the analysis.

The appraisal section (section 4.6) aims to give a qualitative interpretation of these results, focussing on the areas with the 10% greatest reduction in emissions and the relation to key amenities of importance to the various social groups.

4.3 Screening

The impacts of air quality are primarily spatial. It is therefore likely that impacts are likely to be experienced differently throughout the study area. Table 4- 1 shows the screening process used to consider the potential impacts on specific social groups.

Table 4- 1: Screening of air quality impacts (all options)

Grouping Variable	Screened in	Reason for screening in/out
Low income households	✓	Vulnerable groups, including poorer people, are more likely to live in polluted areas and are therefore more likely to experience health problems caused by air pollution (Royal College of Physicians, 2016).
Children	✓	Children are particularly vulnerable to air pollution effects due to different patterns of exposure (i.e. young children crawl on the ground). Also, for their size, children breath in more air each minute than adults (British Lung Foundation, 2018).
The elderly	✓	For older people, air pollution effects can speed up the rate of decline in lung functioning making them more vulnerable to the effects of air pollution (Royal College of Physicians, 2016).
Disabled	×	There is limited evidence to suggest that disabled people are more vulnerable to air pollution effects than any other population group.
Women	×	There is limited evidence to suggest that women are more vulnerable to air pollution effects than any other population group.
Ethnicity (BAME)	×	There is limited evidence to suggest that the BAME population are more vulnerable to air pollution effects than any other population group.
Businesses	×	Businesses themselves are not considered to be vulnerable to air pollution effects. Indirect effects on businesses will be considered under the appraisal of affordability impacts (see affordability assessment – section 0).
LGVs	×	LGVs are used as a proxy for effects on SMEs. LGVs themselves are not considered to be vulnerable to air pollution effects. Indirect effects on SMEs will be considered under the appraisal of Affordability impacts (See affordability assessment – section 0).

4.4 Assessment Criteria

The consideration of whether impacts are disproportionate is important to understand if one group is being unfairly disadvantaged or advantaged by the option/package. In such cases it is necessary to understand how these impacts are occurring and whether it is acceptable or whether the option should be amended or mitigated. Table 4- 2 shows the scale, recommended by TAG Unit A4.2, to be used in the reporting of the distributional impacts.

Table 4- 2: DistributionalImpact Assessment Criteria

Assessment		Impact Description
✓✓✓	Large beneficial	Beneficial and the population impacted is significantly greater than the proportion of the group in the total population
✓✓	Moderate beneficial	Beneficial and the population impacted is broadly in line[16] with the proportion of the group in the total population
✓	Slight beneficial	Beneficial and the population impacted is smaller than the proportion of the group in the total population
-	Neutral	There are no significant benefits or dis-benefits experienced by the group for the specified impact
×	Slight adverse	Adverse and the population impacted is smaller than the proportion of the population of the group in the total population
××	Moderate adverse	Adverse and the population impacted is broadly in line with the proportion of the population of the group in the total population
×××	Large adverse	Adverse and the population impacted is significantly greater than the proportion of the group in the total population

[16] For the purposes of this assessment, 'broadly in line' refers to a +/- 2% threshold between the percentage of net winners and the share of the resident population in each group.

4.5 Air Quality Assessment

4.5.1 Introduction

The following section provides an assessment of the change in total emissions on the relevant grouping variables (low income households, children and the elderly). Air quality impacts associated with PM_{10} and NO_X were calculated for each LSOA within Greater Manchester. For each quintile, the number of LSOAs with improved or worsened air quality was calculated, and their relative populations totalled, to calculate the net winners[17].

As explained in section 4.2 above, the WebTAG distributional impacts methodology refers to 'winners' and 'losers', corresponding to improvements in, or worsening of air quality. Using this methodology, the number of net winners for Option 5(i)/(ii) is approximately 2,750,000 residents compared to a slightly lower figure of 2,720,000 net winners for Option 8. Since the WebTAG methodology does not consider the magnitude of air quality improvement, the results of the overall analysis remain largely the same for all options. The tables presented below include the detailed results for Option 5(i)/(ii) and are illustrative of the results for Option 8.

4.5.2 Low income households

Income deprivation is one of seven domains of deprivation. Measures of income deprivation are concerned with people on low incomes who are in receipt of benefits and tax credits (DfT, 2015). It is not an absolute measure of household income and therefore it does not reflect household income in a given area, nor does it cover the distribution of that income across its resident population. Whilst it effectively captures concentrations of low income households it does not identify areas of affluence. For example, an area with a relatively small proportion of people on low incomes may also have relatively few or no people on high incomes (DfT, 2015).

The distribution of air quality impacts on low income households has been assessed in two ways. Firstly, deprivation was mapped based on the distribution of income deprivation across England and Wales. The second method ranks all the LSOAs within the study area only, based on their income deprivation; this gives a more study area specific distribution.

Table 4- 3 shows the distribution of air quality impacts on low income households in the study area compared to the distribution across England and Wales.

[17] Numbers in tables have been rounded to the nearest thousand.

Table 4- 3: Distributional impact of air quality on low income households (compared to the distribution across England and Wales)

	Deprivation quintile (where 1 is the 20% of the population ranked highest in terms of income deprivation)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved air quality	983,000	562,000	423,000	390,000	409,000
Number of people with no change in air quality	4,000	0	1,000	6,000	3,000
No. of net winners	979,000	562,000	421,000	384,000	407,000
Total number of winners across all groups	2,750,000				
Net winners in each area as % of total	36%	20%	15%	14%	15%
Share of population in impact area (%)	35%	20%	15%	14%	15%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓

Table 4- 4 shows the distribution of air quality impacts on low income households in the study area compared to the distribution across Greater Manchester.

Table 4- 4: Distributional impact of air quality on low income households (compared to the distribution across Greater Manchester)

	Deprivation quintile compared to Greater Manchester (where 1 is the 20% of the population ranked highest in terms of income deprivation)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved air quality	557,000	558,000	555,000	545,000	553,000
Number of people with reduced/no change in air quality	2,000	4,000	1,000	5,000	2,000
No. of net winners	555,000	554,000	554,000	540,000	551,000

	Deprivation quintile compared to Greater Manchester (where 1 is the 20% of the population ranked highest in terms of income deprivation)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Total number of winners across all groups	2,750,000				
Net winners in each area as % of total	20%	20%	20%	20%	20%
Share of population in impact area (%)	21%	21%	20%	19%	19%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓

Table 4- 3 and Table 4- 4 both show that beneficial impacts are experienced equally across all quintiles. This means the proportion of net winners within each quintile is broadly in line with the proportion of the resident population. This shows that areas in which there are high concentrations of low-income households experience equal benefits to areas with a low concentration of low-income households and a score of **moderate beneficial** has been applied to all quintiles. Further analysis on the location of low-income groups and the size of the change in emissions is given in section 4.6.3.

4.5.3 Children (under 16's)

The Equality Act 2010 states that local authorities should show due regard to certain protected characteristics, including age. This includes taking steps to meet the needs of individuals who share a protected characteristic, and minimising the disadvantage associated with it. It is recognised, for the reasons stated in Table 4- 1, that children are particularly vulnerable to the effects of air pollution. Therefore, to assess the distribution of air quality impacts on children, ONS 2016 mid-year population estimates have been used to calculate the distribution of children across Greater Manchester. For the purposes of this assessment, children are defined as those under the age of 16.

Table 4- 5 shows the distributional impacts of air quality on children.

Table 4- 5: Distributional impacts of air quality on children (compared to the distribution across England and Wales)

	Population quintile (where 1 is the 20% of the population with the most under 16s)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved air quality	859,000	575,000	521,000	456,000	357,000
Number of people with reduced/no change in air quality	2,000	5,000	2,000	1,000	5,000
No. of net winners	857,000	571,000	519,000	455,000	352,000
Total number of winners across all groups	2,750,000				
Net winners in each area as % of total	31%	21%	19%	17%	13%
Share of population in impact area (%)	41%	21%	17%	13%	7%
Assessment (✓)	✓	✓✓	✓✓	✓✓✓	✓✓✓

Table 4- 5 shows that beneficial impacts are experienced across all quintiles. The table shows that in quintiles 2 and 3, the population receiving air quality benefits is as expected based on the share of the population in the impact area. Therefore, these quintiles have been assigned a score of **moderate beneficial**. Quintile 1, which represents the 20% of the study area with the most children, has a 41% share of the total population but only 31% of the net winners in terms of reduced emission levels. In this case, the proportion of children receiving air quality benefits is significantly smaller than the proportion of children in this group. This quintile has therefore been assigned a score of **slight beneficial.** Quintiles 4 and 5, which represents the 60-100% of the population with the least children, have a significantly higher share of total net winners compared to their population. This shows that the population in these quintiles are receiving a higher than expected share of the air quality benefits. These quintiles therefore receive a score of **large beneficial**.

Further analysis, including commentary on the number of facilities of importance to children in areas of greatest and least improvements in air quality is given in section 4.6.4.

4.5.4 Elderly (Over 65's)

It is recognised that elderly populations are particularly vulnerable to the effects of air pollution. This is because they are more likely to have long lasting health problems which can be exacerbated by pollutants. Due regard has therefore been given to those over the age of 65 within the study area. For the purposes of this assessment, to assess the distribution of air quality impacts on the elderly, ONS 2016 mid-year population estimates have been used to calculate the distribution of over 65's within the study area.

Table 4- 6 shows the distributional impacts of air quality on the elderly population within the study area.

Table 4- 6: Distributional impacts of air quality on the elderly population (compared to the distribution across England and Wales)

	Population quintile (where 1 is the 20% of the population with the most elderly residents)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved air quality	253,000	426,000	596,000	735,000	757,000
Number of people with reduced air quality	0	3,000	6,000	0	6,000
No. of net winners	253,000	424,000	590,000	735,000	751,000
Total number of winners across all groups	2,750,000				
Net winners in each area as % of total	9%	15%	21%	27%	27%
Share of population in impact area (%)	17%	22%	25%	23%	13%
Assessment (✓)	✓	✓	✓	✓✓✓	✓✓✓

Table 4- 6shows that positive impacts are experienced across all quintiles. In quintiles 1, 2 and 3 (which represent the 0-60% of the study area with the most children), the proportion of air quality benefits experienced are significantly smaller than the proportion of children in this group. A score of **slight beneficial** was therefore assigned to these quintiles. In contrast, quintiles 4 and 5 receive a higher than expected share of the air quality benefits in comparison to their relative populations. A score of **large beneficial** was therefore assigned to these quintiles.

Further analysis of the magnitude of change experienced is provided in section 4.6.5.

4.5.5 Summary Assessment Matrix

Table 4- 7 shows an overview of the assessment stage. Dark green cells represent areas in which the benefits (from a distributional impact perspective) are higher than expected (based on an even distribution)[18]. Light green cells represent areas in which the benefits are lower than expected and those in the middle represent areas in which benefits are as expected based on the proportion of residents and the level of air quality benefits.

[18] An even distribution would be a situation in which the proportion of the net winners is in line with the proportion of the population in that impact group. Therefore, the impacts are distributed evenly across the study area. Impacts 'higher than expected' refer to situations in which the share of the benefits deviate from what would be expected from an even distribution.

Table 4- 7: Distributional impacts appraisal matrix (all options)

	(1 Most)	2	3	4	5 (Least)	Are the impacts distributed evenly?	Key impacts
Low income households (Relative to England and Wales)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	The analysis shows that in both the Greater Manchester and England and Wales context, distributional impacts are spread evenly across all income quintiles.
Low income households (Relative to Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	
Children (Relative to England and Wales)	✓	✓✓	✓✓	✓✓✓	✓✓✓	No	Air quality impacts favour residents in quintiles 4 and 5. Those in quintile 1 (with the highest proportion of children), who may be considered the most vulnerable to air pollution, experience a lower proportion of air quality benefits than may be expected from an even distribution. Residents living in population quintiles 2 and 3 experience moderate benefits as expected.
Elderly (Relative to England and Wales)	✓	✓	✓	✓✓✓	✓✓✓	No	Air quality impacts favour residents in quintiles 4 and 5 with the lowest share of elderly population. Those in quintiles 1, 2 and 3, (with the highest proportion of elderly residents) that may be considered the most vulnerable to air pollution, experience a considerable lower proportion of air quality benefits than may be expected from an even distribution.

4.6 Air Quality Appraisal

4.6.1 Introduction

The analysis in section 4.5 provides an assessment score for each of the grouping variables under consideration. Section 4.6 provides further qualitative narrative to describe the impacts in each case. For the purposes of this analysis, the change in emissions for each LSOA has been multiplied by the resident population. In general, the reduction in emissions of NO_x are significantly higher than PM_{10}. Therefore, the emissions data for each option was converted, using the statistical method of standardisation[19], to ease the comparison between changes in NO_x and PM_{10}.

In the following section, Option 5(i) and 5(ii) are considered separately. Whilst the number of 'net winners' is the same for both options, within the key study areas (Greater Manchester, M60, IRR), the total reduction in emissions varies between options. Similarly, in the section below, the first map (Image 4- 1), which shows reductions in emissions across Greater Manchester, is intended to be illustrative of all options. For reasons of proportionality, further maps in this section are illustrative of Option 5(i) only. Individual maps for each option are provided in Appendix A.

For Option 5(i) and Option 5(ii), 100% of the population of Greater Manchester are anticipated to experience improvements in air quality. For Option 8, a very small percentage of the population (less than 0.5%) is predicted to experience an increase in emissions. It is anticipated that this will affect less than 0.5% of Greater Manchester's over 65's/under 16's and is therefore unlikely to have an impact on any areas with significant numbers of low income households.

As this small increase in emissions in some areas for Option 8 is unlikely to result in significant differences to the overall assessment, the following section focuses on air quality improvements only (i.e. reductions in emissions). To differentiate between areas receiving the greatest air quality benefits and the lowest air quality benefits the narrative in this section focuses on the following two cross-sections of the data:

- High reductions in emissions: LSOAs with the 10% highest reduction in both NO_x and PM_{10} emissions.
- Low reductions in emissions: LSOAs with the 10% lowest reduction in both NO_x and PM_{10} emissions.

[19] Standardization is the process of putting different variables on the same scale. This process allows you to compare scores between different types of variables (e.g. PM_{10} and NOx).

4.6.2 Distribution of air quality improvements

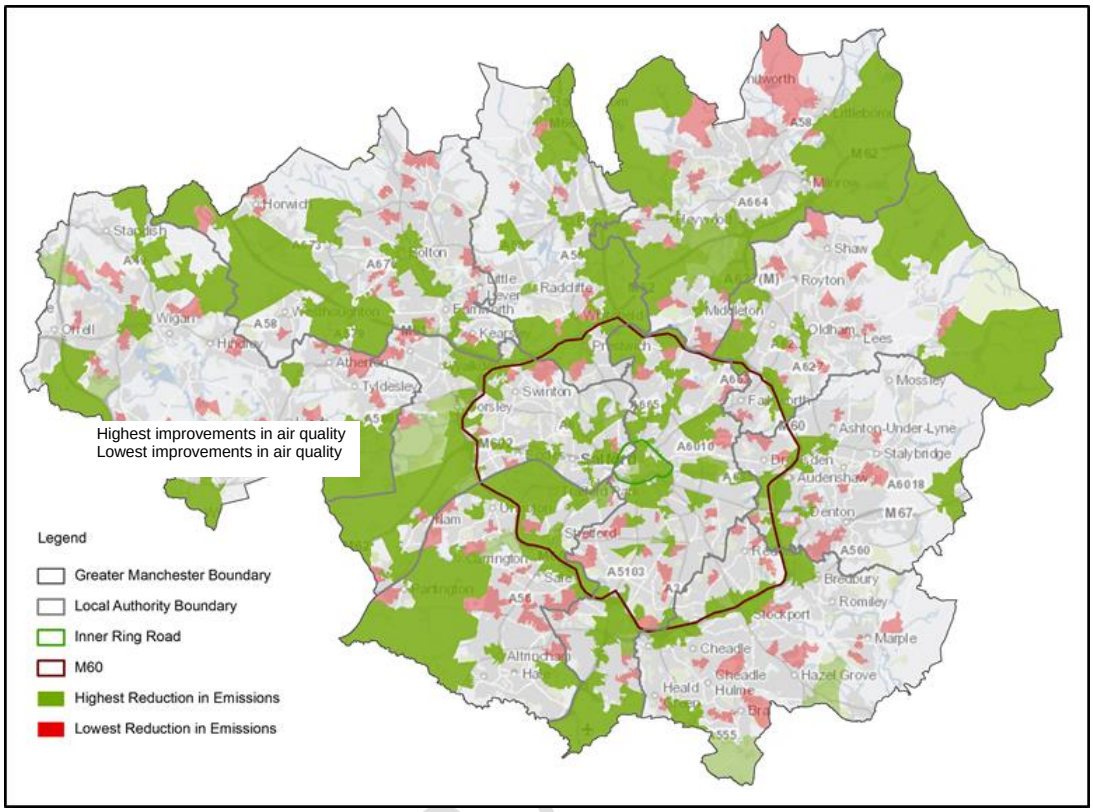
Table 4- 8 shows the reduction in emissions in each of the key study areas for each clean air option modelled. The table shows that for the whole of Greater Manchester, Option 5(i) and Option 5(ii) deliver higher overall reductions in emissions than Option 8. This is also true within the M60 boundary in which the relative reduction in emissions for Option 5(i) (23%) and Option 5(ii) (23%) are also higher than Option 8 (20%). Within the IRR Option 5(ii) delivers the greatest emission reductions of all options, followed by Option 5(i) and Option 8.

Table 4- 8: Reduction in emissions (PM_{10} and NO_x) from a do minimum scenario within the key study areas for all options.

Key study area	Option 5(i)		Option 5(ii)		Option 8	
	Tonnes	% reduction in emissions	Tonnes	% reduction in emissions	Tonnes	% reduction in emissions
Greater Manchester	-1,563	18%	-1,563	18%	-1,471	17%
M60 (including IRR)	-568	23%	-583	23%	-504	20%
IRR	-47	37%	-54	43%	-39	31%

Image 4- 1 below shows the LSOAs with the highest and lowest reductions in emissions for all options combined. This is intended to show all the LSOAs experiencing the greatest benefits (green) and the least benefits (red). The map does not distinguish between options e.g. a light green shade represents an LSOA experiencing the highest emissions reductions for one option (e.g. Option 5(i) only). A darker green shade represents an LSOA with high reductions in emissions for more than one option (e.g. both Option 5(i) and Option 8). Individual maps for each option can be found in the map book (Appendix A).

Image 4- 1: Map to show the overall highest and lowest reductions in emissions for all options



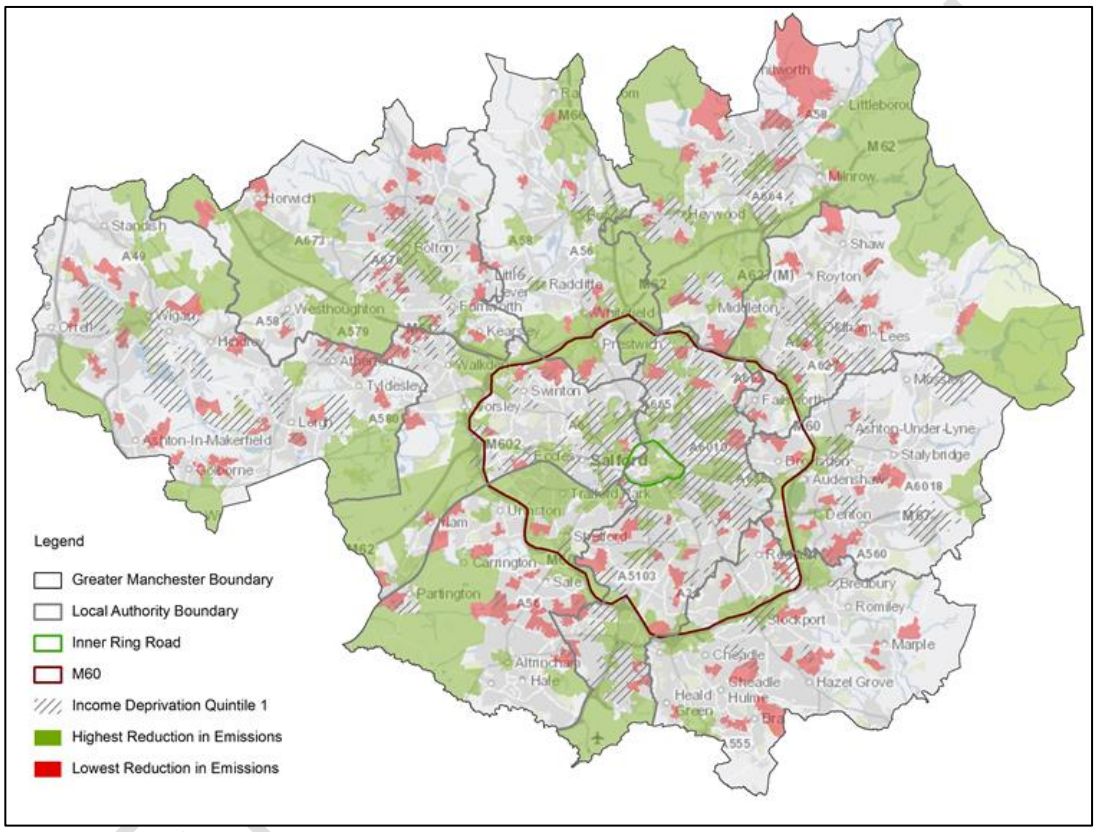
In general, across all options, the areas experiencing the highest reductions in emissions are located along the major road networks including the M6, M60, M61, M62, M602, M66 and the M56. This also includes the LSOAs which border the IRR and connecting road networks to the south east (A5103, A34, A6 and A635) and the north (A56). To the very south of the study area, the area surrounding Manchester Airport is also anticipated to experience high emission reductions. In general, the areas experiencing the lowest reduction in emissions are evenly spread across Greater Manchester. There are no LSOAs with low reductions in emissions located within the IRR.

4.6.3 Low income households

As stated in section 4.3, vulnerable groups, including low income households are more likely to live in polluted areas and are therefore more likely to experience health problems associated with air pollution. Section 4.5.2 showed that using the WebTAG Distributional Impacts methodology, impacts on low income households are distributed evenly, with a score of moderate beneficial applied across the study area. This section provides further qualitative narrative, focussing on the areas with the 10% highest and 10% lowest reductions in emissions (refer to Figure 36, 37 and 38 in Appendix A).

Image 4- 2 provides an example for Option 5(i). Areas coloured green represent those with the 10% highest emission reductions. Those in red represent the 10% lowest emission reductions. The cross shaded areas are those which also contain the 20% of the population ranked highest in terms of income deprivation (compared to the distribution across Greater Manchester).

Image 4- 2: Map to show LSOAs with the 10% highest and 10% lowest reductions in emissions as well as areas with the highest proportion of low income households for Option 5(i)



The map shows that areas of high deprivation are concentrated on the outskirts of the city centre of Manchester (within the M60), and that these are the areas that correlate strongly with the areas experiencing the highest reductions in emissions. There is also a strong correlation in the town centres of Bolton, Bury, Rochdale and Ashton in which there are high emission reductions in areas of high deprivation. Low emissions reductions are scattered evenly across the study area, with no obvious pattern or distribution. Within the IRR, there are no LSOAs with the 10% lowest reduction in emissions.

Table 4- 9 shows the number of residents in quintile 1 (highest levels of deprivation) that receive the highest air quality benefits in each of the key study areas. The last row of the table shows the total population in each of the key study areas (regardless of air quality).

Table 4- 9: Population in deprivation quintile 1 (most deprived) living in areas with the 10% highest reductions in emissions for all options.

		Greater Manchester		M60 (excluding IRR)		IRR	
		Number of residents	% of GM population	Number of residents	% of M60 population	Number of residents	% of IRR population
Low income population (population in quintile 1)	Option 5(i)	82,000	14%	42,000	17%	0	-
	Option 5(ii)	80,000	14%	42,000	17%	0	-
	Option 8	78,000	13%	36,000	15%	0	-
Total low-income population		593,822		242,000		0	

The table shows that for all options, between 78,000 – 82,000 (13%-14%) of residents in highly deprived areas experience the highest emission reductions. Within the M60, between 15-17% of the population is expected to experience the very highest reductions in emissions equating to between 36,000 – 42,000 people. There are no LSOAs with high proportions of low income households (quintile 1) located within the IRR; however, it is expected that the benefits of reduced emissions in this area would still be experienced by the large majority of the population located just outside of this area who travel into the city centre for business and leisure purposes (see travel to work data in Section 3 for those who live in the IRR).

In general, Option 5(i) and Option 5(ii) deliver the greatest benefit, providing high emissions reductions for over 82,000 people. This is closely followed by Option 8 which provides high emissions reductions for over 78,000 residents. For all options, the greatest benefits are anticipated in areas where the most vulnerable people live (within the M60). In the context of wider determinants of health, this is likely to result in positive benefits across the study area by resulting in greater health gains in areas with the greatest health needs. Nevertheless, there are still small areas of the study area in which the most vulnerable (with the highest deprivation levels) are anticipated to experience the lowest health benefits.

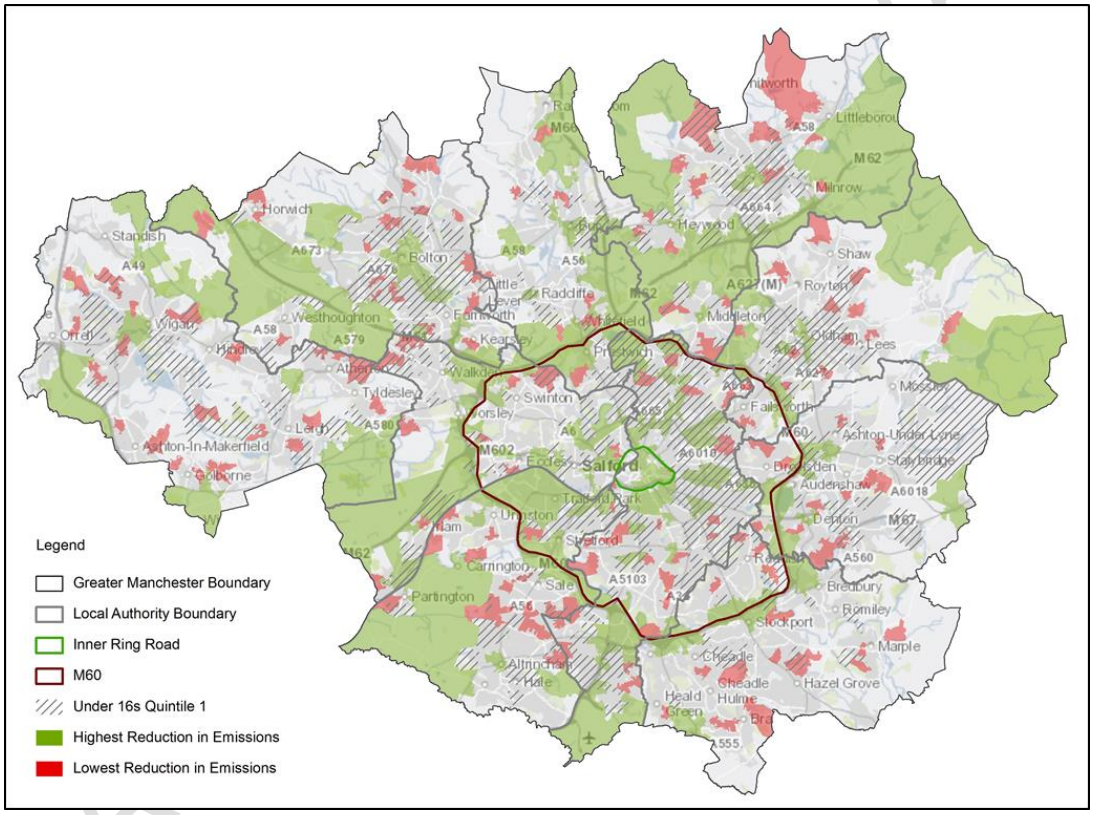
4.6.4 Children (under 16's)

As stated in section 3.3, children are particularly vulnerable to air pollution effects due to them having different patterns of exposure compared to adults (i.e. young children crawl on the ground). Also, for their size, children breath in more air each minute than adults resulting in more profound air quality impacts (British Lung Foundation, 2018). The assessment in section 4.5.3 shows that the effects of air quality on children are unevenly distributed across the study area for both options, with residents in quintiles 4 and 5 (with the least children) receiving a score of **large beneficial** and residents

in quintile 1 (most children) receiving a score of **slight beneficial.** This section describes the distribution of these benefits on the areas with the 10% highest and 10% lowest reductions in emissions (refer to Figure 39, 40 and 41 in Appendix A).

Image 4- 3 provides an example for Option 5(i). Areas coloured green represent those with the 10% highest emissions reductions. Those in red represent the 10% lowest emissions reductions. The shaded (cross checked) areas are those which also contain the 20% of the population with the highest proportion of children.

Image 4- 3: Map to show LSOAs with the 10% highest and 10% reductions in emissions as well as areas with the highest proportion of under 16s for Option 5(i)



The map shows that areas with a high proportion of under 16's (cross shaded on the map) are concentrated on the outskirts of the city centre of Manchester. Within the M60 there are many areas with high levels of under 16's and high reductions in emissions. There are no areas with a high proportion of under 16's located within the IRR however it is expected that the benefits of emissions reductions in this area would still be experienced by the majority of the population located just outside of this area who travel into the city centre for leisure purposes (see Section 2 for data on travel patterns) or to access amenities of importance to children (see Table 4- 11).

Table 4- 10 shows the total number of children (aged under 16), living in areas with the 10% highest reductions in emissions for all options. The last row of the table shows the total population of under 16's in each zone (regardless of air quality).

Table 4- 10: The number of children living in areas with the 10% highest reductions in emissions

		Greater Manchester		M60 (excluding IRR)		IRR	
		Number of residents	**%**	**Number of residents**	**%**	**Number of residents**	**%**
Children (under 16)	Option 5(i)	68,000	12%	27,000	16%	510	48%
	Option 5(ii)	68,000	12%	27,000	16%	660	63%
	Option 8	66,000	12%	24,000	14%	510	48%
Total population under 16		**564,500**		**169,000**		**1,100**	

The table shows that across Greater Manchester, between 66,000-68,000 (12%) children under the age of 16 live in areas experiencing the 10% highest reductions in emissions. Within the M60, between 14-16% of children experience high emissions reductions, with Option 5(i) and Option 5(ii) performing marginally better than Option 8. Within the IRR, Option 5(ii) results in 63% of children in this area receiving the highest reductions in emissions. For Option 5(i) and Option 8, just under half of the children in the IRR experience the highest emissions reductions, this equates to approximately 510 children (less than 1% of the total study area).

The analysis also considers areas with facilities of importance to children such as schools, playgrounds and parks/open space. Table 4- 11 shows the number of facilities of importance to children located in areas experiencing the overall highest and lowest reductions in emissions.

Table 4- 11: The number of facilities of importance to children in areas with 10% lowest and 10% highest reductions in emissions

	10% lowest reductions in emissions						10% highest reductions in emissions					
	Junior, secondary and nurseries/ creches		Parks/ open space		Playgrounds		Junior, secondary and nurseries/ creches		Parks/ open space		Playgrounds	
Option 5(i)	130	7%	89	11%	25	7%	285	16%	104	12%	46	13%
Option 5(ii)	130	7%	89	11%	25	7%	280	15%	104	12%	46	13%
Option 8	137	8%	86	10%	24	7%	265	15%	106	13%	45	13%

The table shows that just over 7% of all schools and nurseries in Manchester are located in areas experiencing the lowest emissions reductions. In contrast, over 15% of schools are located in areas experiencing the highest emissions reductions. For parks and open spaces, approximately 10-13% are located in areas receiving both the 10% highest and 10% lowest reductions in emissions. In general, there are more playgrounds located in areas of high reductions (approximately 13%) than in areas with low reductions (approximately 7%). Overall, there are more facilities used by children located in areas of high emissions reductions with minor differences of less than 2% between Option 5(i), Option 5(ii) and Option 8.

In general, air quality impacts on children are likely to be more beneficial outside of the Manchester IRR boundary. Despite there being high emissions reductions in this zone, this area contains less than 1% of total population of under 16's and only a small number of facilities of importance to children (three nurseries, four parks/open space and no junior/secondary schools). Within the M60 and the rest of Greater Manchester the overall impacts on children are more apparent with residents located in close proximity to the major road networks (M6, M60, M61, M62, M602, M66, M56) likely to experience the greatest air quality benefits.

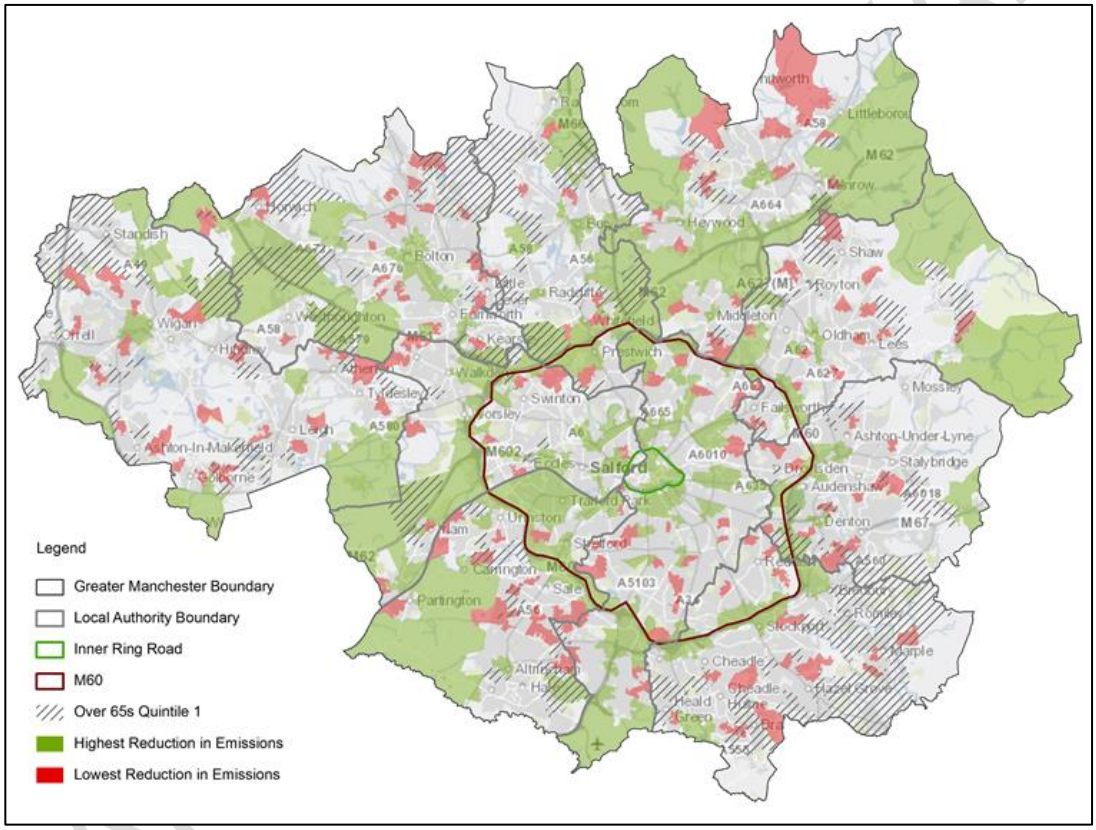
4.6.5 Elderly (over 65's)

The assessment in section 4.5.4 showed that, using the WebTAG Distributional Impacts methodology, the distributional effects of air quality on elderly residents were unevenly distributed across the study area with residents in quintiles 4 and 5 receiving a score of **large beneficial** and residents in quintile 1, 2 and 3 receiving a score of **slight beneficial.**

This section describes the distribution of these benefits on the areas with the 10% highest and 10% lowest reductions in emissions (refer to Figure 42, 43 and 44 in map book).

Image 4- 4 provides an example for Option 5(i). Areas coloured green represent those with the 10% highest emissions reductions. Those in red represent the 10% lowest emissions reductions. The highlighted areas are those which also contain the 20% of the population with the highest proportion of elderly residents.

Image 4- 4: Map to show LSOAs with the 10% highest and 10% reductions in emissions as well as areas with the highest proportion of over 65s for Option 5(i)



The map shows that areas with a high proportion of over 65s are concentrated on the outskirts of Greater Manchester with a small elderly population located within the M60. Within the IRR, there are no areas with a very high concentration of elderly residents. In the south east of the study area, there is a high concentration of elderly residents however this area contains mostly low emissions reductions. In contrast, the north west of the study area contains a high elderly population and high emissions reductions. Table 4- 12 shows the number of over 65's located within each of the key study areas which also experience the highest reductions in emissions. The final row of the table shows the total elderly population within each zone (regardless of air quality impacts).

Table 4- 12: The number of over 65's living in areas with the 10% highest reductions in emissions

		Greater Manchester		M60 (excluding IRR)		IRR	
		Number of residents	**%**	**Number of residents**	**%**	**Number of residents**	**%**
Elderly population (over 65)	Option 5(i)	48,000	12%	15,000	16%	490	70%
	Option 5(ii)	48,000	12%	15,000	16%	540	77%
	Option 8	48,000	12%	14,000	15%	490	70%
Total elderly population		**410,700**		**91,000**		**700**	

Table 4- 12 shows that across the whole of Greater Manchester, approximately 48,000 (12%) of elderly residents experience the highest reductions in emissions. Within the M60, Option 5(i) and Option 5(ii) presents marginally higher benefits than Option 8, with approximately 16% of this area benefitting from high emissions reductions compared to 15% for Option 8. The greatest impact is seen within the IRR in which Option 5(ii) results in 77% of over 65's in this zone receiving the greatest reductions in emissions. For Option 5(i) and Option 8, 70% of the residents in the IRR experience the highest emissions reductions, this equates to approximately 490 elderly residents (less than 1% of the total study area).

The analysis shows that overall, the M60 and IRR are expected to receive the highest air quality benefits. In general, the elderly population are located outside of these zones, on the outskirts of Greater Manchester. Having said that, the small elderly population located within the IRR, does experience largely positive impacts with over 70% (490 residents) located in areas of high emissions reductions. It is likely that given the distribution of the elderly population, benefits are more likely to be experienced through improved accessibility and affordability of local transport services as a result of the CAP rather than reductions in emissions.

4.6.6 Summary

Overall, across the whole of Greater Manchester, Option 5(ii) and Option 5(i) are the best performing options in terms of overall emissions reductions, resulting in an 18% decrease in total emissions compared to the do minimum scenario. Option 8 follows closely behind with a 17% reduction in total emissions of PM and NO_X. This is also true within the M60 where Option 5(ii) and Option 5(i) result in a 23% reduction in emissions compared to a 20% reduction for Option 8.

Within the IRR, Option 5(ii) is the highest performing option, resulting in the greatest reductions in total emissions. This is closely followed by Option 5(i) and Option 8. Within the IRR, the majority (>70%) of the total elderly population experience the highest reductions in emissions.

4.7 Mitigation and enhancement

In line with TAG unit A4-2A, where the distributional impacts analysis shows evidence of an intervention having particularly high benefits or dis-benefits to a certain group, enhancement and mitigation should be considered. Section 4.5 shows that beneficial air quality impacts are experienced across all quintiles. In absence of adverse effects, no mitigation is considered necessary.

It is recommended that further work be undertaken to explore potential enhancement measures for any beneficial distributional impacts.

4.8 Sensitivity analysis

The sensitivity tests reported in this section test the extent to which the conclusions of the assessment may alter because of modelling uncertainties.

Table 4- 13 shows the distributional impacts appraisal matrix from section 4.5.5. In absence of specific guidance on the threshold used to determine moderate beneficial impacts, a threshold of +/- 2% was applied. To test the sensitivity of the results to this threshold, a sensitivity test has been run applying 5% threshold. This is the level used for distributional analysis of user benefits and is recommended by WebTAG Unit A4-2.

Table 4- 13 shows the sensitivity analysis using the results from the assessment on Option 5(i)/(ii) and Option 8.

Table 4- 13: Distributional impacts appraisal matrix with 2% and 5% thresholds on significance levels

	+/- 2% threshold on moderate significance					**+/- 5% threshold on moderate significance**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Low income households (Relative to England and Wales)	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Low income households (Relative to Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓

	+/- 2% threshold on moderate significance					+/- 5% threshold on moderate significance				
	1	2	3	4	5	1	2	3	4	5
Children (Relative to England and Wales)	✓	✓✓	✓✓	✓✓ ✓	✓✓ ✓	✓	✓✓	✓✓	✓✓	✓✓ ✓
Elderly (Relative to England and Wales)	✓	✓	✓	✓✓ ✓	✓✓ ✓	✓	✓	✓✓	✓✓	✓✓ ✓

As seen in Table 4- 13, the distributional impacts appraisal matrix for low income households is not sensitive to this change in significance threshold. For children and the elderly, quintiles 3 and 4 change from large and slightly beneficial to moderate beneficial. Since the results of the sensitivity test result in only minor differences, with no adverse impacts, these can be considered insignificant.

4.9 Limitations

Although there is a lot of evidence linking air pollution with adverse health effects, the ability to quantify these effects presents a challenge. The challenges stem from multiple pollutants coming from the same source and with similar distribution.

The impact factors in Table 5- 13 were derived based on the best available scientific information and medical evidence on the effects of pollutants on health and the environment. However, it is noted that the methodology is not without its limitations. For example, there are a range of other negative health outcomes that are not included in JAQU's impact pathway methodology. These include:

- cognitive decline and dementia, which have been linked to traffic-related air pollutants (Power et al., 2016);
- lower lung function in early life which has been associated to exposure during pregnancy (Morales et al., 2015);
- self-reported life satisfaction has been linked to NO_2 (after controlling for other economic, social and environmental factors) (Knight and Howley, 2017).

The evidence on the health effects of traffic related air pollutants is continually evolving and approaches to measuring health benefits will need to adapt as new evidence emerges.

5 Health and Environment

5.1 Overview

This section presents the findings of the preliminary analysis of health and environmental distributional impacts (DI) for the proposed GM CAP. The analysis is based on outputs of TfGM's EMIGMA (Emissions Inventory for Greater Manchester) software, which provides the change in emissions in tonnes for NO_X and PM_{10} for a 'DM Scenario' (2021) compared to each of the clean air options under analysis (Option 5(i)/(ii) and Option 8).

The findings reported here are intended as illustrative of the final analysis that will be completed for the preferred clean air option selected for Greater Manchester, once the final air dispersion modelling results are available. The aim here is to present an overview of the methodology and the approach to the analysis, and to present some indicative results.

In February 2016, the JAQU was established by Defra and the DfT to coordinate delivery of the Government's plans for achieving NO_2 compliance. Part of the remit of JAQU is to support the implementation of CAZs or other measures selected by local authorities (UK Parliament, 2018).

The outputs from the EMIGMA modelling comprise estimates of mass road traffic emissions for each road or link. A GIS solution was devised to crop the links so that the total change in emissions at LSOA level could be derived. Defra damage cost multipliers were then applied to the change in emissions.

Monetised health and environmental benefits are described for Greater Manchester as a whole, and within each of the proposed charging zones, as well as at the LA level. The health and environmental impact assessment does not look at LSOAs on an individual basis, rather the assessment for these wider study areas is built up from the LSOA level results.

5.2 Key findings

The key findings of the assessment are presented as follows:

- For Option 5(ii), the total monetised health and environmental benefit in Greater Manchester is estimated at around £17.9 million. This is slightly higher than the total monetised benefit of £17.8 million for Option 5(i). Option 8 delivers the lowest benefits of all options at £14.9 million across Greater Manchester.
- Within the IRR, the total monetised health and environmental benefit is estimated at £480,000 for option 5(ii). The benefit within the IRR for Option 5(i) is slightly higher than Option 5(ii), at £430,000. The total benefit within the IRR for Option 8 is the lowest of all three options at approximately £350,000.

5.3 Key health and environmental concerns

The following key health and environmental concerns are considered in this report. A summary of issues screened in/out of the analysis is provided in section 5.5.

5.3.1 Respiratory illness

The links between air quality emissions and health effects are well established. The main pollutants from vehicle emissions are PM and NO_X, which are linked to effects on lung function and other respiratory problems.

PM particles with a diameter of less than 10µm are referred to as PM_{10}. Those with a diameter of less than 2.5µm are called $PM_{2.5}$. $PM_{2.5}$ also consists of ultrafine particles with a diameter of less than 0.1µm which can remain in the atmosphere for days or weeks at a time and are therefore subject to long-range transboundary transport in the air. Both PM_{10} and $PM_{2.5}$ include particles small enough to penetrate the human respiratory system, therefore resulting in health effects (World Health Organisation (WHO), 2013).

Evidence shows high exposure to poor air quality (particularly PM and NO_X) in the short term can result in inflammation of the airways and increased incidence of shortness of breath and wheeze symptoms (Royal College of Physicians, 2016).

In the long term, exposure can affect lung function and increase hospital admissions and mortality for those with existing respiratory conditions such as chronic obstructive pulmonary disease (COPD) and asthma. There is also evidence to suggest that long-term exposure to poor air quality causes new-onset asthma in both children and adults (Royal College of Physicians, 2016).

Recently, evidence has shown links between PM and chronic bronchitis; however, currently there is not sufficient evidence to establish causality. Therefore, this issue would be acknowledged during the assessment but not assessed quantitatively. Impacts related to respiratory illness are captured in the monetisation of health and environmental impacts in sections 5.6.4 to 5.6.6.

5.3.2 Cardiovascular disease

Cardiovascular disease includes all the diseases of the heart and circulation including CHD, angina, heart attack, congenital heart disease and stroke (British Heart Foundation, 2017). CHD is the leading cause of death in the UK (British Heart Foundation, 2015). Evidence shows exposure to high levels of PM both in the short and long term can exacerbate existing cardiovascular disease and is associated with a range of cardiovascular effects such as heart failure and strokes. Impacts related to cardiovascular disease are captured in the monetisation of health and environmental impacts in sections 5.6.4 to 5.6.6.

5.3.3 Mortality

The link between mortality and long-term exposure to air pollution is well evidenced (COMEAP, 2017). Cohort studies looking at the effects of air pollution on health over several years have shown that the deaths from respiratory and cardiovascular causes, in combination with other factors, increase with long term exposure to air pollution. Studies also found that the link between exposure and mortality is much stronger for $PM_{2.5}$ than PM_{10} (WHO, 2013). Impacts related to mortality are captured in the monetisation of health and environmental impacts in sections 5.6.4 to 5.6.6.

5.3.4 Active travel

The GM CAP has the potential to encourage a city-wide transition towards active transport. Journeys by bicycle or on foot not only reduce emissions and improve air quality but have the added advantages of improving health by helping reduce obesity, diabetes, CHD, stroke, road traffic accidents, and improving mental health (UK Alliance on Climate Change, 2016). Impacts related to active travel are considered in the context of baseline data for obesity and other key health indicators, and the results of the analysis of distributional effects on accessibility (section 7).

5.3.5 Productivity

Productivity refers to the impact on the efficiency with which an input is used in the production process e.g. labour, human capital, natural capital. The pathway between air pollution and productivity focusses on the direct impacts of air pollution on human health via inhalation. These pathways subsequently impact on productivity through lost time participating in employment or non-market productive activities (Ricardo AEA, 2014). For example, an individual being admitted to hospital because of a pollution induced respiratory disorder could result in significant time off work, therefore impacting on workplace productivity. Health impacts could also affect non-market productive activities (e.g. volunteering and non-paid caring) by preventing an individual partaking in these activities. Impacts related to productivity are captured in the monetisation of health and environmental impacts in sections 5.6.4 to 5.6.6.

5.3.6 Building soiling

Soiling of buildings by particles is one of the most obvious signs of pollution in urban areas (Defra, 2015). The soiling of buildings includes both residential buildings and historical/cultural buildings. This results in economic damages through both cleaning and amenity costs. In the absence of willingness to pay values, building soiling costs are calculated based on the costs of cleaning. Impacts related to building soiling are captured in the monetisation of health and environmental impacts in sections 5.6.4 to 5.6.6.

5.3.7 Ecosystem effects

Increased nitrogen deposition in the form of NO_X poses a risk to biodiversity, through increased nitrogen deposition and overloading by nitrogen favourable species, reducing plant diversity in natural and semi-natural ecosystems.

5.4 Health and environmental issues screened out

The following effects were screened out, based on the following justification.

5.4.1 Indoor pollution

A report commissioned by the Royal College of Physicians (2016) considered the large potential effect on health of indoor sources of air pollution such as gas cookers, cleaning products and carbon monoxide. The report showed that several thousand's deaths per year in the UK could be attributed to indoor air pollution. Whilst consideration would be made to the potential health effects at built community facilities with limited ability to lessen interference from local emission sources such as hospitals and car homes (in line with TAG Unit 4.2), indoor air pollution falls outside the scope of this study, which focuses on mainly on traffic emissions.

5.4.2 Noise

Noise nuisance and vibration caused by road traffic can increase levels of stress, anxiety and aggression, increase the risk of hypertension and cardiovascular disease, and contribute to sleep disturbance and psycho-physiological effects (WHO, 2011). Noise is also a key contributing factor of neighbourhood amenity with excessive noise reducing the quality of the local environment. This reduction in neighbourhood amenity can lead to avoidance of the street for social use and reduced levels of active travel, ultimately leading to impacts on physical and mental health (Mindell et al., 2011). Key receptors of noise impacts include residential properties, schools, hospitals, care homes, open spaces, streetscapes and public rights of way.

The introduction of a clean air charge means there is potential for some change in fleet composition with older (generally louder engines) vehicles to be replaced with newer vehicles (generally quieter engines) that are subject to tighter noise limits in accordance with Regulation (EU) No 540/2014. Additionally, there is potential for some heavy vehicles to be replaced with multiple smaller vehicles in order to avoid the additional charge. However, these changes are not expected to result in a perceivable noise reduction. Further, establishing causal relationships between exposure to noise and health can be problematic as the effects of exposure vary between different types of noise sources and are also compounded by other factors. As such, noise effects are screened out, although the assessment of distributional impacts has considered where the main changes in traffic flows would occur and the characteristics of the population and facilities in that area. These locations would potentially experience change in levels of noise, as well as other traffic related impacts such as risk of accidents and community severance.

5.4.3 Climate change

Climate adaption in urban areas now considers the impacts of urban heat islands as an important part of forming strategic climate change action plans. Urban heat islands are man-made areas which are significantly warmer than the surrounding countryside. This mainly occurs because the materials used in towns and cities e.g. tarmac and stone have different thermal properties allowing them to absorb more heat than the materials found in rural areas.

The impacts of Urban Heat Island (UHI) compounds intensify the impacts of climate change resulting in hotter summers and heatwaves, preventing night-time cooling.

Whilst there are many factors that contribute to UHI, transport is a major contributor. Vehicles generate a large amount of heat through their exhaust emissions, radiant heat and tyre-road surface friction. As there is a higher density of vehicles in urban areas, this significantly contributes to the UHI and its associated health effects. Improved urban planning and investment in active transport can reduce the effects of the UHI, resulting in improvements to health, air quality and helping to meet climate change targets.

Assessment of the potential effects on the UHI in Greater Manchester resulting from the GM CAP is considered outside the scope of this assessment.

5.4.4 Crime reduction and community safety

In relation to community safety, being a victim of crime has an immediate physical and psychological impact. It can also have indirect long-term health consequences including disability, victimisation and isolation because of fear. Thoughtful planning and urban design that promotes natural surveillance and social interaction can help to reduce crime and the ‘fear of crime’, both of which impacts on the mental wellbeing of residents.

It is recognised that ANPR cameras and surveillance could potentially provide a deterrent for crime; however, given that closed-circuit television (CCTV) has been found to reduce property and vehicle crime, but provide little deterrent for street crime in open areas, the potential for clean air charging in Greater Manchester to provide any additional deterrent to crime is considered unlikely (Gill and Spriggs, 2005). For this reason, this topic has been screened out of the assessment.

5.5 Summary of screening

Table 5- 1 gives a summary of the health and environmental issues screen in/out of the assessment, as detailed in section 3.2 and 3.4. Colour coding in the first column refers to where this is covered within the analysis.

	Health effect considered within damage cost methodology
	Health effect additional to damage cost methodology
	Environmental consideration considered within damage cost methodology
	Environmental consideration additional to damage cost methodology

Table 5- 1: Screening of health and environmental impacts

Health/ environmental consideration	Screened in	Reason for screening in/out
Respiratory illness	✓	The links between air quality emissions and health effects are well established. The main pollutants from vehicle emissions are $PM_{10}$and NO_x, which are linked to effects on lung function and other respiratory problems (Royal College of Physicians, 2016).
Cardiovascular disease	✓	Evidence shows exposure to high levels of PM_{10}both in the short and long term can exacerbate existing cardiovascular disease and is associated with a range of cardiovascular effects such as heart failure and strokes. (British Heart Foundation, 2017).
Mortality	✓	The link between mortality and long-term exposure to air pollution is well evidenced (COMEAP, 2017).
Active travel	✓	The GM CAP has the potential to encourage a city-wide transition towards active transport. Journeys by bicycle or on foot not only reduce emissions and improve air quality but have the added advantages of improving health by helping reduce obesity, diabetes, coronary heart disease (CHD), stroke, road traffic accidents, and improving mental health (UK Alliance on Climate Change, 2016).
Diabetes	✓	Evidence suggests a link between air pollution and diabetes, especially type 2 diabetes mellitus. The association was stronger for traffic associated pollutants including NOx and PM (Royal College of Physicians, 2016). Further work is recommended (see Appendix B).
Cognitive decline and dementia	✓	There is emerging evidence to suggest that poor air quality affects cognitive functioning in both children and adults (Royal College of Physicians, 2016). Further work is recommended (see Appendix B).
Mental health	✓	According to a growing body of evidence, air pollution can be associated with changes in behaviour within society, for example, spending less time outside, which can lead to more sedentary lifestyles and negative psychological effects on our mental health (Crowder, 2017). Further work is recommended (see Appendix B).

Health/ environmental consideration	Screened in	Reason for screening in/out
Risks to unborn baby	✓	There is emerging evidence on the links between high levels of emissions and effects on the unborn child. Further work is recommended (see Appendix B).
Productivity	✓	Productivity refers to the impact on the efficiency with which an input is used in the production process e.g. labour, human capital, natural capital.
Building Soiling	✓	Reduced soiling of buildings by combustion particulates (the soiling of buildings includes both residential dwellings and historic/cultural buildings and causes economic damages through cleaning costs and amenity costs)
Ecosystem effects	✓	Reduced impact of NO_2 on ecosystems (impact of NO_2 results in increased nitrogen deposition and overloading by nitrogen favourable species, reducing plant diversity in natural and semi-natural ecosystems)
Indoor pollution	×	Indoor air pollution (gas cookers, cleaning products, carbon monoxide) falls outside the scope of this study, which focuses on mainly traffic emissions (see section 5.4.1).
Noise	×	Changes in fleet composition could result in perceivable noise reductions, reducing stress, anxiety, aggression and further associated health problems associated with noise. However, changes in fleet composition are unexpected to result in perceivable noise reduction (see section 5.4.2).
Climate change	×	Potential effects of urban heat islands are considered outside the scope of the assessment for reasons of proportionality (see section 5.4.3).
Crime reduction and community safety	×	It is recognised that ANPR cameras and surveillance measures associated with a GM CAP could provide deterrent for crime, increasing safety, however this topic has been scoped out of the assessment due to the limited evidence (see section 5.4.4).

5.6 Damage cost methodology

Damage costs are a simple way to value changes in air pollution. They estimate the cost to society of a change in emissions of different pollutants (Defra, 2015). Damage costs are provided by pollutant type, pollutant source and location. Monetary benefits are calculated by multiplying damage cost by the change in emissions (tonnes of pollutant).

5.6.1 Introduction

This section describes the methodology applied to the assessment of air quality distributional impacts.

1) Firstly, each LSOA was assigned a classification based on ONS residential-based area classifications. Using socio-economic and demographic data from each census, these classifications aim to identify areas of the country with similar characteristics e.g. population size. These were then matched with Defra's pollutant source classifications (see Table 5- 2). Out of 1,673 LSOAs, the majority (97%) are assigned the 'Road Transport Urban Big' classification. 'Road Transport Urban Medium' and 'Road Transport Rural' account for 2.3% and 0.8% respectively.

Table 5- 2: Pollutant source and ONS classifications

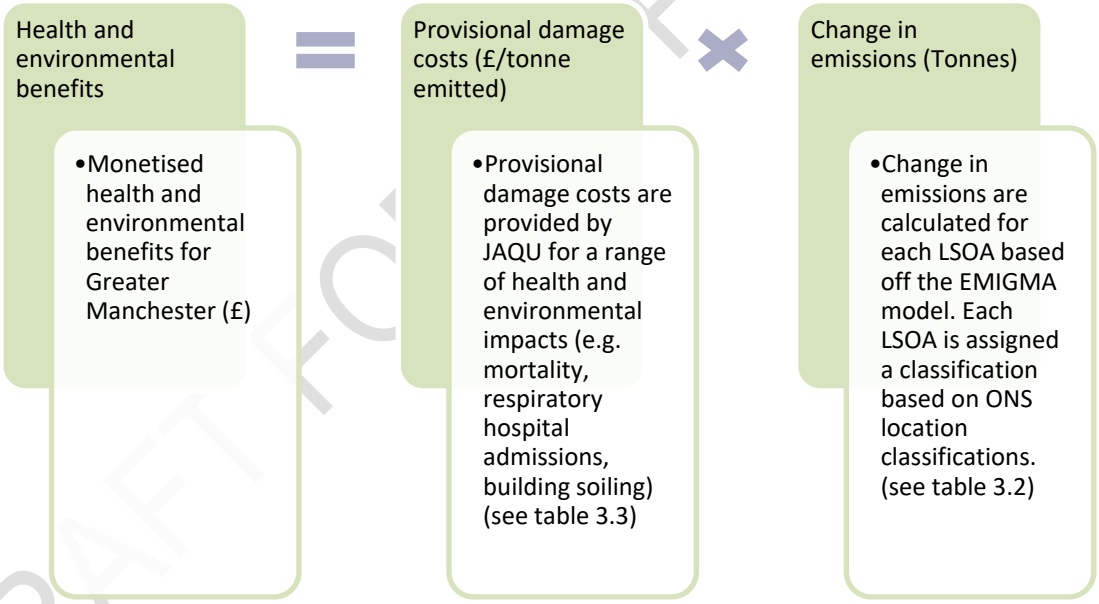
Defra pollutant source classification	Corresponding ONS classification (ONS, 2011)	Rural/urban LA classification (England)
Road Transport Inner Conurbation	Not applied in the assessment	N/A
Road Transport Outer Conurbation	Not applied in the assessment	N/A
Road Transport Urban Big	Urban major conurbation	Major urban: districts with either 100,000 people or 50% of their population in urban areas with a population of more than 750,000. Less than 26% of the population living in rural settlements and hub towns.
Road Transport Urban Large	Not applied in the assessment	N/A
Road Transport Urban Medium	Urban city and town	At least 26% but less than 50% of the population living in rural settlements and hub towns[20].
Road Transport Urban Small	Not applied in the assessment	N/A
Road Transport Rural	Rural town and fringe	At least 50% but less than 80% of population living in rural settlements and hub towns.
	Rural village and dispersed	At least 80% living in rural settlements and hub towns.

[20] Hub towns are built up areas with a population of 10,000 to 30,000 that meet specific criteria relating to dwelling and business densities, suggesting the potential to serve the wider rural hinterland (ONS, 2017).

2) Secondly, the outputs of the EMIGMA model were manipulated using GIS techniques to calculate the approximate change in emissions for each LSOA in the study area. This provided the change in emissions between the DM (2021) and the clean air option scenario (2021) (Option 5(i)/(ii) and Option 8). Provisional damage costs multipliers for NOx and PM10 were uplifted from 2015 prices to 2018 base year, using the WebTAG GDP deflator series (see Table 5- 3 and Table 5- 4). Further work is recommended to uplift these values to more accurately reflect the willingness to pay assumption (see Appendix B). The JAQU guidance indicates that ozone impacts are an optional requirement and are not included in the analysis presented here.
3) The adjusted damage costs and the change in emissions were used to calculate the benefits of a reduction in pollutants emitted at LSOA level. The results are presented in 2018 prices.

Image 5- 1 provides an overview of the approach used to calculate health and environmental benefits.

Image 5- 1: Methodology for the calculation of health and environmental benefits



5.6.2 Provisional damage costs for health effects

The provisional damage costs (Table 5- 3 and Table 5- 4) cover a range of pollutant and exposure pathways as follows:

- NO_2 Mortality – the impact on LE of long-term exposure to average levels of pollutants in the air
- PM_{10} Mortality – the impact on LE of long-term exposure to average levels of pollutants in the air

- PM_{10} Respiratory hospital admissions – emergency admissions to hospital due to pollution induced respiratory problems
- PM_{10} Cardiovascular hospital admissions – emergency admissions to hospital due to pollution induced cardiovascular problems

5.6.3 Provisional damage costs for environmental effects

Using the provisional damage costs, it is also possible to quantify the effects on the environment as follows:

- PM_{10} Productivity – the impact on the efficiency with which an input is used in the production process e.g. labour, human capital, natural capital.
- Building Soiling (PM_{10}) – reduced soiling of buildings by combustion particulates (the soiling of buildings includes both residential dwellings and historic/cultural buildings and causes economic damages through cleaning costs and amenity costs)
- Ecosystem impact (NO_2) – reduced impact of NO_2 on ecosystems (impact of NO_2 results in increased nitrogen deposition and overloading by nitrogen favourable species, reducing plant diversity in natural and semi-natural ecosystems)
- Ozone ecosystem impact – negative effect on human and environmental health from depletion in the ozone layer resulting in greenhouse gas (GHG) effects[21]

[21] The JAQU guidance indicates that ozone impacts are an optional requirement and are not included in the analysis presented here.

Table 5- 3: Provisional Damage Costs (2018 £/tonne emitted) - PM_{10}

Source	PM Mortality	NO_2 Mortality	PM Respiratory hospital admissioN	PM Cardiovascular hospital admission	PM Productivity	PM Building Soiling	NO_2 Ecosystem
Average Road Transport	£80,116	n/a[22]	£702	£429	£7,979	£574	n/a
Road Transport Inner Conurbation	£143,244	n/a	£1,255	£768	£14,266	£574	n/a
Road Transport Outer Conurbation	£85,117	n/a	£746	£456	£8,477	£574	n/a
Road Transport Urban Big	£103,943	n/a	£911	£557	£10,352	£574	n/a
Road Transport Urban Large	£84,033	n/a	£736	£450	£8,369	£574	n/a
Road Transport Urban Medium	£69,123	n/a	£606	£371	£6,884	£574	n/a
Road Transport Urban Small	£51,830	n/a	£454	£278	£5,162	£574	n/a
Road Transport Rural	£23,518	n/a	£206	£126	£2,342	£574	n/a

[22] n/a represents areas in which there is no recognised pathway between the pollutant and the damage cost.

Table 5- 4: Provisional Damage Costs (£/tonne emitted) - NO_X

Source	PM Mortality	NO_2 Mortality	PM Respiratory hospital admission	PM Cardiovascular hospital admission	PM Productivity	PM Building Soiling	NO_2 Ecosystem
Average Road Transport	£528	£4,571	£4.18	£2.56	£52.59	n/a	£64
Road Transport Inner Conurbation	£528	£8,489	£4.18	£2.56	£52.59	n/a	£64
Road Transport Outer Conurbation	£528	£4,854	£4.18	£2.56	£52.59	n/a	£64
Road Transport Urban Big	£528	£6,015	£4.18	£2.56	£52.59	n/a	£64
Road Transport Urban Large	£528	£4,76	£4.18	£2.56	£52.59	n/a	£64
Road Transport Urban Medium	£528	£3,882	£4.18	£2.56	£52.59	n/a	£64
Road Transport Urban Small	£528	£2,850	£4.18	£2.56	£52.59	n/a	£64
Road Transport Rural	£528	£1,136	£4.18	£2.56	£52.59	n/a	£64

5.6.4 Heath and Environmental Impacts - Option 5(i)

For the entirety of Greater Manchester, the total health and environmental benefit provided by the implementation of Option 5(i) is estimated at around £18 million, as illustrated in Table 5- 5.

Table 5- 5: Health and environmental benefits for Greater Manchester – Option 5(i)

Pollutant emitted / impact	Monetised health and environmental benefit (£, 2018)	% contribution to the total health and environmental benefit
PM_{10} / Mortality	£8,050,000	45%
NO_2 / Mortality	£8,750,000	49%
PM / Respiratory hospital admission	£70,000	0.4%
PM / Cardiovascular hospital admission	£40,000	0.2%
PM / Productivity	£800,000	4.5%
PM / Building Soiling	£40,000	0.2%
NO_2 / Ecosystem	£100,000	0.5%
Total	**£17,850,000**	**100%**

Approximately half (49%) of the total health and environmental benefit is derived from the avoided deaths (reduced rates of mortality) resulting from reduced exposure to NO_2. Reduced exposure to PM_{10} and the associated avoided deaths (reduced rates of mortality) contributed 45% to the overall total. The reduction in lost productivity resulting from the reduction in concentrations of PM_{10} accounts for 4.5% of the total. All other impacts contribute less than 1% to the total benefit. Overall, health factors contribute approximately £17million (95%) to the total whilst environmental factors contribute approximately £1million (5%).

The breakdown of the total benefit for each of the proposed charging zones is illustrated in Table 5- 6.

Table 5- 6: Health and environmental benefits by charging zone – Option 5(i)

Zone description	Number of LSOAs	Total monetised health and environmental benefit (£, 2018)
Greater Manchester (all LSOAs)	1,673	£17,850,000
Greater Manchester (excluding M60 and IRR)	1,182	£11,690,000

Zone description	Number of LSOAs	Total monetised health and environmental benefit (£, 2018)
LSOAs within the M60 (including IRR)	491	£6,160,000
LSOAs within the M60 (excluding IRR)	474	£5,730,000
IRR	17	£430,000

Within the IRR, the total monetised health and environmental benefit (£430,000) contributes 2% to the overall total benefit across Greater Manchester. Within the M60 (including the IRR), the total benefit is approximately £6million, contributing 34% to the overall total.

5.6.5 Heath and Environmental Impacts - Option 5(ii)

For the entirety of Greater Manchester, the total health and environmental benefit provided by the implementation of Option 5(ii) is estimated at around £18 million, as illustrated in Table 5- 7.

Table 5- 7: Health and environmental benefits for Greater Manchester – Option 5(ii)

Pollutant emitted / impact	Monetised health and environmental benefit (£, 2018)	% contribution to the total health and environmental benefit
PM_{10} / Mortality	£8,060,000	45%
NO_2 / Mortality	£8,790,000	49%
PM_{10} / Respiratory hospital admission	£70,000	0.4%
PM_{10} / Cardiovascular hospital admission	£40,000	0.2%
PM_{10} / Productivity	£800,000	4.5%
PM_{10} / Building Soiling	£40,000	0.2%
NO_2 / Ecosystem	£100,000	0.5%
Total	**£17,900,000**	**100%**

Approximately half (49%) of the total health and environmental benefit is derived from the avoided deaths (reduced rates of mortality) resulting from reduced exposure to NO_2. Reduced exposure to PM_{10} and the associated avoided deaths (reduced rates of mortality) contributed 45% to the overall total. The reduction in lost productivity resulting from the reduction in concentrations of PM_{10} accounts for 4.5% of the total. All other impacts contribute less than 1% to the total benefit.

The breakdown of the total benefit for each of the proposed charging zones is illustrated in Table 5- 8.

Table 5- 8: Health and environmental benefits by charging zone – Option 5(ii)

Zone description	Number of LSOAs	Total monetised health and environmental benefit (£, 2018)
Greater Manchester (all LSOAs)	1,673	£17,900,000
Greater Manchester (excluding M60 and IRR)	1,182	£11,640,000
LSOAs within the M60 (including IRR)	491	£6,270,000
LSOAs within the M60 (excluding IRR)	474	£5,790,000
IRR	17	£480,000

Within the IRR, the total monetised health and environmental benefit contributes 3% (£480,000) to the overall total benefit across Greater Manchester. Within the M60 (including the IRR), the total benefit is approximately £6.2million, contributing 35% to the overall total.

5.6.6 Health and Environmental Impacts – Option 8

For the entirety of Greater Manchester, the total health and environmental benefit provided by the implementation of Option 8 is estimated at around £17 million, as illustrated in Table 5- 9.

Table 5- 9: Health and Environmental benefits for Greater Manchester - Option 8

Pollutant emitted / impact	Monetised health and environmental benefit (£, 2018)	% contribution to the total health and environmental benefit
PM_{10} / Mortality	£5,890,000	39%
NO_2 / Mortality	£8,300,000	55%
PM / Respiratory hospital admission	£50,000	0.3%
PM / Cardiovascular hospital admission	£30,000	0.2%
PM / Productivity	£590,000	3.9%
PM / Building Soiling	£30,000	0.2%
NO_2 / Ecosystem	£90,000	0.6%
Total	**£14,980,000**	**100%**

Reduced exposure to NO_2 and the associated avoided deaths (reduced rates of mortality) contributed over half (55%) of the overall total. Less than half (39%) of the total health and environmental benefit is derived from the avoided deaths (reduced rates of mortality) resulting from reduced exposure to PM_{10}. The reduction in lost productivity resulting from the reduction in concentrations of PM_{10} accounts for 3.9% of the total. All other impacts contribute less than 1% to the total benefit.

5.6.7 Total health and environmental benefits all options

Table 5- 10 shows the total health and environmental benefits for all options.

Table 5- 10: Total health and environmental benefits – all options

Total health and environmental benefit (£, 2018)	Option 5(i)	Option 5(ii)	Option 8
Health	£16,910,000	£16,963,000	£14,270,000
Environmental	£938,700	£940,000	£709,000
Total	**£17,850,000**	**£17,900,000**	**£14,980,000**

The table shows that Option 5(ii) delivers the most benefits contributing almost £18 million in health and environmental benefits to Greater Manchester. This is very closely followed by Option 5(i) which is £50,000 less than Option 5(ii). Overall, Option 8 delivers the lowest health benefits in the region of £15 million.

Table 5- 11: Total health and environmental benefits in key study areas – all options

Zone	Option 5(i)	Option 5(ii)	Option 8[23]
Greater Manchester (excluding M60 and IRR)	£11,690,000	£11,640,000	£9,870,000
M60 (excluding IRR)	£5,730,000	£5,790,000	£4,760,000
IRR	£430,000	£480,000	£350,000
Total (Greater Manchester Wide)	**£17,850,000**	**£17,900,000**	**£14,980,000**

[23] Option 8 is a Greater Manchester wide scheme. The figures for the M60 and IRR key study areas are presented for comparison only.

5.7 Sensitivity Tests

The sensitivity tests reported in this section test the extent to which the conclusions of the assessment may alter because of modelling uncertainties.

5.7.1 Population weightings

Damage costs are provided by pollutant, source and location. In absence of the ADMS data required to complete a full impact pathway analysis, the methodology applied here classified all LSOAs according to ONS residential-based areas classifications. These have then been matched to Defra's pollutant source classifications. To test the sensitivity of the results to this process, all areas have been re-classified as "Road Transport Urban Big" and the results have been compared representing a worst-case scenario.

Table 5- 12 shows the total damage cost for all options with original classifications and a sensitivity test.

Table 5- 12: Sensitivity test of population weightings

	Option 5(i)	**Option 5(ii)**	**Option 8**
Total damage cost with original LSOA classifications.	£17,850,000	£17,900,000	£14,980,000
Total damage cost with all LSOAs classified as 'Urban Big'	£18,300,000	£18,360,000	£15,450,000
% difference	2.5%	2.6%	3.2%

The results show minor differences (less than 4%) across all options. Overall, Option 5(ii) still delivers the greatest health and environmental benefits. It is therefore concluded that the results of the analysis are not sensitive to the population weightings used in the analysis.

5.8 Impact pathway methodology

5.8.1 Introduction

This section describes the impact pathway methodology, which could be applied subject to a workable methodology using ADMS results (see section 1.1 Appendix B).

The full impact pathway approach is outlined below:

- Initial location-specific air quality modelling is undertaken to calculate the change in air quality emissions between a baseline scenario (i.e. when no interventions have taken place) and the modelled scenario (i.e. the implementation of a clean air intervention).

- The change in population weighted mean concentrations between the baseline and the modelled scenario are calculated. The population weighted mean concentration is the estimated average exposure of the population to different pollutants. This is weighted by population so that the concentration data in more populated areas are given a higher weight than those in less populated areas.
- The health impacts are then quantified and monetised using a set of impact factors provided by JAQU. The impact factors capture the value in GBP per person of a 1 μgm^{-3} change in concentration of a pollutant. The impact factors represent the pathway between exposure to a pollutant and the ultimate health outcome.

5.8.2 Impact pathway pollutants for health effects

The provisional impact factors, provided by JAQU (Table 5- 13), are based on the recommended concentration response functions from the Committee on the Medical Effects of Air Pollutants (COMEAP). These are then monetised using the value of a life year and recommendations from a study by Chilton et al (2004). Applying he approach recommended by JAQU, the following impacts can be quantified:

- NO_2 Mortality – the impact on LE of long-term exposure to average levels of pollutants in the air
- PM_{10} Mortality – the impact on LE of long-term exposure to average levels of pollutants in the air
- PM_{10} Respiratory hospital admissions – emergency admissions to hospital due to pollution induced respiratory problems
- PM_{10} Cardiovascular hospital admissions – emergency admissions to hospital due to pollution induced cardiovascular problems
- PM_{10} Productivity – the impact on the efficiency with which an input is used in the production process e.g. labour, human capital, natural capital.

5.8.3 Impact pathway pollutants for non-health (environmental) effects

Using the JAQU impact factors, it is also possible to quantify the effects on the environment, such as the effects of PM on building soiling and the associated costs involved in cleaning buildings in urban areas. It is possible to quantify the following impacts:

- Building Soiling (PM_{10}) – reduced soiling of buildings by combustion particulates (the soiling of buildings includes both residential dwellings and historic/cultural buildings and causes economic damages through cleaning costs and amenity costs)

- Ecosystem impact (NO_2) – reduced impact of NO_2 on ecosystems (impact of NO_2 results in increased nitrogen deposition and overloading by nitrogen favourable species, reducing plant diversity in natural and semi-natural ecosystems)
- Ozone ecosystem impact – negative effect on human and environmental health from depletion in the ozone layer resulting in GHG effects

Table 5- 13: Provisional Damage Cost Impact Factors (£/ug^{-3}/person) (2015 prices)

Pollutant	PM Mortality	NO_2 Mortality	PM Respiratory Hospital Admissions	PM Cardiovascular hospital admission	PM productivity	Building Soiling (PM_{10})	Ecosystem Impact ($N0_2$)	Ecosystem Impact (Ozone)
	(£/ug-3/person)				(£ per tonne emitted)			
PM_{10}	£16.20	n/a	£0.10	£0.06	£1.61	£543	n/a	n/a
NO_2	n/a	£2.47	n/a	n/a	n/a	n/a	£61	-£35

6 Affordability

6.1 Overview

This report presents the findings of the preliminary analysis of affordability distributional impacts for the proposed GM CAP. The method of appraisal has been developed with reference to the guidance set out in DfT's TAG Unit A4-2 'Distributional Impact Appraisal' (DfT, 2015). This follows three stages of screening, assessment and appraisal to identify groups which could be disproportionately impacted by a proposed scheme. This approach has been supplemented with additional qualitative narrative relating to the potential affordability impacts on different social or economic groups in different geographies.

Three key topics are considered within this appraisal: personal affordability, user benefits and business affordability. These are explained below:

Personal affordability

Personal affordability is the cost of travel for local people commuting to a place of work or education and undertaking journeys for social or leisure purposes via private vehicle. For this scheme, changes to personal affordability are linked to the costs associated with either paying the clean air

charge for non-compliant vehicles or upgrading to a compliant vehicle where required, and in operating a vehicle (such as fuel and oil consumption, mileage related depreciation and tyre wear) that are considered critical to the decision of whether to undertake a journey.

User benefits

User benefits capture the experience of people commuting to a place of work or education and undertaking journeys for social or leisure purposes via private vehicle, and are associated with reduced journey times and reductions in the cost of operating a car, as described above. In contrast to personal affordability, this impact variable considers time and money costs that affect a person's experience when travelling, which are not likely to be critical to the decision of whether to undertake a journey.

Business affordability

The introduction of clean air charging zones in Greater Manchester would impose direct costs on businesses through increased transportation costs associated with either paying the clean air charge for non-compliant vehicles or upgrading to a compliant vehicle where required, and/or procurement costs.

6.2 Methodology

The DI appraisal applies the three-stage method set out in TAG Unit A4-2. The stages are:

1) Screening: The stage where the variety of impacts that the option may have are considered and particular impacts are prioritised for further analysis so that only the most relevant issues for the scheme are appraised to ensure proportionality.
2) Assessment: The stage where information is collected on the geographical area likely to be affected by the option and how different social and business groups are distributed within that geographical area.
3) Appraisal: The assessment of the extent of the impact of the option on the social or business groups identified.

JAQU guidance on the appraisal of distributional impacts acknowledges that in some cases it is appropriate to use a more 'light touch' approach than is set out in TAG unit A4-2, depending on scheme particulars and available information and research. The approach for this distributional impact appraisal has therefore been to screen for which types of impact are the most relevant to the influence of the CAP, and then to determine what level of analysis is proportionate, taking into account the availability of data to inform the assessment in the context of the GM CAP.

In order to identify societal groups who could be 'disproportionately' impacted, the population within the study area has been divided into quintiles, based on the distribution across England and Wales. For example, to assess income deprivation, the population is first divided into five equal parts depending on the level of income: the first quintile contains the top fifth of the population on the scale (i.e. the 20% of the population with the highest income), the second quintile represents the second fifth (from 20% to 40%) and the fifth quintile represents the 20% of the population with the lowest income. Once the population has been divided into quintiles, it is then possible to see which groups receive the highest share of the benefits.

The aim of the analysis is to ascertain whether any social or business groups may experience disproportionate or differential affordability impacts. This can inform measures to mitigate the impact of the option if required, or if the option should be amended.

6.2.1 Personal affordability and user benefits

In accordance with JAQU and WebTAG unit 4.2 (Section 2.4), quantitative appraisals of the distributional impacts of user benefits and personal affordability have been undertaken using the outputs of Transport User Benefit Appraisal (TUBA), a software tool which calculates the economic benefits to road users. TUBA compares the economic benefits of a 'Do Something' scenario (i.e. implementation of one of the shortlisted clean air options) relative to the economic benefits of the 'Do Minimum' scenario. These can include user charges, travel time and vehicle operating costs.

The TUBA model produces monetised outputs for geographical zones correlated with UK 2011 census merged wards, which can then be disaggregated to LSOA level according to the proportion of the total population of a ward or wards resident in the intersecting area of a given LSOA. It is assumed that journeys undertaken during the morning peak in traffic flows originate from the driver's place of residence, and vice versa for those undertaken during the early evening peak.

Table 6- 1 shows the monetised outputs generated by TUBA and indicates which outputs were included in the two affordability appraisals (personal affordability and user benefits). Although the two appraisals rely on some of the same outputs, each approach is independent and serves a difference purpose.

Table 6- 1: TUBA outputs applied in the personal affordability and user benefits appraisals

TUBA output	Personal affordability	User benefits
Fuel vehicle operating costs (i.e. changes in fuel consumption)	✓	✓
Non-fuel vehicle operating costs (for example oil consumption, tyres, vehicle maintenance and mileage-related depreciation.	✓	✓
Clean Air Plan charges as derived from operator revenue (local authority tolls) calculations	✓	×
Time benefits (a monetised value of forecast changes in travel time).	×	✓

The quantitative assessment of personal affordability described above has been supplemented with a qualitative assessment of the impacts on specific social or business groups who may experience disproportionate or differential impacts over and above those defined by their geographical location or specific needs (for example mobility level).

Distributional impacts on personal affordability and user benefits have been assessed for Greater Manchester, which constitutes the core area represented by the transport model.

6.2.2 Business affordability

JAQU Options Appraisal Guidance describes a method for quantitively assessing the distributional impacts of business affordability. This considers the distribution of SMEs and LGVs registered across the study area and uses this as an indicator for the distribution of businesses which depend on vehicles. However, there are several limitations with this approach. For example;

- Many businesses depend on cars as well as other forms of vehicle, meaning the use of LGVs is only a partially useful indicator for transport dependent businesses;
- Many vehicles are registered to addresses which are not the main location of use, for example they may be registered to a personal address or business headquarters but are in use elsewhere;
- Many businesses may not use their own vehicles but would nevertheless depend on the transport of their suppliers.

This appraisal therefore takes a high-level qualitative approach to assessing business affordability considering the baseline conditions described in section 3.12 to section 3.14. This includes an understanding of the economic context in which businesses are operating, the location and sector of

operation of SMEs, business turnover, future growth areas, visitor and night time economies, employment patterns and land use.

Business affordability distributional impacts have been assessed by examining the following study areas that coincide with the proposed charging zones:

- The area within the IRR; and
- Greater Manchester.

6.2.3 Assessment criteria

The consideration of whether impacts are disproportionate is important to understand if one group is being unfairly disadvantaged or advantaged by the option/package. In such cases it is necessary to understand how these impacts are occurring and whether it is acceptable or whether the option should be amended or mitigated. The following scale, as recommended by TAG Unit A4.2, is used in the reporting of the DI assessment.

Table 6- 2: Distributional Impact Assessment Criteria

Assessment		Impact Description
✓✓✓	Large beneficial	Beneficial and the population impacted is significantly greater than the proportion of the group in the total population
✓✓	Moderate beneficial	Beneficial and the population impacted is broadly in line[24] with the proportion of the group in the total population
✓	Slight beneficial	Beneficial and the population impacted is smaller than the proportion of the group in the total population
-	Neutral	There are no significant benefits or dis-benefits experienced by the group for the specified impact
×	Slight adverse	Adverse and the population impacted is smaller than the proportion of the population of the group in the total population
××	Moderate adverse	Adverse and the population impacted is broadly in line with the proportion of the population of the group in the total population
×××	Large adverse	Adverse and the population impacted is significantly greater than the proportion of the group in the total population

[24] For the purposes of this assessment, 'broadly in line' refers to +/- 5% threshold between the percentage of net winners/losers and the share of the resident population in each group.

6.3 Screening

6.3.1 Affordability impact screening

This section presents the findings of the first step of the appraisal process: the screening stage. The 'affordability' impact variable was screened in on the basis that it was one of the minimum requirements of JAQU. Changes to costs associated with private transport are anticipated through requirement to pay charge/upgrade non-compliant vehicles/change mode and loss of free parking. Differences in ability to absorb these costs or change mode may arise, based on income distribution or size of business.

Table 6- 3 shows the screening process used to consider the potential for affordability impacts on specific social groups as well as the rationale for what has been screened in or out.

Table 6- 3: Screening of personal affordability impacts

Grouping Variable	Screened in/out	Reason for screening in/out
	Option 5(i)/(ii) and Option 8	
Low income households	✓	Low income households have reduced ability to absorb increases in cost of private travel (Crisp et al., 2018).
Children	×	Whilst the GM CAP could affect the availability and cost of community transport services used by children, the effect on children as a group is one of accessibility and is therefore is considered within section 7.
Older people	×	Whilst the GM CAP could affect the availability and cost of community transport services used by older people, the effect on older people as a group is one of accessibility and is therefore is considered within section 7.
Disabled people	✓	Disabled people typically have lower average household income and the cost of upgrading wheelchair adapted private vehicles is higher, making them particularly vulnerable to increases in the costs of private transport services and private car travel (Scope, 2018). *Screened in but assessed qualitatively.
Women	×	There is limited evidence to suggest that women are more vulnerable to increases in the cost of private or public transport (section 3.9) although they may have differing transport preferences. For this reason, effects associated with the accessibility of different transport options is considered within section 7.

Grouping Variable	Screened in/out	Reason for screening in/out
	Option 5(i)/(ii) and Option 8	
Black, Asian and Minority Ethnic (BAME)	×	There is limited evidence to suggest that BAME people are more vulnerable to increases in the cost of private transport, therefore this impact is screened out.
Religious groups	×	The CAP could affect access to religious facilities within the study area, however this issue is primarily one of accessibility and is therefore considered within section 7.

6.3.2 Business group screening

The introduction of clean air charging zones in Greater Manchester would impose direct costs on businesses. These include businesses that are located within Greater Manchester, and transport service providers of people and goods into and out of the city. How businesses and individuals decide to respond "will depend on availability of funds to upgrade their non-compliance vehicle, or pay the charge, or flexibility to change behaviour in another way" (Defra, 2016) (e.g. switch transport mode or re-route travel).

Table 6- 4 shows the screening process used to consider the potential for affordability impacts on specific business groups as well as the rationale for what has been screened in or out.

Table 6- 4: Screening of business affordability impacts

Grouping Variable	Screened in/out	Reason for screening in/out
	Option 5(i)/(ii) and Option 8	
Small and Medium Sized Enterprises (SMEs)	✓	The impact on SMEs has been identified as a key area of concern since smaller businesses are less adaptable to increases in overhead costs. It is acknowledged that there is potential for compounded affordability impacts on owners of SMEs, resulting from: Increased procurement costs (passed on from suppliers) for all SMEs who are reliant on the transportation of goods and services on the road network.

Grouping Variable	Screened in/out	Reason for screening in/out
	Option 5(i)/(ii) and Option 8	
		Increased transportation costs, particularly if the business relies on HGVs, or if the LGV fleets are owned by individuals rather than registered to the company. The greatest impact is likely to be on employee-owned vans where the rate of fleet turnover is typically slower, meaning they will account for a higher proportion of non-compliant vehicles in 2021. Businesses are less likely to own HGV vehicles, but may rely on HGV services, which may become more expensive. No option to relocate outside of the charging zones for businesses that rely on specific environmental licenses or permits (e.g. hazardous material handling).
Buses and coaches	×	Businesses that provide or are dependent on passenger transport may be more exposed to financial pressures linked to the GM CAP. For the purpose of traffic and air quality modelling, it was assumed that buses and coaches will achieve 100% compliance rate (i.e. no buses or coaches will pay the charge); this has been factored into the cost of the Clean Bus Fund in order to provide support to operators allowing them to upgrade or retrofit. Recommendations for further work include a review of the residual impact on bus and coach operators.
HGVs	×	Businesses dependent on freight transport may be more exposed to financial pressures linked to the GM CAP. Assessment would require information such as TfGM fleet mix, DVLA registration data and DVSA vehicle operator licencing statistics. Therefore, this group has been screened out to maintain a proportionate approach at this stage. Refer to Appendix B: Recommendations for Further Work.
LGVs	✓	Businesses dependent on transport may be more exposed to financial pressures linked to the proposed clean air measures.
Taxis	×	Businesses that provide or are dependent on private passenger transport would be more exposed to financial pressures linked to the GM CAP. For the purpose of traffic and air quality modelling, it was assumed that taxis will achieve 100% compliance rate (i.e. none will pay the charge); this has been factored into the cost of the Clean Taxi Fund in order to provide support to operators allowing them to upgrade. Further review of the residual impact on taxi operators is recommended.

Grouping Variable	Screened in/out	Reason for screening in/out
	Option 5(i)/(ii) and Option 8	
PHVs	×	Businesses that provide or are dependent on private passenger transport would be more exposed to financial pressures linked to the GM CAP. A full assessment would require analysis of licensing information for taxis and PHVs from councils within GMCA has been screened out to maintain a proportionate approach.

6.4 Assessment

6.4.1 Introduction

The following section provides an assessment of the distributional impacts of personal affordability and user benefits on the relevant grouping variable (low income households) using the prescribed Web TAG methodology. The impacts on personal affordability for people with a disability and the impacts on business affordability have been assessed qualitatively, following a bespoke methodology, and are therefore not assessed in this section (see section 6.5.4 and section 6.5.5).

For the purposes of this assessment, user costs are deemed to be associated with the LSOA in which the trip originated. It is acknowledged that this methodology does not explain where the car making the trip is registered to, or who is driving the car. For example, it could be the case that a journey is taking place from destination A to destination B, yet the driver (and therefore the person incurring the cost), lives in destination C. For the purposes of this assessment, it is assumed that trips generating user costs occur in the same LSOAs that the cars are registered in. Therefore, as an example, a moderate adverse impact for those in deprivation quintile 1 represents a situation in which user costs (personal affordability impact) associated with trips originating in these areas are roughly in line with the proportion of the population that are the most deprived (refer to the assessment criteria guide in Table 6- 2).

6.4.2 Personal Affordability - Income deprivation

As described in section 6.2.1, the distributional impacts on personal affordability have been assessed quantitively following the method set out in TAG Unit A4.2. TUBA analysis has been run to calculate the user cost impacts for each option. Modelling was undertaken separately for Option 5(i), Option 5(ii) and Option 8 however since the results of the analysis are comparable for both Option 5(i) and Option 5(ii), these options are considered as one – Option 5(i)/(ii).

Table 6- 5 shows the distributional impacts of user costs by income group, relative to the distribution of income deprivation across England and Wales for Option 5(i)/(ii).

Table 6- 5: User costs by income group (compared to the distribution across England and Wales) for Option 5(i)/(ii)

	IMD Income deprivation quintile (England and Wales)					Total
	1 (most deprived)	2	3	4	5 (least deprived)	
Net change in user costs (Sum over LSOAs)	-1,062,397	-658,112	-490,229	-465,089	22,349	-2,653,378
Share of net user cost decreases	40%	25%	18%	17%	0%	100%
Share of population in impact area (%)	35%	20%	15%	14%	15%	100%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✖✖✖	

Table 6- 5 shows that user cost decreases are experienced across most quintiles, but not all. For quintiles 1 to 4, the share of decreased user costs is in line with the share of the study area population within those respective quintiles. A score of moderate beneficial has been assigned to these quintiles.

Quintile 5, which represents the 80-100% least deprived LSOAs and accounts for 15% of the study area population, experiences a zero percent decrease in user costs. As the population impacted is significantly greater than the proportion of the group in the total population, and since the population in the least deprived quintiles do not experience any reduction in user costs, a score of large adverse has been assigned to this group. This is as expected based on the distribution of income deprivation across the study area and the relatively low levels of deprivation within the IRR. This is further explained in section 6.5.3.

Table 6- 6 shows the distributional impacts of user costs by income group, relative to the distribution of income deprivation across Greater Manchester for Option 5(i)/(ii).

Table 6- 6: User costs by income group (compared to the distribution across Greater Manchester) for Option 5(i)/(ii)

	IMD Income deprivation quintile (within Greater Manchester)					Total
	1 (most deprived)	2	3	4	5 (least deprived)	
Net change in user costs (Sum over LSOAs)	-626,405	-648,140	-574,893	-691,639	-112,301	-2,653,378
Share of net user cost decreases	24%	24%	22%	26%	4%	100%
Share of population in impact area (%)	21%	21%	20%	19%	19%	100%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓✓	✓	

Table 6- 6 shows that cost decreases are experienced across all quintiles. Quintile 4 experiences a large share of the user cost decreases (26%), relative to the population (19%). A score of large beneficial has been assigned to this group. For quintiles 1 to 3, the share of decreased user costs are in line with the share of the study area population within those respective quintiles. A score of moderate beneficial has been assigned to these quintiles. Quintile 5, which represents the least deprived LSOAs, accounts for 19% of the study area population but only experiences 4% of the decreased user costs. A score of slight beneficial has been assigned to this group.

Table 6- 7 shows the distributional impacts of user costs by income group, relative to the distribution of income deprivation across England and Wales for Option 8.

Table 6- 7: User costs by income group (compared to the distribution across England and Wales) for Option 8

	IMD Income deprivation quintile (England and Wales)					
	1 (most deprived)	2	3	4	5 (least deprived)	Total
Net change in user costs (Sum over LSOAs)	-104,485	-65,360	-60,739	-74,326	-60,331	-365,241
Share of net user cost decreases	29%	18%	17%	20%	17%	100%
Share of population in impact area (%)	35%	20%	15%	14%	15%	100%
Assessment (✓)	✓	✓✓	✓✓	✓✓✓	✓✓	

Table 6- 7 shows that cost decreases are experienced across all quintiles. For quintiles 2, 3 and 5, the share of the decreased user costs are in line with the share of the study area population within those respective quintiles. A score of **moderate beneficial** has been assigned to these quintiles. Quintile 1, which represents the 20% most deprived LSOAs, account for 35% of the study area population but only experience 29% of the decreased user costs. A score of **slight beneficial** has been assigned to this group. Quintile 4 experiences a large share of the user costs decreases (20%), relative to the population (14%). A score of **large beneficial** has been assigned to this group. Table 6- 8 shows the distributional impacts of user costs by income group, relative to the distribution of income deprivation across Greater Manchester for Option 8.

Table 6- 8: User costs by income group (compared to the distribution across Greater Manchester) for Option 8

	IMD Income deprivation quintile (within Greater Manchester)					
	1 (most deprived)	**2**	**3**	**4**	**5 (least deprived)**	**Total**
Net change in user costs (Sum over LSOAs)	-63,785	-60,296	-69,662	-85,193	-86,306	-365,241
Share of net user cost decreases	17%	17%	19%	23%	24%	100%
Share of population in impact area (%)	21%	21%	20%	19%	19%	100%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓	

Table 6- 8 shows that cost decreases are experienced evenly across all quintiles. For all quintiles, the share of decreased user costs are in line with the share of the study area population within those respective quintiles. A score of **moderate beneficial** has been assigned to all quintiles.

Further qualitative narrative on the impact on low income households is provided in section 6.5.3.

6.4.3 User benefits

As described in 6.2.1, the distributional impacts of user benefits have been assessed quantitively following the method set out in TAG Unit A4.2. TUBA analysis has been run to calculate the user cost impacts for each option. This includes fuel vehicle operating costs (changes in fuel consumption), non-fuel vehicle operating costs (e.g. tyres/ vehicle maintenance) and time benefits. Modelling was undertaken separately for Options 5(i) and Option 5(ii), however it has been assumed that the same assessment can apply to both scenarios.

Table 6- 9 shows the distributional impacts of user benefits by income group, relative to the distribution of income deprivation across England and Wales for Option 5(i)/(ii).

Table 6- 9: User benefits by income group (compared to the distribution across England and Wales) for Option 5(i)/(ii)

	IMD Income deprivation quintile (England and Wales)					Total
	1 (most deprived)	2	3	4	5 (least deprived)	
Net change in user benefits (Sum over LSOAs)	5,452,710	3,588,391	3,328,966	2,993,614	3,096,884	18,460,566
Share of net user benefit	30%	19%	18%	16%	17%	100%
Share of population in impact area (%)	35%	20%	15%	14%	15%	100%
Assessment (✓)	✓	✓✓	✓✓	✓✓	✓✓	

Table 6- 9 shows that user benefits are experienced across all quintiles. For quintiles 2 to 5, the share of user benefits is in line with the share of the study area population within those respective quintiles. A score of moderate beneficial has been assigned to these quintiles. Quintile 1, which represents the 20% most deprived LSOAs, accounts for 35% of the population but only experience 30% of the benefit. A score of slight beneficial has been assigned to this quintile.

Table 6- 10 shows the distributional impacts of user benefits by income group, relative to the distribution of income deprivation across Greater Manchester for Option 5(i)/(ii).

Table 6- 10: User benefits by income group (compared to the distribution across Greater Manchester) for Option 5(i)/(ii)

	IMD Income deprivation quintile (within Greater Manchester)					Total
	1 (most deprived)	2	3	4	5 (least deprived)	
Net change in user benefits (Sum over LSOAs)	3,258,338	3,376,995	3,735,385	4,034,295	4,055,553	18,460,566
Share of net user benefit	18%	18%	20%	22%	22%	100%

	IMD Income deprivation quintile (within Greater Manchester)					Total
	1 (most deprived)	2	3	4	5 (least deprived)	
Share of population in impact area (%)	21%	21%	20%	19%	19%	100%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓	

Table 6- 10 shows that user benefits are experienced evenly across all quintiles with the population impacted broadly in line with the share of the user benefits in each group. A score of **moderate beneficial** has been assigned to these quintiles.

Table 6- 11 shows the distributional impacts of user benefits by income group, relative to the distribution of income deprivation across England and Wales for Option 8.

Table 6- 11: User benefits by income group (compared to the distribution across England and Wales) for Option 8

	IMD Income deprivation quintile (England and Wales)					
	1 (most deprived)	2	3	4	5 (least deprived)	Total
Net change in user benefits (Sum over LSOAs)	1,702,140	1,120,270	1,078,826	1,047,400	886,364	5,835,000
Share of net user benefit	29%	19%	18%	18%	15%	100%
Share of population in impact area (%)	35%	20%	15%	14%	15%	100%
Assessment (✓)	✓	✓✓	✓✓	✓✓	✓✓	

Table 6- 11 shows that user benefits are experienced across all quintiles. For quintiles 2 to 5, the share of user benefits is in line with the share of the study area population with those respective quintiles. A score of **moderate beneficial** has been assigned to these quintiles. Quintile 1, which represents the 20% most deprived LSOAs, accounts for 35% of the population but only experiences 29% of the benefit. A score of **slight beneficial** has been assigned to this quintile.

Table 6- 12 shows the distributional impacts of user benefits by income group, relative to the distribution of income deprivation across Greater Manchester for Option 8.

Table 6- 12: User benefits by income group (compared to the distribution across Greater Manchester) for Option 8

	IMD Income deprivation quintile (within Greater Manchester)					
	1 (most deprived)	**2**	**3**	**4**	**5 (least deprived)**	**Total**
Net change in user benefits (Sum over LSOAs)	1,006,229	1,034,494	1,198,147	1,359,928	1,236,202	5,835,000
Share of net user benefit	17%	18%	21%	23%	21%	100%
Share of population in impact area (%)	21%	21%	20%	19%	19%	100%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓	

Table 6- 12 shows that user benefits are experienced evenly all quintiles with the population impacted broadly in line with the share of the user benefits in each group. A score of **moderate beneficial** has been assigned to these quintiles.

Further qualitative narrative on the impact on low income households is provided in section 6.5.3.

6.4.4 Summary Assessment Matrix

Table 6- 13 shows an overview of the Distributional Impact assessment stage for Option 5(i)/(ii) and Option 8. Colour coding in the table refers to the assessment matrix (Table 6- 2) presented in section 6.2.3.

Table 6- 13: Distributional impacts appraisal matrix (all options)

	(1 Most)	2	3	4	5 (Least)	Are the impacts distributed evenly?	Key impacts
Option 5(i)/(ii)							
Personal Affordability - Income deprivation (England and Wales)	✓✓	✓✓	✓✓	✓✓	✗✗✗	No	The share of increased user costs experienced by the lowest income households in quintiles 1, 2 and 3 is in line with the share of the population in these areas. When compared to the distribution across England and Wales, those in quintile 5 receive a score of large adverse, compared to slight beneficial when mapped in comparison to Greater Manchester only. Differences exist within quintile 4, which receives a score of moderate beneficial when mapped against England and Wales and a score of large beneficial when mapped in comparison to Greater Manchester only.
Personal Affordability - Income deprivation (Greater Manchester)	✓✓	✓✓	✓✓	✓✓✓	✓	No	
Personal affordability – Disabled	Personal affordability impacts on the disabled population are assessed qualitatively. See section 6.5.4.						
User benefits Income deprivation (England and Wales)	✓	✓✓	✓✓	✓✓	✓✓	No	When compared to the distribution across Greater Manchester, user benefits are equally distributed across all income groups with all quintiles receiving a score of moderate beneficial. When compared to the distribution across England and Wales, those in quintile 1 receive a score of slight beneficial.
User benefits Income deprivation (Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	
Business affordability – SMEs	Business affordability impacts are assessed qualitatively. See section 0.						
Business affordability – LGVs	Business affordability impacts are assessed qualitatively. See section 0.						

	(1 Most)	2	3	4	5 (Least)	Are the impacts distributed evenly?	Key impacts
Option 8							
Personal Affordability - Income deprivation (England and Wales)	✓	✓✓	✓✓	✓✓✓	✓✓	No	When compared against the distribution across England and Wales, the share of decreased user costs (user benefit) experienced by the lowest income households in quintile 1 is in line with the share of the population in these areas. In quintile 4, there is a large beneficial impact where the population experiencing decreased costs is higher than the total population in this area. When compared to the distribution across Greater Manchester, user benefits are equally distributed across all income groups (moderate beneficial impacts).
Personal Affordability - Income deprivation (Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	
Personal affordability – Disabled	It is recognised that people with a disability are less likely to drive and more likely to be dependent on public transport (including taxis and PHVs) and community transport. Disabled people typically have lower average household income making them particularly vulnerable to increases in the costs of private transport services and private car travel (Crisp et al., 2018)[25]. As there is no charging of private vehicles under the conditions of Option 8, there would be no requirement for wheelchair-adapted private vehicles to be upgraded. Similarly, disabled people receiving lifts from family and friends would not be affected.						
User benefits Income deprivation (England and Wales)	✓	✓✓	✓✓	✓✓	✓✓	No	When compared to the distribution across Greater Manchester, user benefits are equally distributed across all income groups with all quintiles receiving a score of moderate adverse. When compared to the distribution across England and Wales, those in quintile 1 receive a score of slight adverse.
User benefits Income deprivation (Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	
Business affordability – SMEs	Business affordability impacts are assessed qualitatively. See section 0.						
Business affordability – LGVs	Business affordability impacts are assessed qualitatively. See section 0.						

[25] Crisp et al., (2018). Tackling transport-related barriers to employment in low-income neighbourhoods. Joseph Roundtree Foundation. Available at: https://www.jrf.org.uk/report/tackling-transport-related-barriers-employment-low-income-neighbourhoods [Accessed 03/12/2018]

6.5 Appraisal

6.5.1 Introduction

The assessment in section 6.4 provides an assessment score of each of the grouping variables under consideration. Section 6.5 provides further qualitative narrative to describe the impacts in each case. This section also provides narrative on the impacts on personal affordability for people with a disability and the impacts on business affordability which were not assessed using the distributional impacts methodology as seen in section 6.4.

6.5.2 Population distribution of key grouping variables

Table 6- 14 shows the distribution of social and business groups within the key study areas. This table aims to provide context to the narrative regarding the scale of the impact on the relative grouping variables.

Table 6- 14: Distribution of the key grouping variables within the key study areas

	Greater Manchester (excluding M60/IRR)		M60 (excluding IRR)		IRR	
	Number	**%**	**Number**	**%**	**Number**	**%**
Low income households (population in quintile 1)	352,100	59.30%	242,000	40.70%	0	0%
Disability	853,200	58.49%	567,800	39.54%	14,300	1%
SMEs	76,910	62.46%	33,385	27.11%	12,840	10%
LGVs	83,150	76.82%	23,716	21.91%	1,372	1%

Table 6- 14 shows that no LSOAs within the IRR contain the highest levels of deprivation (deprivation quintile 1) when compared to the rest of Greater Manchester. In contrast, approximately 40% of the population live in LSOAs classified as quintile 1 within the M60. The remaining 59% of the population in quintile 1 are distributed across Greater Manchester.

The table also shows that for those with a high level of health deprivation (used as a proxy for disability), less than 1% of the study area in this group live within the IRR and approximately 40% live within the M60. In the SME category, 10% of the total SMEs are located within the IRR and over 25% are located within the M60. Finally, for LGVs, the large majority (over 75%) are registered within Greater Manchester, outside of the key study areas (M60 and IRR).

6.5.3 Low income households

The assessment above shows that using the WebTAG Distributional Impacts methodology, distributional impacts of low income households are distributed unevenly for Option 5(i)/(ii) and Option 8. This is as expected based on the distribution of income deprivation across the study area and the proposed clean air measures.

Under Option 5(i)/(ii), low income households in quintile 5 (least deprived) are anticipated to experience large adverse impacts, as described by the distributional impacts methodology. Within the IRR, the majority of LSOAs fall within quintile 5 (least deprived) for income deprivation (see Figure 6 in Appendix A). The IRR is the only area in which non-compliant cars would incur a cost for travel. Therefore, the adverse impacts would fall disproportionately on residents within this zone.

Although there is no reduction in user costs within the IRR and drivers will experience a charge for undertaking journeys, it is likely that since the IRR contains low levels of income deprivation, drivers are more likely to be able to afford the charge. Similarly, 'sunset periods' will be provided for residents of the zone, who otherwise have no choice other than to comply lessening the impact on this group.

Having said this, LSOAs immediately surrounding the IRR area fall largely within quintile 1 for income deprivation (highest levels of income deprivation) and also have a relatively high proportion of households with no access to a car (see Figure 24). These residents will not benefit from 'sunset periods' and may therefore experience disproportionate adverse impacts.

Personal affordability is influenced not only by user costs but also the ability of households to upgrade their vehicles or change their travel behaviour. The costs of replacing a vehicle are particularly significant for low income households. Overall, Greater Manchester has a higher proportion of low income households relative to England and Wales, with 35% of the population living in LSOAs that are in the most income-deprived quintile (quintile 1). Table 6- 13 shows that whilst there are no LSOAs in quintile 1 within the IRR, 40% of the population within the M60 boundary live in LSOAs categorised as 'low income'.

Under Option 5(i)/(ii) the burden of costs associated with upgrading private cars to compliant vehicles across Greater Manchester would be expected to fall disproportionately on low income households. In some cases, if the cost of compliance is unaffordable, this will leave many households reliant on public transport. This is particularly true of job seekers who are more than twice as likely to use buses than anyone else (Raikes, 2016). Similarly, since the costs of public transport have increased consistently above the rate of inflation for the last two decades, the adverse effects on low income households could be further exacerbated.

Under Option 8 no non-compliant cars would incur a cost for travel, therefore there may be significantly less impact on low income households. There is however potential for low income households to be affected by increases in costs of public transport, i.e. where the cost of compliance for public transport operators is passed onto users.

It is recognised that there may be further impacts in cases where employees are required to have their own car as part of an employment contract. This includes occupations such as community-based care work that involves travelling between patients. This is identified as an area for further work (refer to Appendix B: Recommendations for further work).

6.5.4 Disabled people

It is recognised that people with a disability are less likely to drive and more likely to be dependent on public transport (including taxis and PHVs), community transport that offers door to door usage, or lifts from family and friends (DfT, 2018a). Similarly, disabled people typically have lower average household income and the cost of upgrading wheelchair adapted private vehicles is higher, making them particularly vulnerable to increases in the costs of private transport services and private car travel (Crisp et al., 2018).

Evidence from the London ULEZ project has been used to identify potential impacts on disabled drivers within Manchester, on the assumption that some of the issues would be similar for both cities.

- In 2011, the average age of a blue badge[26] registered petrol vehicle entering the London Congestion Charge Zone was eight years (TfL CCZ data, 2011). Assuming the age profile of vehicles is the same in 2020, approximately 16% of all petrol blue badge registered vehicles could be non-compliant when the clean air measures comes into operation.
- In 2011, the average age of a blue badge diesel vehicle was five years (TfL CCZ data, 2011). Assuming the age profile of vehicles is the same in 2020, approximately 45% of all diesel blue badge registered vehicles could be non-compliant, which is higher than the level of non-compliance across all vehicles.

Therefore, the cost of the charge and/or replacing or retrofitting non-compliant vehicles for disabled people is less likely to be affordable, on the basis that a person with disability is more likely to be on a low income, and in general disabled people have higher living costs (Scope, 2018).

A proportion of blue badge holders will require vehicles adapted for wheelchair use. It is expected that the absolute number of non-compliant adapted vehicles would be lower than in the population as the majority of wheelchair users rely on vehicles supplied through the Motability[27] scheme,

[26] 'Blue Badges' are parking badges for disabled people issued by local authorities to individuals and organisations concerned with the care of disabled people. Once a Blue Badge is issued, it remains valid for three years. In 2017, Greater Manchester issued a total of 47,212 Blue Badges. This equated to 49% of the total Blue Badges issued in the North West.

[27] Motability is a registered charity which provides a service for disabled people to lease a car, scooter or wheelchair in exchange for their mobility allowance.

through which they receive VAT relief on substantially and permanently adapted vehicles. Motability leased vehicles are generally no more than three or four-years old so the majority would be CAZ compliant (HMRC, 2014), however some Wheelchair Adapted Vehicles (WAVs) can be leased for up to seven years.

Community transport is also an important form of public transport for disabled people who are unable to make use of conventional public transport. The age profile of community transport vehicles is typically older than average, and hence more likely to be non-compliant. Non-profit organisations are unlikely to have the cash reserves to either pay the clean air charge or upgrade to a compliant vehicle without increasing the cost of their services to end users and/or reducing the availability of services that they offer. This is because their vehicles tend to be older, and as services are run on a not-for-profit basis, organisations are unlikely to have the cash reserves to absorb the additional cost of compliance. Community transport availability is considered as part of the Accessibility DI assessment and therefore not considered further here.

Figure 9 (Appendix A) shows that LSOAs with high levels of health deprivation are concentrated in the centre of Greater Manchester, within the M60 boundary. These LSOAs contain approximately 40% of the total population of the study area within deprivation quintile 1 (see Table 6- 14). High concentrations of LSOAs in quintile 1 (high levels of health deprivation) are also found in the key centres of Bolton, Bury, Rochdale, Oldham, Wigan and to the south of the study area surrounding Manchester airport. The IRR contains less than 1% of the total population in quintile 1 (most health deprived).

The high concentration of LSOAs with relatively high levels of health deprivation located within the M60 suggests that for Option 5(i)/(ii), in which private cars are charged for entering the IRR, there may be a disproportionate adverse impact on disabled people. Under Option 8, the impact on those with a disability is likely to be significantly less as there would be no impact on private vehicles and therefore affordability impacts would only be experienced in cases where disabled people are dependent on non-compliant community transport vehicles. For Option 5(i)/(ii), an exemption for blue badge holders, wheelchair adapted vehicles and specialist vehicles would provide some mitigation.

6.5.5 Business and Personal Affordability

SMEs

Figure 12 (Appendix A) shows the proportion of SMEs by quintile, based on the distribution across England and Wales. The mapping is based on the percentage of SMEs compared to total business counts (including large businesses) as required by the JAQU guidance. Since the proportion of SMEs in comparison to total business counts is typically greater than 95%, the map shows that within the IRR and surrounding areas, there are a greater number of registered large businesses than the rest of the study area. Based on this, it is more useful to rely on raw business counts as explained below.

As shown in Table 6- 14, approximately 10% of the total SMEs within Greater Manchester are located within the IRR. The business profile of Greater Manchester (83.9% micro, 12.9% small, 3.2% medium and 0.4% large) is broadly in line with the national average for each business type (84.6% micro, 12.4% small, 2.6% medium and 0.4% large). The greatest deviation from this profile is within the IRR, where there is a slight shift away from micro businesses, and a larger proportion of small, medium and large businesses. Larger businesses would be expected to be more resilient to a new clean air charge than SMEs since they have greater resources and can better adapt to increasing costs. However, it is assumed that levels of resilience are homogenous across the study area and that all SMEs would be vulnerable to potential affordability impacts resulting from the Greater Manchester Clean Air Plan (GM CAP).

It is noted that although businesses in the IRR might have a slightly elevated level of resilience than the national and regional average, approximately 10% of the total SMEs within Greater Manchester are concentrated within the IRR and therefore overall this area is likely to experience a disproportionate business affordability impact compared to the Greater Manchester region as a whole.

It is assumed that almost all Greater Manchester SMEs would be reliant on the transportation of goods and services on the road network, meaning that impacts could directly affect suppliers travelling from outside of Greater Manchester, potentially resulting in indirect effects on the businesses located within. Similarly, increased costs could be generated if the business relies on HGVs, or if the LGV fleets are owned by individuals rather than registered to the company. For employee-owned vans, the rate of fleet turnover is typically slower, meaning these vehicles would account for a higher proportion of non-compliant vehicles in 2021. Businesses are less likely to own HGV vehicles but may rely on HGV services, which could become more expensive if the providers choose to pass on any costs to the customer

Figure 25 (in Appendix A) shows the location of SMEs with a turnover of less than £200k per annum. The map clearly shows higher concentrations of businesses with this level of turnover within the IRR. Section 3.12.5 in the baseline also shows that within the IRR, approximately 19% of businesses are in the lowest turnover bracket of £0-£49,000 a year, making them particularly vulnerable to increasing costs. In some cases, for example businesses that rely on specific environmental licenses or permits (e.g. hazardous material handling), there will be no option to relocate outside of this zone to avoid paying the charge.

Overall, impacts on SMEs are expected to be similar for Option 5(i)/(ii) and Option 8. It is assumed that all businesses across Greater Manchester are reliant on commercial vehicles, all of which face the same charges under each clean air option. In cases where businesses are dependent on the use of personal cars, it is anticipated that Option 5(i)/(ii) would result in greater adverse impacts on business affordability than Option 8. There is also a risk under the conditions of Option 5(i)/(ii) that SME workers within the IRR could choose to move to employment outside of the IRR to avoid a charge, potentially resulting in lost productivity and an increase in recruitment costs.

Whilst there is a high potential for SMEs to feel disproportionate impacts as a result of a clean air package, the introduction of 'sunset period' for small and micro businesses is likely to lessen the initial impact for some SMEs.

LGVs

Manchester is a net importer of goods, importing 58 million tonnes to the region per year (TfGM, 2017). On average 17,000 goods vehicles make trips into Greater Manchester town centres each day. This means that there is a large potential for adverse impacts on LGVs from the implementation of the GM CAP. It is assumed that business sectors that are more heavily reliant on LGVs and HGVs, such as Retail, Wholesale and Transport and Storage, would be more greatly impacted by clean air measures. As shown in Table 3- 13, 37% of the SMEs within the IRR are either Retail, Wholesale or Transport and storage.

Figure 13 (Appendix A) shows the proportion of non-compliant LGVs by quintile, based on the distribution across England and Wales. The mapping is based on the percentage of non-compliant LGVs compared to total LGV counts, as required by the JAQU guidance. Since the proportion of non-compliant LGVs is typically greater than 95%, the map shows that the majority of LSOAs are within quintile 1. Based on this, it is more useful to rely on raw business counts as explained below.

Across Greater Manchester, only 1% of LGVs are currently compliant (euro rating of four or above for petrol and six or above for diesel) as shown in Figure 29 (Appendix A). This suggests that for all options (Option 5(i)/(ii) and Option 8) almost all businesses reliant on LGVs would incur additional costs by 2023 for replacing LGVs with compliant vehicles.

LGV-dependent businesses may be more susceptible to additional costs associated with the GM CAP, or with the need to accelerate fleet upgrades to ensure vehicles are compliant. However, some vehicle replacement and improvement in compliance levels are expected by 2023 as part of routine fleet upgrade, with an average reduction of 17% for non-compliant LGVs and 33% for non-compliant HGVs across Greater Manchester in this time. To this end, fleet upgrades would lessen the severity of all options where the Low Emission Zone for travel in Greater Manchester would come into effect during phase two in 2023.

Analysis undertaken by Element Energy for the Birmingham Clean Air Plan in 2018 looked at the options available to non-compliant van owners. These options included;

- Continuing to operate the vehicle and pay the charge
- Purchasing a compliant vehicle (Euro four or above Petrol and Euro 6 Diesel)
- Purchasing an electric van.

Overall, the decisions were based on the frequency with which the van would need to enter the charging zone, the van types and range of finance options available, and the charging infrastructure or upfront costs associated with the change. The analysis showed that whilst Birmingham has overall higher levels of compliance than Greater Manchester, the economically best option was to purchase a second-hand electric vehicle as these have overall lower running costs, however this market is very limited. Recommendations for further work include an analysis of the options available to van owners based on costs of compliance in Greater Manchester.

Consideration also needs to be made where a business is a sole trader or family owned business, the impact of charging non-compliant LGVs could shift from a business affordability issue to a personal affordability issue. WebTAG guidance shows there is a split in the number of LGVs that are marked for personal or business purposes. However, where LGVs are marked as 'business' they may also be used for personal reasons, which would not be captured in the same way if the LGV was marked as 'personal'. For example, a small-scale business i.e. a sole trader working from home, may use their 'business' LGV for leisure and non-work-related trips. A person may use their LGV to pick their child up from school because it is easier to access at that time of the day. In this case the affordability impact would be captured as a personal impact on the individual and not an impact on the business.

Overall, the analysis shows that based on current and forecasted compliance levels, for all options (Option 5(i)/(ii) and Option 8) there is potential for adverse effects on LGV users. The magnitude of this impact will depend on the frequency of journeys a van owner will need to make, and the behavioural response made.

6.6 Methodology limitations

6.6.1 Personal affordability and user benefits

Personal affordability and user benefits distributional impacts have been assessed using TUBA outputs according to the method set out in TAG Unit A4-2. The key limitations of this approach are:

- Income deprivation indices are used as a proxy to determine relative average levels of household income within an area but the method does not identify whether travel is undertaken by people from relatively higher or lower income levels.
- The TUBA methodology does not account for costs associated with replacing vehicles, or user benefits or dis-benefits associated with changing travel behaviour (such as increasing public transport usage) prompted by the introduction of charging.

6.6.2 Business affordability

It is noted that some transport dependent businesses are more likely to have compliant fleets than others and so the impact of clean air charging would be distributed unequally across businesses.

Business affordability distributional impacts have been assessed using a qualitative approach whereas a quantitative approach is desirable where possible and proportionate. JAQU Options Appraisal Guidance describes a method for quantitively assessing business affordability distributional impacts which is to consider the distribution of SMEs and LGVs registered across the LSOAs as an indicator for the distribution of businesses which depend on vehicles. However, there are a number of limitations with this approach. For example;

- Many businesses depend on cars as well as other forms of vehicle, meaning the use of LGV is only a partially useful indicator for transport dependent businesses;
- Many vehicles are registered to addresses which are not the main location of use, for example they may be registered to a personal address or business headquarters but are in use elsewhere;
- Many businesses may not use their own vehicles but would nevertheless depend on the transport of their suppliers.

7 Accessibility

7.1 Overview

Accessibility describes changes to the ability and ease of individuals or businesses to get to places of work, social networks and public amenities. This links with severance impacts which include barriers to accessibility and impacts on personal affordability which can also affect an individual's ability to access a key service or amenity (See section 6).

As recommended by JAQU, the method of appraisal follows the guidance set out in DfT's TAG Unit A4-2 'Distributional Impact Appraisal' (DfT, 2015). This follows three stages of screening, assessment and appraisal to identify groups which could be disproportionately impacted by a proposed scheme. This approach is supplemented with additional qualitative narrative relating to the potential impacts on specific groups in specific geographies.

The appraisal of accessibility distributional impacts is supplemented by further analysis of potential severance effects (see section 8), looking at community facilities along links that are expected to experience an increase in traffic flow.

In this section, accessibility benefits are described for Greater Manchester as a whole, and within each of the proposed charging zones.

The key findings of the assessment are presented as follows:

- Overall, for Option 5(i)/(ii) Option 8 all study areas (quintiles) experience either slight, moderate or large accessibility benefits (improvement in accessibility).
- For Option 5(i)/(ii), moderate benefits are experienced evenly across all quintiles for low income households and BAME residents. Areas with high proportions of disabled people and children experience the highest share of accessibility benefits. In contrast, areas with low proportions of elderly and female populations experience the highest share of the benefits.
- For Option 8 moderate benefits are experienced evenly across all quintiles for elderly and BAME residents. Areas with high concentrations of low income households, under 16s and disabled people experience the highest share of accessibility benefits.
- For Option 5(i)/(ii) there is a slight shift towards areas of Greater Manchester with the least elderly residents receiving the greatest share of the benefits. This is as expected based on the distribution of the resident population and the locations likely see the greatest changes in journey times, i.e. in the city centre locations, which typically has lower numbers of elderly residents relative to other areas.

7.2 Methodology

The appraisal of the accessibility distributional impacts is a minimum requirement of the Joint Air Quality Unit (JAQU).

A three-step approach, in line with TAG unit A4-2, has been applied to the distributional impacts appraisal. The three steps are:

1) Screening: The stage where the variety of impacts that the option may have are considered and particular impacts are prioritised for further analysis so that only the most relevant issues for the scheme are appraised to ensure proportionality.
2) Assessment: The stage where information is collected on the geographical area likely to be affected by the option and how different social and business groups are distributed within that geographical area. To calculate the number of areas with improved accessibility, GIS techniques were used to calculate the change in journey times between the baseline scenario and the intervention for each LSOA[28] in the study area.
3) Appraisal: The assessment of the extent of the impact of the option on the social or business groups identified.

[28] Output Areas and Lower Super Output Areas are geographical definitions used for the mapping of socio-economic characteristics. These cover different scales: for example, Lower Super Output Areas typically have a resident population of around 1,500 people.

The assessment method set out in the DfTs TAG Unit A4-2 'Distributional Impact Appraisal' (DfT, 2015) focuses the assessment of accessibility on public transport accessibility. Whilst there may be some indirect effects on public transport travel times because of changes in traffic volumes and patterns following the implementation of a clean air package, no change to train or bus schedules, routes or fares are anticipated because of the scheme. The main impacts are likely to be related to increased journey times and accessibility to employment, services and social networks. Therefore, the bespoke approach developed for this scheme was considered more proportionate.

It is acknowledged that a large beneficial impact, as reported by the distributional impacts methodology, does not represent the areas receiving the greatest accessibility benefits. From an accessibility perspective, the benefits are greatest in areas where reduction in traffic flows are highest. Since the distributional impacts methodology refers to only 'winners' or 'losers,' it is not possible to distinguish the magnitude of change experienced by each group. Therefore, care must be taken when interpreting the results of the distributional impacts analysis. The appraisal section (section 7.6) aims to give a qualitative interpretation of these results, focussing on the areas with the 10% greatest change in emissions and the relation to key amenities of importance to the various social groups.

To calculate changes in accessibility, outputs from the Traffic Modelling software 'SATURN' were used, specifically journey times derived from 24 hours Annual Average Daily Traffic (AADT24) 2-way link flows. These outputs were manipulated in GIS to determine the change in journey times for each LSOA for each of the proposed GM CAP options. Areas with reduced journey times are considered 'winners' and areas with increased journey times are considered 'losers'.

To identify societal groups who could be 'disproportionately' impacted by changes in journey times, the population within the study area was divided into quintiles, based on the distribution across England and Wales. For example, to assess income deprivation, the population was first divided into five equal parts depending on the level of income: the first quintile contains the top fifth of the population on the scale (i.e. the 20% of the population with the highest income), the second quintile represents the second fifth (from 20% to 40%) and the fifth quintile represents the 20% of the population with the lowest income. Once the population was divided into quintiles, it was then possible to see which groups receive the highest share of the accessibility benefits by looking at the number of 'winners' or those with reduced journey times.

This analysis has been supplemented with further qualitative narrative about how the implementation of the shortlisted options may affect access to community facilities for those groups whose mobility limits the range of transport options available to them.

7.3 Screening

The screening process below considers the impacts of most relevance to the GM CAP on different social groups. This considers the availability of data and the sensitivity of the issue in the context of the CAP proposals. Table 7-1 shows the screening process used to consider the potential accessibility impacts on specific social groups.

Table 7- 1: Screening of accessibility impacts

Grouping Variable	Screened in/out		Reason for screening in/out
	Option 5(i)/(ii)	Option 8	
Low income households	✓	✓	It is widely evidenced that people on low incomes living in households with no access to a car are particularly vulnerable to social exclusion if public transport does not provide the accessibility needed to reach key destinations (Crisp et al., 2018).
Children	✓	✓	Children, or people with children may place greater value on the availability of routes closer to home, lower priced fares and higher frequency services than other groups (DfT, 2017c).
The elderly	✓	✓	The elderly community are less mobile and often report great difficulty in accessing local amenities, especially when no longer driving. This group area therefore more likely to be dependent on public or community transport that offers door to door usage, or lifts from family and friends (Musselwhite et al. 2015).
Disability	✓	✓	People with disabilities face many barriers when accessing transport facilities. This includes physical infrastructure (i.e. accessible vehicles, stations etc.) and lack of information on travel options (DfT, 2018a).
Women	✓	×	In some cases, women are less likely than men to have access to a car during the day and often undertaking more complex trip chains relating to caring responsibilities or school drop offs/pickups (Crisp et al., 2018). Under a CAZ C scenario cars are excluded from the charges and therefore the impacts on women is screened out for Option 8.
Ethnicity (BAME)	✓	✓	There are potential differential impacts on BAME communities based on differing travel patterns and access to key amenities. A study by Transport for London found that BAME Londoners cite a greater number of barriers to increased public transport use than white Londoners, this includes concerns over crime whilst travelling (TfL, 2015). Based on limited evidence, a light touch is taken in this assessment.

Grouping Variable	Screened in/out		Reason for screening in/out
	Option 5(i)/(ii)	Option 8	
Businesses	×	×	Businesses themselves are not considered to be vulnerable to accessibility effects. Indirect effects on businesses will be considered under the appraisal of affordability impacts (see affordability report).
LGVs	×	×	LGVs are used as a proxy for effects on SMEs. LGVs themselves are not considered to be vulnerable to accessibility effects. Indirect effects on SMEs will be considered under the appraisal of Affordability impacts (see Section 0).

7.4 Assessment criteria

The consideration of whether impacts are disproportionate is important to understand if one group is being unfairly disadvantaged or advantaged by the option/package. In such cases it is necessary to understand how these impacts are occurring and whether it is acceptable or whether the option should be amended or mitigated. The following scale, as recommended by TAG Unit A4.2, is used in the reporting of the distributional impacts.

Table 7- 2: Distributional Impact Assessment Criteria

Assessment[29]		Impact Description
✓✓✓	Large beneficial	Beneficial and the population impacted is significantly greater than the proportion of the group in the total population
✓✓	Moderate beneficial	Beneficial and the population impacted is broadly in line[30] with the proportion of the group in the total population
✓	Slight beneficial	Beneficial and the population impacted is smaller than the proportion of the group in the total population
-	Neutral	There are no significant benefits or dis-benefits experienced by the group for the specified impact
×	Slight adverse	Adverse and the population impacted is smaller than the proportion of the population of the group in the total population
××	Moderate adverse	Adverse and the population impacted is broadly in line with the proportion of the population of the group in the total population
×××	Large adverse	Adverse and the population impacted is significantly greater than the proportion of the group in the total population

[29] The assessment criteria (ticks) have been applied to the raw data outputs. The accessibility results tables present rounded figures. There may be instances where an increase/decrease in net winners does not exactly match the number of ticks assigned to the quintile due to rounding.

[30] For the purposes of this assessment, 'broadly in line' refers to +/- 2% threshold between the percentage of net winners and the share of the resident population in each group.

7.5 Accessibility Assessment

7.5.1 Introduction

The following section provides an assessment of the change in journey times on the relevant grouping variables (low income households, children, the elderly, the disabled, women and BAME communities). Accessibility impacts were calculated for each LSOA within the Greater Manchester area. For each quintile, the number of LSOAs with improved or worsened traffic flows was calculated, and their relative populations totalled, to calculate the net winners.

This section applies to all options; 5(i)/(ii) and 8. The definitions of options results in no difference in traffic modelling outputs for Option 5(i) and Option 5(ii). The results for Option 5(i)/(ii) and Option 8 are outlined below. Further analysis on the differences in accessibility impacts between options is provided in section 7.6.

7.5.2 Low income households

Income deprivation is one of seven domains of deprivation, and its aim is to capture the proportion of the population experiencing income deprivation in an area (DfT, 2015). It is not an absolute measure of household income and therefore it does not reflect household income in a given area, nor does it cover the distribution of that income across its resident population. Whilst it effectively captures concentrations of low income households it does not identify areas of affluence. Instead, it identifies areas of relatively low deprivation i.e. areas with lower proportions of low income households (DfT, 2015).

Evidence shows that the key transport barriers faced by low income households include limited availability of transport services, resource constraints (e.g. lack of money) and travel times and their interaction with caring responsibilities (Crisp et al., 2018).

For the purpose of this assessment, income deprivation is assessed in two ways. Firstly, income is mapped based on the distribution of income across England and Wales. This results in uneven numbers of LSOAs within each quintile. The second method ranks all the LSOAs within the study area only, based on their income deprivation; this gives a more study area specific distribution.

Table 7- 3 shows the distribution of accessibility impacts across different income deprivation groups in the study area compared to the distribution across England and Wales for Option 5(i)/(ii).

Table 7- 3: Distribution of accessibility impacts on income deprivation (compared to the distribution across England and Wales) for Option 5(i)/(ii)

	Deprivation quintile (where 1 is the 20% of the population ranked highest in terms of income deprivation)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	805,000	480,000	346,000	312,000	295,000
Number of people with reduced accessibility	182,000	83,000	79,000	84,000	117,000
No. of net winners	623,000	397,000	267,000	229,000	178,000
Total number of winners across all groups	1,694,000				
Net winners in each area as % of total	37%	23%	16%	13%	11%
Share of population in impact area (%)	35%	20%	15%	14%	15%
Assessment (✓)	✓✓	✓✓✓	✓✓	✓✓	✓

Table 7- 3 shows that in quintile 2, the population receiving accessibility benefits is higher than expected based on the share of the population in the impact area. A score of **large beneficial** has been assigned to this quintile. Quintiles 1, 3 and 4 represent the 0-20% and 40%-80% of the study area with the most income deprivation. In this case, the population receiving accessibility benefits is as expected based on the share of the population in the impact area. A score of **moderate beneficial** has been assigned to these quintiles. Quintile 5, which represents the least deprived areas of the study area, receive benefits slightly lower than the share of the population. A score of **slight beneficial** has been assigned to this group.

Overall, the analysis shows that at LSOA level, the majority of households would benefit from increased accessibility however, from a distributional impacts perspective, those in the most deprived areas, on average, experience the highest share of the accessibility benefits.

Table 7- 4 shows the distribution of accessibility impacts on low income households in the study area compared to the distribution across Greater Manchester for Option 5(i)/(ii).

Table 7- 4: Distribution of accessibility impacts on income deprivation (compared to the distribution across GM) for Option 5(i)/(ii)

	Deprivation quintile (where 1 is the 20% of the population ranked highest in terms of income deprivation)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	455,000	461,000	454,000	435,000	433,000
Number of people with reduced accessibility	104,000	102,000	103,000	115,000	121,000
No. of net winners	351,000	358,000	351,000	321,000	312,000
Total number of winners across all groups	1,694,000				
Net winners in each area as % of total	21%	21%	21%	19%	18%
Share of population in impact area (%)	21%	21%	20%	19%	19%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓

Table 7- 4 shows that beneficial impacts are experienced equally across all quintiles. This means the proportion of net winners within each quintile is broadly in line with the proportion of the resident population. This shows that areas in which there are high concentrations of low income households receive an equal share of benefits to areas with a low concentration of low income households. A score of **moderate beneficial** has been assigned to all quintiles. Section 7.6.3 provides further analysis on the magnitude of the impact and the number of low income households that are likely to be affected by the proposed clean air measures.

Table 7- 5 shows the distribution of accessibility impacts across different income deprivation quintiles in the study area compared to the distribution across England and Wales for Option 8.

Table 7- 5: Distribution of accessibility impacts on income deprivation (compared to the distribution across England and Wales) for Option 8

	Deprivation quintile (where 1 is the 20% of the population ranked highest in terms of income deprivation)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	748,000	441,000	312,000	293,000	271,000
Number of people with reduced accessibility	239,000	121,000	113,000	103,000	142,000
No. of net winners	509,000	320,000	199,000	190,000	129,000
Total number of winners across all groups	1,347,000				
Net winners in each area as % of total	38%	24%	15%	14%	10%
Share of population in impact area (%)	35%	20%	15%	14%	15%
Assessment (✓)	✓✓✓	✓✓✓	✓✓	✓✓	✓

Table 7- 5 shows that in quintile 1 and 2, the population receiving accessibility benefits is higher than expected based on the share of the population. A score of large beneficial has been assigned to these quintiles. Quintiles 3 and 4 represent the 40-80% of the study area with the most income deprivation. In this case, the population receiving accessibility benefits is as expected based on the share of the population. A score of moderate beneficial has been assigned to these quintiles. Quintile 5, which represents the least deprived areas of the study area, receive benefits lightly lower than the share of the population. A score of slight beneficial has been assigned to this group.

Overall, the analysis shows that at LSOA level, the majority of households are likely to benefit from increased accessibility however, from a distributional impacts perspective, those in the most deprived areas experience the highest share of the accessibility benefits.

Table 7- 6 shows the distribution of accessibility impacts on low income households in the study area compared to the distribution across Greater Manchester for Option 8.

Table 7- 6: Distribution of accessibility impacts on income deprivation (compared to the distribution across GM) for Option 8

	Deprivation quintile (where 1 is the 20% of the population ranked highest in terms of income deprivation)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	410,000	432,000	413,000	408,000	401,000
Number of people with reduced accessibility	148,000	131,000	144,000	142,000	153,000
No. of net winners	263,000	301,000	270,000	267,000	248,000
Total number of winners across all groups	1,347,000				
Net winners in each area as % of total	19%	22%	20%	20%	18%
Share of population in impact area (%)	20%	20%	20%	20%	20%
Assessment (✓)	✓✓	✓✓✓	✓✓	✓✓	✓✓

Table 7- 6 shows that in quintile 2, the population receiving accessibility benefits is higher than expected based on the share of the population in the impact area. A score of **large beneficial** has been assigned to this quintile. Across the other quintiles, the proportion of net winners is broadly in line with the proportion of the resident population. This shows that the areas with the highest concentration of low income households (quintile 1) receive an equal share of benefits to the area with the lowest concentration of low income households (quintile 5). A score of **moderate beneficial** has been assigned to this group. Section 7.6.3 provides further analysis on the magnitude of the impact and the number of low income households that are likely to be affected but the proposed clean air measures.

7.5.3 Children (Under 16's)

The Equality Act 2010 states that local authorities should show due regard to certain protected characteristics, including age (legislation.gov.uk, 2010). This includes taking steps to meet the needs of individuals who share a protected characteristic, and minimising the disadvantage associated with it. It is recognised, for the reasons stated in Table 7- 1, that children are particularly vulnerable to accessibility impacts. Therefore, ONS 2016 mid-year population estimates have been used to calculate the proportion of under 16's compared to the distribution across England and Wales to assess the distribution of accessibility impacts on children.

Table 7- 7 shows the distribution of accessibility impacts on children for Option 5(i)/(ii).

Table 7- 7: Distribution of accessibility impacts on children (compared to the distribution across England and Wales) for Option 5(i)/(ii)

	Population quintile (where 1 is the 20% of the population with the most under 16s)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	190,000	92,000	81,000	58,000	32,000
Number of people with reduced accessibility	42,000	29,000	15,000	17,000	8,000
No. of net winners	148,000	63,000	66,000	41,000	25,000
Total number of winners across all groups	343,000				
Net winners in each area as % of total	43%	19%	19%	12%	7%
Share of population in impact area (%)	41%	21%	17%	13%	7%
Assessment (✓)	✓✓✓	✓	✓✓✓	✓✓	✓✓

Table 7- 7 shows that positive impacts are experienced across all quintiles for Option 5(i)/(ii). For quintiles 4 and 5 the under 16s receiving accessibility benefits is as expected based on the share of the population in the impact area. A score of **moderate beneficial** has been assigned to this group. Quintile 1 and 3 which have a higher proportion of under 16s, receives a high share of the accessibility benefits. A score of **large beneficial** has been assigned to these quintiles. Quintile 2 has a slightly lower share of net winners than the share of the population in the impact area. A score of **slight beneficial** has been assigned to this quintile.

Table 7- 8 shows the distribution of accessibility impacts on children for Option 8.

Table 7- 8: Distribution of accessibility impacts on children (compared to the distribution across England and Wales) for Option 8

	Population quintile (where 1 is the 20% of the population with the most under 16s)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	177,000	85,000	72,000	57,000	28,000
Number of people with reduced accessibility	55,000	36,000	24,000	18,000	12,000
No. of net winners	122,000	50,000	48,000	40,000	16,000
Total number of winners across all groups	276,000				
Net winners in each area as % of total	44%	18%	17%	14%	6%
Share of population in impact area (%)	41%	21%	17%	13%	7%
Assessment (✓)	✓✓✓	✓	✓✓	✓✓	✓✓

Table 7- 8 shows that in quintile 1, the under 16 population receiving accessibility benefits is higher than expected based on the share of the under 16 population in the impact area. A score of **large beneficial** has been assigned to this quintile. Quintiles 3, 4 and 5 have the highest concentration of under 16's, the under 16s receiving accessibility benefits is as expected based on the share of the under 16 population in the impact area. A score of **moderate beneficial** has been assigned to these quintiles. Quintile 2, which represents the 20-40% of the study area with the most under 16s receives benefits slightly lower than the share of the under 16 population. A score of **slight beneficial** has been assigned to this quintile.

7.5.4 Elderly (Over 65's)

It is recognised that people over 65 are particularly susceptible to accessibility impacts as they are more likely to have a disability with reduced mobility or a long-term illness than any other age group. Therefore, good access to health services or shopping amenities is key to improving their independence and quality of life. Due regard is therefore given to those over the age of 65 within the study area.

Table 7- 9 shows the distributional impacts of accessibility on the elderly population within the study area for Option 5(i)/(ii).

Table 7- 9: Distribution of accessibility impacts on the elderly population for Option 5(i)/(ii)

	Population quintile (where 1 is the 20% of the population with the most elderly residents)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	54,000	67,000	81,000	78,000	45,000
Number of people with reduced accessibility	15,000	24,000	20,000	16,000	10,000
No. of net winners	39,000	43,000	61,000	62,000	34,000
Total number of winners across all groups	239,000				
Net winners in each area as % of total	16%	18%	26%	26%	14%
Share of population in impact area (%)	17%	22%	25%	23%	13%
Assessment (✓)	✓✓	✓	✓✓	✓✓✓	✓✓

Table 7- 9 shows that positive impacts are experienced, across all quintiles for Option 5(i)/(ii). For those in quintiles 1, 3 and 5, this benefit is of a magnitude as expected based on the share of the population in these areas. A score of **moderate beneficial** has been assigned to these quintiles. Quintile 2 has a lower number of net winners compared to the share of population in the impact area. A score of **slight beneficial** has been assigned to this group**.** In contrast, quintile 4 has a higher number of winners compared to the resident population. A score of **large beneficial** has been assigned to this group**.**

Overall the analysis for Option 5(i)/(ii) shows that at LSOA level there is a slight shift towards areas of Greater Manchester with the least elderly residents receiving the greatest share of the benefits. This is as expected based on the distribution of the resident population and the clean air options, which are likely to affect city centre locations with lower numbers of elderly residents.

Table 7- 10 shows the distribution of accessibility impacts on the elderly for Option 8.

Table 7- 10: Distribution of accessibility impacts on the elderly population for Option 8

	Population quintile (where 1 is the 20% of the population with the most elderly residents)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	52,000	67,000	74,000	71,000	41,000
Number of people with reduced accessibility	18,000	25,000	28,000	23,000	14,000
No. of net winners	34,000	42,000	46,000	48,000	27,000
Total number of winners across all groups	197,000				
Net winners in each area as % of total	17%	21%	23%	24%	14%
Share of population in impact area (%)	17%	22%	25%	23%	13%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓

Table 7- 10 shows that positive impacts are experienced equally across all quintiles. This means the proportion of net winners within each quintile is broadly in line with the proportion of the resident population. This shows that area which have a high concentration of elderly experience equal benefits to areas with a low concentration of elderly. A score of **moderate beneficial** has been assigned to all quintiles. Further analysis, including commentary on the magnitude of change, is provided in Section 7.6.5.

7.5.5 Disability

People with a physical or mental impairment are less likely to drive and more likely to be dependent on public transport (including taxis and PHVs), community transport that offers door to door usage, or lifts from family and friends. Throughout this assessment, the health deprivation and disability domain of the IMD (2015) has been used. The health and deprivation domain takes into consideration years of potential life lost, illness and disability, admissions to hospital and mood and anxiety disorders.

Table 7- 11 shows the distributional impacts of accessibility on the population with disabilities within the study area for Option 5(i)/(ii).

Table 7- 11: Distribution of accessibility impacts on the disabled for Option 5(i)/(ii)

	Population quintile (where 1 is the 20% of the population with the most disabled residents)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	1,210,000	513,000	323,000	154,000	38,000
Number of people with reduced accessibility	248,000	104,000	107,000	76,000	9,000
No. of net winners	962,000	409,000	216,000	78,000	28,000
Total number of winners across all groups	1,694,000				
Net winners in each area as % of total	57%	24%	13%	5%	2%
Share of population in impact area (%)	52%	22%	15%	8%	2%
Assessment (✓)	✓✓✓	✓✓	✓✓	✓	✓✓

Table 7- 11 shows that in quintiles 2, 3 and 5 the population receiving accessibility benefits is as expected based on the share of the population in the impact area. A score of **moderate beneficial** has been assigned to these quintiles. Quintile 1, which has the highest proportion of health deprived residents, receives the highest share of accessibility benefits, significantly more than the share of the population in this quintile. A score of **large beneficial** has been assigned to this quintile. Quintile 4 has a slightly lower share of net winners than the share of the population in the impact area. A score of **slight beneficial** has been assigned to this quintile.

Table 7- 12 shows the distributional impacts of accessibility on the population with disabilities within the study area for Option 8.

Table 7- 12: Distribution of accessibility impacts on the disabled for Option 8

	Population quintile (where 1 is the 20% of the population with the most disabled residents)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	1,117,000	461,000	301,000	148,000	38,000
Number of people with reduced accessibility	341,000	156,000	129,000	82,000	9,000
No. of net winners	776,000	305,000	172,000	65,000	28,000
Total number of winners across all groups	1,347,000				
Net winners in each area as % of total	58%	23%	13%	5%	2%
Share of population in impact area (%)	52%	22%	15%	8%	2%
Assessment (✓)	✓✓✓	✓✓	✓	✓	✓✓

Table 7- 12 shows that in quintiles 2 and 5 the population receiving accessibility benefits is as expected based on the share of the population in the impact area. A score of **moderate beneficial** has been assigned to these quintiles. Quintile 1, which has the highest proportion of health deprived residents, receives the highest share of accessibility benefits, significantly more than the share of the population in this quintile. A score of **large beneficial** has been assigned to this quintile. Quintile 3 and 4 have a slightly lower share of net winners than the share of the population in the impact area. A score of **slight beneficial** has been assigned to these quintiles.

Overall the analysis for both options shows that at LSOA level areas with the most health deprived residents experience a greater share of the benefits that those with less health deprived areas. Further analysis is provided in Section 7.6.6 on this distribution across the study area in relation to key facilities.

7.5.6 Women

As stated in section 7.3, in some instances, women are less likely than men to have access to a car during the day and after often undertaking more complex trip chains relating to caring responsibilities or school drop offs/pickups (Crisp et al., 2018). This can make them more vulnerable to changes in transport as a result of an intervention.

Table 7- 13 shows the distributional impacts of accessibility on women within the study area for Option 5(i)/(ii).

Table 7- 13: Distribution of accessibility impacts on women for Option 5(i)/(ii)

	Population quintile (where 1 is the 20% of the population with the most women)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	188,000	189,000	229,000	255,000	264,000
Number of people with reduced accessibility	51,000	60,000	55,000	60,000	51,000
No. of net winners	137,000	129,000	175,000	195,000	213,000
Total number of winners across all groups	849,000				
Net winners in each area as % of total	16%	15%	21%	23%	25%
Share of population in impact area (%)	17%	18%	20%	22%	22%
Assessment (✓)	✓✓	✓	✓✓	✓✓	✓✓✓

Table 7- 13 shows that positive impacts are experienced, in accessibility terms, across all quintiles. For those in quintiles 1, 3 and 4, the number of net winners is in line with the resident population. A score of **moderate beneficial** has been assigned to these quintiles. Quintile 2 has a slightly lower share of net winners than its population. A score of **slight beneficial** has been assigned to this quintile. In contrast, quintile 5, which has the 20% least women, has a slightly higher share of the net winners compared to its resident population. A score of **large beneficial** has been assigned to this quintile.

Overall the analysis for Option 5(i)/(ii) shows that at LSOA level there is a slight shift towards areas of Greater Manchester with the least women receiving the greatest share of the benefits. However, the difference between quintiles is small with only a 10% difference between the percentage of net winners in the least and the worst effected group. Further analysis is provided in section 7.6 to consider how female travel patterns and accessibility to key locations may be affected by a clean air proposal.

Under Option 8 (a CAZ C scenario), private cars are not part of the proposed charging regime so private vehicle users would not incur an increase in the cost of private travel. Analysis in section 3.9.2 shows women are more likely to use cars to make multi-purposes trips, e.g. school runs, and would be more likely to incur this cost.

7.5.7 Option 8 is also not expected to lead to a change in service times for trains and buses (including night-time services which women are more likely to avoid). The distributional impact on women has therefore been screened out of the accessibility assessment for Option 8.Ethnicity

As stated in section 7.3, there are potential differential impacts on BAME communities based on travel patterns and access to key amenities. Additionally, as reported in the baseline report, minority ethnic groups are less likely to have access to a car than other ethnicities which could make this group particularly vulnerable to the effects of a transport intervention.

Table 7- 14 shows the distributional impacts of accessibility on BAME residents within the study area for Option 5(i)/(ii).

Table 7- 14: Distribution of accessibility impacts on BAME for Option 5(i)/(ii)

	Population quintile (where 1 is the 20% of the population with the most BAME residents)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	778,000	75,000	4,000	-	-
Number of people with reduced accessibility	201,000	19,000	-	-	-
No. of net winners	577,000	56,000	4,000	-	-
Total number of winners across all groups	637,000				
Net winners in each area as % of total	91%	9%	1%	0%	0%
Share of population in impact area (%)	91%	9%	0%	0%	0%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓

Table 7- 14 shows that positive impacts are experienced equally, in accessibility terms, across all quintiles. This means the proportion of net winners within each quintile is broadly in line with the proportion of the resident population. This shows that the areas which have a high concentration of BAME residents experience equal accessibility benefits to areas with a low concentration of BAME residents. A score of **moderate beneficial** has been assigned to all quintiles.

Table 7- 15 shows the distributional impacts of accessibility on BAME residents within the study area for Option 8.

Table 7- 15: Distribution of accessibility impacts on BAME for Option 8

	Population quintile (where 1 is the 20% of the population with the most BAME residents)				
	1 (0-20%)	**2 (20-40%)**	**3 (40-60%)**	**4 (60-80%)**	**5 (80-100%)**
Number of people with improved accessibility	706,000	71,000	4,000	-	-
Number of people with reduced accessibility	274,000	24,000	1,000	-	-
No. of net winners	433,000	47,000	4,000	-	-
Total number of winners across all groups	483,000				
Net winners in each area as % of total	90%	10%	1%	0%	0%
Share of population in impact area (%)	91%	9%	0%	0%	0%
Assessment (✓)	✓✓	✓✓	✓✓	✓✓	✓✓

Table 7- 15 shows that beneficial impacts are experienced equally, in accessibility terms, across all quintiles. This means the proportion of net winners within each quintile is broadly in line with the proportion of the resident population. This shows that the areas which have a high concentration of BAME residents experience equal accessibility benefits to areas with a low concentration of BAME residents. A score of **moderate beneficial** has been assigned to all quintiles.

Overall the analysis for both options shows that the share of accessibility benefits are experienced equally across the study area. Further analysis is provided in section 7.6.8 on the magnitude of change experienced by this group.

7.5.8 Summary Assessment Matrix

Table 7- 16 shows an overview of the assessment stage. Dark green cells represent areas in which the benefits are higher than expected; light green cells represent areas in which the benefits are lower than expected and those in the middle represent areas in which benefits are of a magnitude as expected based on the proportion of residents and the level of accessibility benefits.

Table 7- 16: Accessibility distributional impacts appraisal matrix (for all options)

Socio-economic group	1 (Most)	2	3	4	5 (Least)	Are the impacts distributed evenly?	Key impacts
Option 5(i)/(ii)							
Low income households (Relative to England and Wales)	✓✓	✓✓✓	✓✓	✓✓	✓	No	Residents in quintile 2 experience the highest proportion of accessibility benefits, while residents in quintile 5 experience the least. Those in quintiles 1, 3 and 4 experience benefits as expected based on the proportion of the population in these groups.
Low income households (Relative to Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	The analysis shows that moderate benefits are experienced evenly across all income groups.
Children (Relative to England and Wales)	✓✓✓	✓	✓✓✓	✓✓	✓✓	No	Residents in quintile 1 and 3 experience the highest proportion of accessibility benefits, while residents in quintile 2 experience the least. Those in quintiles 4 and 5 experience benefits as expected based on the proportion of the population in these groups.
Elderly (Relative to England and Wales)	✓✓	✓	✓✓	✓✓✓	✓✓	No	Residents in quintile 4 experience the highest proportion of accessibility benefits, while residents in quintile 2 experience the least. Those in quintiles 1, 3 and 5 experience benefits as expected based on the proportion of the population in these groups.
Disabled People (Relative to England and Wales)	✓✓✓	✓✓	✓✓	✓	✓✓	No	Residents in quintile 1 experience the highest proportion of accessibility benefits, while residents in quintile 4 experience the least. Those in quintiles 2, 3 and 5 experience benefits as expected based on the proportion of the population in these groups.
Women (Relative to England and Wales)	✓✓	✓	✓✓	✓✓	✓✓✓	No	Residents in quintile 5 experience the highest proportion of accessibility benefits, while residents in quintile 2 experience the least. Those in quintiles 1, 3 and 4 experience benefits as expected based on the proportion of the population in these groups.
BAME (Relative to England and Wales)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	The analysis shows that moderate benefits are experienced evenly across all groups.
Option 8							

Socio-economic group	1 (Most)	2	3	4	5 (Least)	Are the impacts distributed evenly?	Key impacts
Low income households (Relative to England and Wales)	✓✓✓	✓✓✓	✓✓	✓✓	✓	No	Residents in quintile 1 and 2 experience the highest proportion of accessibility benefits, while residents in quintile 5 experience the least. Those in quintiles 3 and 4 experience benefits as expected based on the proportion of the population in these groups.
Low income households (Relative to Greater Manchester)	✓✓	✓✓✓	✓✓	✓✓	✓✓	No	Residents in quintile 2 experience the highest proportion of accessibility benefits. Those in quintiles 1, 3, 4 and 5 experience benefits as expected based on the proportion of the population in these groups.
Children (Relative to England and Wales)	✓✓✓	✓	✓✓	✓✓	✓✓	No	Residents in quintile 1 experience the highest proportion of accessibility benefits, while residents in quintile 2 experience the least. Those in quintiles 3, 4 and 5 experience benefits as expected based on the proportion of the population in these groups.
Elderly (Relative to England and Wales)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	The analysis shows that moderate benefits are experienced evenly across all groups.
Disabled People (Relative to England and Wales)	✓✓✓	✓✓	✓	✓	✓✓	No	Residents in quintile 1 experience the highest proportion of accessibility benefits, while residents in 3 and 4 experience the least. Those in quintiles 2 and 5 experience benefits as expected based on the proportion of the population in these groups.
BAME (Relative to England and Wales)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	The analysis shows that moderate benefits are experienced evenly across all groups.

7.6 Accessibility Appraisal

The analysis in section 7.5 provides an assessment score for each of the grouping variables under consideration. This section provides further qualitative narrative on how accessibility impacts might differ between the different groups. For example, the introduction of a clean air charge could change the cost of travel by car or specialist transport services (for example school transport or community transport), which could affect how easy it is for people to access places of employment or study and to visit places of worship, friends and family or recreational facilities.

7.6.1 Population distribution

Table 7- 17 shows the distribution of social groups within the key study areas. This aims to provide context to the narrative regarding the scale of the impact on the relative grouping variables. This table should also be looked at in parallel with Figure 27 (Appendix A) which gives the population density per hectare across the study area.

Table 7- 17: Distribution of the population of social groups within the key study areas

	Greater Manchester (excluding M60/IRR)		M60 (excluding IRR)		IRR	
	Number	**%**	**Number**	**%**	**Number**	**%**
Low income households (population in quintile 1)	352,100	59.30%	242,000	40.70%	0	0.00%
Elderly (over 65's)	318,500	77.55%	91,000	22.27%	700	0.17%
Children (Under 16s)	394,100	69.81%	169,000	30.00%	1,100	0.19%
BAME populations	765,800	70.98%	274,000	25.40%	19,600	1.81%
Disability	853,200	58.49%	567,800	39.54%	14,300	0.98%
Women	963,800	68.83%	406,000	29.01%	15,100	1.08%

The table shows that for the elderly population, under 16's, BAME population, disabled and women, less than 2% are located within the IRR. The majority (over 58%) of these residents are located outside of the M60 boundary in the rest of Greater Manchester.

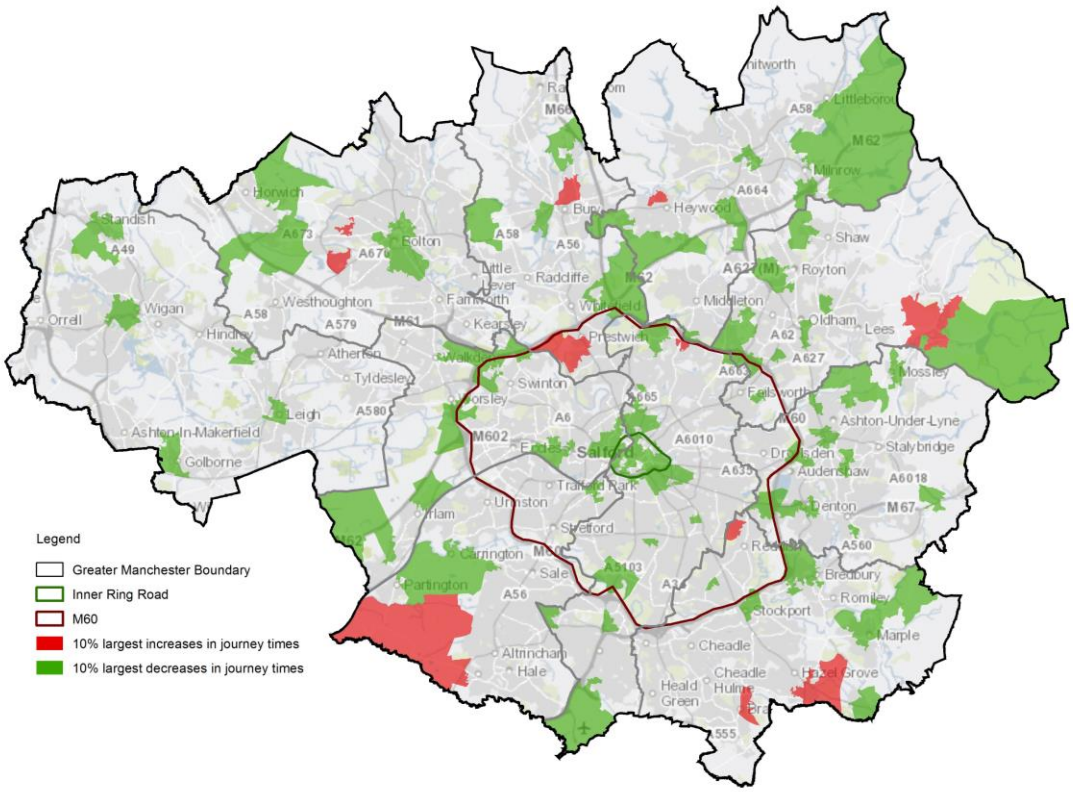
The table also shows that no low-income households (categorised as those within quintile 1, when compared to the rest of Greater Manchester) are located within the IRR. Approximately 40% of low income households are however, located within the M60. The remaining 59% are distributed across Greater Manchester.

7.6.2 Areas with the greatest increases and decreases in journey times

Image 7.1 show the LSOAs with the 10% largest increase and decrease in journey times for Option 5(i)/(ii).

Image 7- 1 shows the LSOAs with 10% greatest increases and decreases in journey times for Option8. These are also shown in Figure 49 and Figure 50 (Appendix A).

Image 7- 1: LSOAs with increases and decreases in journey times greater than 10% of the 'Do Minimum' for Option 5(i)/(ii)



Overall, the areas with the highest decrease in journey times are distributed evenly across the study area. Most notably there are a number of LSOAs located along the M62 that experience a decrease in journey times. The main improvements in journey time exist within the IRR, Salford and in LSOAs bordering or overlapping the M60. Journey time improvements also exist to the north of the city centre in Strangeways and Cheetham Hill and to the south of the IRR along the oxford road corridor into Hulme. The largest increases in journey times are seen in a small number of LSOAs, particularly in the south west of Greater Manchester, east of Oldham and three LSOAs within the M60. There are no LSOAs within the IRR that experience a large increase in journey times.

There are only a few differences between the Option 5(i)/(ii) and Option 8 maps. Most notably within the M60 and IRR, there are much fewer areas that experience a large decrease in journey times with Option 8 compared to

Option 5(i)/(ii). There are a few LSOAs in Option 8 that experience a large increase in journey time which are not seen under Option 5(i)/(ii), in the following locations;

- Ashton-under-Lyne;
- Higher Blackley; and
- Far Moor on the west edge of Greater Manchester.

7.6.3 Income deprivation

As stated in section 7.3, low income households are particularly vulnerable to accessibility impacts. The assessment for all options in section 7.5.2 showed that when income deprivation is looked at in the context of Greater Manchester the impacts are evenly distributed across all groups. When compared to the distribution across England and Wales, the impacts were uneven with areas with more deprivation receiving a score of **large beneficial** and those in less deprived areas receiving a score of **slight beneficial**.

The ability of low income households to find paid work often depends on affordable, regular and reliable transport. Similarly, evidence shows that for low income groups, there is a spatial mismatch between the location of affordable housing and major centres of employment (Crisp et al., 2018). As shown in Table 6- 14, there are no residents in quintile 1 located within the IRR. It is therefore assumed that those working in the IRR would be required to commute using car or public transport. Often, difficulties are exacerbated by shift work or other anti-social working patterns which make accessibility to employment and key amenities hard for this group. People in low incomes living in households with no access to a car are also particularly vulnerable to social exclusion if public transport is not available nearby to reach key destinations.

Figure 5 and 6 (Appendix A) show the distribution of income deprivation across Greater Manchester. The maps show that areas of high deprivation largely correlate with areas experiencing the 10% largest decrease in journey times (Figures 49 and 50 in the map book (Appendix A)). This includes the town centre of Bolton, Rochdale, Oldham and the area to the south east of the IRR. In contrast, there are some areas which experience both the highest levels of deprivation and the 10% largest increase in journey times. This includes part of Bury and in the LSOA west of Reddish.

In some cases, if low income households cannot afford to upgrade personal transport to meet the latest standards, this could result in them being unable to access key facilities or amenities. It is therefore likely that there would be a disproportionate and differential adverse impact on low income households if there is an increase in cost to users or reduction in availability of services. As Option 8 will not charge cars this distributional impact on low income households is expected to be less with this option, although impacts on PHVs would still be captured under all options.

7.6.4 Children (under 16's)

As stated in section 7.3, children are more likely to place greater value on the availability of routes closer to home, lower priced fares and higher frequency services than other groups. The assessment in section 7.5.3 showed that **large beneficial** impacts were experienced in quintiles 1 and 3, **slight beneficial** in quintile 2 and **moderate beneficial** in quintile 4 and 5 for Option 5(i)/(ii). For Option 8 the benefits are similarly spread with **large beneficial** impacts experienced by the area with the most under 16s (quintile 1).

For Option 5(i)/(ii), journey time benefits are highest within the IRR (Figure 49 and 50 in Appendix A). This has little impact on children as less than 1% of the total residents of Greater Manchester under the age of 16 live within the IRR and the area also contains no schools (Figure 7 in Appendix A). Benefits are more likely to be experienced by children who live or go to school in in the wider Greater Manchester area, particularly close to town centres such as Bolton, Rochdale and Oldham.

As reported in the baseline report, there are 14 schools in the Greater Manchester for those with special educational needs, eleven of which are within the M60. It is likely that a high proportion of pupils attending these schools are not able to use conventional public transport and are transported to and from school. There are no special educational needs schools within areas with increased journey times. However due to limited numbers of special educational needs schools, some pupils may travel from outside of the Greater Manchester area and experience increased journey times. It is assumed that in most cases, transport of SEN pupils is funded by the LA or schools themselves and/or undertaken in vehicles registered in the disabled passenger vehicle tax class, and hence there would be no increase in cost of travel to the end user. Where this is not the case, then there would be a differential adverse impact on children attending these schools if introduction of the CAP discourages or prevents families from supporting their attendance at the school.

7.6.5 Elderly (over 65's)

As stated in section 7.3, the elderly community are often less mobile and frequently report great difficulty in accessing local amenities, especially when no longer driving. This group are therefore more likely to be dependent on public or community transport that offers door to door usage, or lifts from family and friends (Musselwhite et al. 2015). The assessment for Option 5(i)/(ii) in section 7.5.4 showed that whilst all areas received accessibility benefits, the impacts across the elderly population are uneven with areas with the least elderly people receiving a score of **large beneficial** and areas with more elderly residents receiving a score of **slight beneficial**. The Option 8 assessment showed that the accessibility benefits are experienced evenly across all groups, with all areas receiving a score of **moderate beneficial.**

Figure 8 (Appendix A) shows that the areas with the highest proportion of elderly residents are located towards the outskirts of Greater Manchester. When compared to Figure 21 (Appendix A) (which shows average accessibility levels) these areas also correspond with the areas which are least accessible by public transport.

People over the age of 65 are more likely to have a disability than any other age group and therefore may also be more reliant on community transport than other age groups. The age profile of community transport vehicles is typically older than average, and hence more likely to be non-compliant. Non-profit organisations are unlikely to have the cash reserves to either pay the clean air charge or upgrade to a compliant vehicle without increasing the cost of their services to end users and/or reducing the availability of services that they offer. This is because their vehicles tend to be older, and as services are run on a not-for-profit basis, organisations are unlikely to have the cash reserves to absorb the additional cost of compliance. It is therefore likely that there would be a disproportionate and differential adverse impact on users if there is an increase in cost to users or reduction in availability of such services.

For Option 8, the share of accessibility benefits are expected to be evenly distributed across the Greater Manchester. However, for Option 5(i)/(ii) the greatest share of accessibility benefits are expected within the M60 and IRR boundaries. As seen in Figure 8, the M60 contains less than 23% of the total over 65's in the study area and the IRR contains less than 0.5%. This suggests that changes in accessibility within the city centre are unlikely to have a significant impact on resident elderly population within the IRR however there is still potential for impacts on the elderly population travelling within this area for leisure purposes.

7.6.6 Disability

As stated in section 7.3, disabled populations face many barriers when accessing transport facilities. This includes physical infrastructure (i.e. vehicles, stations etc. designed for use for all) and lack of information on transport options (DfT, 2018a). The assessment in section 7.5.3 showed that whilst accessibility benefits were experienced across the whole population the distribution is uneven with the areas containing the highest proportion of disabled people receiving a score of **large beneficial** and areas with less disabled people receiving a score of **slight beneficial**.

Figure 9 (Appendix A) shows the location of populations with relatively high levels of health deprivation across the study area. Areas of high levels of health deprivation are concentrated in the centre of Greater Manchester, within the M60 boundary, which contains approximately 40% of the total population of the study area within deprivation quintile 1. Concentrations of health deprived populations are also found in the key centres of Bolton, Bury, Rochdale, Oldham, Wigan and to the south of the study area surrounding Manchester airport. Less than 1% of the health deprived population of Manchester live within the IRR where accessibility benefits are expected to increase the most. This suggests that whilst the impacts are likely to be beneficial, they are not likely to be of large significance when looked in the context of the whole study area.

When compared to Figure 49 and 50 (Appendix A), which show areas of decreased journey times, there is a good correlation, suggesting beneficial impacts on journey times for these areas in all options. Disabled people with reduced mobility may be unable to make use of conventional public transport services or active transport modes (walking and cycling), and therefore more reliant on private cars for personal journeys than people who do not have reduced mobility. If the increased costs associated with these journeys (discussed further in the affordability report) are sufficient to deter disabled people with mobility problems from making these journeys then there would be a differential adverse impact on accessibility for this group. As car owners only experience a travel cost under Option 5(i)/(ii) the impact on accessibility on the disabled group would be larger under this option than it would be under Option 8 (a CAZ C which excludes cars).

Taxis are another important form of transport for people unable to drive, use conventional public transport or use active travel modes due to disability. DfT data shows that, in England, the proportion of personal trips undertaken by taxi is on average three times higher for adults with mobility difficulties than those without (DfT, 2017a). A reduction in the availability of taxis would therefore have a disproportionate and differential effect on disabled people.

Wheelchair adapted vehicles that are used solely for the transport of disabled people, and hence are registered as disabled passenger vehicles, are exempted from the clean air charge for those travelling within the IRR. However, a proportion of community transport vehicles operating within Greater Manchester may not be registered as disabled passenger vehicles as they are also used to transport people who do not have a disability. As stated in the baseline report, only 1% of the total PHVs in Greater Manchester are currently wheelchair accessible. Since WAVs are more expensive than standard vehicles, these types of adapted vehicles tend to be kept or leased by their owners for longer than non-adapted vehicles. This makes them more likely to be non-compliant. If the cost of upgrading vehicles is too high, this could have a disproportionate impact on this group.

7.6.7 Women

As stated in section 7.3, women are often less likely than men to have access to a car during the day and are regularly undertaking more complex trip chains relating to caring responsibilities or school drop offs/pickups (Crisp et al., 2018). The assessment in section 7.5.6 showed that whilst accessibility benefits were experienced across the whole population, the distribution is uneven with the areas containing the lowest proportion of women receiving a score of **large beneficial** and areas with less women receiving a score of **slight beneficial**. Distributional impacts on women were screened out under Option 8, see section 7.5.6.

A study of public transport behaviour in London undertaken by Transport for London (TfL) in 2014 found that women are more concerned than men with regards to personal safety when using public transport (TfL, 2014), and a recent report by Sustrans found that fears surrounding personal safety are a key barrier to undertaking active travel journeys particularly when travelling

at night (Sustrans, 2018). The increase in cost of travel by private vehicle associated with the introduction of clean air charging in Greater Manchester would therefore have a differential adverse accessibility impact on women due to their perceived negative experience of alternative travel options. Similarly, DfT data from 2017 shows that women are slightly more likely to use taxis and PHVs than men (DfT, 2017). As such, any changes in the availability of taxis and/or PHV or increases in fares would have a slightly disproportionate and differential adverse impact on women.

7.6.8 Ethnicity

As stated in section 7.3, there are potential differential impacts on BAME communities based on differences in travel patterns and access to key amenities. For all options the assessment in section 7.5.6 showed that the accessibility benefits are experienced evenly across all groups, with all areas receiving a score of **moderate beneficial.**

Within Greater Manchester, the highest proportion of BAME populations are located within the M60, outside of the IRR (Figure 11 in Appendix A). This area contains 25% of the total BAME population within Greater Manchester. There are also high concentrations of BAME populations within the key centres of Bolton, Bury, Rochdale, Oldham and Ashton however this equates to less than 3% of the total population of Greater Manchester. Figures 49 and Figure 50 (Appendix A) show that for all clean air options, journey times in the key centres are likely to decrease suggesting potential benefits for the population in these areas.

As reported in the baseline report, minority ethnic groups are less likely to have access to a car than other ethnicities. Similarly, between 2013 and 2017, ethnic minorities travelled the smallest distance and made the fewest trips (DfT, 2017i). A study by Transport for London also found that BAME Londoners cite a greater number of barriers to increased public transport use than white Londoners including concerns over crime whilst travelling (TfL, 2015). The increase in cost of travel by private vehicle associated with the introduction of clean air charging in Greater Manchester could therefore have a differential adverse accessibility impact on ethnic minorities due to their perceived negative experience of alternative travel options.

7.7 Mitigation

In line with TAG unit A4-2A, where the Distributional Impact analysis shows evidence of an intervention having particularly high benefits or dis-benefits to a certain group, enhancement and mitigation ought to be considered. Section 7.5 shows that beneficial accessibility impacts are experienced across the study area. In absence of adverse effects, no mitigation is considered necessary.

It is recommended that further work be undertaken to explore potential enhancement measures for any beneficial distributional impacts.

8 Severance

8.1 Overview

The appraisal of severance impacts looks at the potential barriers to accessibility within a local community due to road traffic and transport infrastructure.

WebTAG unit 4.2 states that certain groups are potentially vulnerable to severance effects, including people without access to a car, older people, people with disabilities, parents with pushchairs and children. At the options appraisal stage, the analysis focused on identifying road links that are at risk of causing severance and their relative proximity to facilities used particularly by these groups.

Criteria used to identify routes with the potential to cause severance are when combinations of conditions arise[31]:

- Annual Average Daily Traffic (AADT) flows exceed 8,000 vehicles per day **and** the predicted change in traffic flows is greater than 10%, or
- Annual Average Daily Traffic (AADT) flows exceed 8,000 vehicles per day **and** the predicted change in HGV composition of traffic flows is greater than 10%, or
- The predicted change in traffic flows exceeds 10% and the predicted change in the HGV composition of traffic flows is greater than 10%.

The key findings of the assessment of potential severance impacts are presented as follows:

- For Option 5(i)/5(ii), 96 roads/corridors are expected to experience traffic flow conditions under which severance impacts could occur. The potential for severance impacts on medical/health and educational facilities has been identified along 26 roads/corridors. Along these, 27 education facilities and 19 medical/healthcare facilities were identified (Figures 45 and 46 in Appendix A).
- For Option 8, 82 roads/corridors are expected to experience traffic flow conditions under which severance impacts could occur. The potential for severance impacts on medical/health and educational facilities has been identified along 25 roads/corridors. Along these, 19 education facilities and 23 medical/healthcare facilities were identified (Figures 47 and 48 in Appendix A).

[31] Guidance on AADT flows are from the Highways Agency (1993) and on proportionate change in traffic flows and vehicle composition from DfT (2015)

Given that a very small proportion of facilities are potentially affected across the entire network of Greater Manchester, the overall impact is not expected to be significant; however, further monitoring of traffic flows at these locations would be recommended to ensure that any potential community severance effects can be properly managed.

Further work on identified receptors could look at analysis of travel modes and populations of vulnerable groups for a better understanding of potential severance effects.

8.2 Methodology

Outputs from the Traffic Modelling software SATURN were manipulated in a spreadsheet to determine the change in traffic flows and HGVs composition across the Greater Manchester road network.

Links shorter than 200m in length were screened out as they were considered unlikely to represent a significant barrier to accessibility. Shorter road sections in proximity to one another that individually met the criteria for severance were combined into corridors, and their overall length and impacts were considered.

To determine key locations with potential for severance effects[32], medical/health and educational facilities within a 200m radius of road sections were identified and mapped in GIS, using Open Street Map datasets[33]. The locations of routes affecting these facilities is shown in Figures 45-48 (see Appendix A).

Note that this methodology provides an indication of the potential for severance on facilities used particularly by vulnerable groups. The methodology does not allow for assessing how groups access this facility, or the wider levels of pedestrian movement in the area. Other datasets could identify wider facilities. However, routes impacting more than one facility indicate a location that is likely to be more highly accessed, such as close to a town centre or education cluster, and where levels of pedestrian movement are likely to be higher with greater potential for severance effects.

8.3 Severance Analysis

8.3.1 Analysis of Option 5(i)/(ii)

Under the conditions of Option 5(i)/(ii), compared to the 'Do-Minimum' scenario, most of the road network within Greater Manchester (95%) would not experience a change in traffic flow (increase or decrease) that meets the conditions set out in Section 8.1. As such, most of the network is excluded from any further assessment of severance impacts.

[32] Note that the analysis of severance impacts does not differentiate between Option 5(i) and Option 5(ii) since the same AADT24 2-way link flows from 'SATURN' were utilised.

[33] The facility classes include care/nursing homes, hospitals/hospices, GP surgeries and clinics, preparatory, first, primary, infant, junior and middle schools, secondary schools and universities.

Approximately 3% of the network would experience a decrease in traffic flows (AADT24) of more than 10%, and 2% of the road network would experience an increase in traffic flows (AADT24) greater than 10%.

Areas of increased traffic flows

For Option 5(i)/(ii), the potential for community severance impacts has been identified along 96 roads/corridors due to increased traffic flows. Using available data, 26 are located within a distance that means they could affect accessibility to health and educational facilities (see Table 8- 1). The facilities identified here could be vulnerable to severance impacts if traffic flows increase further in the future.

Table 8- 1: Key impact roads for effects related to Changes in Traffic Flows for Option 5(i)/(ii)

CAP	Local Authority	Road	Length (metres)	Medical facilities (including care/nursing homes)	Education centres
IRR	Manchester	Byron Street/ Hardman Street	696	None	John Rylands University Library
M60	Bury	King's Road (Prestwich)	206	Fernica Residential Care Home Outreach Community & Residential Services – 118 King's Road Langdon Foundation Outreach Community and Residential Services - 17 York Avenue	Sedgley Park School
M60	Manchester	Vine Street (Gorton)	724	None	St. Clements C of E Primary School
		Richmond Grove (Longsight)	496	Little Sisters of The Poor Care Fertility	Dean Trust Ardwick Plymouth Grove Primary School St. Josephs RC Primary School
		Abbey Hey Lane (Gorton)	450	St Georges Residential Home	Abbey Hey Academy
		Stanley Grove (Longsight)	260	Lighthouse	St. Peters RC High School
		Reddish Lane (Gorton)	253	None	Oasis Academy Aspinal

CAP	Local Authority	Road	Length (metres)	Medical facilities (including care/nursing homes)	Education centres
	Salford	Lower Broughton Road (Salford)	2263	None	River View Primary School
		Bolton Road (Salford)	361	Pendleton Court Care Home Dental Surgery	None
		King's Road (Prestwich)	206	None	St. Phillips RC Primary School
GM	Bolton	New Lane (Harwood)	936	The Respite House Care Home	Bolton St Catherine's Academy
		Stitch-Mi Lane (Harwood)	433	None	Bolton St. Catherine's Academy Harwood Meadows Primary School
		Hindley Road (Westthoughton)	248	None	St. James C of E School
	Bury	Bradley Fold Road (Ainsworth)	301	None	Ainsworth C of E Primary School
	Manchester	Car Bank Street (Atherton)	271	Surgery	St. Richards RC School Meadowbank Primary School & Nursery Education Centre
	Oldham	Broaders Lane/Lane Head Road (Mossley)	687	Ashbourne House Residential Home	St. Agnes C of E School St. Georges C of E Primary School
	Stockport	Wellington Street (Stockport)	487	None	St. Josephs RC Primary School
		Buckingham Road/Queens Road (Cheadle Hulme)	267	Dr Seabrook & Partners	Oak Tree Primary School
	Tameside	Old Road (Hyde)	1366	Sure Start Children's Centre	Dale Grove School
		Broaders Lane/Lane Head Road (Mossley)	687	None	St. Georges C of E Primary School
		Mottran Road (Hyde)	428	Tameside General Hospital	None

CAP	Local Authority	Road	Length (metres)	Medical facilities (including care/nursing homes)	Education centres
		Smith Street/Ryecroft Street/Hamilton Street (Ashton-Under-Lyne)	423	Moss Cottage Nursing Home	St. Peters Primary School Ashton West End Primary Academy
		Knott Lane (Hyde)	213	Laurel Bank Residential Care Home	None
	Trafford	Broad Road (Sale)	225	None	Holy Family RC Primary School
	Wigan	Car Bank Street (Atherton)	271	Atherton Start Well Family Centre	None

Table 8- 1 shows that the potential for severance has been identified for 27 educational facilities and 19 health facilities, using Open Street Map data.

Under Option 5 (i)/(ii), nursing or residential homes are the main type of health/medical facility that could potentially experience severance effects, while primary schools are the most common type of educational facility that could be affected. As more than half of children across Greater Manchester aged 5-10 walk to school, the potential for severance effects to these facilities may need to reviewed further.

There is likely to be greater potential for severance effects associated with some specific roads that are close to town centres and multiple facilities. Analysis of data available shows that a small number of roads/corridors have the potential to affect access to 3 or more health or educational facilities: King's Road (Prestwich), Richmond Grove (Longsight), Car Bank Street (Atherton), Broaders Lane/Lane Head Road (Mossley) and Smith Street/Ryecroft Street/Hamilton Street (Ashton-under-Lyne). Additional datasets could be used to review risk of severance on receptors in such locations.

Areas of reduced traffic flows

Figures 45 and 46 show links that are expected to experience levels of reductions in traffic flows (AADT levels, traffic flow or HGV content) that, combined, meet the opposite conditions against the severance criteria set out in section 8.1.

There is a concentration of roads within the IRR; outside of the IRR the distribution of roads that are expected to have reduced traffic flows is generally even across local authority areas.

Some of the roads identified in the IRR form important access routes to and from the city centre such as Camp Street/Upper Camp Street (Broughton), Bury New Road (Broughton), and Oxford Road. Within the M60, there is a slightly greater concentration to the north of the city centre, in proximity to a number of care and nursing facilities. In the Greater Manchester area, a similar pattern arises around care homes and nursing facilities around Rochdale centre.

Roads on the outer boundary of Greater Manchester also show reductions in traffic flows, such as Moor End Road (Mellor) and Watling Street (Bury). However modelled changes in flows in rural areas can be skewed by the relatively low levels of traffic using these roads, such that a small change in vehicle numbers can easily exceed the 10% change in traffic flow threshold.

8.3.2 Analysis of Option 8

Under the conditions of Option 8, compared to the 'Do-Minimum' scenario, most of the road network within Greater Manchester (98%) is unlikely to experience a change in traffic flow (increase or decrease) that meets the conditions set out in section 8.1 and therefore the majority of the network is excluded from any further assessment of severance impacts.

Approximately 1% of the network would experience a decrease in traffic flows (AADT24) of more than 10%, and 1% of the road network would experience an increase in traffic flows (AADT24) greater than 10%.

Areas of increased traffic flows

For Option 8, the potential for community severance impacts has been identified along 82 roads/corridors i.e. are expected to experience an increase in traffic flows against the criteria for potential severance effects. Using available data, 25 are located within a distance that means they could affect accessibility to health and educational facilities (Table 8- 2). The facilities identified here could be vulnerable to severance impacts if traffic flows increase further in the future.

Table 8- 2: Key impact roads for effects related to Changes in Traffic Flows for Option 8

CAP	Metropolitan Borough	Link/Corridor	Length	Medical facilities (including care/nursing homes)	Educational facilities
M60	Manchester	Elizabeth Slinger Road (Didsbury)	371	Ashley House Residential Care Home Rowlsey House Care Home Withington Community Hospital Holmfield Residential Care Home Spire Manchester Hospital	None
		Stanley Grove (Longsight)	260	Lighthouse Care UK	St. Peters RC High School
		Yew Tree Road (Fallowfield)	210	The Dental Practice	None
	Salford	Great Cloves Street (Lower Broughton)	1075	The Willows Nursing Home Bluebell Court	None
		Bolton Road (Salford)	361	Pendleton Court Care Home Dental Surgery	None
	Bury	Butterstile Lane (Prestwich)	437	The Salvation Army	None
GM	Bolton	Hindley Road (Westthoughton)	248	None	St. James C of E School
	Bury	Eton Hill Road (Radcliffe)	2419	The Regard Partnership	Radcliffe Hall C of E Methodist Primary School
		Bradley Fold Road (Ainsworth)	301	None	Ainsworth C of E Primary School
	Oldham	Broaders Lane/Lane Head Road (Mossley)	687	Ashbourne House Residential Home	St. Agnes C of E School

CAP	Metropolitan Borough	Link/Corridor	Length	Medical facilities (including care/nursing homes)	Educational facilities
	Rochdale	Dale Street (Milnrow)	207	Rosemary Care Home	None
	Stockport	Wellington Street (Stockport)	487	None	St. Josephs RC Primary School
	Tameside	Old Road (Hyde)	1366	None	Dale Grove School
		Mottran Road (Hyde)	428	Tameside General Hospital	None
		Lancaster Road (Hindley)	1047	The Acorns Care Centre	All Saints C of E Primary School
		Warrington Road (Ashton in Makerfield)	518	Ashwood Residential Care Home	Byrchall High School St. Edmund Arrowsmith Catholic High School St. Oswalds Primary School
		Car Bank Street (Atherton)	271	Surgery	St. Richards RC School Meadowbank Primary School & Nursery Education Centre
		Bolton Road (Ashton in Makerfield)	207	Ashton View Care Home	St. Thomas C of E Primary School
	Tameside	Old Road (Hyde)	1366	Sure Start Children's Centre	None
		Broaders Lane/Lane Head Road (Mossley)	687	None	St. Georges C of E Primary School
		Smith Street/Ryecroft Street/Hamilton Street (Ashton-under-Lyne)	423	Moss Cottage Nursing Home	St. Peters Primary School Ashton West End Primary Academy
		Knott Lane (Hyde)	213	Laurel Bank Residential Care Home	Dowson CP School

CAP	Metropolitan Borough	Link/Corridor	Length	Medical facilities (including care/nursing homes)	Educational facilities
	Trafford	Broad Road (Sale)	225	None	Holy Family RC Primary School

Using the available data, potential for severance has been identified for 19 educational and 23 health facilities. Tameside has the highest number (5) of links that could affect educational centres, however none would impact more than one facility. This is the same for most of the roads/corridors assessed, although there are two high schools and one primary school within radius of Warrington Road (Wigan).

Overall, the potential for severance to health facilities is primarily in relation to residential care homes in the outer areas of Greater Manchester, where the majority of such facilities are located (Table 3- 3). Several within the M60 may also be impacted. Several roads/corridors across the study area have the potential to impact multiple health facilities including Elizabeth Slinger Road (Didsbury), Great Cloves Street (Lower Broughton) and Bolton Road (Salford).

There is likely to be greater potential for severance effects associated with some specific roads that are close to town centres and multiple facilities, and additional datasets could be used to review risk of severance on receptors in these locations.

Areas of reduced traffic flows

Figures 46 and 47 show roads that are expected to experience a reduction in the magnitude in traffic flows (AADT, percentage change in flow or HGV content) against the criteria set out in section 8.1.

The majority of changes are located outside the IRR and M60 boundaries and are relatively evenly dispersed. Parts of the network around Rochdale are expected to experience a reduction in traffic flows, including areas in close proximity to a number of care and nursing home facilities.

Roads on the periphery of Greater Manchester also show reductions in traffic flows, such as Moor End Road (Mellor) and Monks' Road (Glossop). However modelled changes in flows in rural areas can be skewed by the relatively low levels of traffic using these roads, such that a small change in vehicle numbers can easily exceed the 10% change in traffic flow threshold, and therefore no further analysis of these peripheral traffic flow reductions have been completed at this time.

9 Conclusion

Across the whole of Greater Manchester, Option 5(i)/(ii) is the best performing option in terms of overall emissions reductions, resulting in an 18% decrease in total emissions compared to the do minimum scenario. Option 8 follows closely behind with a 17% reduction in total emissions of PM and NO_X. This is also true within the M60 where Option 5(i)/(ii) results in a 23% reduction in emissions compared to a 20% reduction for Option 8.

For all **social groups** screened into the **analysis of air quality impacts** (low income households, children and the elderly), the results are comparable for Option 5(i)/(ii) and Option 8. Option 8 provides slightly better opportunities for enhancement of impacts on low income households than Option 5(i)/(ii), and the reverse is true for impacts on children (Option 5(i)/(ii) provides slightly better opportunities for enhancement than Option 8). Air quality benefits for elderly people are more evenly spread across quintiles for Option 8 than for Option 5(i)/(ii), although it is noted that, given the distribution of the elderly population, impacts on this group are more likely to be experienced through changes in accessibility and affordability rather than reductions in emissions.

The **analysis of affordability impacts** shows that, under option 5(i)/(ii), adverse impacts fall disproportionately on residents of the IRR who would have no choice other than to comply with the charges for private car travel. These impacts could be mitigated in part through 'sunset periods' (time-limited discounts) for IRR residents.

Under Option 5(i)/(ii), the least deprived LSOAs within the IRR account for a relatively high proportion of the low deprivation population across the study area (Greater Manchester) and yet they experience zero reductions in user costs. This is as expected based on the distribution of income deprivation across the study area and the relatively low levels of deprivation within the IRR. However, the analysis also shows that under Option 5(i)/(ii), the burden of costs associated with upgrading private cars to compliant vehicles across Greater Manchester would fall disproportionately on low income households, including the high proportion of low income households (quintile 1), located just outside of the IRR. Under Option 8, the use of non-compliant private cars would not incur a charge, therefore there is likely to be a significantly lower affordability impact on low income households under this option.

The **analysis of accessibility impacts** shows that, for Option 5(i)/(ii) and Option 8, large accessibility benefits are anticipated in the areas with the greatest income deprivation. The areas with the greatest improvements in journey times are located within the IRR and in the key centres of Bolton, Rochdale and Oldham.

For children, beneficial accessibility impacts are experienced unevenly across all quintiles for Option 5(i)/(ii) and Option 8, although for both options, large beneficial impacts are experienced in quintile 1 (highest numbers of children). The same is true for the beneficial impacts on disabled people.

Overall, there is little to distinguish the social impacts of Option 5(i)/(ii) versus Option 8. Both options show that all social groups are likely to experience moderate beneficial air quality, personal affordability and accessibility impacts. Exceptions to this are summarised as follows.

- Under Option 5(i)/(ii), adverse impacts fall disproportionately on residents in IRR who otherwise have no choice other than to comply with the charge for private car travel. These impacts fall disproportionately on the least deprived populations of Greater Manchester due to the relatively low levels of deprivation within the IRR.
- Under Option 8, the use of non-compliant private cars would not incur a charge, therefore there is likely to be a significantly lower affordability impact on low income households under this option compared to Option 5(i)/(ii).
- The analysis identified potential adverse affordability impacts on disabled people under Option 5(i)/(ii) due to the potential for increased costs of community transport services and the costs associated with upgrading wheelchair accessible vehicles.
- Similarly, the accessibility impact of Option 5(i)/(ii) on disabled people would be greater than under Option 8, since people with reduced mobility may be more reliant on private cars for personal journeys than people who do not have reduced mobility.
- Although accessibility benefits for the BAME community are more evenly spread across quintiles for Option 8 than for Option 5(i)/(ii), it is noted that for Option 5(i)/(ii), any increase in the cost of travel by private vehicle could have a differential adverse accessibility impact on ethnic minorities due to their perceived negative experience of alternative travel options.

For the **analysis of economic impacts**, it was assumed that levels of economic resilience are homogenous across the study area and that all SMEs would be vulnerable to potential adverse business affordability impacts. However, given that approximately 10% of all SMEs within Greater Manchester are concentrated within the IRR, it is likely that this area would experience a disproportionate adverse business affordability impact compared to the Greater Manchester region as a whole.

It is assumed that almost all Greater Manchester SMEs would experience increased costs related to the transportation of goods and services on the road network, although businesses that are more heavily reliant on LGVs and HGVs, such as Retail, Wholesale and Transport and Storage, would be more heavily impacted. The magnitude of this impact would depend on the frequency of journeys and the behavioural response to the GM CAP.

Across Greater Manchester, only 1% of LGVs are currently compliant (euro rating of four or above for petrol and six or above for diesel). The majority of businesses with an LGV fleet would therefore be expected to incur additional vehicle replacement costs between 2021 and 2023. However, some vehicle replacement and improvement in compliance levels are expected by 2023 as

part of routine fleet upgrade, with an average reduction of 17% for non-compliant LGVs and 33% for non-compliant HGVs across Greater Manchester in this time.

High concentrations of LGV registrations were identified just outside the IRR suggesting this area could also be disproportionately impacted by the GM CAP.

Although LGV affordability impacts are considered as business costs rather than social costs, there is potential for LGVs to also be used for leisure/personal purposes. In these instances, the impact could shift from a business affordability issue to a personal affordability issue.

For the two **economic groups** considered, SMEs and LGVs, the analysis shows that the distribution of adverse **business affordability** impacts on SMEs are expected to be similar for Option 5(i)/(ii) and Option 8. In cases where businesses are dependent on the use of personal cars, it is anticipated that Option 5(i)/(ii) would result in greater adverse impacts on business affordability than Option 8. There is also a risk under the conditions of Option 5(i)/(ii) that SME workers within the IRR could choose to move to employment outside of the IRR to avoid a charge, potentially resulting in lost productivity and an increase in recruitment costs.

Several key assumptions have been applied throughout the distributional impacts analysis including a reliance on current publicly available information, medical evidence, and guidance. The limitations of each assessment (air quality, affordability and accessibility) have been identified in the relevant sections of this report, and recommended areas for further work are described in Appendix B.

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