OUTLINE BUSINESS CASE

Bristol City Council Clean Air Plan: Outline Business Case – Economic Case

Prepared for

Bristol City Council

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JACOBS ch2m

Economic Case

3.1 Introduction

This chapter sets out the economic case and forms part of the BCC CAP Outline Business Case. The completed Outline Business Case will contain the following information:

- Strategic Case –sets out the case for change and the spending objectives of the Plan.
- Economic Case – assesses the shortlisted options that achieve compliance in the shortest possible time from a value for money perspective, as well as identifying distributional impacts of the shortlisted options.
- Commercial Case – establishes the preferred route to procurement, based on supplier capability and likely delivery solution.
- Financial Case - sets out the detailed costings for the Plan and available funding sources.
- Management Case – provides the governance and management arrangements to deliver the preferred option.

This economic case has the following supporting documents:

- Appendix D Air Quality Assessment Reports
- Appendix E Transport Modelling Reports
- Appendix F Stated Preference Survey Report
- Appendix G Economics Methodology Report
- Appendix H Social Distributional Impacts Report

3.2 Options assessed

The Option Assessment Report (Appendix C to the OBC) concluded the better performing options are:

- Option 4 – Medium area Class D charging option with complementary non-charging interventions.
- Option 2c – Diesel car exclusion over a small area with bus and taxi fleet improvement to Euro 6 or better (assumed to be implemented 24 hours a day/7 days a week).

These options are assessed in this economic case.

During the development of the economic case, legislative issues have been identified associated with a diesel car exemption. Research about the legislative powers required to implement the scheme 24 hours a day, 7 days a week indicates that the Traffic Regulation Order (TRO) rules would sufficiently support a vehicle restriction (or ban) however this would need to be within a time limit.

If this option were to be progressed, the project team would work with JAQU to understand the feasibility (and associated programe) of a legislative amendment in relation to S.3.1.b of the Road Traffic Regulation Act 1984 to enable local authorities to introduce measures that are not “charging” but nonetheless may reduce pollution.

3.3 Transport Modelling Approach

3.3.1 Modelling methodology

This modelling methodology summarises the detailed methodology found in the Local Plan Transport Modelling Methodology Report (T3), and its appended technical notes, bringing together an overview of all the components of how the baseline and option testing has been carried out using the GBATS4M Transport Model.

3.3.2 Base and Baseline

3.3.2.1 Model Development

The Local Plan Transport Modelling Methodology Report (T3), chapters 3, 4 and 7, outlines the modelling methodology for the Base and Baseline models. It states that the GBATS4M variable demand model has been used to develop the 2021 baseline models, based on the inputs from the updated Uncertainty Log.

The Uncertainty Log was developed in 2015 therefore details for an up-to-date Uncertainty Log have been collated. This will cover both development and scheme assumptions. The baseline model (2021) has the most recent scheme assumptions for the assessment year modelled within it based on the Near Certain and More than Likely entries in the Uncertainty Log.

A growth model has been developed within the Demand Model which creates highway and public transport future year demand matrices using the production and attraction trip end totals for the new development, a gravity model to distribute these new developments using base year travel costs and then converting to origin and destination format. These new trips are then added to the base year matrices. Three-dimensional matrix balancing to build full reference case matrices is undertaken, retaining the base year trip length distribution and control to the National Trip End model (NTEM, Tempro V7.2) growth for West of England and external zones.

These matrices are then run through the variable demand model until convergence is achieved within the limits specified by the DfT.

Light and heavy goods vehicle growth is based on forecasts produced by the National Transport Model (NTM) as advised by WebTAG. Goods vehicles are not subject to change via the demand model.

Joint Spatial Plan growth has not been included in the development of the 2021 and 2031 baseline models as it is not sufficiently certain, in terms of the WebTAG criteria, to be included.
The 2021 Baseline highway model developed has been adapted to be able to model the implementation of a charging CAZ. The matrices have been split by compliance for each user class using the surveyed Automatic Number Plate Recognition (ANPR) data.

3.3.2.2 ANPR Data

The 2017 Automatic Number Plate Recognistion (ANPR) surveys were undertaken in July and the analysis (including tabulated data) and use is discussed fully in the ANPR Data Analysis and Application technical note which is appended to T3. A summary is provided here.

The ANPR data has been used to determine the compliance splits of the current fleet when compared to the CAZ framework criteria relating to Euro Standards. The registration data from the ANPR surveys have been cross referenced with data purchased from Carweb to gain information on vehicle type, fuel type and Euro standard. The ANPR data has also been used to split the taxi fleet from the car matrices and the coaches from the HGV matrices, by applying global factors, by time period.

The base year compliance splits by vehicle type (Car, Taxi, LGVs, Coaches and HGVs) have been determined from the 2017 ANPR data worked back to 2015 using the Emission Factor Toolkit national euro standard splits. The baseline has been adjusted to 2021 using the fleet projection tool within the Emission Factor Toolkit.

3.3.2.3 Matrix Compliance Splits

The highway model has 6 user classes: Car Non-business (Low Income), Car Non-business (Medium Income), Car Non-business (High Income), Car Business, LGV and HGV. These has been split into 12 user classes using the following methodology:

- Split the Car user classes into Car and Taxi user classes
- Split the HGV user class into HGV and Coach user classes
- Split Car, Taxi, LGV, HGV and Coach matrices into compliant and non-compliant using the time period splits

3.3.2.4 Post-Processing

The ANPR data collected has also been used to determine the HGV rigid/artic split by compliance and fuel type splits for cars and LGVs. This has been used to add more detail to the modelled outputs via post processing, to produce inputs into the EFT.

First Bus provided information regarding the 2021 fleet composition by service. Non-First bus compliance splits have been derived from ANPR data adjusted to 2021 using the EFT tool. The bus fleet composition has been handled outside the transport model, before input to the EFT. This has enabled vehicle details for particular routes to be accounted for in both the current and future fleet.

3.3.2.5 Euro Standard Splits

The EFT has national Euro Standard splits within it. These have been overwritten with splits calculated from the 2017 ANPR data, projected forward to 2021.

3.3.2.6 2015 Base Compliance Splits

The base year compliance splits have been determined from the 2017 ANPR data worked back to 2015 using the EFT national euro standard splits. The ANPR Data Analysis and Application technical note (appended to T3), Chapter 3, details this process and the outputs. Table 3.1 shows the projected 2015 compliance data by time period – AM peak, IP (Interpeak) and PM peak.

Table 3.1: 2015 Compliance Splits by Time Period, Medium Cordon

Vehicle	AM		IP		PM	
Category	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	36.1%	63.9%	34.7%	65.3%	35.3%	64.7%
LGV	0.2%	99.8%	0.2%	99.8%	0.2%	99.8%
HGV rigid	20.2%	79.8%	19.0%	81.0%	15.2%	84.8%
HGV artic	35.0%	65.0%	36.3%	63.7%	34.0%	66.0%
HGV	22.7%	77.3%	21.7%	78.3%	19.2%	80.8%
Taxi	11.5%	88.5%	9.1%	90.9%	10.7%	89.3%
Bus	7.6%	92.4%	7.9%	92.1%	7.7%	92.3%
Coach	14.7%	85.3%	15.1%	84.9%	15.8%	84.2%
Total	28.4%	74.8%	27.1%	76.6%	30.0%	71.3%

3.3.2.7 2021 Baseline Compliance Splits

The fleet projection tool within the EFT version 8 has been used to project the euro standard splits from the 2017 ANPR data to the Baseline year of 2021. The ANPR Data Analysis and Application technical note (appended to T3), Chapter 4, details this process and the outputs. A summary of the projected 2021 compliance data by time period is provided in Table 3.2.

Table 3.2: 2021 Compliance Splits by Time Period

Vehicle	AM		IP		PM	
Category	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	74.0%	26.0%	72.8%	27.2%	73.4%	26.6%
LGV	58.0%	42.0%	63.1%	36.9%	58.2%	41.8%
HGV rigid	73.9%	26.1%	72.5%	27.5%	66.7%	33.3%
HGV artic	85.7%	14.3%	86.4%	13.6%	85.2%	14.8%
HGV	76.6%	23.4%	75.6%	24.4%	72.6%	27.4%
Taxi	39.7%	60.3%	33.7%	66.3%	37.7%	62.3%
Bus	65.2%	34.8%	66.3%	33.7%	65.7%	34.3%
Coach	68.8%	31.2%	69.6%	30.4%	70.6%	29.4%
Total	72.5%	30.8%	72.0%	31.7%	70.9%	30.3%

3.3.3 Clean Air Zone Option Testing

3.3.3.1 Primary Behavioural Responses

The primary responses have been modelled using the G-BATS4M highway model using the following methodology, as described in the Local Plan Transport Modelling Methodology Report (T3), Chapter 5:

- Pay Charge – no change to the model
- Avoid Zone – a charge has been applied to each inbound link to replicate the expected percentage change from the baseline case of non-compliant cars, LGVs and HGV's within the CAZ
- Cancel journey / change mode – this has been modelled by reducing the number of trips made by non-compliant vehicles to/from and within the CAZ area, to replicate the expected percentage change from the baseline case
- Replace Vehicle – an adjustment to the matrices by extracting select cordon matrices for the non-compliant trips and switching the proportion of replace vehicles, calculated from the stated preference surveys, from the non-compliant matrices to the compliant matrices

3.3.3.2 Secondary Behavioural Responses

In addition to the primary behavioural responses, JAQU have set out some further assumptions on secondary responses for a charging CAZ for cars in paragraph 3.3 of the Evidence Package guidance. These have been used due to lack of any available local data.

These secondary responses have been applied during the calculation of the upgrade costs and post-processing of the extracted link-based flow data from the Transport Model for the 'replace vehicle' response.

3.3.3.3 Stated Preference Surveys

Stated preference survey of BCC / South Gloucestershire Council (SGC) / North Somerset Council (NSC)/ Bath and North East Somerset (B&NES) residents were undertaken in 2018. The work targeted owners of non-compliant cars / LGVs who drive in central Bristol, and 1100 online surveys completed Feb / March 2018.

The questionnaires asked how owners would respond to a small and medium size charging CAZ using structured 'multiple choice' exercises and then the results were analysed using logistical regression statistical techniques.

3.3.3.4 Upgrade Costs

In order to determine the primary response rates over a range of CAZ charges from the stated preference surveys, an upgrade cost is required for cars. The LGVs methodology for determining response rates also requires an estimation of an upgrade cost. The upgrade costs of other vehicle types (HGVs, Taxi, Bus and Coaches) were not used to calculate the primary response rates; rather, the primary response rates for these vehicle types were determined by other information collated.

3.3.3.5 Proposed Charge Rates

Table 3.3 shows the proposed charges. These are selected as the minimum charges required to address the air quality exceedances within Bristol and are in line with charges being considered by other local authorities.

Table 3.3: Bristol CAZ Proposed Charges

Charge Class	Daily Charge
Cars	£9.00
Taxis	£9.00
LGVs	£9.00
HGVs	£100.00
Buses	£100.00
Coaches	£100.00

3.3.3.6 Calculated Response Rates for Medium area CAZ D with Complementary Measures

The methodology for calculating the primary response rates for all vehicle type is summarised as follows:

- Cars - The upgrade cost has been used to determine a range of primary responses for different charge rates using the stated preference survey responses from the Medium zone area
- LGVs - The primary response rates are calculated from the stated preference survey responses which were identified as a 'van'. Again, the upgrade cost is used to determine a range of primary responses for different charge rates from the Medium zone area
- HGVs - The primary behavioural responses rates for HGVs were taken from 'Table 2 – Behavioural responses to charging Clean Air Zones' in the Evidence Package, provided by JAQU
- Taxis - The taxi response rate is based on Bristol enforcing compliance for Taxis through their licensing agreements with taxi operators
- Coaches - The initial response rates for coaches were taken from 'Table 2 – Behavioural responses to charging Clean Air Zones' in the Evidence Package, provided by JAQU
- Buses - The response rates for buses were determined through discussions between Bristol and bus operators

An adjustment for foreign vehicles has been applied to the responses rates calculated from the methodology set out above, as foreign vehicles cannot be reliably charged (their details are not captured in the Driver and Vehicle Licensing Agency (DVLA) database in order to determine if the vehicle is compliant and so enforcement can only occur through a manual process with limited powers). The final response rates will assume a 'worst case', i.e. that these vehicles continue to drive within the zone but do not pay the charge. In reality it is unlikely that this will be the case for all foreign vehicles.

Table 3.4 shows the final primary behavioural response rates by vehicle type produced the methodology set out above and the charge rates in Table 3.3. These are the response rates that have been applied to the core modelling scenarios within the traffic model.

Table 3.4: Final Primary Behavioural Response Rates for Medium Area Class D

Response	Cars Low Income	Cars Medium Income	Cars High Income	Cars Employers Business	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	4.4%	7.3%	5.2%	9.4%	4.1%	15.9%	8.8%	0.0%	17.8%
Avoid Zone	10.8%	14.1%	16.1%	18.0%	0.0%	19.2%	4.3%	0.0%	0.0%
Cancel Journey / Change Mode	39.9%	22.1%	14.2%	14.5%	0.0%	2.6%	4.3%	6.4%	11.4%
Replace Vehicle	44.9%	56.5%	64.5%	58.1%	95.9%	62.2%	82.6%	93.6%	70.8%

3.3.3.7 Calculated Response Rates for Diesel car exclusion over a small area with bus and taxi fleet improvement to Euro 6 or better

The methodology for calculating the primary response rates for all vehicle type is summarised as follows:

- Cars – Diesel Cars are excluded from the Small area, the pay charge response rate was set to zero, the avoid zone rate has been determined by the model assignment, where through trips can reroute and for trips with either an origin or destination point within the Small area, the cancel trip/change mode and replace vehicle responses from the stated preference surveys have been proportioned so that the total response rate totals 100 per cent
- Taxis – Assumed 100 per cent replace vehicle
- Buses - Assumed 100 per cent replace vehicle

Table 3.5 shows the final primary behavioural response rates by vehicle type produced the methodology set out above. These are the response rates that have been applied to the core modelling scenarios within the traffic model.

Table 3.5: Final Primary Behavioural Response Rates for Diesel car exclusion over a small area with bus and taxi fleet improvement to Euro 6 or better

Response	Cars Low Income	Cars Medium Income	Cars High Income	Cars Employers Business	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avoid Zone	43.1%	41.0%	37.1%	38.8%	0.0%	0.0%	0.0%	0.0%	0.0%
Cancel Journey / Change Mode	16.4%	17.0%	18.1%	17.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Replace Vehicle	40.5%	42.0%	44.7%	43.6%	100.0%	0.0%	100.0%	0.0%	0.0%

3.4 Air Quality Modelling Approach

3.4.1 Overview of approach

Dispersion modelling has been undertaken using ADMS-Roads version 4.1, which is one of the "standard" models recommended in JAQU's 'Transport and Air Quality' guidance. The model is approved by Defra and used extensively in the United Kingdom.

The model base year is 2015, with monitoring data for this year used to verify and adjust the modelled concentrations. Options 4 and Option 2c, have been modelled for the future years 2021 and 2031, together with the future baseline (whiteout the aforementioned measures) for the same years.

Both options showed exceedances of the NO_2 limit in Bristol city centre in 2021 and no exceedances in 2031. So, in order to compare the two options in terms of reaching compliance in the shortest time possible and estimate in which year compliance would be reached, modelling results have been interpolated between 2021 and 2031.

The model domain includes all roads that are listed within the national Pollution Climate Mapping (PCM) model for the study area, as exceeding the annual mean Limit Value in 2021 for NO_2 (as published by Defra), as well as roads where annual mean NO_2 concentrations are known to exceed the national air quality objective, based on the most recent review and assessment report published by BCC.

The domain also includes all potential displacement routes which may affected by the measures, identified from the traffic model.

3.4.2 Summary of results

A detailed assessment of the impacts of the two preferred options on air quality has been undertaken for the OBC using traffic and air quality models. The results of this work are summarised in Table 3.6.

Table 3.6: Summary of AQ impacts

Option	Has the options been modelled?	Does the option achieve compliance in BCC by 2021?	Number of sites not meeting compliance by 2021
Baseline 2021	Yes	No	>10
Option 4 – Medium Area Class D Charging Option with complementary non-charging interventions	Yes	No	6 locations
Option 2c Diesel car exclusion across small area with bus and taxi fleet improvement so that everything is Euro 6 or better	Yes, the Diesel car exclusion over a small area together with taxi and bus fleet improvements	No	4 locations

Plans showing the AQ impacts are presented in Table 3.7 and Figures 3.1 and 3.2.

Table 3.7: Comparison of modelled options at locations with exceedances at one of more location

Road Name	Rupert Street	Upper Maudlin Street	Upper Maudlin Street	Park Row	Park Street	Queen's Road	College Green	Ward Bdy	Newfoundland Way	Easton Way	Church Road
Modelled Link/s	2677_1518	1236_2683 & 2683_1236	1224_1236 & 1236_1224	1225_1815 & 1815_1225	1227_1793 & 1793_1227	1787_1227	1237_2535 & 2535_1237	1110_4033 & 4033_1110	1470_3977	1248_1620	1253_2351 & 2351_1253
Modelled Scenario	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)	**Modelled Results** (µg/m³)
Baseline	54.88	67.2	51.6	48.1	52.2	58.8	52.1	41.1	47.3	38.7	50.5
Medium Area Class D Charging Option with complementary non-charging interventions	46.09	52.4	41.4	38.9	40.5	47.9	39.1	35.7	41.4	32.7	45.6
Diesel car exclusion over a small area with bus and taxi fleet improvement to Euro 6 or better	42.84	45.4	36.8	33.5	36.3	43.0	39.1	37.7	36.3	32.7	45.2

Figure 3.1 AQ impacts of Option 4: Medium Area Class D Charging Option with complementary measures

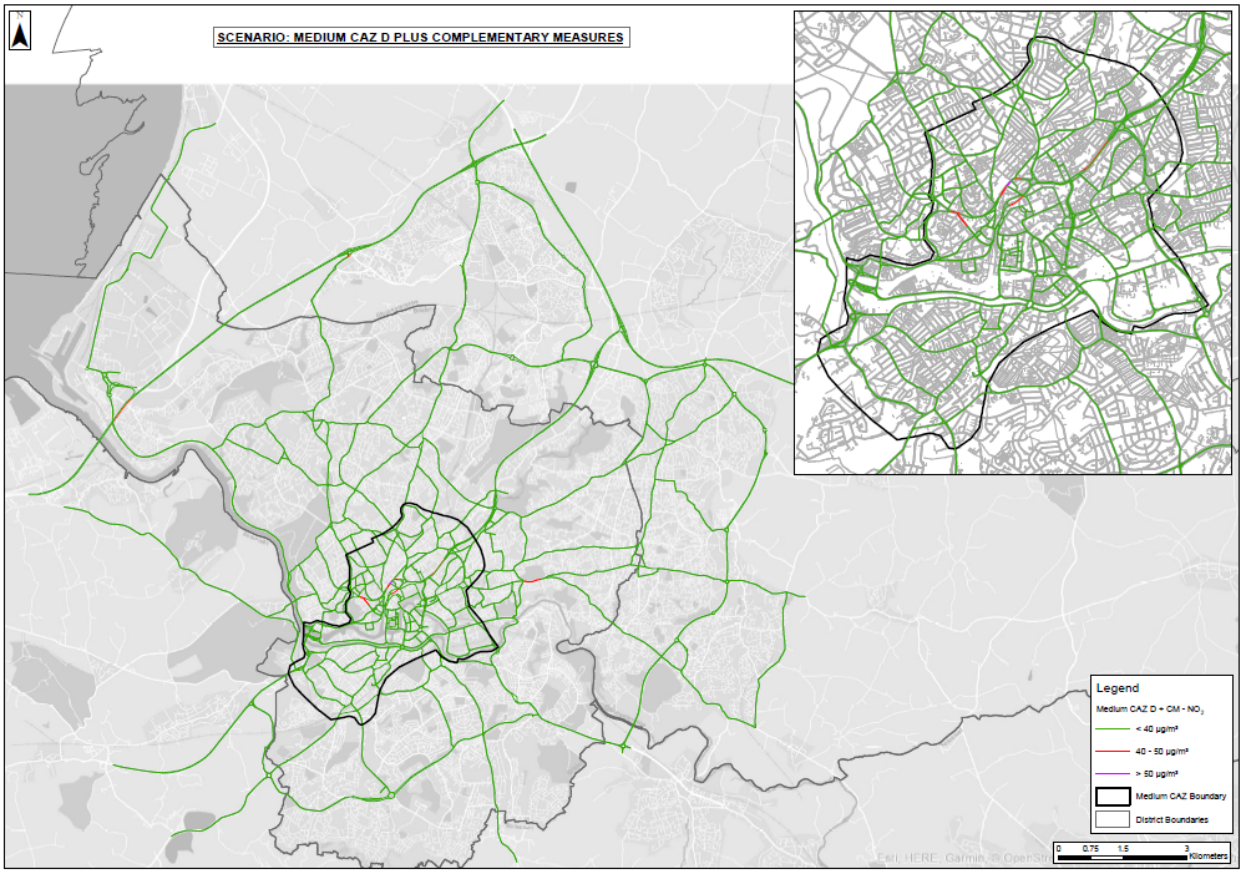


Figure 3.2 AQ impacts of Option 2c – Package of non-charging interventions including small area car diesel ban with taxi and bus fleet improvements

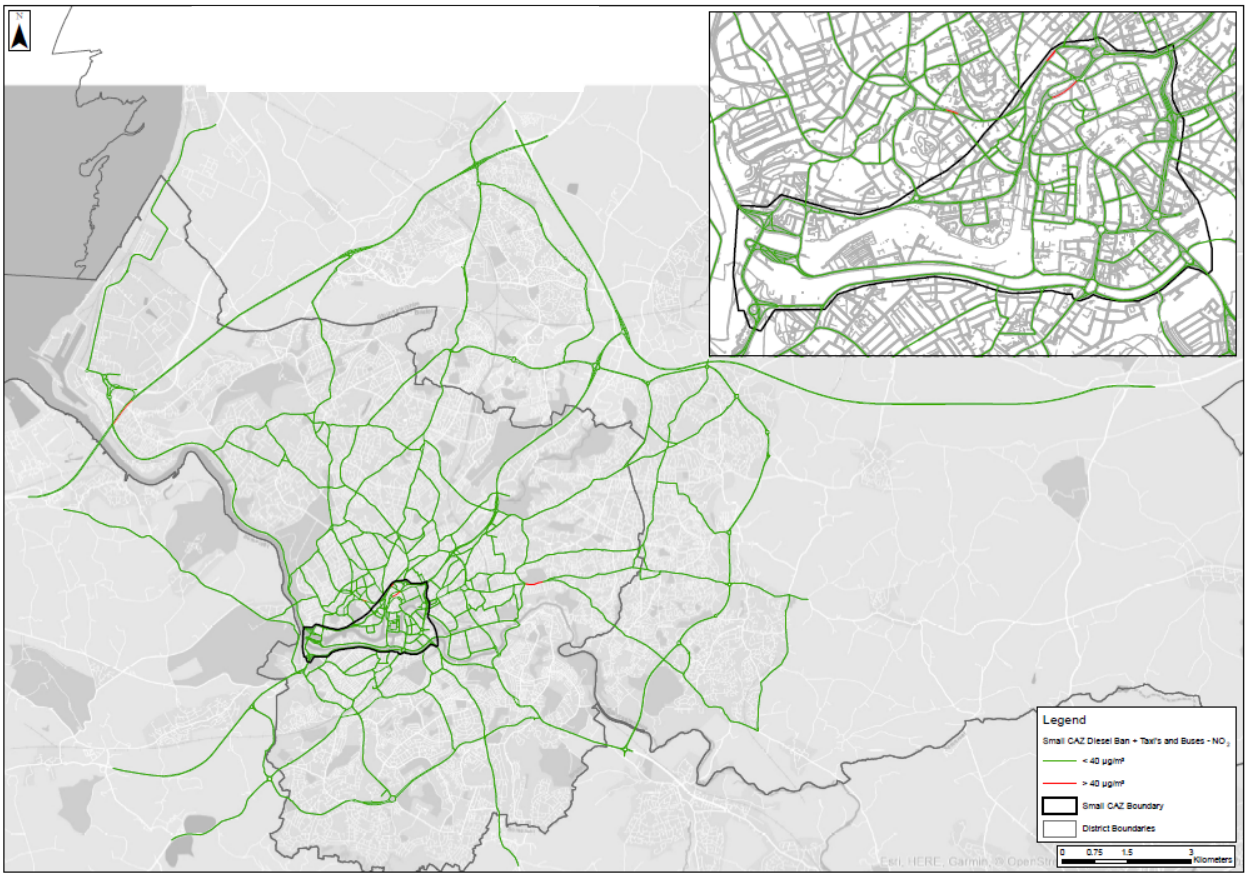


Figure 3.3 Road Names of Key Links Experiencing Non-Compliance

Below is a description of the air quality issues at locations in the City with exceedances in one of more options:

3.4.2.1 Rupert Street

Rupert Street (based on PCM receptors) exceeds the Air Quality objective of 40 µg/m³ in all scenarios.

The topography along Rupert Street is relatively flat. As a result of the tall buildings along the route, a canyoning effect is created, reducing the dispersion of pollutants.

The best performing option is the Option 2c, which results in a significant reduction in emissions from Diesel Cars, as well as Buses, with the highest emission apportionment (as calculated in the EFT) being linked to Diesel LGVs (42.1%).

3.4.2.2 Upper Maudlin Street

Upper Maudlin Street (north of Lower Maudlin Street) exceeds the Air Quality objective of 40 µg/m³ in all scenarios.

There is a relatively steep gradient along the route, and as a result of the tall buildings along the route (Bristol Royal Infirmary), a canyoning effect is created, reducing the dispersion of pollutants.

The best performing option is again the Option 2c, which results in a significant reduction in emissions from Diesel Cars, with the highest emission apportionment (as calculated in the EFT) being linked to Diesel LGVs (67%).

Upper Maudlin Street (south of Lower Maudlin Street) also exceeds the Air Quality objective of 40 µg/m³ with Option 4 while would meet compliance with Option 2c .

3.4.2.3 Park Row

Park Row exceeds the Air Quality objective of 40 µg/m³ in Baseline 2021 scenario, and both Option 4 and Option 2c would bring NO_2 levels into compliance by 2021.

3.4.2.4 Park Street

Park Street exceeds the Air Quality objective of 40 µg/m³ with Option 4 due to the increase in Diesel cars and HGVs movements diverted on this route.

There is a steep gradient along this street, and with the buildings along the route creating a canyoning effect is created, reducing the dispersion of pollutants.

The best performing option is Option 2c, which results in a significant reduction in emissions from Diesel Cars, with the highest emission apportionment (as calculated in the EFT) being linked to Diesel LGVs (45.7%).

3.4.2.5 Queen's Road

Queen's Road still exceeds the Air Quality objective of 40 µg/m³ with both Option 4 and Option 2c.

There is a relatively steep gradient along the route, and as a result of the buildings along the route a canyoning effect is created, reducing the dispersion of pollutants.

The best performing option is Option 2c, which results in a significant reduction in emissions from Diesel Cars, with the highest emission apportionment (as calculated in the EFT) being linked to Diesel LGVs and Buses and Coaches (44.1% / 26.7%).

3.4.2.6 College Green

College Green exceeds the Air Quality objective of 40 µg/m³ in the Baseline 2021 while both Option 4 and Option 2c would be sufficient to bring this link into compliance by 2021.

3.4.2.7 A38 Cheltenham Road (Between B4051 junction and Arley Hill junction)

A38 Cheltenham Road (Between B4051 junction and Arley Hill junction) the Baseline 2021 while both Option 4 and Option 2c would be sufficient to bring this link into compliance by 2021.

3.4.2.8 Newfoundland Way

Newfoundland Way exceeds the Air Quality objective of 40 µg/m³ with Option 4 in 2021, while Option 2c would bring compliance by 2021. Option 2c is the best option thanks to the significant reduction in emissions from Diesel Cars, with the highest emission apportionment (as calculated in the EFT) being linked to Diesel LGVs (76.3%).

3.4.2.9 Easton Way

Easton Way exceeds the Air Quality objective of 40 µg/m³ in the Baseline 2021, while both Option 4 and Option 2c would be sufficient to bring this link into compliance by 2021.

3.4.2.10 Church Road

Church Road exceeds the Air Quality objective of 40 µg/m³ in 2021 with both Options .There is a gradient along this street, and canyoning effect reducing the dispersion of pollutants.The best performing option is Option 2c, with the highest emission apportionment (as calculated in the EFT) being linked to Diesel Cars (41.6%).

3.4.3 Year of compliance

The impact of the two preferred options has been assessed in terms of reduced time needed to reach compliance compared to the Baseline (i.e. a scenario without measures). The modelling results obtained for the years 2021 and 2031 have been interpolated to identify the options that will achieve compliance at all locations in the shortest time possible. Table 3.8 shows the result of the compliance year assessment at the most relevant locations.

Option 4 will achieve compliance at all location by 2027, with the exception of the north section of Upper Maudlin Street that would be compliant only by 2030.

Option 2c will achieve compliance at all location by 2023, with the exception of the north section of Upper Maudlin Street that would be compliant only by 2024.

Table 3-8: Compliance Year at relevant locations for the Baseline 2021, Option 4 and Option 2c scenarios

Years	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Rupert Street											
Baseline	54.9	53.1	51.3	49.5	47.7	46.0	44.2	42.4	40.6	38.8	37.1
Medium CAZ D + CM	46.1	44.9	43.7	42.5	41.3	40.1	39.0	37.8	36.6	35.4	34.2
Small Car DiselBan + fleet improvements	42.8	41.4	40.1	38.7	37.3	35.9	34.5	33.1	31.7	30.3	28.9
Upper Maudlin Street (north)											
Baseline	67.2	64.8	62.4	60.0	57.6	55.2	52.8	50.4	48.0	45.6	43.2
Medium CAZ D + CM	52.4	51.2	50.0	48.8	47.6	46.4	45.2	44.0	42.8	41.6	40.4
Small Car DiselBan + fleet improvements	45.4	43.9	42.5	41.1	39.6	38.2	36.8	35.3	33.9	32.4	31.0
Upper Maudlin Street (south)											
Baseline	51.6	49.7	47.9	46.0	44.1	42.3	40.4	38.5	36.6	34.8	32.9
Medium CAZ D + CM	41.4	40.4	39.3	38.3	37.3	36.3	35.3	34.2	33.2	32.2	31.2
Small Car DiselBan + fleet improvements	36.9	35.8	34.6	33.5	32.4	31.2	30.1	29.0	27.8	26.7	25.6
Park Row											
Baseline	48.1	46.4	44.7	43.0	41.3	39.6	37.9	36.2	34.5	32.8	31.1
Medium CAZ D + CM	39.0	38.1	37.2	36.3	35.4	34.5	33.6	32.7	31.8	30.9	30.1
Small Car DiselBan + fleet improvements	33.5	32.4	31.4	30.4	29.4	28.4	27.4	26.3	25.3	24.3	23.3
Park Street											
Baseline	52.2	50.6	48.9	47.3	45.6	43.9	42.3	40.6	39.0	37.3	35.6
Medium CAZ D + CM	40.5	39.6	38.6	37.6	36.6	35.6	34.7	33.7	32.7	31.7	30.8
Small Car DiselBan + fleet improvements	36.3	35.0	33.7	32.5	31.2	29.9	28.7	27.4	26.1	24.9	23.6
Queen's Road											
Baseline	58.8	56.8	54.8	52.8	50.8	48.7	46.7	44.7	42.7	40.7	38.6
Medium CAZ D + CM	48.0	46.8	45.6	44.4	43.3	42.1	40.9	39.7	38.6	37.4	36.2
Small Car DiselBan + fleet improvements	43.0	41.6	40.2	38.8	37.4	36.0	34.5	33.1	31.7	30.3	28.9
College Green											
Baseline	52.1	50.1	48.0	46.0	43.9	41.9	39.8	37.8	35.7	33.7	31.6
Medium CAZ D + CM	39.1	38.0	36.8	35.7	34.6	33.4	32.3	31.1	30.0	28.9	27.7
Small Car DiselBan + fleet improvements	39.1	37.7	36.4	35.0	33.6	32.3	30.9	29.5	28.2	26.8	25.5
Newfoundland Way											
Baseline	47.3	45.6	43.9	42.2	40.6	38.9	37.2	35.5	33.8	32.1	30.4
Medium CAZ D + CM	41.4	40.2	39.0	37.8	36.6	35.4	34.2	33.0	31.9	30.7	29.5
Small Car DiselBan + fleet improvements	36.3	35.2	34.0	32.8	31.7	30.5	29.4	28.2	27.0	25.9	24.7
Church Road											
Baseline	50.5	48.6	46.6	44.7	42.7	40.8	38.8	36.9	34.9	33.0	31.0
Medium CAZ D + CM	45.6	44.0	42.5	40.9	39.4	37.9	36.3	34.8	33.2	31.7	30.2
Small Car DiselBan + fleet improvements	45.2	43.6	42.1	40.5	38.9	37.3	35.7	34.1	32.5	30.9	29.3

3.5 Economic Modelling Approach

JAQU's Option Appraisal Guidance states that each shortlisted option identified at SOC stage should be subject to detailed assessment of their overall costs and benefits and their distributional impacts. The results from these assessments are intended to allow local authorities to identify the preferred option for a scheme based on its value to society, distributional impacts and achieving compliance in the shortest possible time. However, the Options Appraisal Guidance is also clear that only option packages that are likely to lead to compliance as quickly as possible will be accepted, using some pass/fail criteria as part of the Primary Critical Success Factors.

As demonstrated in Section 3.4, none of the identified shortlisted options derived from the Options Assessment Report achieve compliance by 2021. However, two better performing options are identified:

- Option 4 – Medium area Class D charging option with complementary non-charging interventions
- Option 2c – Diesel car exclusion over a small area with bus and taxi fleet improvement to Euro 6 or better

The economic analysis presented below is predicated on a comparative assessment of the two options.

The economic modelling approach is aligned with JAQU's Option Appraisal Guidance and gives full consideration to all of the economic impact types specified in that document. The results of the analysis are outlined in the following section; the overall framework and methodology applied to the analysis is presented in OBC-18 'Economic Methodology Report' in Appendix F of this OBC.

3.6 Economic Impacts

3.6.1 Health and Environmental Impacts

3.6.1.1 Greenhouse Gas Emissions

By changing travel behaviours (including number of trips, trip mode and vehicle type), the intervention options may influence the quantum of Greenhouse Gas (GHG) emissions generated by road transport. A change in GHG emissions, and CO_2 emissions in particular, could generate variable effects on climate change processes.

Based on air quality modelling outputs, the impact of the intervention options can be summarised as follows:

- Medium area CAZ D: forecast to initially reduce and then slow the growth of GHG emissions for much of the appraisal period, before inducing acceleration in emissions in later years of the appraisal period.
- Small area diesel car exclusion: forecast to initially reduce emissions, then accelerate emissions from the mid-point of the appraisal period.

Relative to their respective baseline scenarios, both intervention options will therefore initially reduce the quantum of CO_2 emissions released into the atmosphere before increasing emissions at a later date. This impact is monetised through the application of Department for Business, Energy and Industrial Strategy (BEIS) carbon prices.

The monetised impact of a change in GHG emissions is presented in Table 3-9, which demonstrates that the scheme will generate a net benefit of almost £1.2 million over the ten-year appraisal period for the Medium area CAZ D intervention option. Due to the earlier onset of accelerated emissions under the Small area diesel car exclusion intervention option (potentially linked to the switch from diesel to petrol cars for some vehicle owners), the net impact is negative.

Table 3-9: GHG impacts

Impact	Medium area CAZ D	Small area diesel car exclusion
Cumulative Difference in CO_2 Emissions, 2021-30 (tonnes)	(18,843)	2,308
BEIS Carbon Prices, 2021-2030(£/tonne)	69.3 - 79.4	69.3 - 79.4
Present Value (PV) of Impact (£'s 2018 Prices and Values)	**1,153,292**	**-116,651**

3.6.1.2 Air Quality (PM/NO_2) Emissions

Based on air quality modelling outputs, the intervention options are forecast to reduce the level of PM and NO_2 emissions across the appraisal period, contributing to an improvement in air quality. Improvements in air quality can lead to a range of public health, natural and built environment benefits. These benefits can be monetised through the application of JAQU's Damage Cost estimates.

The monetised impact of a change in air quality is presented in Table 3-10 which demonstrates that the intervention options will generate a benefit between £17 million and £21 million over the ten-

year appraisal period. The scale of benefit is greater in the Small area diesel car exclusion intervention option because this option is likely to induce existing diesel owners to upgrade vehicles or change travel patterns/behaviours.

Table 3-10: Air quality impacts

Impact	Medium area CAZ D	Small area diesel car exclusion
Cumulative Difference in NO_2 Emissions 2021-2030 (tonnes)	655.54	626.9
NO_2 Damage Costs 2021-2030 (£/tonne)	7,332-8,762	7,332-8,762
PV of NO_2 Change (£'s 2018 Prices and Values)	**4,146,929**	**3,888,265**
Cumulative Difference in PM Emissions 2021-2030 (tonnes)	118.29	150.39
PM Damage Costs 2021-2030 (£/tonne)	131,467-157,115	131,467-157,115
PV of PM Change (£'s 2018 Prices and Values)	**12,841,002**	**17,060,067**
Aggregate PV (£'s 2018 Prices and Values)	**16,987,932**	**20,948,332**

3.6.2 Impacts on Transport Users

3.6.2.1 Fuel Switch Impacts

The transport analysis assumes that some car drivers will switch fuel type from diesel to petrol, when upgrading their vehicle in response to the intervention option. The change in fuel switch costs is reflected in the change in vehicle operating costs to the user, captured as part of the DfT's Transport User Benefits Assessment (TUBA) presented in Section 3.7.2.5. No additional or separate analysis is provided here.

3.6.2.2 Transaction Costs

Based on the traffic forecasting analysis, the intervention options will accelerate the rate at which vehicle owners' purchase or upgrade to compliant vehicles. Each upgrading transaction incurs time costs for vehicle owners relating to identifying and buying a compliant vehicle. By applying JAQU's recommended transaction cost data (provided as part of the National Data Inputs for Local Economic Models) to the number of vehicles anticipated to upgrade, Table 3-11 suggests that the scheme will impose a transaction cost of between £83,000 and £149,000 over the ten-year appraisal period. The scale of transaction costs is higher for the Medium area CAZ D intervention option as more vehicles are induced to upgrade.

Table 3-11: Transaction cost impacts

Impact	Medium area CAZ D	Small area diesel car exclusion
Number of Vehicles Upgrading	27,012	15,228
Transaction Cost (£'s 2018 Prices and Values)	**(148,856)**	**(82,831)**

3.6.2.3 Consumer Welfare Impacts

The intervention options will affect consumer behaviour by inducing a change in travel behaviour for non-compliant vehicle trips (for example through upgrading vehicles, using alternative modes, cancelling journeys etc, as suggested by the stated preference survey, Section 3.3, and reflecting in traffic model forecasts). However, because consumers would have preferred their original action in

the baseline, this change in behaviour leads to a consumer welfare impact. Two elements of analysis were identified to estimate aggregate consumer welfare loss as a result of intervention:

- Welfare loss associated with vehicles upgrading earlier
- Welfare loss associated with changing travel patterns or behaviours (i.e. mode shift, cancelled journeys, diverted journeys)

The cost of upgrading was estimated by establishing the average cost differential for upgrading a vehicle in the intervention scenario, compared to the baseline scenario. The cost differential was driven by the change in depreciation rates over time and therefore, the change in residual vehicle value between replacement and replaced vehicles, at the time of upgrading in the intervention scenario, relative to the baseline scenario. As vehicles were expected to upgrade earlier in the intervention scenario, the cost of upgrading is expected to be higher as the difference in value between replacement and replaced vehicles is also expected to be higher.

By applying the average cost differential for upgrading to the number of vehicles, upgrading (split by vehicle type [i.e. cars, LGVs, buses etc) and upgrade type [i.e. to new or used vehicles]) the consumer welfare loss associated with upgrading earlier is estimated to cost between £30 million and £35 million, as shown in Table 3-12. The upgrading cost for the Small area diesel car exclusion intervention option is higher than for the Medium area CAZ D option. This is because the Small area diesel car exclusion intervention option will induce a greater number of newer (diesel) cars to upgrade ahead of otherwise planned. Note that this figure reflects use of the 'rule of half' to estimate the average loss to each upgrader.

Table 3-12: Consumer welfare: cost of upgrading impacts

Impact	Medium area CAZ D	Small area diesel car exclusion
Number of Vehicles Upgrading	27,012	15,228
Consumer Welfare Loss (£'s 2018 Prices and Values)	**(29,995,696)**	**(35,097,830)**

The cost of changing travel behaviour was estimated by establishing the number of vehicle trips in the baseline that would be fundamentally changed in the intervention scenario. The cost of each individual trip cancelled, changed or switched to a new mode was assumed to be equal to half the cost of the charge, where a charge applied (i.e. only in the Medium area CAZ D intervention option). This approach, in line with JAQU's Options Appraisal Guidance, was adopted to reflect that only those trips that were valued at less than the cost of the charge were cancelled; any trips valued more than the charge were assumed to pay the charge. However, as it is not possible to value every trip that induced a behavioural response, each cancelled, changed or mode shifted trip was assumed to be valued at half the price of the charge.

For the Small area diesel car exclusion option, traffic modelling assumes that all diesel cars adhere to the exclusion zone. Therefore, no charge applies that is comparable to the CAZ charge. As such, no welfare loss is assumed for vehicle trips being changed under the Small area diesel car exclusion intervention option.

For the Medium area CAZ D intervention option, combining the number of vehicle trips changed with the adjusted charge to enter the zone Table 3-13 indicates that the consumer welfare loss associated with changing travel patterns or behaviours could cost nearly £210 million over the ten-year appraisal period.

Table 3-13: Consumer welfare: cost of changing travel pattern or behaviour impacts

Impact	Medium area CAZ D	Small area diesel car exclusion
Number of Vehicles Trips Changed	197,528,864	264,265,131
Consumer Welfare Loss (£'s 2018 Prices and Values)	**(209,845,003)**	**0**

3.6.2.4 Vehicle Scrappage Costs

As part of the upgrading process, it is assumed that the overall size of the vehicle fleet remains fixed. Therefore, for every new vehicle purchased (25% of all upgrades), an older vehicle is scrapped. The differential in lost asset value associated with scrapping a vehicle earlier in the intervention case relative to the baseline case allows monetisation of this impact. By combining the number of vehicles expected to be scrapped in the intervention scenario by the average differential in lost asset value between the intervention and baseline scenarios, Table 3-14 demonstrates that vehicle scrappage costs could amount to between £3 million and £9 million across the ten-year appraisal period.

The scale of vehicle scrappage impacts is larger for the Small area diesel car exclusion intervention option because the option will induce the scrappage of a greater number of high(er) value diesel cars that can no longer enter the exclusion zone. This drives up the average differential in lost asset value for vehicles under this intervention option, resulting in a high aggregate scrappage cost despite a lower number of vehicles being scrapped.

Table 3-14: Vehicle scrappage cost impacts

Impact	Medium area CAZ D	Small area diesel car exclusion
Number of Vehicles Scrapped	5,022	3,874
Vehicle Scrappage Costs (£'s 2018 Prices and Values)	**(2,589,907)**	**(9,359,810)**

3.6.2.5 Journey Time/Vehicle Operating Costs

By influencing travel patterns and behaviours, the intervention options could also have an impact on transport economic efficiency (TEE), measured in terms of changes to journey time savings and vehicle operating costs. By reducing vehicle flows, increasing vehicle speeds and reducing congestion, travel time could be reduced alongside reduced running costs. Using DfT's TUBA software, the change in vehicle movements induced by the intervention options could contribute to benefits in the region of £22 million to £72 million, based on journey time and vehicle operating cost benefits for road users in Bristol (Table 3-12).

The scale of benefits is considerably larger for the Medium area CAZ D intervention option. This is because the option has the potential to remove a larger volume of traffic over a larger area relative to the Small area diesel car exclusion intervention option

Table 3-15: Journey time/vehicle operating cost impacts

TUBA Impact Category	Medium area CAZ D	Small area diesel car exclusion
PV Travel Time Impacts (2010 prices and values)	45,889	16,700
PV Vehicle Operating Costs (2010 prices and values)	2,205	-2,057
PV Total (£'s 2018 Prices and Values)	**£72,119,048**	**21,957,816**

3.6.2.6 Accident Impacts

By changing travel patterns and behaviours, thus affecting vehicle trip numbers and speeds, the intervention options could influence the frequency and severity of accidents. The number of accidents and casualties is expected to reduce under both intervention options, leading to an accident benefit of between £315,000 and £471,000 over the ten-year appraisal period based on utilisation of DfT's CoBALT software (Table 3.16).

Table 3-16: Journey time/vehicle operating cost impacts

Accident Impact Category	Medium area CAZ D	Small area diesel car exclusion
PV of Accident Costs in Baseline (2010 prices and values)	16,355,400	16,355,400
PV of Accident Costs in Intervention (2010 prices and values)	16,145,900	16,041,300
Reduction in Accident Costs	209,500	314,100
PV Total (£'s 2018 Prices and Values)	**314,154**	**471,007**

3.6.2.7 Walking/Cycling Impacts

By inducing mode shift, the intervention options will increase the number of individuals making walking and cycling trips. This has a positive economic impact, primarily by improving general health of people, by walking and cycling more regularly, and by reducing absenteeism from work. Using the DfT's Active Mode Appraisal Toolkit, the forecast growth in the number of walking and cycling trips is expected to lead to a benefit of between £51 million and £55 million (Table 3-17).

The scale of impacts is greater in the Small area diesel car exclusion intervention option because more trips are induced to change mode relative to their alternative action in the baseline. This is partially driven by the fact that in the baseline for the Small area diesel car exclusion option, use of diesel cars within the exclusion zone is maintained at a high level throughout the appraisal period. All of these trips become non-compliant in the intervention option. In comparison, the number of trips in the Medium area CAZ D baseline option that would be non-compliant in the intervention option is initially higher, but drops markedly over the appraisal period as older cars are forecast to be replaced even in the absence of the intervention option.

Table 3-17: Walking/cycling impacts

Impact	Medium area CAZ D	Small area diesel car exclusion
Number of Trips Changing Mode	37,640,568	41,444,230
Number of New Cycling Trips	1,930,286	2,125,345
Number of New Walking Trips	25,093,712	27,629,487
PV Total (£'s 2018 Prices and Values)	**51,258,892**	**55,194,944**

3.6.3 Costs to Central and Local Government

3.6.3.1 Scheme costs

Tables 3-18 and 3-19 provide a summary of the costs for the scheme costs, further details will be provided in the financial case.

Table 3-18: Estimated Scheme Costs for Option 4 – Medium area CAZ D with complementary measures

Item	Estimated Cost
System Capital Costs	
CAZ system (cameras and back office)	£19,059,048
Street works (incl. power, comms and signage)	£3,736,250
Non-Charging Measures Capital Costs	
Vehicle scrappage scheme	£17,325,000
Business Rate Relief for SME's	£39,375,000
Total Scheme Capital Cost	**£79,493,298**
Revenue (Annual) Costs	
CAZ operations	£2,680,230
Maintenance and support	£562,091
Other ongoing costs (e.g. staff, scheme monitoring)	£771,981
Total Scheme Revenue (Annual) Cost	**£4,014,302**

Note:
The above cost estimates include optimism bias as defined in HMT Green Book for the relevant item classification.
The total capital cost excludes all costs associated with decommissioning of the CAZ system.

Table 3-19: Estimated Scheme Costs for Option 2c – Small area diesels car exemption with bus and taxi fleet improvements

Item	Estimated Cost
System Capital Costs	
CAZ system (cameras and back office)	£7,117,938
Street works (incl. power, comms and signage)	£1,436,951
Non-Charging Measures Capital Costs	
Vehicle scrappage scheme	£17,325,000
Business Rate Relief for SME's	£39,375,000
Total Scheme Capital Cost	**£65,254,889**
Revenue (Annual) Costs	
CAZ operations	£545,937
Maintenance and support	£223,119
Other ongoing costs (e.g. staff, scheme monitoring)	£755,706
Total Scheme Revenue (Annual) Cost	**£1,524,762**

Note:
The above cost estimates include optimism bias as defined in HMT Green Book for the relevant item classification.
The total capital cost excludes all costs associated with decommissioning of the CAZ system.

3.6.3.2 Set-Up Costs

The capital costs associated with delivering the scheme are estimated at between £66 million and £79 million, as summarised in Table 3-20. Costs are greater for the Medium area CAZ D intervention option because the enforcement system is more expensive to install (primarily attributable to the requirement for more ANPR cameras to cover a wider zone). More detail on the derivation of these costs can be found within OBC-33 'Project Costs' in Appendix J of this OBC.

Table 3-20: Set-up cost impacts (2018 prices and values)

Impact	Medium area CAZ D	Small area diesel car exclusion
PV of Capital Costs (£'s 2018 Prices and Values)	79,110,638	65,817,064

3.6.3.3 Running Costs

The operational costs associated with delivering the scheme are estimated at between £10 million and £30 million over the ten-year appraisal period, as summarised in Table 3-21. Costs are greater for the Medium area CAZ D intervention option due to the need to make contributions to the Clean Air Zone central payment system on an ongoing basis. Note that revenue associated with CAZ charges and Penalty Charge Notices (PCNs) are ignored from the analysis on the basis that this economic benefit to local/central Government is neutralised by the economic cost to individuals of paying the charge/fine.

Table 3-21: Operational cost impacts (2018 prices and values)

Impact	Medium area CAZ D	Small area diesel car exclusion
PV of Operational Costs (£'s 2018 Prices and Values)	30,085,478	10,290,754

3.6.4 Summary

By combining the economic impacts discussed in the previous sections, the intervention options could generate a NPV of between -£22m and £210m, as shown in Table 3-22. The economic costs for both intervention options therefore outweigh the economic benefits by a considerable margin, particularly for the Medium area CAZ D option. This is primarily driven by the loss in consumer welfare associated with changing travel patterns and behaviours, as well as onerous set up and running costs.

Table 3-22: Net economic impacts (2018 prices and values £)

Impact	Medium area CAZ D	Small area diesel car exclusion
Air Quality	£16,987,932	£20,948,332
NO_x	£4,146,929	£3,888,265
PM	£12,841,002	£17,060,067
Consumer Welfare	-£239,840,698	-£35,097,830
Behavioural Response: Replace Vehicle	-£29,995,696	-£35,097,830
Behavioural Response: Cancel Trip/Avoid Zone/Re-mode	-£209,845,003	£0
Vehicle Scrappage	-£2,589,907	-£9,359,810
Transactions	-£148,586	-£82,831
Traffic Flows	£72,119,048	£21,957,816
GHGs	£1,153,292	-£116,651
Set Up	-£79,110,638	-£65,817,064
Running Costs	-£30,085,478	-£10,290,754
Active Mode Impacts	£51,258,892	£55,194,944

Impact	Medium area CAZ D	Small area diesel car exclusion
Accident Impacts	£314,154	£471,007
Net Present Value (NPV)	**-£209,941,989**	**-£22,192,840**

To provide scale context, these NPVs, have been compared to the forecast GVA in Bristol (forecast at £137 billion in present value terms [2018 prices and values] between 2021-30). Across the 10 year period assessed, the NPV of the intervention options represent between -0.02% and -0.15% of present value GVA in B&NES over the same period.

3.7 Multi-criteria assessment

Allied to the economic modelling impacts monetised above, a multi-criteria assessment (MCA) was prepared at OAR stage to differentiate between the two shortlisted options. This supports the economic modelling by outlining the differential impact of the shortlisted options on a range of economic actors not explicitly considered as part of the core economic modelling. This includes employment markets, income deprivation, businesses and economic sectors (e.g. retail/leisure). It also incorporates some economic impacts considered within the economic modelling above (e.g. consumer welfare loss, vehicle scrappage costs and transaction costs).

3.7.1 Introduction

The qualitative economic analysis of options follows a two-step approach:

- Step One –outlines the baseline position for Bristol's economy, covering a range of key economic indicators, in order to establish an economic narrative
- Step Two – multi-criteria assessment (MCA) of the potential impact of the various options on key economic indicators

The economic narrative established in Step One provides the context within which the MCA undertaken as part of Step Two is considered.

3.7.2 Step One: Economic Narrative

This section presents a brief economic narrative for the City of Bristol. It outlines key baseline economic indicators at both local authority level as well as for the varying spatial scales pertaining to the various Clean Air Plan options. The analysis contains a summary of the following indicators:

- Business count
- Employment data/labour market characteristics
- Deprivation analysis
- Vehicle compliance patterns

To establish the function and form of Bristol's economy in the context of the forthcoming Clean Air Plan. This information is utilised to develop the multi criteria assessment presented later in this report.

3.7.2.1 Business Count

Business count data from National Online Manpower Information System (NOMIS) provides an insight into the number and size of businesses in a given context area. Businesses are classified into various sizes based on the number of employees within that business. The data illustrates that the Bristol economy consist of 22,170 businesses, with 18,025 of these classified as micro-businesses. Micro-businesses make up a significant proportion (81%) of the market structure within the local

authority, whilst SMEs account for 18% of all businesses within Bristol. Overall, micro and small businesses account for 96.3% of the business within Bristol. Table 3.23 below presents the distribution of businesses by type across Bristol.

Table 3.23: Business types within Bristol

	Business Type				
Context Area	**Micro (0 to 9)**	**Small (10 to 49)**	**Medium-sized (50 to 249)**	**Large (250+)**	**Total**
Bristol LA	18,025	3,320	700	125	22,170

Table 3.24 summarises the business count data pertaining to the geographic scales directly affected by potential intervention options (i.e. small area CAZ[15] and medium area CAZ). Between 3,000 and 7,400 businesses are located within the small and medium boundaries respectively. These figures suggest that 13% of all Bristol businesses will be located within the small boundary and one-third will be located within the medium boundary.

The overarching theme, irrespective of the geographic scale, is that micro businesses make up the largest proportion of businesses. Further, combining micro and SME businesses reveals that around 99% of all businesses located within across the local authority and within small and medium boundaries employ fewer than 50 employees. Therefore, there is limited differentiation between the geographic scales from a business size perspective. That said, there are nearly 60% fewer micro businesses and SMEs within the small area CAZ boundary relative to the medium area CAZ boundary.

Table 3.24: Business types within CAZ proposals

	Business Type				
Context Area	**Micro (0 to 9)**	**Small (10 to 49)**	**Medium-sized (50 to 249)**	**Large (250+)**	**Total**
Small Area CAZ	2,210	675	145	35	3,065
Medium Area CAZ	5,985	1,075	245	55	7,360

Business count data was also considered for two key sectors within the Bristol economy: tourism[16] and retail[17]. Table 3.25 reveals that for as per the economy-wide analysis, micro businesses in the retail sector comprise a majority of the market structure, irrespective of context area being analysed. Within the small area CAZ boundary, micro-businesses make up 71% of the businesses, this increases to 80% and 79% for the medium area CAZ and Bristol respectively. It should be noted that there is also a large presence of small retail businesses in the small CAZ area, 27%, this drops to 19% at the Medium area CAZ area and Bristol geographical measures. In total, all retail businesses at all geographic scales are defined as micro or SMEs. At a spatially disaggregated level, less than 40% of Bristol's retail businesses are located within the Medium area CAZ area, and only one-third of these are located within the small CAZ area.

[15] Used as a proxy for small area over which the diesel car exclusion zone is applied

[16] The definition of tourism is based on ONS' 'workers in the tourism sector' report

[17] The definition of retail is based on the SIC category 47

Table 3.25: Retail businesses by type

Industry	Business Type				
Retail	**Micro (0 to 9)**	**Small (10 to 49)**	**Medium-sized (50 to 249)**	**Large (250+)**	**Total**
Small Area CAZ	180	70	5	0	255
Medium Area CAZ	605	140	10	0	755
Bristol	1,565	375	30	0	1,970

Similar patterns are evident within the tourism sector. Micro businesses make up majority of the market share, with 61% of tourism related business in the small area CAZ being micro. This increases to 77% and 75% for both the medium area CAZ and Bristol respectively. Small businesses in the small CAZ make up 36% of the market share, this is higher than the 23% in the medium area CAZ and 24% in Bristol. In total, all tourism businesses at all geographic scales are defined as micro or SMEs. At a spatially disaggregated level, less than 40% of Bristol's tourism businesses are located within the medium area CAZ boundary, but the majority of these (nearly 80%) are located within the small area CAZ boundary. This suggests a disproportionate number of tourism businesses are located within the small area CAZ boundary; this is understandable given that Bristol City Centre falls within this zone.

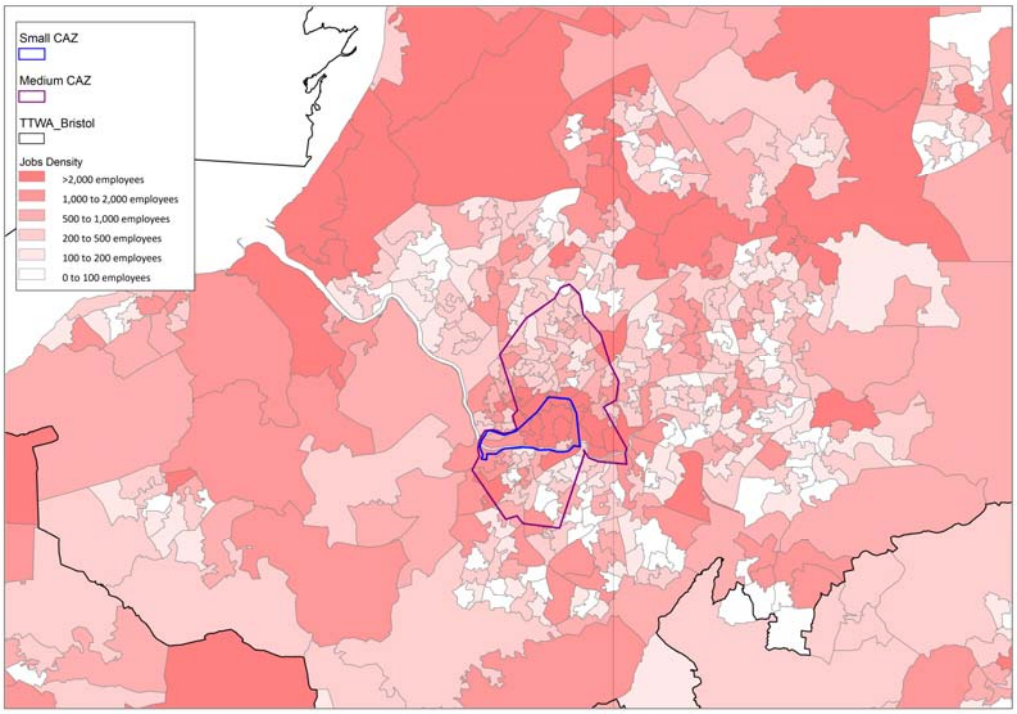
Table 3.26: Tourism businesses by type

Industry	Business Type				
Tourism	**Micro (0 to 9)**	**Small (10 to 49)**	**Medium-sized (50 to 249)**	**Large (250+)**	**Total**
Small Area CAZ	295	175	15	0	485
Medium Area CAZ	480	140	0	0	620
Bristol	1,270	405	15	0	1,690

3.7.2.2 Labour Market Characteristics

Employment density outlines the distribution of jobs across Lower Super Output Areas (LSOAs) that make up Bristol, as per data from the Business Register and Employment Survey (BRES). This data has been mapped and is presented as Figure 3.4. The analysis demonstrates that LSOAs that predominantly lie within the small CAZ boundary have the highest jobs density, with more than 2,000 employees per LSOA. Whilst the work illustrates that LSOAs outside the city centre generally have a lower jobs density. Overall, there is a clear concentration of employment within Bristol City Centre, which lies within the small area CAZ boundary. Nevertheless, because the medium area CAZ boundary includes the small area CAZ boundary, the total level of employment within the medium area CAZ boundary exceeds the smaller boundary.

Figure 3.4: Employment Density in Bristol



The trends presented in Figure 3.4 are reflected in Table 3.27, which illustrates the sectoral profile of employment for Bristol and the focussed geographic scales, compared to national benchmarks. The analysis reveals that within the small area CAZ boundary the main industries of employment are business services (industrial sectors: J, K, L, M, and N). A larger proportion of individuals ,63%, are employed within these industries in the small area CAZ boundary relative to the medium area CAZ boundary (45%), Bristol local authority area (35%) and nationally (28%). These sectors tend to make a significant contribution to economic output and value added, as well as offering competitive salaries. As has been mentioned previously, the small CAZ boundary includes Bristol City Centre which is where the majority of business services jobs are located.

Table 3.27: Proportion of individuals in industrial sectors by context area

Industrial Sectors	Small CAZ	Medium area CAZ	Bristol	England
Agriculture, forestry & fishing (A)	0%	0%	0%	1%
Mining, quarrying & utilities (B,D and E)	1%	2%	1%	1%
Manufacturing (C)	1%	2%	4%	8%
Construction (F)	1%	2%	4%	5%
Motor trades (Part G)	0%	1%	2%	2%
Wholesale (Part G)	0%	2%	4%	4%
Retail (Part G)	7%	7%	8%	9%
Transport & storage (inc postal) (H)	1%	3%	4%	5%
Accommodation & food services (I)	9%	8%	7%	7%
Information & communication (J)	10%	7%	6%	4%
Financial & insurance (K)	14%	10%	7%	4%

Property (L)	1%	1%	1%	2%
Professional, scientific & technical (M)	19%	15%	11%	9%
Business administration & support services (N)	17%	12%	10%	9%
Public administration & defence (O)	10%	7%	4%	4%
Education (P)	2%	7%	9%	9%
Health (Q)	3%	10%	15%	13%
Arts, entertainment, recreation & other services (R,S,T and U)	4%	4%	4%	5%

Focussing specifically on the previously defined retail and tourism sectors, over 4,400 and 4,600 individuals are employed within the tourism and retail sectors respectively within the small CAZ boundary. The number of employees in these sectors increases to over 11,000 in the retail sector and nearly 18,000 individuals in the tourism sector across the medium area CAZ boundary. At a spatially disaggregated level, more than 50% of all retail employment in Bristol is located within the Medium area CAZ boundary (less than half of which is also found in the small area CAZ boundary). Around 40% of all tourism jobs in Bristol are also located within the medium area CAZ boundary (only a quarter of which are also included in the small area CAZ boundary), Therefore based on employment, the medium area CAZ area is home to a disproportionate level of retail and tourism employees.

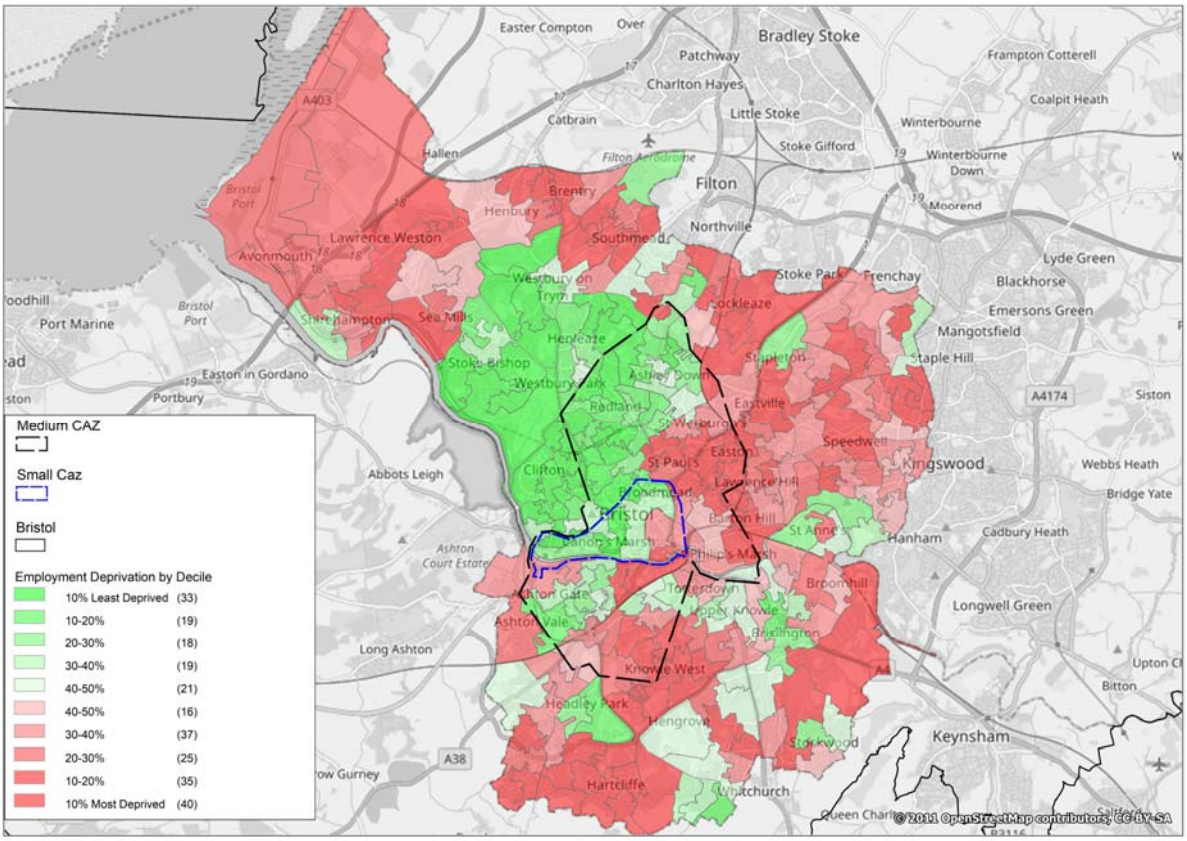
Table 3.28: Number of individuals employed across different sectors

Context Area	Retail	Tourism
Small Area CAZ	4,620	4,380
Medium Area CAZ	11,005	17,645
Bristol	20,050	45,695

3.7.2.3 Deprivation Analysis

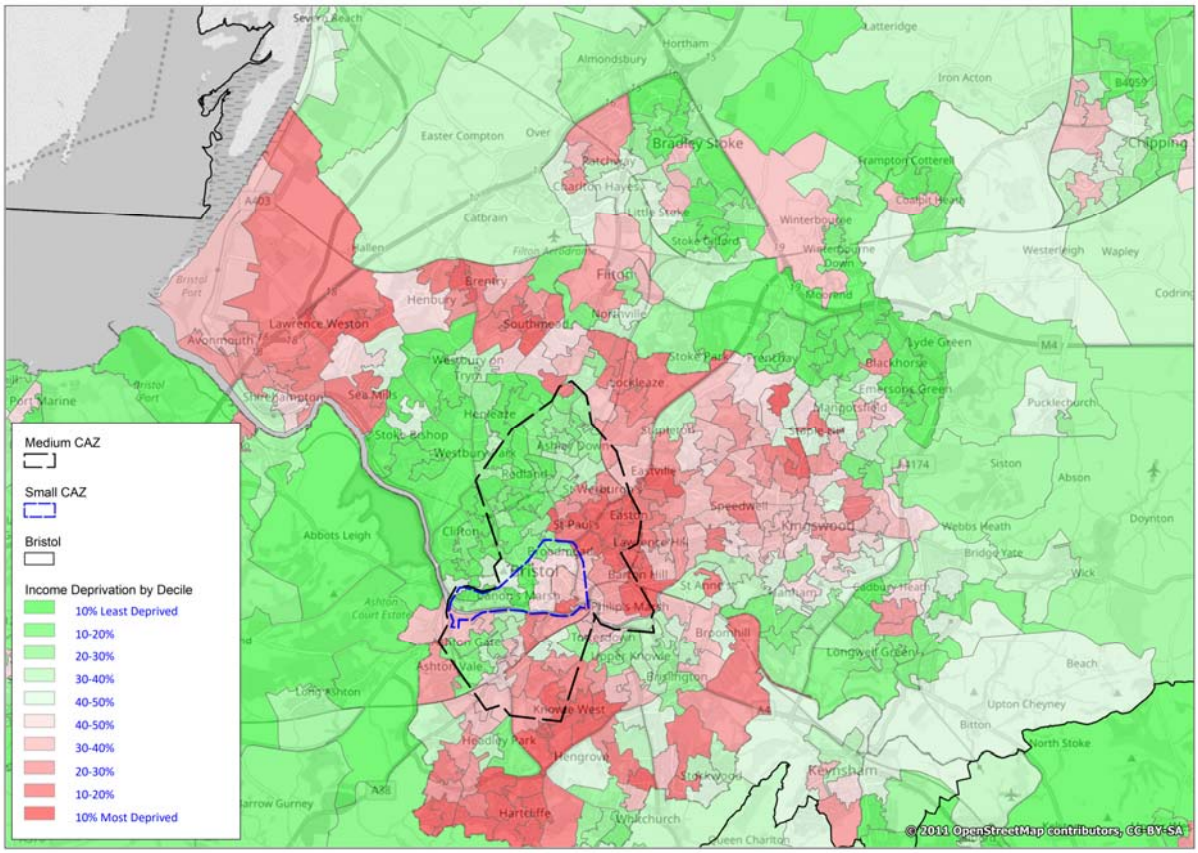
Employment deprivation data from the Indices of Multiple Deprivation reveals that the majority of the LSOAs that lie within the small area CAZ are amongst the least deprived nationally, in terms of employment deprivation. This indicates the strong economic performance of the city centre which is encompassed by the small area CAZ. The medium area CAZ illustrates that there is a pocket of LSOAs to the north-west of the small area CAZ boundary that suffers from acute employment deprivation.

Figure 3.5: Employment Deprivation



Income deprivation data from the Indices of Multiple Deprivation reveals that overarching trends are consistent with employment deprivation patterns. Communities within the small area CAZ boundary are amongst the least income deprived in comparison to the communities nationally. However, there are few pockets of income deprivation of varying degrees on the west side of the zone. For the medium area CAZ boundary, significant income deprivation is apparent in to the north-west of the small area CAZ boundary.

Figure 3.6: Income Deprivation



3.7.2.4 Vehicle Compliance Patterns

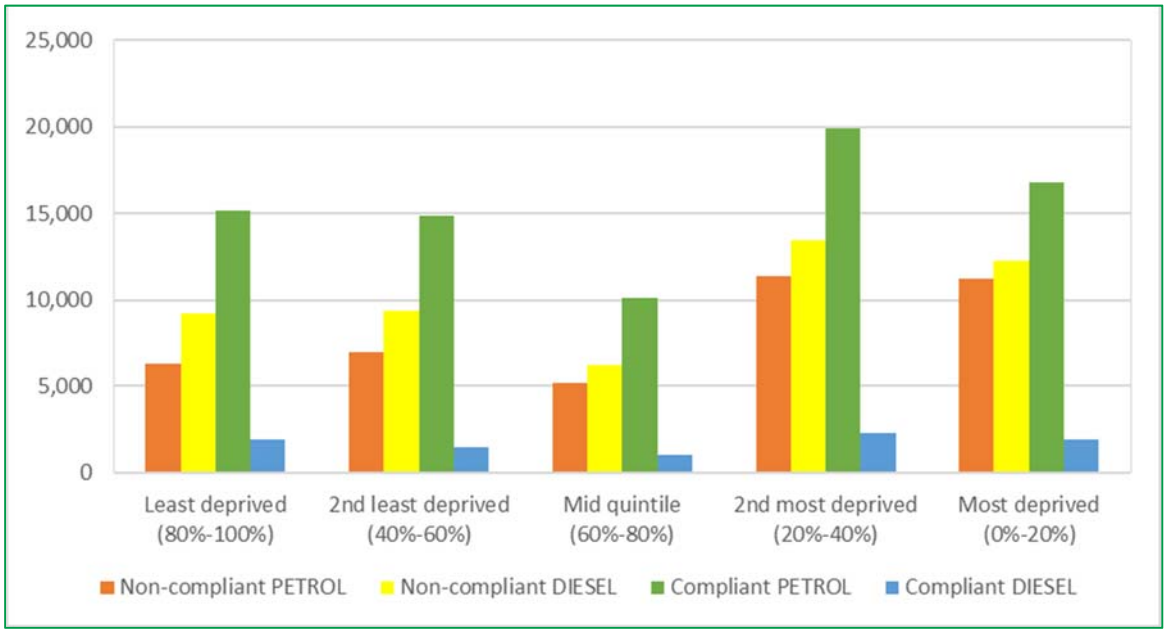
Cross-referencing those communities that fall within the two most income deprived quintiles with vehicle registration data reveals that there are large numbers of vehicles registered to properties in low-income areas that use diesel fuel and/or fail to meet current air quality standards within the small and Medium area CAZ areas. Table 3.29 reveals that there are 16,000 non-compliant cars and LGVs registered in low-income areas within the medium area CAZ boundary, as well as 13,000 diesel vehicles. Further, there are more than 350 non-compliant cars and LGVs registered in low-income areas within the small area CAZ boundary, as well as more than 300 diesel vehicles. These could be vulnerable to any future charge or punitive action against non-compliant vehicles within the medium or small area boundary.

Table 3.29: Number of Vehicles Registered to Communities within the Two Most Income Deprived Quintiles

Vehicles Registered in Two Most Income Deprived Quintiles	Small CAZ	Medium area CAZ
Non-Compliant Cars	282	9,675
Non-Compliant LGVs	72	6,126
Diesel Cars	234	5,905
Diesel LGVs	89	7,026

Overall, Figure 3-7 indicates that non-compliant vehicles and diesel vehicles are concentrated in the most deprived communities in Bristol.

Figure 3.7: Vehicles Registered in Bristol LA by Category, Deprivation and Zone



The number of LGVs registered within an LSOA is reflective of certain types of business activity occurring within it (e.g. tradespeople, courier services, sole-proprietors). LGV registration data reveals that 86% of LGVs that are registered within the small area CAZ boundary are non-compliant with regulations. Whilst 88% of those in the medium area CAZ and 90% of those registered in Bristol are non-compliant.

Table 3.30: Proportion of compliant and non-compliant LGVs[18]

	Compliant		Non Compliant	
Context area	**Petrol**	**Diesel**	**Petrol**	**Diesel**
Small area CAZ	0	58	0	361
Medium area CAZ	5	1,225	151	8,643
Bristol	10	2,562	341	22,048

Whilst vehicle registration is not a sound proxy for the business activities and patterns of LGV users, the data gives an indication of the number of LGV users that are based in certain areas. The analysis suggests that only a small proportion of the non-compliant LGV owners within Bristol are based in the small area CAZ boundary. However, the medium area CAZ boundary extends across nearly 9,000 non-compliant LGVs, amounting to around 40% of all non-compliant LGVs in the whole of Bristol.

3.7.3 Step Two: Multi-Criteria Assessment

3.7.3.1 MCA Methodology

Based on the key issues identified in the economic narrative above, combined with key transport impacts anticipated as a result of intervention, this section presents an MCA of the shortlisted Clean Air Plan options. The MCA provides qualitative information about each shortlisted option based on the impact of that option on various key economic indicators:

- Deprivation / income

[18] For this analysis the LSOA E01014623 has been excluded as its deemed to be an outlier.

- Businesses - SMEs
- Businesses – LGVs/HGVs
- Businesses – Taxis
- Consumer Welfare costs
- Vehicle Scrappage costs
- Transaction costs
- Effects to the employment market
- Retail/tourism

The MCA uses a combination of qualitative and quantitative analysis to assess the relative impact of each option against the above indicators. Broadly speaking, qualitative judgements are based on:

- The geographical extent of the options, with options covering a wider area assumed to affect more economic receptors (i.e. businesses, employees) than smaller areas.
- Whether the options impose absolute restrictions and/or charges on economic receptors, with absolute restrictions considered to have greater impact than charges.

Quantitative judgements are informed by the baseline data presented in Section 3.6.2, alongside transport modelling data which provides an indication of the scale of any changes to travel patterns and behaviours induced by the various options.

Table 3.31: MCA Criteria

Economic Indicator	MCA Criteria
Deprivation / income	The Indices of Multiple Deprivation ranks lower super output areas according to the extent of income deprivation within that area. Options which extend across and therefore directly affect communities with high levels of income deprivation will score badly. Further, Options that indirectly affect communities with high levels of income deprivation (e.g. affecting Journey to Work patterns based on the Census 2011) will also score badly.
Businesses - SMEs	SMEs are considered to be particularly vulnerable to changes in economic conditions. Options that extend over and therefore directly affect a larger number of SMEs will score badly. Options that indirectly affect travel choices for a larger number of customers/suppliers/employees of SMEs will also score badly.
Businesses – LGVs/HGVs	LGVs/HGVs act as the main mode of transport for many economic activities. Options that extend over and therefore directly affect a greater number of registered addresses for LGVs/HGVs will score badly. Options that indirectly affect travel supplier/delivery patterns for most businesses will also score badly. Options that do not discriminate against LGVs/HGVs will score best.
Businesses – Taxis	Taxis are typically older and fail to meet current air quality standards. Taxis are therefore vulnerable to options that introduce a CAZ D. Options that affect a wider geographical area are likely to affect a greater number of taxis and will therefore score badly. Options that include retrofitting/upgrades for taxis will alleviate air quality non-compliance and therefore score well.
Consumer Welfare costs	Consumer welfare loss is associated with two elements: 1) the additional cost of upgrading sooner rather later, relating to reduced impact of depreciation on vehicle values. Options resulting in more upgrades will induce a greater welfare loss. 2) the cost of changing travel behaviour to avoid zone, cancel journey, change mode, change destination. This cost is valued at half the cost of the CAZ charge, otherwise individuals would continue to make the same journey using the same behaviours. Options resulting in more changes in travel behaviours will induce a greater welfare loss.
Vehicle Scrappage costs	Vehicle scrappage costs capture the loss in asset value associated with scrapping a vehicle earlier than would otherwise be the case without intervention. This results in vehicles being scrapped when they have greater residual value. JAQU assumes that 25% of all upgrades will result in a new vehicle being purchased. For every new vehicle purchased, JAQU's working assumption is that an older vehicle within the fleet will be scrapped. Options resulting in more upgrades will induce more new vehicles being purchased resulting in a greater number of scrapped vehicles and therefore higher vehicle scrappage costs. Options that necessitate scrappage of newer, more valuable vehicles will also generate higher vehicle scrappage costs.
Transaction costs	Some policies, will bring forward vehicle owners' decisions to purchase newer, cleaner vehicles. This will result in a cost to these owners in having to locate a vehicle that is to their taste. This type of

Economic Indicator	MCA Criteria
	expense is termed, in economics, a transaction (or search) cost. Options resulting in more upgrades will induce greater transaction costs.
Effects to the employment market	By influencing travel patterns and behaviours, the options could fundamentally alter the structure of the labour market by encouraging labour supply to look at labour demand in other locations. Options that trigger the greatest change in travel behaviour (measured in terms of change in the number of employment trips that avoid zone, cancel journey/change mode/change destination) will score badly, as by implication, labour will be working elsewhere suggesting a change in jobs density as a result of the option. Options that affect a greater number of jobs will also score badly.
Retail/tourism	The retail and tourism sectors are core activities within Bristol's economy. Options that extend over and therefore directly affect a larger level of employment and business will score badly. Options that will affect travel patterns of customers/suppliers/employees will also score badly.

3.7.4 MCA Outputs

Table 3.32 presents the output of the MCA, based on qualitative and quantitative appraisal of the impact of each option on each economic indicator. This is a relative assessment of one option against the other. The analysis demonstrates that a diesel car exclusion over a small area (with associated taxi/bus fleet improvements) is the preferred option from an economic perspective. This is because it does not discriminate against key economic receptors (e.g. taxis/HGVs) and is expected to induce fewer changes in travel patterns and behaviour (thus minimising consumer welfare, vehicle scrappage and transaction costs), relative other options. The medium area CAZ D option is least preferred; due to its wider geographic coverage it is anticipated to impact on a greater number of economic receptors than other options, even though it does not propose an absolute ban on any particular vehicle type. Differences between options against economic indicators are set out in Table 3.32.

Table 3.32: Differences between options against economic indicators

Economic Indicator	Options	
	Medium Area CAZ D	Diesel car exclusion over a small area – and taxi/bus fleet improvement
Deprivation / income	This option will extend across and therefore directly affect areas north-west and south of Bristol City Centre, which have a high concentration of income deprivation. A high number of non-compliant vehicles (8,700) are registered to households in low-income areas within this boundary and will be charged. Low income households are least likely to be able to afford the charge or to upgrade their vehicle. Further, a high number of residents of low income areas within Bristol that lie outside the Medium Area CAZ boundary are required to travel into the medium Area CAZ boundary for work (9,500 employees). They could face additional charges that could affect employment and therefore exacerbate income deprivation.	This option will extend across areas to the west of Bristol City Centre, which have a high concentration of income deprivation. The extent of non-compliant vehicles registered within the area is significantly less than for the medium area CAZ (though nearly 250 diesel cars will be banned). Low-income households are least likely to be able to upgrade their vehicle, and the diesel ban is absolute. Further, a moderate number of residents of low income areas within Bristol that lie outside the small area CAZ boundary are required to travel into the small area CAZ boundary for work (5,100 employees). They could face a complete ban on travel which could affect employment and therefore exacerbate income deprivation.
Businesses - SMEs	This option will extend across and therefore directly affect the largest number of SMEs (7,300 businesses with less than 50 employees). As the option charges non-compliant cars as well as other forms of non-compliant vehicles, employees and customers for SMEs may be affected as well as suppliers. That said, there is no outright ban on diesel cars.	This option extends across a smaller area and will therefore directly affect fewer SMEs (3,000 businesses with less than 50 employees). However, rather than charging non-compliant cars, the option restricts access within the small area CAZ boundary. In the absence of a charging CAZ and any restriction on non-compliant HGVs/LGVs, suppliers will not be affected by the option.

Economic Indicator	Options	
	Medium Area CAZ D	Diesel car exclusion over a small area – and taxi/bus fleet improvement
Businesses – LGVs/HGVs	A high number of non-compliant LGVs are registered within the medium area CAZ and are therefore directly affected by medium area CAZ C (8,800 vehicles) via imposition of charges. Further, nearly 7,400 businesses are located within the medium boundary; their operations (in terms of suppliers/deliveries made by LGVs/HGVs) could be affected.	This option does not impose absolute restrictions or charges on HGVs and LGVs, meaning such vehicles are unaffected.
Businesses – Taxis	Under this option, non-compliant taxis will be charged for entering the medium area CAZ boundary. As the Medium area CAZ covers a wide geographical area, a significant number of taxi trips within Bristol are likely to be affected (including trips to/from Bristol City Centre), so a large portion of the (non-compliant) taxi fleet could be affected.	This option will improve the taxi fleet without imposing absolute restrictions or charges. Taxis can therefore continue to operate as they do now.
Consumer Welfare costs	This option involves the largest consumer welfare loss (£240m; see Section 3.6)	This option involves a smaller consumer welfare loss (£35m; see Section 3.6)
Vehicle Scrappage costs	This option involves a smaller aggregate vehicle scrappage cost (£3m; see Section 3.6)	This option involves a larger aggregate vehicle scrappage cost (£9m; see Section 3.6)
Transaction costs	This option involves the largest transaction cost (£149,000; see Section 3.6).	This option involves a smaller transaction cost (£83,000; see Section 3.6).
Effects to the employment market	This option involves the smallest number of daily trips avoiding the zone, cancelling journey/changing mode/changing destination. This implies that supply patterns are least influenced by this option. Data on car-based employment trips is consistent with this view (3,600 daily trips impacts; lowest of any option).	This option involves a high number of daily trips avoiding the zone, cancelling journey/changing mode/changing destination. This implies that labour supply patterns are significantly influenced by this option. Data on car-based employment trips is consistent with this view (6,000 daily trips impacts; joint highest of any option).
Retail/tourism	Focussed on the medium area CAZ boundary, this option extends across and therefore directly impacts a higher number of retail/tourism jobs and businesses than the small area option (c. 28,000 employees and 1,400 businesses) Further, some employees, customers and tourists may be deterred from travelling to the medium area CAZ area due to the charge on all non-compliant vehicles. Further, the CAZ D designation will impose charges on LGVs/HGVs, thus making supplies/deliveries to retail and tourism businesses more expensive/difficult. That said, there are no absolute restrictions on car use.	Focussed on the small area CAZ boundary, this option extends across and therefore directly impacts a lower number of retail/tourism jobs than the medium area CAZ option (c. 9,000 employees and 700 businesses). However, some employees, customers and tourists may be prevented from travelling to the small area CAZ area due to the absolute restriction on diesel cars. That said, LGVs/HGVs will not be restricted or charged for access, meaning such vehicles are unaffected.

3.8 Distributional and Equalities Assessment

The distributional and equalities analysis has been conducted relating to the locations where the benefits/disbenefits accrue and it has been mapped to the individuals that live in those areas. The analysis represents the relative distribution of impacts on socio-economic quintiles compared to the

quintiles' population share across the Bristol City Council area. The assessment is presented in the distributional and equalities analysis report appended to the OBC (Reference Appendix H OBC-31). The key conclusions from this work are:

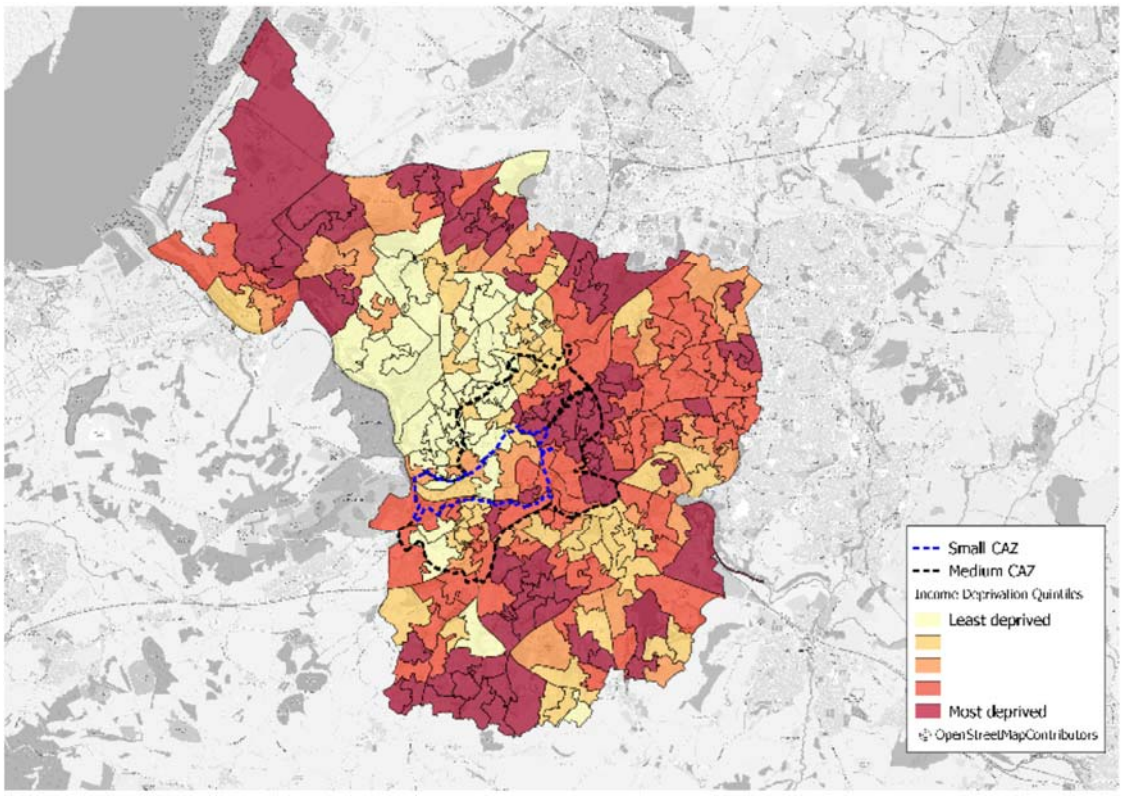
- Air quality benefits are felt by all neighbourhoods. The positive impacts of improved air quality disproportionately fall on the least income deprived communities alongside those communities with the most children and elderly residents.
- Accessibility impacts are adverse across the full range of relevant socio-economic groups. Accessibility impacts fall most heavily on the middle quintiles of income deprived communities, those communities with the most children and those communities that have the lowest proportions of females. Further, impacts are disproportionately felt by those communities towards the higher quintiles in terms of concentration of ethnic minorities, middle quintiles for disabled residents and more evenly for elderly residents.
- Affordability impacts are adverse across the full range of relevant socio-economic and business groups. Impacts are disproportionately felt by the most income deprived communities. They also fall on businesses operating non-compliant LGVs and HGVs who are either based in the CAZ areas or operate within central Bristol.

3.9 Spatial analysis of the impact of the scheme options on low income households

In defining and implementing a CAZ, consideration is being given to potential impacts on residents and businesses, including disadvantaged groups such as lowest-income households. It is recognised that affordability impacts are often disproportionately felt by the most income deprived communities. As such, the implementation of a scheme which includes charging or requires upgrading of vehicles could overly penalise vulnerable groups in society, depending on the geographic location, scale and the structure of vehicle compliance standards.

One of the most deprived areas in Bristol is located within a potential small CAZ area (Totterdown), with several areas included within a potential medium area CAZ option focussed around the central eastern portion of the zone, as shown in the following map (such as Lawrence Hill and Easton). These lowest-income areas, plus others that neighbour the potential zone, need to be given special consideration as a CAZ could directly impact them daily if they drive into/through the area or have a noncompliant vehicle.

Figure 3.8: Income distribution map



The assessment work has showed the following response from the lowest income group modelled:

Medium area CAZ D with complementary measures:

- 542 people pay the £9 charge a day;
- 5,599 people choose to upgrade their vehicle, at a cost of £5,733 for a petrol car, and £4,431 for a diesel car; and
- 6,320 people choose to change their route, mode, destination or change mode.

Small area car diesel ban with bus and taxi fleet improvements:

- 4,680 people choose to upgrade their vehicle; and
- 6,867 people choose to change their route, mode, destination or change mode.

Any CAZ or diesel car ban is likely to impact on residential areas both within and on the edges of the area. To understand the relationship between the lowest-income areas and destinations in the city centre, the number of trips made into the small and Medium area CAZ areas in noncompliant cars has been mapped for the AM and PM peaks. The lowest-income areas have been ranked based on the number of trips made, as the following maps show.

Figure 3.9: Low income areas: number of trips (ranked) made by no-compliant cars to the small CAZ area in the AM peak

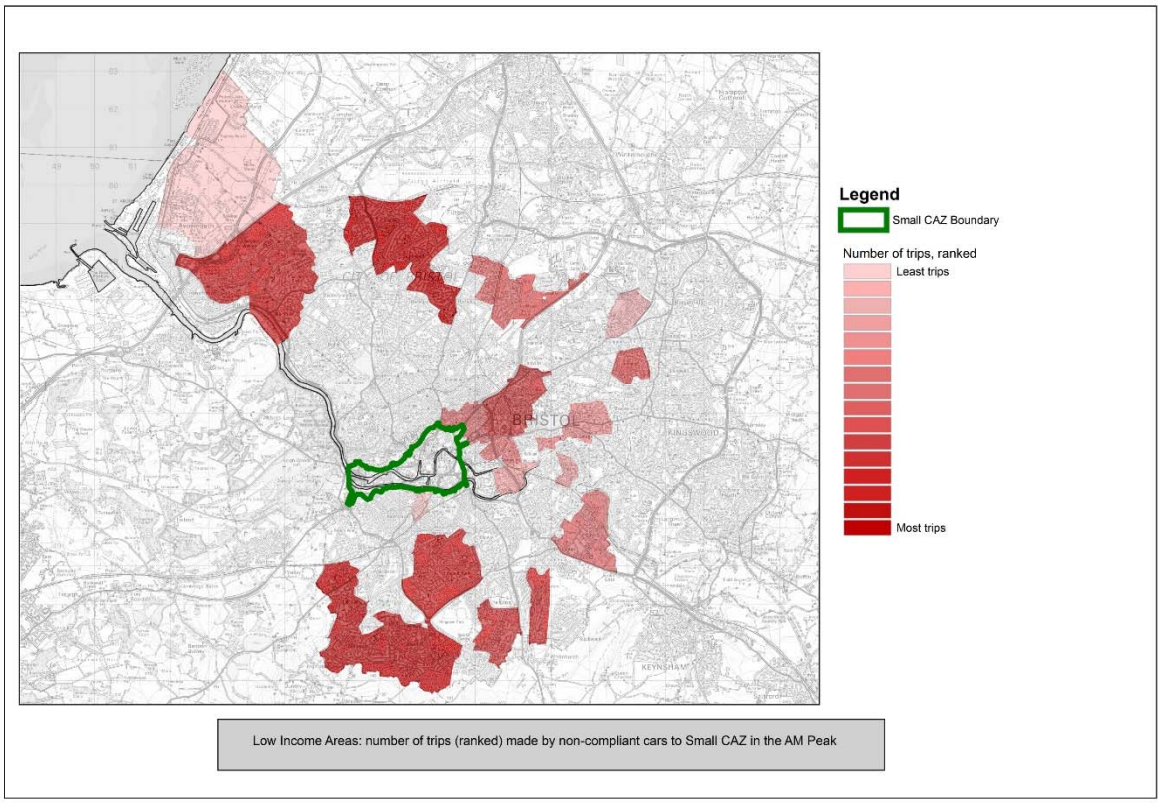
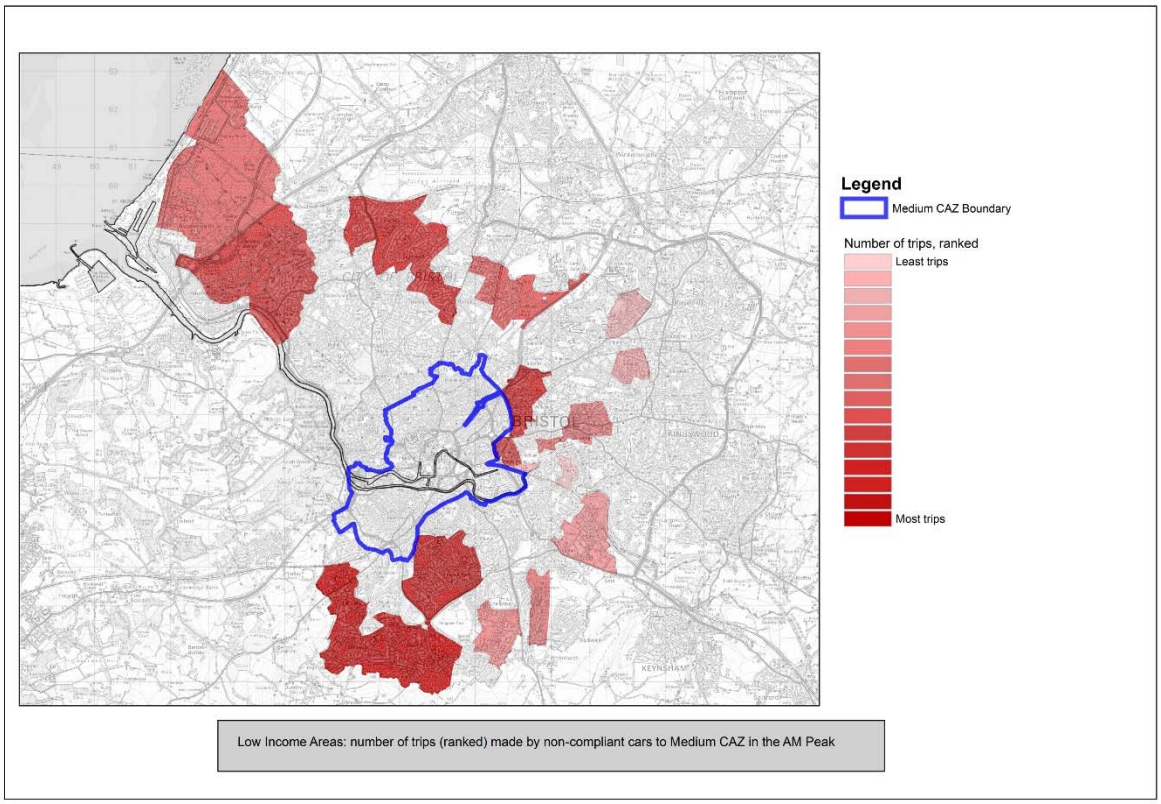


Figure 3.10: Low income areas: number of trips (ranked) made by no-compliant cars to the Medium area CAZ area in the AM peak



In the AM peak, most trips into the Medium area CAZ area by noncompliant cars come from the lowest-income areas in the south and north of the Bristol area, including Hengrove and Avonmouth. There is a close relationship with the area immediately to the east of the boundary (around Lawrence Hill and Easton), some of which is included in the Medium area CAZ area (e.g. St Philips), but generally trips from the eastern lowest-income areas generate fewer car trips. This could reflect the availability of alternative modes to make trips from these areas and suggests public transport could be less viable from the south.

Figure 3.11: Low income areas: number of trips (ranked) made by no-compliant cars to the small CAZ area in the PM peak

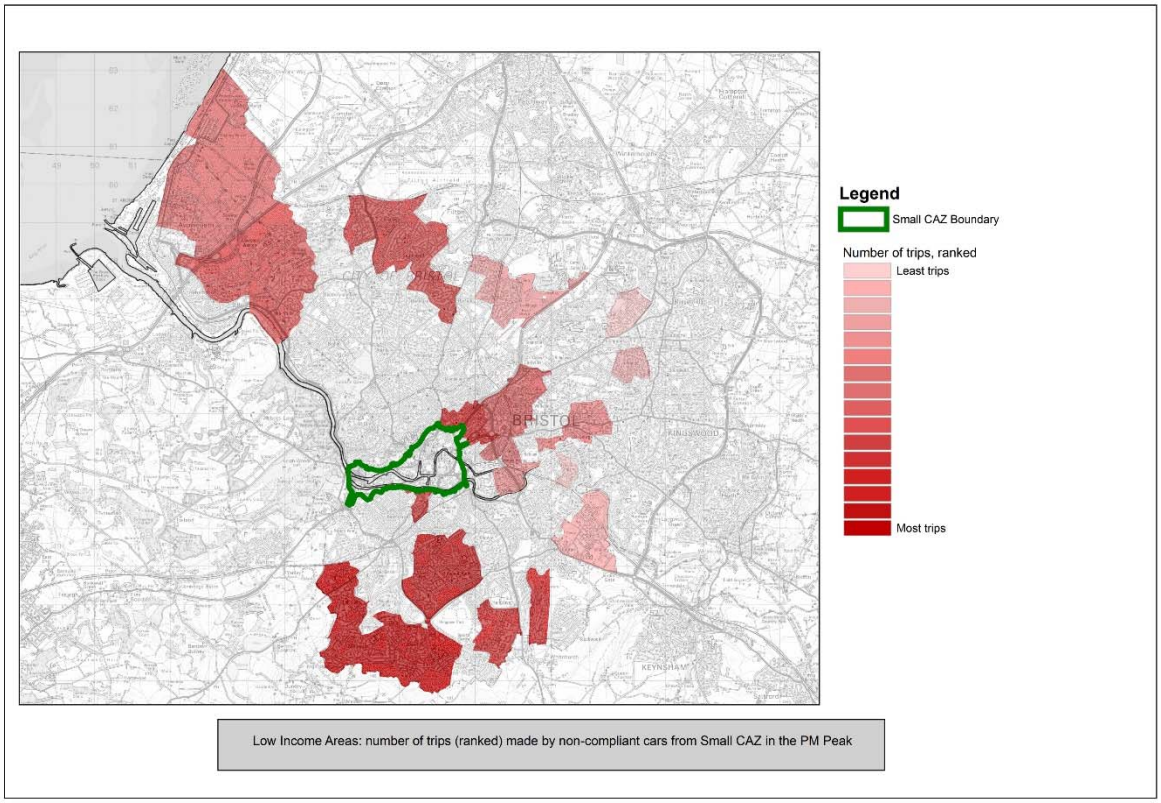
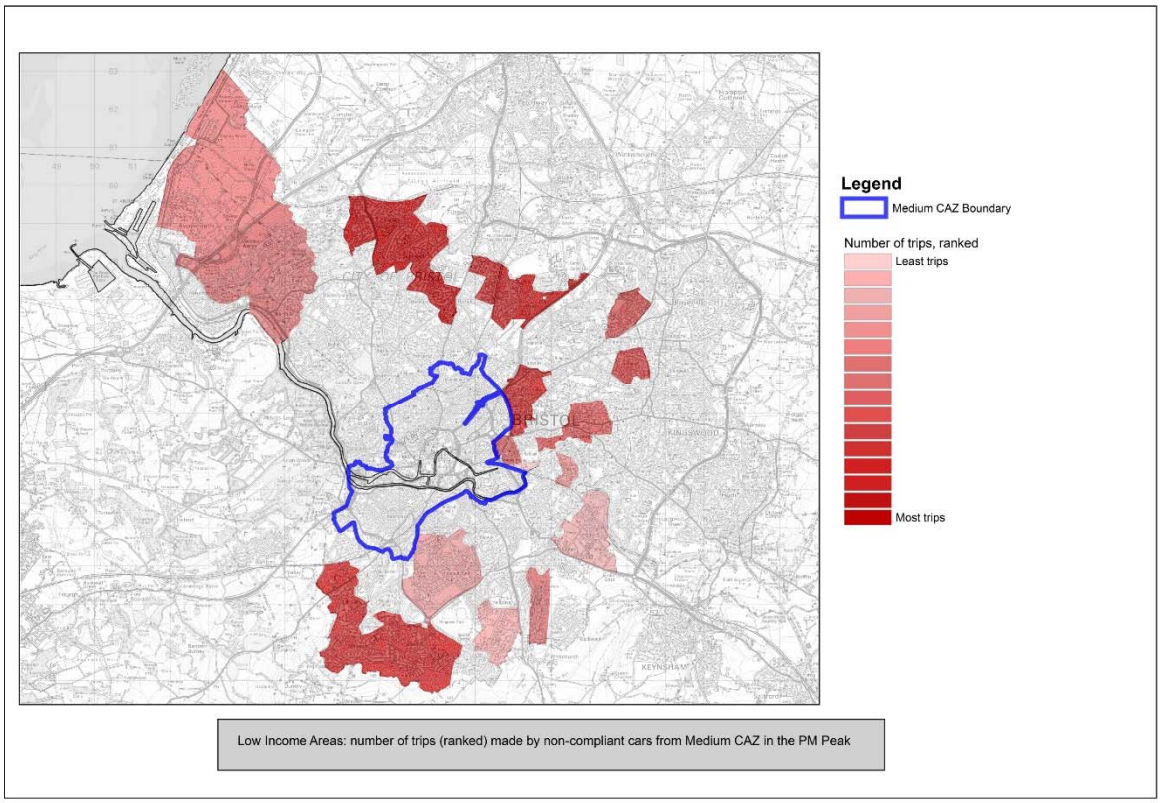


Figure 3.12: Low income areas: number of trips (ranked) made by no-compliant cars to the Medium area CAZ area in the PM peak



In the PM peak, the maps show that lowest-income areas with the highest ranking for noncompliant car trips out of the medium and small CAZ areas are to the north and south of Bristol, in areas such as Southmead and Hengrove with fewer trips to the areas further east. The eastern area, around St Philips, that is included within the Medium area CAZ area but bounds the small CAZ area is also ranked quite highly. With the Medium area CAZ area, the ranking of the lowest-income areas to the south east of Bristol, around Hengrove, is much lower than with the small CAZ area.

3.9.1 Summary of likely impacts to low income households

The maps provide a proxy for how the lowest-income areas relate to a CAZ. For AM and PM peak trips, public transport could offer an alternative for trips into the city centre from lowest-income areas. For those in areas closer to the city centre, walking and cycling could offer a viable alternative to car use. It is recognised that a CAZ will have direct impacts for some lowest-income families who do not have a choice to travel by another mode. This could be due to mobility issues or employment not being in central areas that can be easily accessed by alternative modes.

This analysis has not considered noncompliant car trips with origins/destinations in the lowest-income areas that travel through the city centre, such as to employment sites on the opposite side of Bristol. The city centre may currently provide the most direct and quickest routes for some people, but with the introduction of a CAZ there could be financial implications or increases in journey time and distance because of the need to re-route trips. Although this would positively contribute to the air quality objectives, it could have a detrimental impact on lowest-income families and the ability to access employment.

The outputs of the economic modelling undertaken suggest that for the medium area CAZ D plus complementary non-charging interventions option, people are not likely to pay a charge to drive into the CAZ (£9/day), they are most likely to avoid the zone or cancel the journey/change mode or destination. They are also much more likely to replace their vehicle than pay the charge. Under the small car diesel ban plus taxi and bus Euro 6 option, paying a charge is not an option, and more

people (bigger difference than with medium area CAZ D) are likely to avoid the area or cancel a trip, than replace their vehicle. For lowest-income households, this could mean that people may not be able to afford to drive to their place of employment or have to spend more time travelling to avoid the zone, which could have an impact on other elements of their lives.

The proposal includes grants to assist people replace their vehicles, but these may not appeal to the lowest-income households, as the grant would not cover the full cost of the replacement.

There are potential mitigation strategies that could minimise the impact of a CAZ on lowest-income households. These will need to be designed to provide greater travel choice, support changing travel behaviours and minimise the cost burden of making such changes. Working with communities to identify specific needs and opportunities to travel by alternative modes will be critical to not adversely impacting on already deprived areas. These measures could support trips for retail/leisure and employment within a CAZ area. However, trips that are passing through a CAZ, such as to employment areas on the other side of Bristol or elsewhere, are less likely to be satisfied by alternative modes.

Accessibility and availability of alternative modes, such as walking and cycling, could be enhanced by the introduction of a CAZ. Fewer car trips could result in an improved local environment and improve the attractiveness of walking and cycling. There are wider benefits that could be realised by this, such as improved health through increased physical activity, as well as realising the health impacts of better air quality. Public transport journey times could also be improved, further increasing its attractiveness and use. The Councils smarter choices initiatives could be expanded to target those effected by the scheme by providing information about public transport services and cycling routes, and the wider benefits that can be realised by using these modes. This will be critical in minimising the impact of a CAZ on lowest-income users.

The impact of trips rerouting onto other routes to avoid any charging zone or vehicle restriction would need to be monitored, to ensure there is no detrimental impact to air quality, safety and the attractiveness of walking, cycling and public transport in these areas.

3.10 Spatial analysis of the of the scheme options on businesses

An objective of the project is to minimise impacts on economic growth and development, helping to accelerate the transition to a low emission economy and creating a healthy place to live, visit and work. However, with any sort of charging scheme, there will be affordability impacts on businesses operating non-compliant LGVs and HGVs, who are either based in or operate within central Bristol. If not effectively mitigated these impacts may negatively impact on the viability of businesses, particularly SMEs, or could encourage relocation.

The impacts could be related to staff or the operation of the business. If a charge needs to be paid to travel into the area of the business, staff could choose to work elsewhere, or people may choose not to visit. However, fewer vehicles on the highway network could improve journey times and reliability for compliant business vehicles.

3.10.1 Noncompliant LGVs

An assessment has been undertaken on the number of trips made by noncompliant LGVs from LGV reliant areas into a CAZ (small and medium) in both peak periods. The findings are presented on the following maps.

Figure 3.13: LGV reliant areas: number of trips (ranked) made by non-compliant LGVs to the small CAZ area in the AM peak

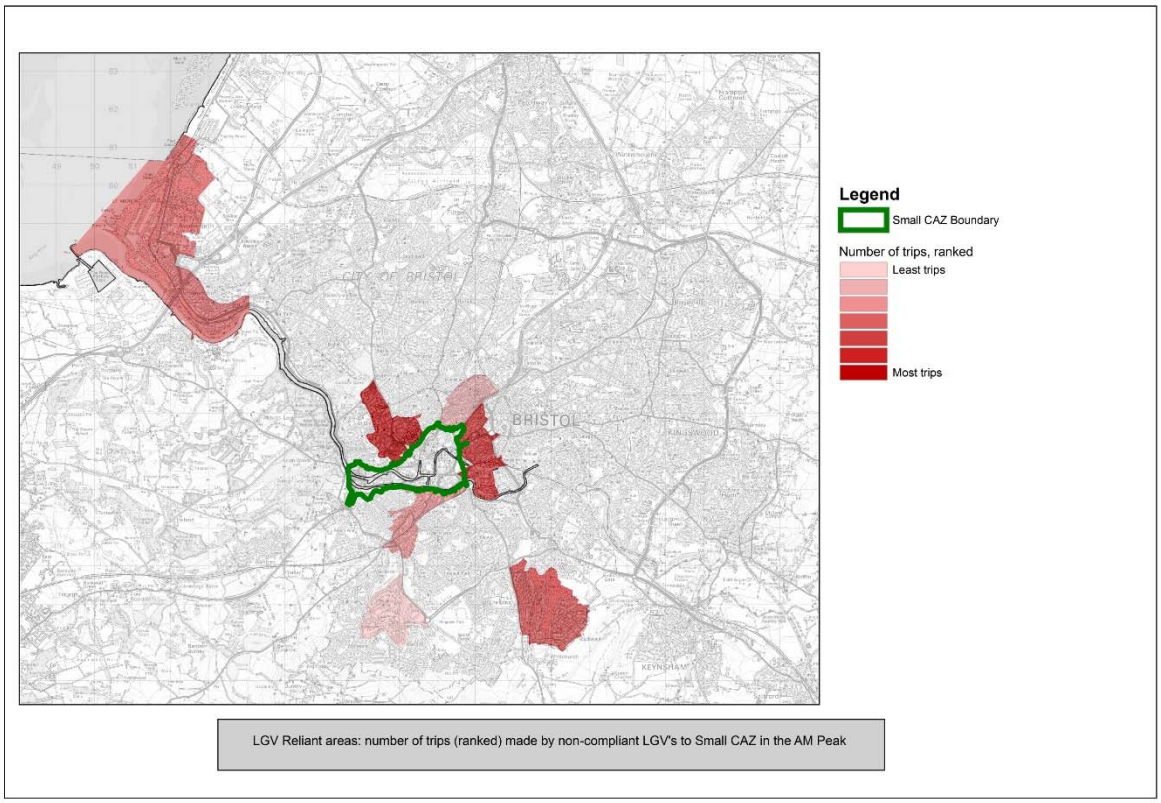


Figure 3.14: LGV reliant areas: number of trips (ranked) made by non-compliant LGVs to the Medium area CAZ area in the AM peak

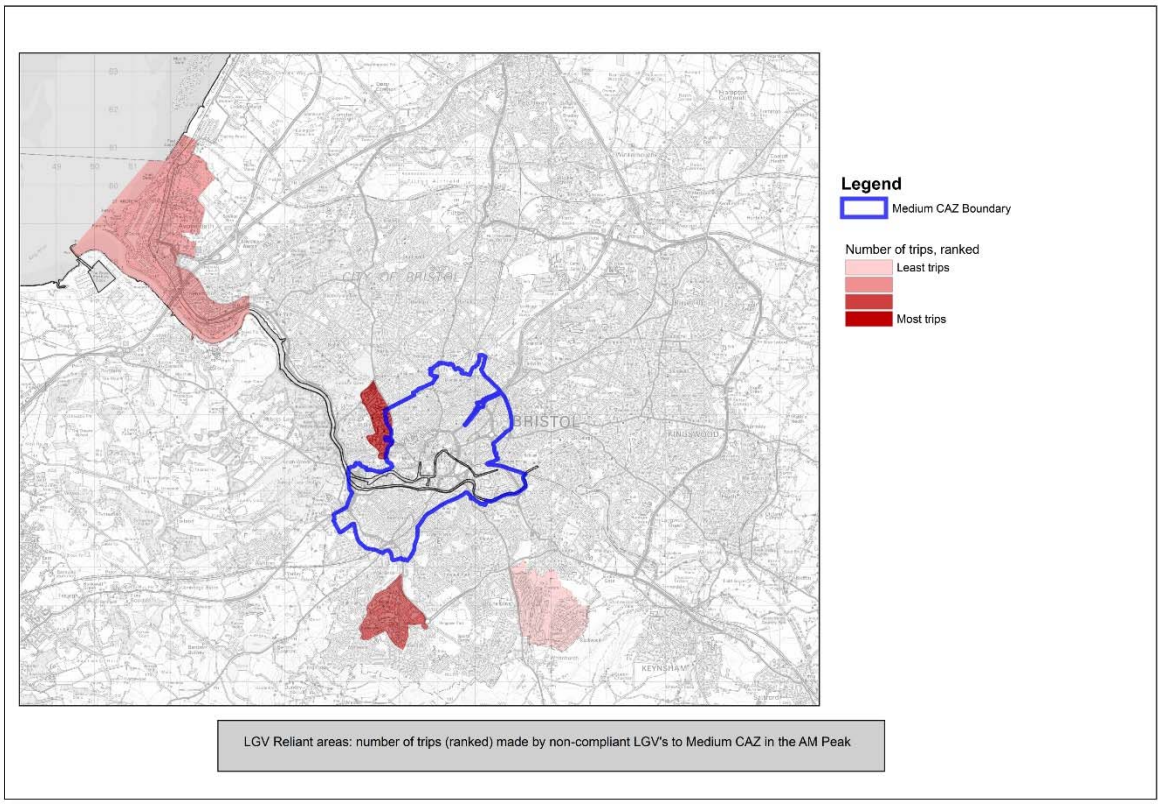


Figure 3.15: LGV reliant areas: number of trips (ranked) made by non-compliant LGVs to the small CAZ area in the PM peak

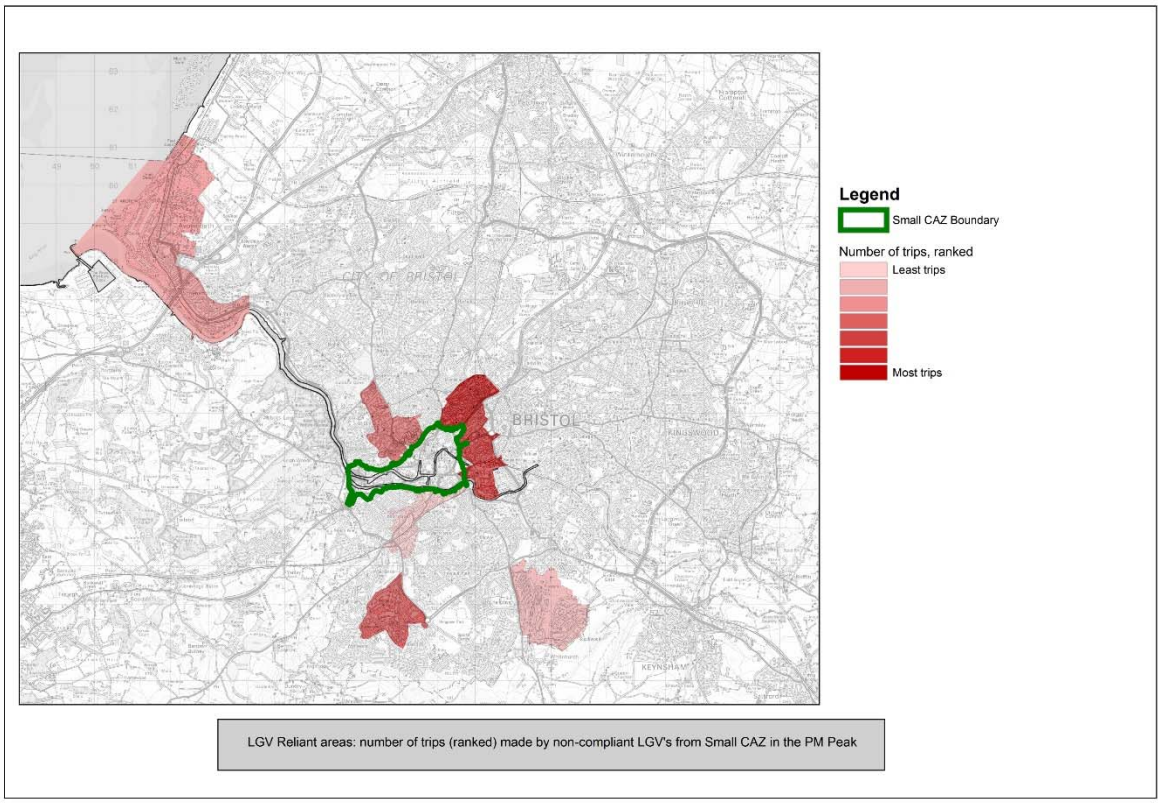
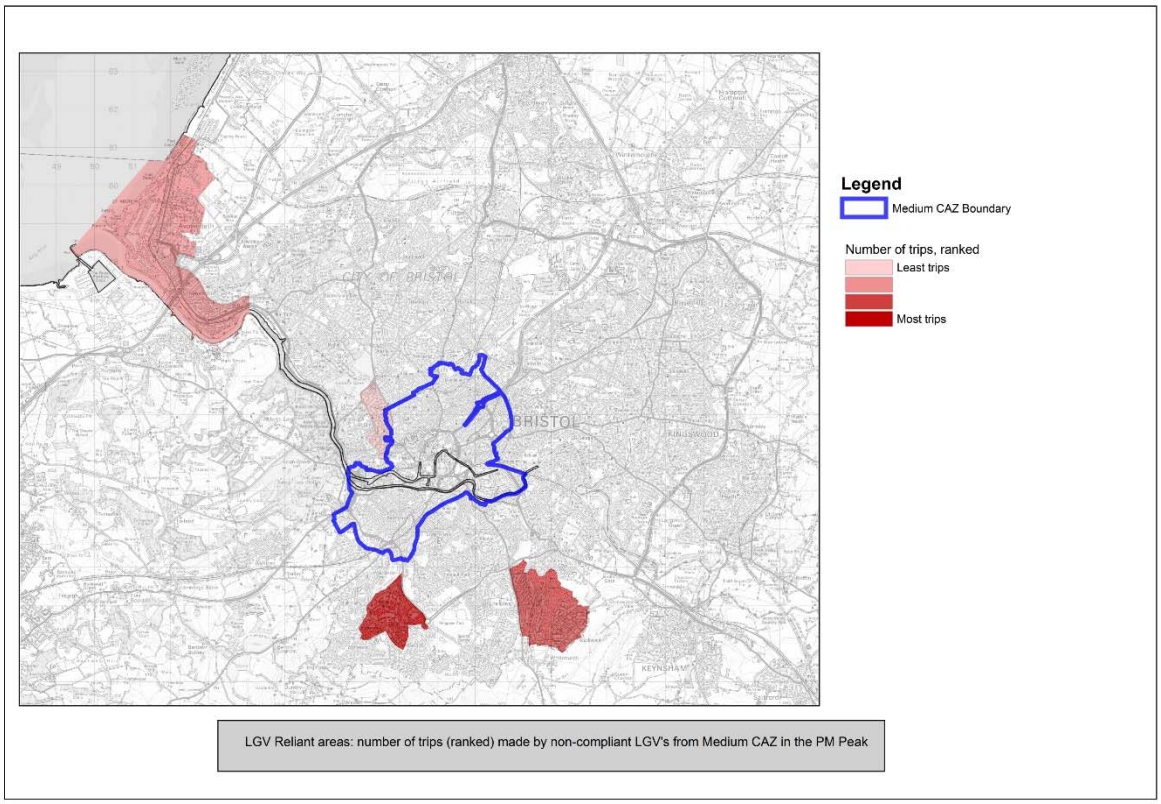


Figure 3.16: LGV reliant areas: number of trips (ranked) made by non-compliant LGVs to the Medium area CAZ area in the PM peak



The small CAZ area maps, for both the AM and PM peak, show that most noncompliant LGV trips originate in the areas bounded by the CAZ. These areas are included within the Medium area CAZ area. This suggests many noncompliant LGV trips are short in length and there is likely to be a direct impact on these businesses if either a small area car diesel ban or medium area CAZ D was implemented.

The area immediately north west of the CAZ boundary, Clifton, has a high number of ranked trips reflecting the retail and services offered in this area. The Avonmouth area is also a source of many noncompliant trips in both peak periods, reflecting where trading and industrial estates are located. It is likely that this reflects freight movement and distribution to destinations in Bristol City Centre.

3.10.2 Noncompliant HGVs

An assessment of noncompliant HGVs has been undertaken for retail business areas, for both the small area car diesel ban and medium area CAZ D in the AM and PM peak periods, as shown on the following maps.

Figure 3.17: HGV reliant areas: number of trips (ranked) made by non-compliant HGVs to the small CAZ area in the AM peak

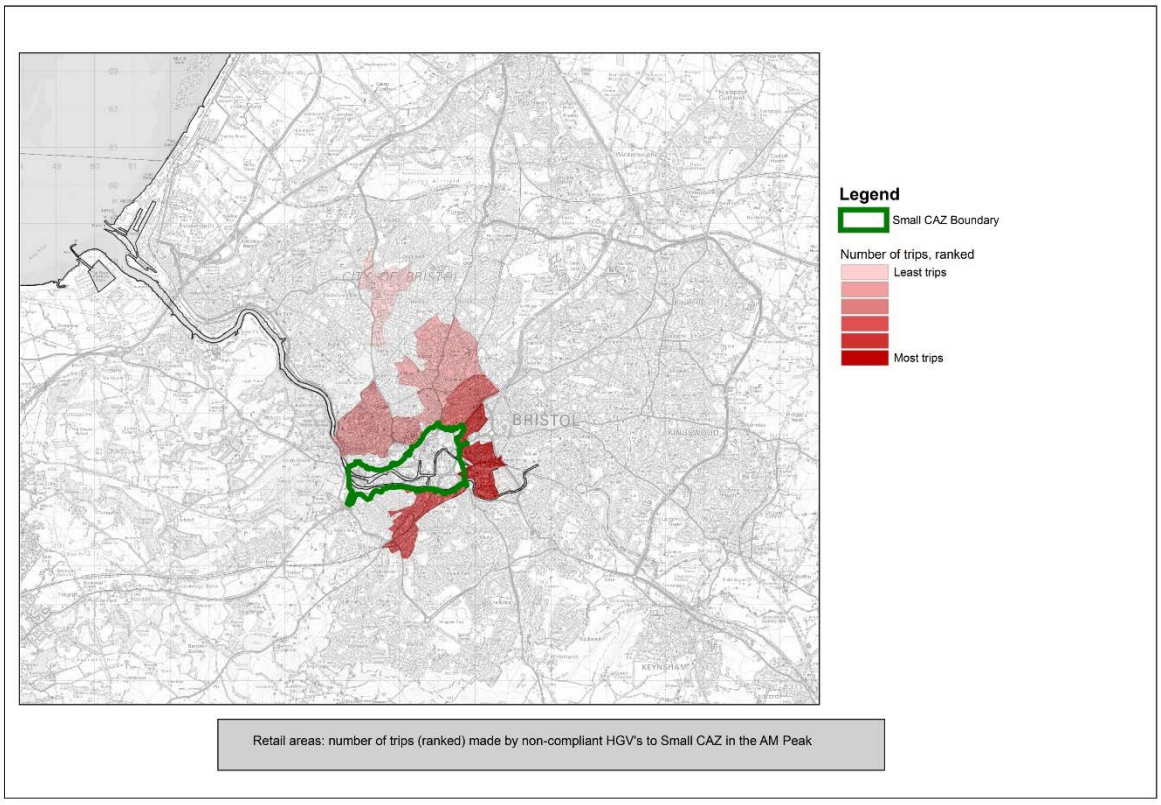


Figure 3.18:: HGV reliant areas: number of trips (ranked) made by non-compliant HGVs to the Medium area CAZ area in the AM peak

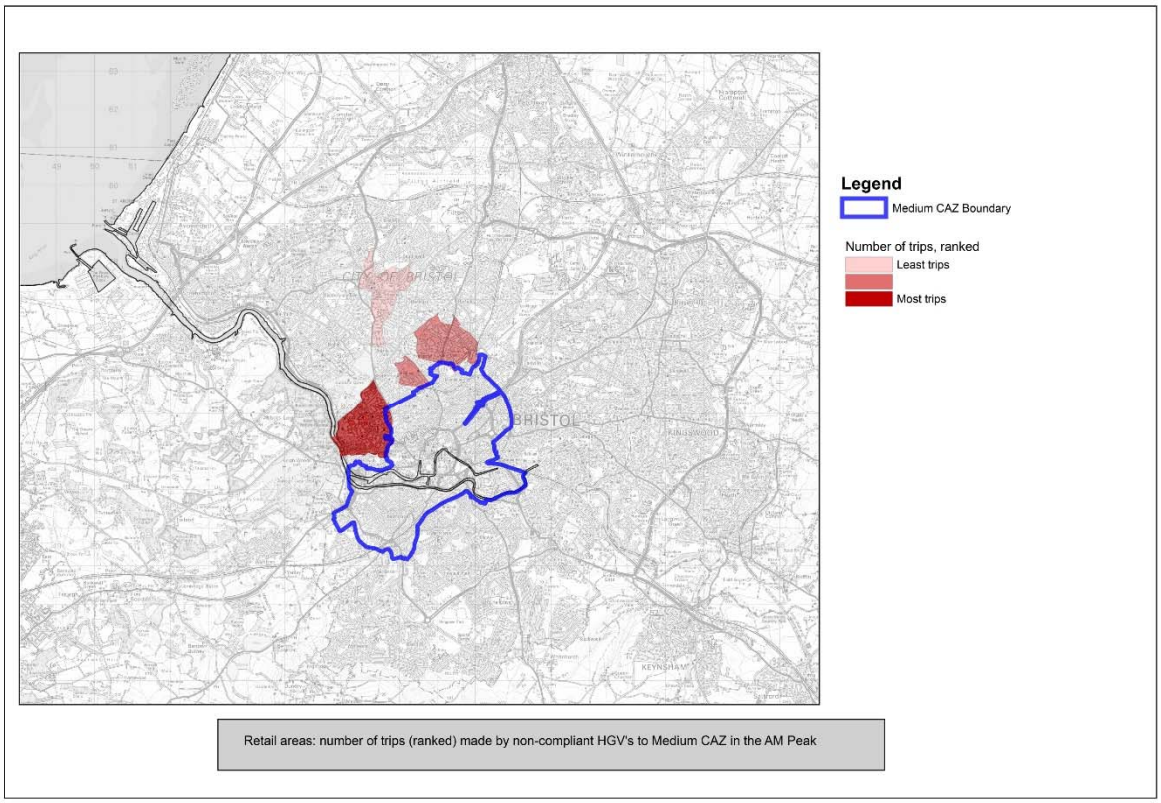


Figure 3.19: HGV reliant areas: number of trips (ranked) made by non-compliant HGVs to the small CAZ area in the PM peak

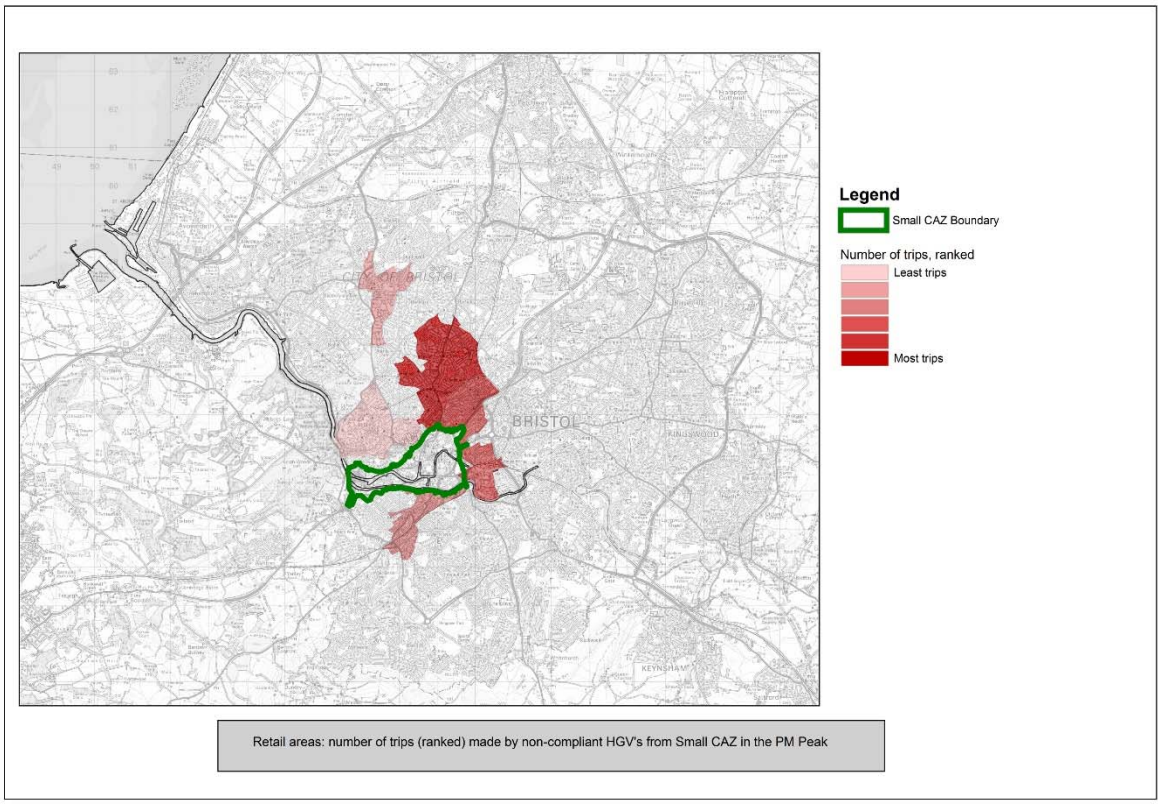
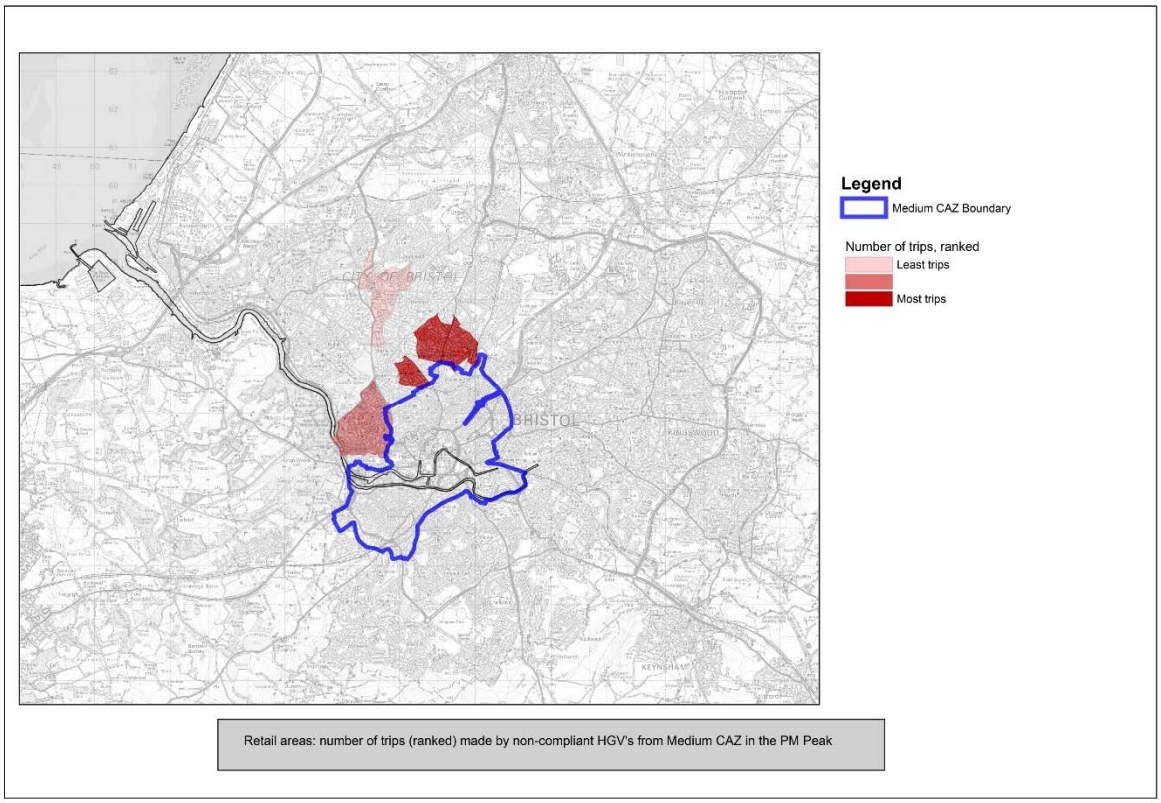


Figure 3.20: HGV reliant areas: number of trips (ranked) made by non-compliant HGVs to the Medium area CAZ area in the PM peak



The ranking of noncompliant HGV trips is the same in both peak periods. The noncompliant HGV trips originate from within the medium area CAZ area or bounding the area, except for the area to the north near Westbury on Trym/Henleaze.

The ranking shows that the uncompliant HGV trips originate much closer to the boundary of the CAZ than LGV trips. This suggests that either HGV trips within Bristol are very short, or they are travelling through the city centre to other destinations, without an origin or destination. It is these trips that need to be targeted if the CAZ objectives are to be achieved.

3.10.3 Summary if impacts to businesses

The behavioural response rate for medium area Class D suggests that noncompliant LGVs will continue to make journeys, with just over 60% replacing the vehicle and about 35% paying the charge or avoiding the zone. However, the HGV response suggests over 80% of vehicles would be replaced, with less than 10% paying the charge. This is likely to be due to the level of the proposed charge, with HGVs subject to £100/day and LGVs £9/day, which is the same as cards and taxis.

Funding will be sought to deliver mitigation measures that are designed to minimise the cost burden of making changes for businesses, as they are critical for economic growth and supporting the West of England region. Investigation is ongoing into freight consolidation centres, which could reduce the number of trips being made into the centre by consolidating freight onto less polluting vehicles on the outskirts of the city. Options are also being looked at for first and last mile trips, with smaller packages being transported by cargo bikes, for example.

Businesses rely on staff and customers being able to access their sites. It is likely that a CAZ will also impact on these trips. Support will continue to be given to businesses in enabling their staff to work flexibly, including working from home, and ensuring provision is available for those wanting to walk and cycle, such as showers and secure storage.

3.11 Sensitivity Analysis

To understand the sensitivity of the assessment to changes in model assumptions, as series of sensitivity tests will be undertaken on the preferred option (when confirmed), these tests will include:

- High / low growth assumptions
- Variations to fleet composition
- Variations to fleet projections
- Variations to response rates
- Differential Bias, associated with fleet used for verification
- Alternative assumptions for Euro 6 diesel emissions
- Variations to background concentrations

3.12 Preferred Option

The primary success factor of the scheme is to deliver compliance with NO_2 air quality Limit Values and Air Quality Objectives in the shortest possible timescales. The assessment work shows:

- Option 4 will achieve compliance at all location by 2027, with the exception of the north section of Upper Maudlin Street that would be compliant only by 2030.
- Option 2c will achieve compliance at all location by 2023, with the exception of the north section of Upper Maudlin Street that would be compliant only by 2024.

Hence the assessment work presented in this chapter shows that the diesel car exemption over a small area with bus and taxi fleet improvements would deliver compliance in the shorested possible time. However, there are legislative risks associated with this option, and it may not be possible to implement this scheme 24 hours a day/7 days a week. If this is the case, the scheme benefits would be reduced, and the Medium area CAZ D option with complementary measures may provide an earlier year of compliance.

The assessment concluded that in terms of economic impact, the intervention options could generate a NPV of between -£22m for the car diesel exclusion over a small area and -£210m for the Medium area CAZ D with complementary measures. The economic costs for both intervention options therefore outweigh the economic benefits by a considerable margin, particularly for the Medium area CAZ D option. This is primarily driven by the loss in consumer welfare associated with changing travel patterns and behaviours, as well as onerous set up and running costs.

Affordability impacts are adverse across the full range of relevant socio-economic and business groups for both options. Impacts are disproportionately felt by the most income deprived communities.