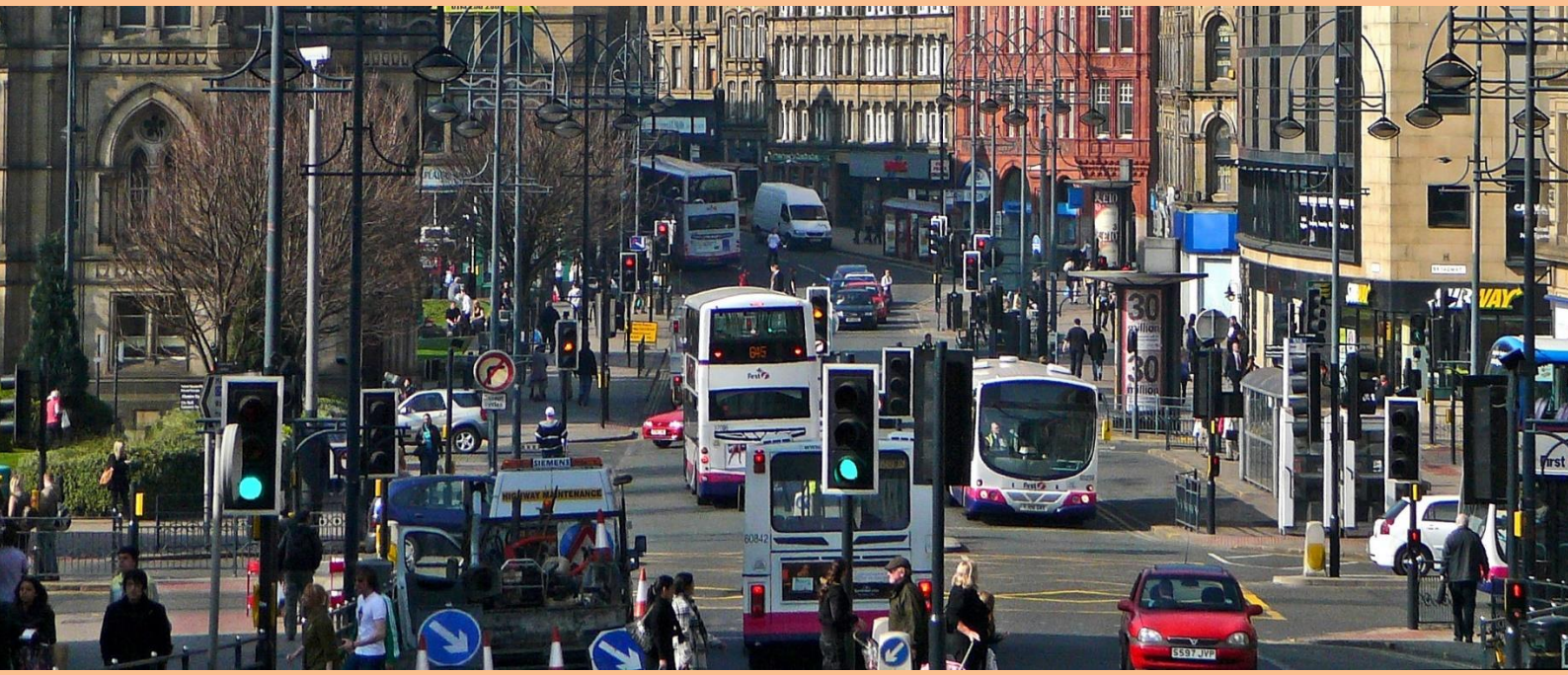
Chapter 2: Economic Case

Bradford Clean Air Plan



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City of BRADFORD METROPOLITAN DISTRICT COUNCIL

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Notes

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Section 1: Introduction

1. Bradford Council is required to implement a Clean Air Plan to ensure that the city is compliant with national and international air quality objectives within the shortest time possible. The plan brings together local measures to deliver immediate action to improve air quality and health, with support for cities to grow, while delivering sustained reductions in pollution and a transition to a low emission economy. Where there are the most persistent pollution problems, this is supported by restrictions to encourage only the cleanest vehicles to operate in the city.

2. To ensure the optimum solution for Bradford is delivered, which achieves compliance with air quality targets within the shortest time possible whilst minimising the socio-economic impacts on both residents and businesses, a comprehensive modelling process is required to evaluate all options and discount those that do not meet compliance and/or have excessive socio-economic impacts.

3. This Economic Business Case builds on the economic evaluation of the CAZ options from the Outline Business Case (OBC) to achieve compliance in Bradford. The Case:

- summarises the rationale for the shape of the CAZ and current air quality problems
- outlines the key success criteria for assessing options;
- sets out the previous OBC analysis including how the class of CAZ has been defined
- summarises the modelling of the preferred option
- sets out how the preferred option has developed and the evidence base
- Presents the results for preferred option in terms of distributional analysis
- Presents the results for preferred option in terms of cost benefit analysis

Defining the Options

4. Bradford has been monitoring and modelling air quality since around 2000. Air Quality Management Areas were declared in response to exceedance of the objective in 2006. There have been a number of studies carried out during this time by both Bradford and Government that have provided evidence to inform Bradford's options for dealing with this complex problem; these are set out in Table 1.

Table 1: Defining the Options - Previous Work

Evidence	When	Outputs	Methodology
LAQM[1]	2000 onwards	Indicated exceedances in Bradford. Leading to Declaration of AQMAs in 2006 and Air Quality Action Plan	Monitoring (7 real time monitors and 50-100 NOx Tubes and ADMS Urban modelling
Government Modelling	2013	Indicated Low Emission Zones may achieve compliance in West Yorkshire	• PCM Modelling
Bradford Low Emission Zone Feasibility Study[2]	2014	Indicated an LEZ would improve air quality and health in Bradford	• Used air viro and the West Yorkshire transport model. Based on actual ANPR data
Government modelling	2017	Indicated exceedances in 2021 in Bradford. Bradford Ministerial direction to carry out TFS	• PCM Modelling
Targeted Feasibility Study (TFS)[3]	2018	Exceedances identified. Long list of mitigation options were sifted and the short list were modelled. Findings were that a whole city CAZ solution would be required leading to ministerial direction to develop a Clean Air Plan	• Air quality modelling complex dispersion model. Scaled 2016 Tempro speed and flow data • ANPR from 2012 projected forward using NAEI
Outline Business Case – defining the Class of CAZ	2019	Identified a CAZ C+ would be required to meet compliance. Bradford Ministerial direction to implement a Clean Air Plan and submit FBC identifying Class of CAZ	• 2018 ANPR data • 2018 Flows and Speeds outputs • SP data. • Full complex dispersion model with transport model inputs (see Appendix 5 & 7) • Economic analysis of short listed options.

1 Review and Assessment of Air Quality in Bradford Metropolitan District

2 Report of the Bradford Low Emission Zone Feasibility Study

3 Third Wave Local Authorities – Targeted Feasibility Study to Deliver Nitrogen Dioxide concentration compliance in the shortest possible time (Bradford)

Evidence	When	Outputs	Methodology
Full Business Case - Finalising CAZ C+ details	2020	CAZ C+ Option fully developed taking into account OBC feedback from JAQU. Distributional impacts assessed and demonstration of compliance within shortest possible timeframe	• 2018 ANPR data • 2018 Flows and Speeds outputs • SP data. • Full complex dispersion model with transport model inputs (see Appendix 5 & 7)

Success Criteria / Critical Success Factors

5. The Primary Critical Success Factor (CSF) which has been applied to all assessed options is that the preferred option will:

- **Bring about compliance with nitrogen dioxide limits in the shortest possible time** - this is a pass/fail criterion.

6. The secondary critical success factors for the CAP are:

- effectiveness (ability to remove NOX emissions from Bradford's relevant air quality problem areas);
- cost-effectiveness (effectiveness divided by the likely cost of the scheme);
- deliverability (no barriers to delivering the scheme within the required timescales);
- acceptability ('no losers' and likelihood of public/political support); and
- strategic fit (how well does the measure and its outcomes match with Bradford's broader aims/vision/responsibilities.

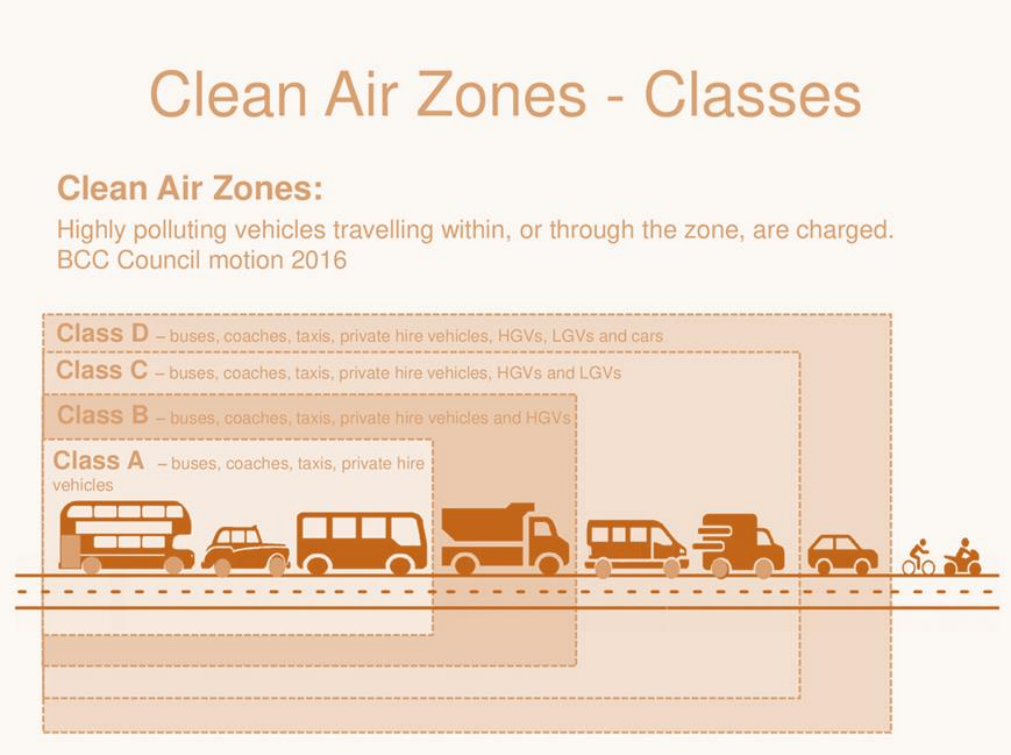
Spending Objectives

- **Spending Objective 1**: to achieve compliance with the EU Limit Value for NO_2 in the shortest possible timeframe
- **Spending Objective 2**: deliver a package of measures that improves the health of the residents of Bradford
- **Spending Objective 3**: ensure that local residents, disadvantaged groups and businesses are supported where appropriate with the changes we need to improve local air quality for everyone.

OBC – Defining the Class of the Clean Air Zone

7. The CAZ framework[4] defines the classes of CAZ as shown in Figure 1;

Figure 1: Clean Air Zone Classes



8. Previous work on the Targeted Feasibility Study (TFS) had indicated that a CAZ 'A' would not be sufficient to meet the primary success factor. In addition, government modelling in 2017 indicated that Bradford would require a Class 'C' CAZ. For this reason the first scenario to be modelled at OBC stage was a CAZ 'B'. The following OBC options were modelled for the proposed CAZ zone:

Table 2: Option Assessment

Option	CAZ Class	Additional Measures	Anticipated to meet CSF1 in 2022	Policy Alignment	Taken forwards to shortlist
1	B	N/A	No	Yes Concerns for Local HGV SME's	No this option does not meet CSF
2	B+	• Electric buses • ULEV taxis – Hybrid petrol 5/6 • Park & Ride	No	Yes Concerns for local HGV SME's	No this option does not meet CSF

[4] Clean Air Zone Framework for England

Option	CAZ Class	Additional Measures	Anticipated to meet CSF1 in 2022	Policy Alignment	Taken forwards to shortlist
		• Saltaire platooning • Travel Planning • 30% EV Taxis • Traffic light phasing at Shipley Airedale Road			
3	C	N/A	No	Yes Concerns for local HGV & LGV SMEs	No This option does not meet CSF
4	C+	• Electric buses • ULEV Taxis – Hybrid Petro 5/6 • Park & Ride • Saltaire platooning • Travel Planning • 30% EV Taxis • Traffic light phasing at Shipley Airedale Road • Local Exemptions	Yes	Yes	Yes
5	D	N/A	Yes	No – impact on communities, political considerations, takes longer to implement. Also concerns for local HGV & LGV SME's	Yes

9. The short listed options underwent distributional analysis and cost benefit analysis as part of the OBC. This study indicated that of all four options assessed the one that negatively economically impacts the most on the deprived in society and businesses is the CAZ D. This has to be weighed against the improvements in air quality and health which make the CAZ D the option with the highest value (NPV). Bradford has concluded that the CAZ D intervention is not required due to the fact that there are other options available which achieve the Critical Success Factor (CSF) without the level of adverse distributional

impacts on households and businesses in the City. Of the remaining options CAZ 'B++' plus does not meet the CSF, leaving a variant of the CAZ 'C+' as the option to be taken forward.

10. Bradford preferred option is the CAZ 'C+' option for the following reasons;

- CAZ C++ has the next highest NPV after CAZ 'D', this is due to reductions in CO_2 and fuel cost savings via the use of electric vehicles in the taxi and bus fleet.
- CAZ C++ aligns with strategic priorities of the Council to respond to a climate emergency.
- CAZ C++ is the only one of the four options which shows improvements in air quality across the entire district due to the use of electric taxis across the whole study area.
- CAZ C++ exemptions and grants for local SMEs HGV and LGVs will reduce the risks of the intervention to have detrimental economic impacts on smaller local business which are shown to be at risk in other scenarios.

11. For the identified distributional impacts to be avoided it will be essential for the Council to provide support for resident LGV drivers and businesses to help with upgrade costs.

Additional Plus Measures

12. The CAZ 'C' alone would not reach compliance as shown in the table below;

Table 3: Residual NO_2 emissions accounting for CAZ benefits

Census ID	Road name	Description	Nitrogen Dioxide in 2022 µg/m³*		
			Baseline	CAZ C	CAZ C+
47969	A6181	Godwin Street	37	33	32
7413	A650	Bingley Rd, Saltaire	46	39	37
8580	A650	Shipley Airedale Rd	48	42	40
* versus threshold compliance level of 40 µg/m³					

13. Plus measures were added to improve the effectiveness of the Class 'C' as follows;

- ULEV hybrid Euro 5/6 standard for private hire
- 25% EV taxis private hire and hackney

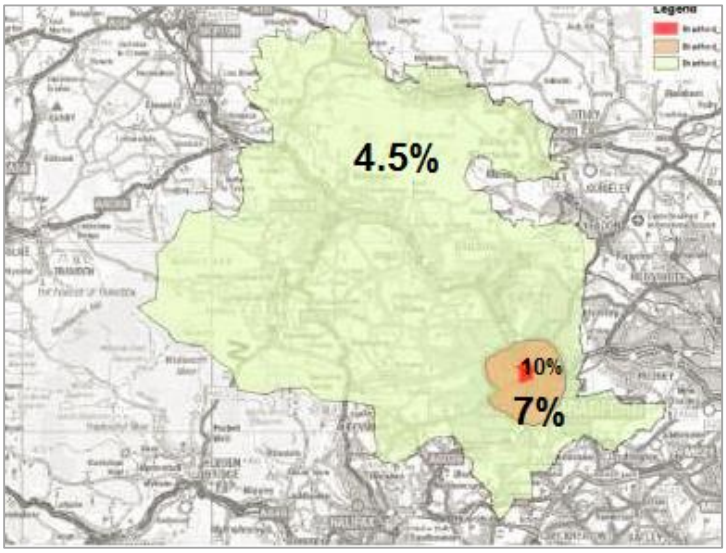
14. Following liaison with JAQU the park and ride and electric bus route were removed from the CAZ 'C+' as they were not eligible for funding at this time due to not being critical to compliance. Electric buses and park and ride remain key ambitions for the CAP. Other source of funding will be pursued to implement these key interventions which will improve

air quality and health in Bradford further whilst contributing towards both the climate emergency response and modal shift in the City.

Modelling the ULEV Taxi Package

15. Taxis were identified within the model using the fleet list of vehicles licensed in the City and identifying these vehicles within the anpr data. The study found the following distribution for taxis; within the inner ring road taxis contribute 10% of vehicle movements, this is 7% between the inner and outer irng road and 4.5% in the rest of the district. This is likely to be an underestimate due to the additional trips from out of town taxis which will not have been identified from their vehicle registration numbers (VRNs). This study indicates that taxi movements play a significant role in the City.

Figure 2: Taxi Distribution (%)



16. The modelling for the CAZ C+ had the following taxi fleet profile;

- Private hire vehicles Euro 5/6 hybrid petrol standard
- Hackney vehicles at Euro 6 diesel standard
- 25% electric taxi, private hire and hackney

17. The Bradford proposal would be to achieve the standard via licensing. This means that noncompliant vehicles would not be licensed to operate in Bradford. In Bradford the charge would apply to out of town taxis only. This maximises the number of compliant vehicles in the fleet.

18. The measure also has strategic alignment with climate change policies as petrol hybrid vehicles offer fuel savings and CO_2 reductions.

Electric Taxis

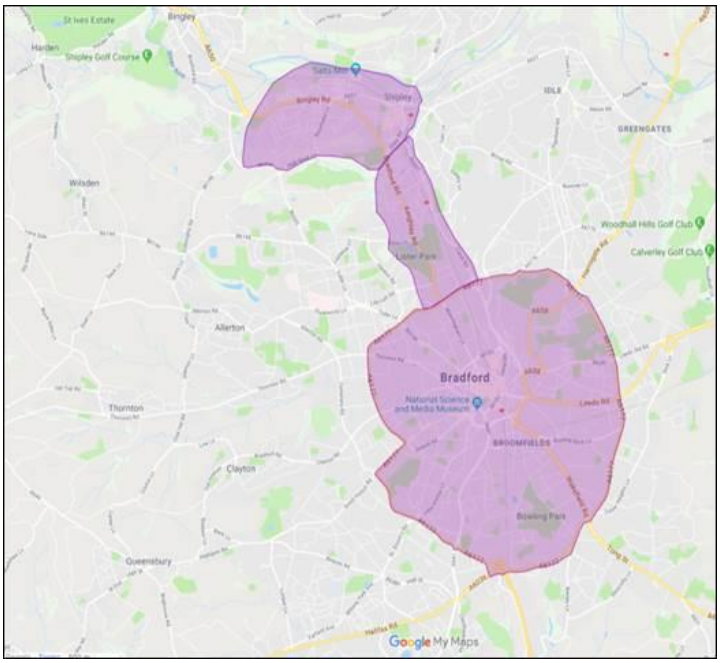
19. The engagement survey results (see Appendix 14) indicated that over 30% of Bradford taxi drivers are considering an electric vehicle at their next upgrade. This intervention is the incentivisation of electric vehicles within the taxi fleet, via providing infrastructure (20

rapid charge points currently being installed), contributions to running costs and a 'try before you buy' demonstration scheme to reduce barriers to uptake. The intervention aligns with the Councils Climate emergency declaration. Within the modelling there is a 25% assumed take-up.

Rationale for the Geographic Scope of the Clean Air Zone

20. The Clean Air Zone boundary has been defined and modelled as below, Shipley, the Canal Road Corridor and the City Centre, out to and including the outer ring road.

Figure 3: Geographic Scope (CAZ Boundary)



21. Reasons for the geographic scope are:

- **Baseline Modelling data** -The baseline study indicated that the key areas of NO_2 exceedance are located in the city centre (both inner ring road and along the outer ring road), key locations identified in the outline business case were Godwin Street, Hall Ings, Shipley Airedale Road and at a number of locations in Saltaire and Shipley, particularly along Bingley Road in Saltaire;

Table 4: Baseline NO_2 data

Census ID	Road name	Description	Local Modelled Concentration (µg/m3)				
			2018	2019	2020	2021	2022
47969	A6181	Godwin Street	48	45	43	40	37
37991	A6181	Hall Ings	45	43	40	38	35
7413	A650	Bingley Rd, Saltaire	60	57	53	46	46

Census ID	Road name	Description	Local Modelled Concentration (µg/m3)				
			2018	2019	2020	2021	2022
8580	A650	Shipley Airedale Rd	51	50	49	49	48

- **Monitoring data** – Bradford Council has extensive monitoring over many years indicating that there are exceedances in the identified CAZ zone. This can be evidenced in Bradford Council annual monitoring reports[5].
- **Air Quality Management Areas (AQMAs) –** The Council has declared 4 AQMAs and has an area of concern in Shipley under consideration for declaration, the proposed zone incorporates all of those areas.
- **Health –** The proposed CAZ is a relatively large area. This gives maximum health benefit and reduces exposure for some of the most deprived populations, including large numbers of schools, health care settings and other vulnerable receptors.
- **Displacement –** The larger area CAZ reduces the likelihood of displacement (shifting of the problem) and encourages upgrade as an alternative.
- **Strategic Fit** - Consideration has also been given to different classes of CAZ in the 3 areas, it was determined this would be confusing and create enforcement and public engagement problems.
- **Practical Considerations** – The proposed CAZ boundary gives a practical extent to the CAZ (outer ring road and Canal Road corridor), this makes enforcement and camera deployment possible.
- **Political Considerations** – Councillors and residents in Shipley have expressed a desire for the area to be included in the CAZ. The clean air engagement survey indicated high levels of response in that area to the survey, and concern about air quality. The modelling supports this and indicates that Bingley Road in Saltaire would be in exceedance of the objective without CAZ.

Charging Level

22. Based on the Bradford Stated Preference survey carried out and research from other cities Bradford have defined the charging levels for non-compliant vehicles as follows:

Table 5: CAZ Charging Level (£)

Vehicle	CAZ C+ or D	Charge (£/day)	Reasoning
Car	D only	£5	Stated Preference Survey

[5] Review of Air Quality across the Bradford Metropolitan District

Vehicle	CAZ C+ or D	Charge (£/day)	Reasoning
Taxi	C+, D Out of town fleet only	£12.50	Alignment with Leeds City Council in development phase (Leeds CAZ now cancelled)
Van	C+, D	£9	Stated Preference Survey
Lorry	C+, D	£50	Stated Preference Survey and alignment with other Cities
Buses & Coaches	C+, D	£50	Stated Preference Survey and alignment with other Cities

23. The stated preference survey was used to find the optimum charge, this was the charge which achieved the greatest shift in upgrade rate, without undue economic impact.

Compliance Year

24. The management case shows that the earliest full year that Bradford can achieve implementation is 2022. This is Bradford's compliance year.

Transport Modelling

25. The transport modelling for the Clean Air Plan has been carried out by WSP consultants in accordance with JAQU guidance and in close liaison with JAQU. An issue for the Clean Air Plan was that at the time the ministerial direction was served Bradford's strategic transport model was 12 years out of date, with a new version based on Saturn in development. Bradford Council have worked closely with JAQU transport modelling experts to devise innovative solutions to this. An elasticity CAZ transport model has been developed to inform the air quality baseline and CAZ scenarios (see Appendix 7 trackers T1-T4 for details). Additionally, Bradford Council have carried out a comprehensive Stated Preference survey to inform the model (see Appendix 9). The purpose of this survey was to ask affected transport sectors what their reaction would be to a CAZ in Bradford. Would they upgrade their vehicle, change or cancel their journey or would they pay the daily charge? Whilst this data has been used to inform upgrade assumptions, unfortunately the CAZ response data was found to be unreliable due to the small sample sizes for commercial vehicles, which were skewed by some of the larger operators. This was discussed with JAQU and a decision was taken to use the national CAZ response factors as an alternative.

Air Quality Modelling

26. The air quality modelling for the Clean Air Plan has been carried out by Ricardo-AEA in accordance with JAQU guidance and in close liaison with JAQU. The modelling has utilised Ricardo Energy's Rapid-Air complex dispersion modelling system (see Appendix 6 trackers AQ1-3 for details). The air quality modelling has used the outputs of the transport modelling of the baseline and scenarios as an input along with other local data on industrial sources, train services, background concentrations, domestic heating and planned developments.

Section 2: Economic Modelling

Introduction

27. The economic modelling for the Clean Air Plan has been carried out by Ricardo-AEA in accordance with JAQU guidance (See E2 methodology, Appendix 11). The modelling has utilised JAQU methodologies and spreadsheets for the analysis. The method calculates the cost of different scenarios. This is done using HM Treasury's Green Book guidance via the monetisation of benefits and the calculation of associated costs. The economic analysis weighs up the gains in reductions in journeys and damage costs associated with pollution (mainly health costs, but also climate change related) against the cost of upgrade for society and the cost of infrastructure needed for the scheme. This cost benefit analysis is detailed in the E2 report (Appendix 17). There is also Distributional analysis which looks at the benefits, costs and dis-benefits, the aim being that the more vulnerable in society benefit and are not disproportionately impacted (see Appendix 11 for the full DA report).

Distributional Analysis

28. The Distributional Analysis study was undertaken following JAQU's guidance and for the preferred option CAZ C+ See Appendix 11 for the full Distributional Analysis (DA) report.

Methodology

29. The **screening process** was undertaken on the basis of the list of impacts listed in WebTAG A4.2 taking into account the likely local issues of the proposed policy options. A summary of the screening is included Table 6 below.

Table 6: Screening of WebTAG Impacts

Impact	Description of impact	Screening Assessment
Air Quality	Change in NO_2 concentrations	There will be changes in concentrations across the city and for different user groups in these locations.
Affordability and user benefits		
User Benefits	Changes in vehicle operating costs met by the user	Vehicle changes and/or routes diversion will be generated by this option and so there will be changes in operating costs (both positives and negative)
Affordability	Changes in user charges, including fares, tariffs and tolls;	Charging CAZ will have significant impact on costs which will vary by vehicle ownership
Traffic and Transport		
Travel Times	Changes in travel time	Possible distributional impacts where diversion affects generate changes in

Impact	Description of impact	Screening Assessment
		traffic and journey times on individual links
Noise	Changes in noise levels – move in line with traffic on roads	Possible distributional impacts where diversion affects generate changes in traffic on individual links
Accidents	Changes in accident rates – move in line with traffic / speed on roads	Possible distributional impacts where diversion affects generate changes in traffic on individual links
Security	Any change in public transport waiting/interchange facilities including pedestrian access expected to affect user perceptions of personal security.	Charging CAZ will not impact on security. Could be indirect impact on public transport provision
Severance	Introduction or removal of barriers to pedestrian movement, either through changes to road crossing provision, or through introduction of new public transport or road corridors.	CAZ will not impact on physical road crossings.
Accessibility	Changes in routings or timings of current public transport services, any changes to public transport provision, including routing, frequencies, waiting facilities (bus stops / rail stations) and rolling stock, or any indirect impacts on accessibility to services (e.g. demolition & re-location of a school).	A charging scheme could have an impact on travel times as rerouting is expected by vehicles to avoid paying the charge.

Approach to Assessing Impacts

30. The approach to appraising each of the impacts closely follows the methodology set out in the JAQU and supporting WebTAG guidance. Namely, the 'impact variables' (describing how the impacts vary or are distributed across a geographic area) are overlaid with the 'grouping variables' (describing how different societal groups are distributed across the same area).

31. Table 7 indicates the impacts that should be appraised for each group.

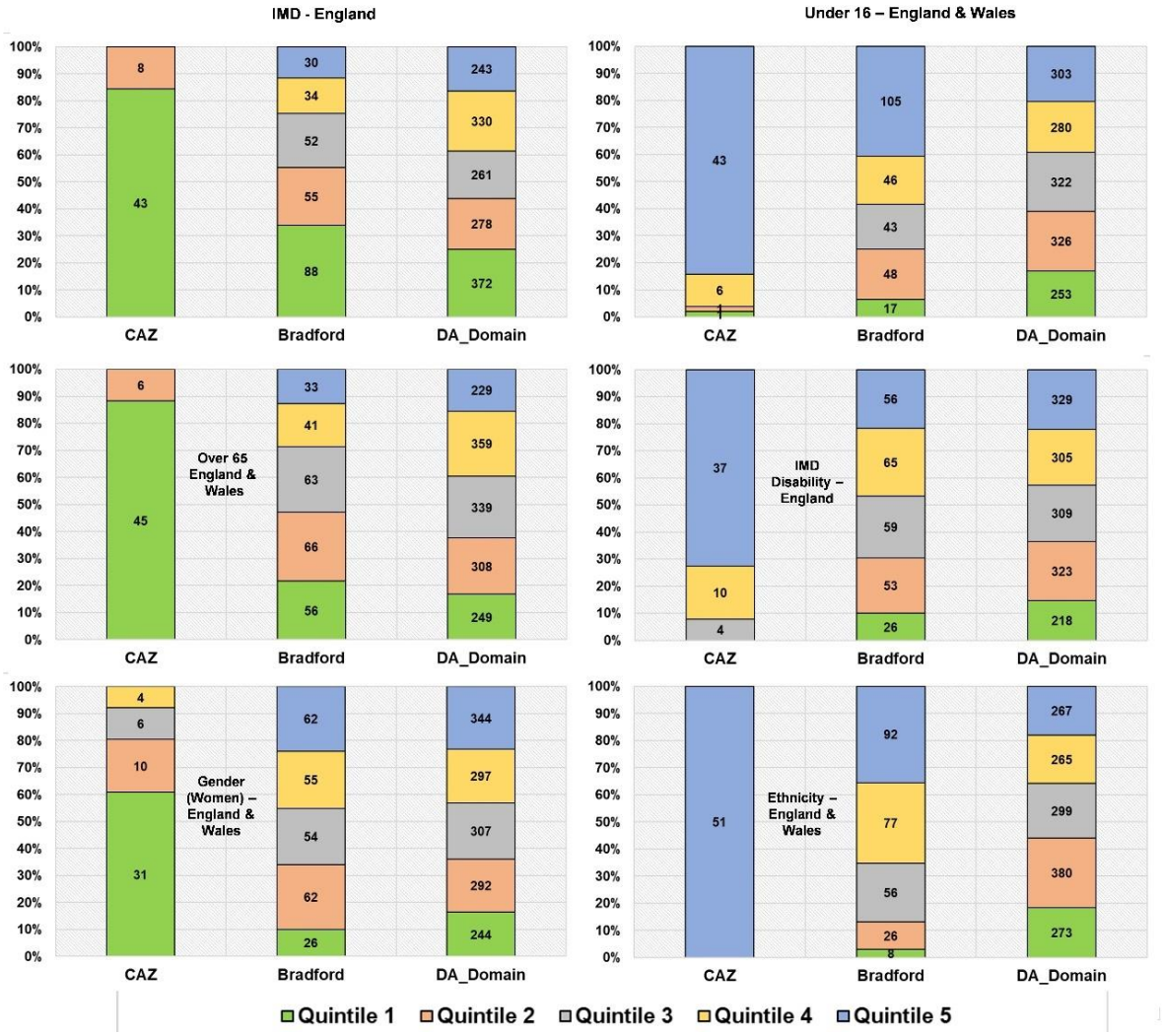
Table 7: Impact Categories in Scope

Group	Air quality	Affordability	Traffic impacts
Deprivation / income	✓	✓	✓
Children	✓		✓
Old people			✓
Disability			✓
Sex			✓
Ethnicity			✓
Businesses		✓	

32. Impacts were assessed on the populations which were the most likely impacted by those options, defined with the number of trips to the CAZ area. Impacts in Air Quality, affordability for households, business, traffic safety/noise and travel times were assessed for groups of income, under 16, over 65, gender, population with disabilities and “non-white” people. The quintile distribution for each impact group living within each of the assessment domains (Bradford TWW, AQ modelling domain and charging scheme areas) is summarised in Figure 4**.** Some of the key points from these charts can be summarised as follows:

- The city centre area (within the Charging Scheme boundary) has the highest proportion of low income families, children under 16 and disabled compared to the other areas. As such improvements in air quality in this area will have greater benefits for these potentially disadvantaged groups.
- Conversely the wider DA area has the lowest proportion of high income households, however the quintiles are distributed evenly among the different demographic groups.
- The city centre also seems to have the lowest proportion of over 65s and proportion of women, but high proportions of a “non-white” population.
- More generally the distribution of these socioeconomic groups is more even outside the city centre.

Figure 4: Relative percentage of quintiles for each geographical zones and demographic groups[6]



[6] The number within each bar represents the number of LSOAs in each quintile and each demographic group. The total number of LSOAs within the different zones are as follows: 51 (Charging scheme area); 259 (Bradford excluding the Charging scheme area); 1484 (Remaining LSOAs inside the DA_Domain).

Section 3: Overview of the Air Quality Results

Introduction

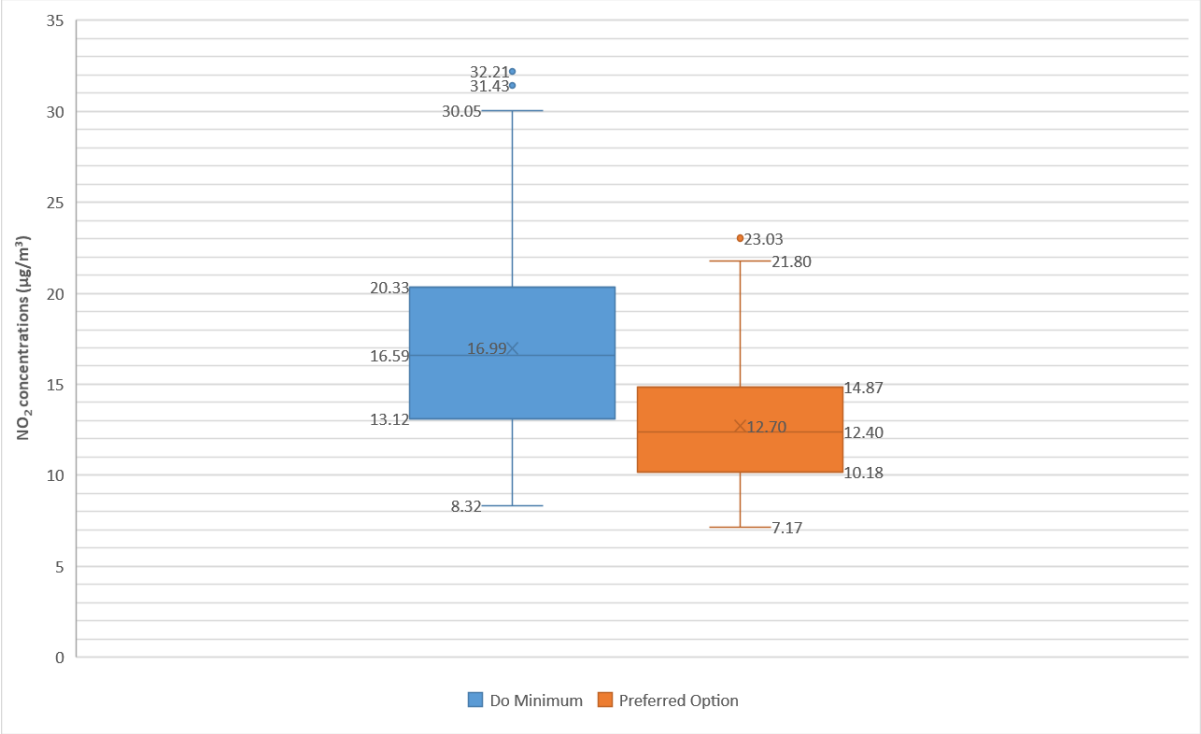
33. This section of the report details the effect of the preferred option on NO_2 concentration within each Lower Super Output Area (LSOA) and provides an overall picture of how the preferred option will impact the IMD-income and U16 demographic groups.

34. CAZ aims to reduce annual mean concentrations of NO_2 in areas that exceed national objectives. This analysis therefore needs to consider the locations where annual mean NO_2 concentrations are likely to change and how this change may impact the local population.

35. To assess the average NO_2 concentration for each LSOA falling within the air quality modelling domain in 2022 for the baseline and each of the modelled options, the calculation was carried out using the zonal statistics function in GIS. The number of LSOAs within the air quality modelling domain for which average concentrations could be calculated was 158 (only those LSOA with greater than half of their area in the modelling domain were included).

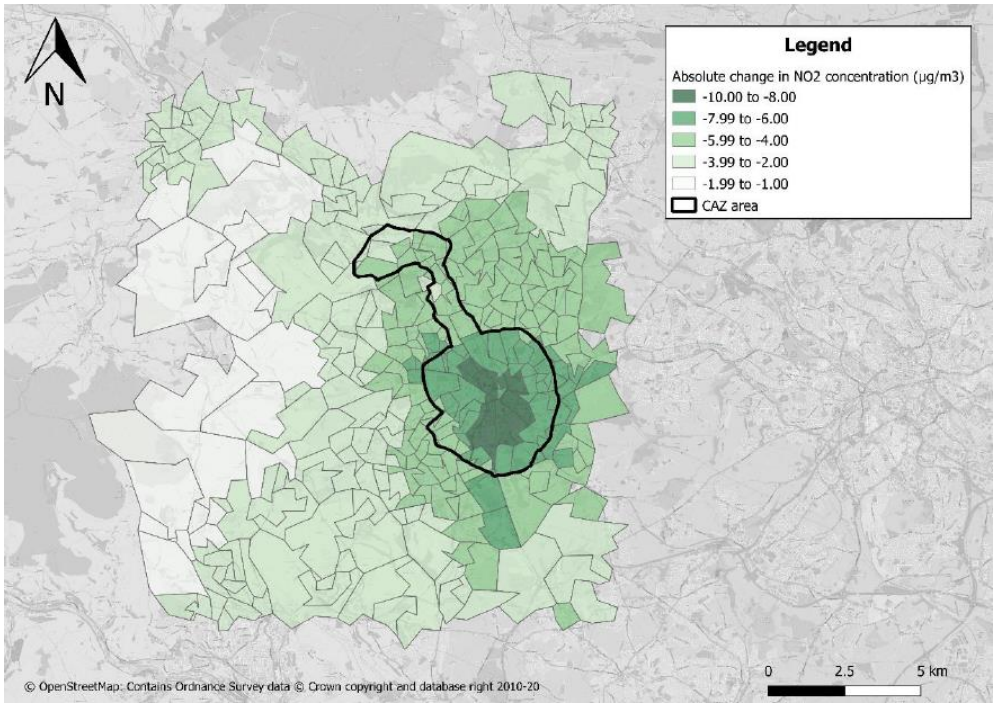
36. To evaluate the impact of the options on each LSOA, the change in the average NO_2 concentrations for each LSOA was calculated by subtracting the 2022 Do Minimum scenario (the baseline) from the policy options. If the resulting change is *positive* this means there is an *improvement* in air quality as a result of the introduction of the policy option.

Figure 5: Comparison of Annual NO_2 concentrations (µg/m3) for the AQ study domain in both the 'do minimum' and 'preferred' option scenarios for 2022.[7]



The results of this analysis are summarised in Figure 6 below:

Figure 6: Illustration of the preferred option's effect on average NO_2 concentration (µg/m3) in LSOAs across the AQ study area



[7] The 'x' marker represents the mean value, middle bar line represents the median value. The upper or lower quartiles are presented by the upper and lower edges of each box. The upper and lower bars represent the greatest value without being

Figure 6 shows how the annual average NO_2 concentration (µg/m^3) changes after the introduction of the preferred option. The figure shows that average concentration in NO_2 pollutant is reduced across the entire domain with LSOAs within the CAZ area decreasing with the biggest absolute value. The figure suggests that the reduction in average NO_2 pollutant will correlate with the distance moved away from the CAZ boundary.

37. Table 8 shows the results from analysis undertaken to understand the proposed options impact on different IMD – income deprived classes. The table shows, on average, the biggest relative change in NO_2 pollutant is shown to occur in the AQ domains most deprived LSOAs where concentrations reduce by about 26% from the Do Minimum baseline. The table shows a clear relationship between levels of income deprivation and changes in the average concentration of NO_2 pollutant, with those in living in the most deprived areas receiving the biggest benefit. Although those living in the least income deprived areas of the study area benefit least, they still are likely to experience the least average exposure to NO_2 pollutant. The range in values for the absolute (2.28 µg/m^3) and relative (3.79%) show that although the more income deprived class is benefiting slightly more than the lesser income deprived the range is fairly small so the share of the benefits from the implementation of the preferred option are fairly evenly distributed across the domain.

Table 8: Quantile Analysis - IMD Quantile

Option	Income IMD Quintile domain	Most deprived ←			→ Least deprived	
		1	2	3	4	5
2022 CAZ C+	Average NO_2 concentration (µg/m^3)	14.05	12.52	11.76	10.41	9.72
	Absolute difference in NO_2 concentration compared to the do minimum scenario (µg/m^3)	-5.09	-4.16	-3.55	-2.99	-2.81
	Relative difference in NO_2 concentration compared to the do minimum scenario (%)	-25.82%	-24.37%	-22.42%	-22.02%	-22.03%

40. Table 9 shows this effect further, the biggest improvements in air quality are in the most deprived communities, with a significant positive impact across the entire population.

Table 9: WebTAG 'quintile' analysis for the IMD - Income deprived demographic within the AQ study domain

Income IMD	Most Deprived ←			→ Least Deprived		Total
	0-20% (1)	20%-40% (2)	40%-60% (3)	60%-80% (4)	80%-100% (5)	
Population with improved air quality	257,884	117,888	85,415	52,452	31,731	545,370
Population with no changes[8]	0	0	0	0	0	0
Population with deteriorating air quality	0	0	0	0	0	0
Percentage of quintile with an improved concentration of NO_2	100.00%	100.00%	100.00%	100.00%	100.00%	
Percentage of the domain population	47.29%	21.62%	15.66%	9.62%	5.82%	
Assessment †	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	

†: X X X: significant negative impact; X X: negative impact X: some negative impact; -- no overall impact; ✓ some positive impact; ✓✓: positive impact; ✓✓✓: significant positive impact.

41. The DA report also looked at the change in NO_2 pollutant at sensitive receptors. The results from this analysis found that on average, receptors whether located inside or outside the CAZ where predicted to benefit from lower annual average NO_2 concentrations. The analysis indicates that receptors listed as *educational* premises are most likely to receive the biggest benefit relative to its do minimal concentration. The range of relative change between classes of relative receptors is 4.73% and therefore the distribution of change can be considered only slightly more beneficial for sensitive locations with a higher relative change. Overall, the receptor class with the lowest relative change in its annual average pollutant concentration, *Public Parks and Gardens* is predicted to have a significant change in its concentration -24.39% and therefore the CAP should be considered to be largely beneficial to all receptor classes.

[8] For this category it has been assumed a difference in NO_2 concentration between the modelled CAZ scenario and the baseline to be 0.

Affordability for Businesses

42. Businesses could be affected by the CAZ through many different pathways. The options for internalising or passing on the costs of CAZ are summarised below, the opportunities to do so are limited and it is therefore certain that some sectors will require external support:

Table 10: Summary of internalised cost absorption options for each vehicle type

Operator	Can firms pass through costs to customers?	Can firms internalise costs?
LGV/HGV operator	Commercial vehicles operate in a sector of intense competition with more economically active customers. In 2020, there will already be many vehicles which are CAZ compliant. Hence strong competition in sector severely limits ability to pass through costs.	Low profit margins (1-4%) significantly reduce ability to internalise – for a non-compliant vehicle, CAZ charge could be greater than margin on trip. That said, larger operators may be able to spread the costs of the charge over a larger fleet and operations or redistribute fleet to reduce the burden.
Bus Operator	The need to upgrade bus fleets may have a knock-on effect on public transport fares. This is problematic as buses are more utilised by lower income and vulnerable households.	Bus users tend to be of lower income and from more vulnerable groups such as the elderly, limiting the possibility of passing on costs.
Coach operator	Competition from compliant coaches and non-marginal impact for frequent travellers will reduce the capacity for some to pass through costs. For those carrying infrequent customers, this may allow some pass through of the costs.	National operators have higher profits and wider operations across which the costs of the CAZ can be spread. But local operators with smaller fleets are less able to internalise.
Taxi driver	Customer base and lack of alternatives may allow some pass through (but will affect regular customers, e.g. people with disabilities).	The comparison between costs and margins is different to other businesses: given the ownership profile, the comparison is relative to household income, rather than profit, which limits ability to internalise. Upgrade costs could represent a significant proportion of take-home pay of taxi drivers, in particular those lower on the income distribution.

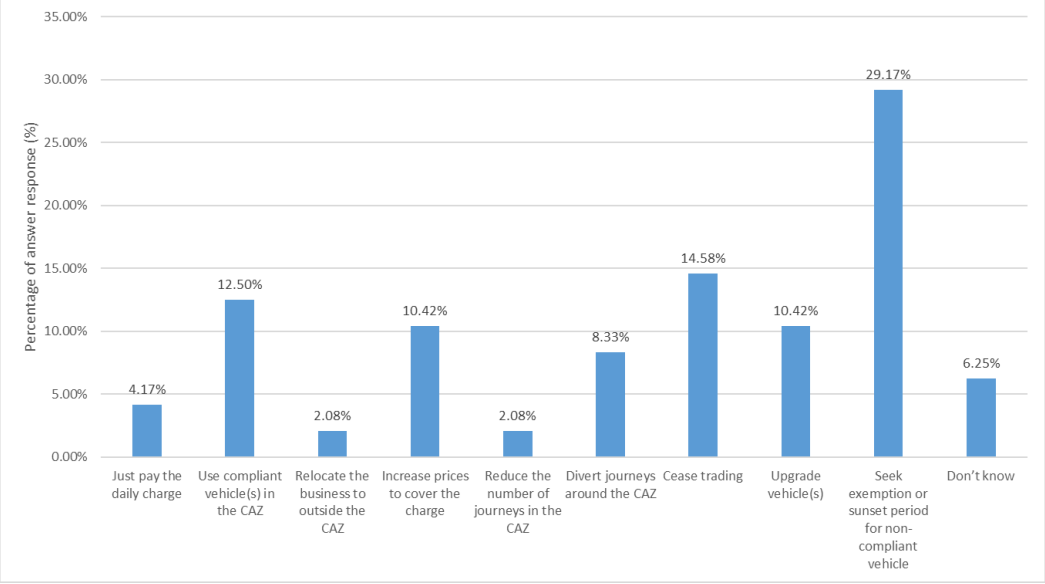
43. The response of businesses to the CAZ, and the risk to whether they can ‘afford’ the costs could have subsequent impacts on employment and economic activity in the local area. Analysis suggests that some affected operators would have some ability to pass

through or internalise costs, namely national coach operators, as they could spread costs across wider business activities. However, several operators could struggle to afford additional costs, including HGV operators, more local coach services and taxi drivers.

44. Although the key impacts of a CAZ are anticipated to be negative, there will be some mitigating influences. The key impact of the CAZ is to bring vehicle upgrades forward. As such, the baseline is anticipated to 'catch-up' with the CAZ at some point, increasing the potential for more firms to internalise costs. There are also associated fuel cost savings to be made. For larger firms, it is worth emphasising that risks are lessened by the ability to redistribute fleets between different geographical areas. In the longer-term, balancing forces in the economy will limit the knock-on effects and potentially mitigate some of the short-term impacts. Therefore, there will be shorter and longer-term impacts, and the latter will depend on how Bradford's economy adjusts to the structural changes.

45. it is useful to highlight the expected responses of businesses to the implementation of a CAZ. Assumptions were made for the response levels in the cost-benefit analysis (see E1) to enable analysis. Responses may differ in practice; the public consultation offers a different insight into the potential response of non-compliant vehicle owners. The opinions expressed in the public consultation are displayed in Figure 7.

Figure 7: Stated likely response to the CAZ by business owners with a fleet



46. Figure 7 shows how business owners believe they will adapt to the introduction of the CAZ. The responses show that only 10% of businesses will upgrade their vehicles as a primary response. The most likely action shown is that business owners will seek an exemption or sunset period for non-compliant vehicles within their fleet (29.17%). The response also shows that a significant number (14.58%) of businesses will cease trading. Only a small number of businesses (2.08%) have stated that they would reduce the number of journeys into the CAZ or relocate their business to outside the CAZ boundary.

Smaller Businesses

47. Smaller firms are more likely to face greater affordability risks through their operation (e.g. they tend to operate older vehicles and enter the CAZ more frequently). The nature of them being smaller businesses itself further increases the risk facing these businesses, in particular smaller firms:

- do not have large fleets which can be redistributed, reducing the response options available to them to respond to the CAZ charge;
- are likely to have smaller cash reserves to fund upgrades;
- have smaller operations over which costs can be spread;
- may also find it more difficult to access capital or may face higher borrowing charges; and
- Are more likely to have a smaller geographical scope over which they conduct operations, so are likely to be based within and conduct a greater proportion of their trips within the CAZ.

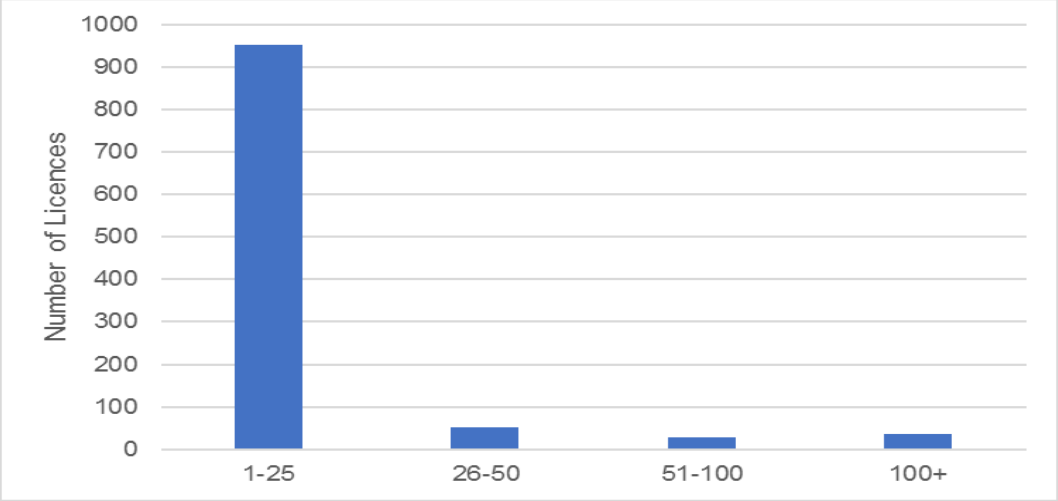
48. In response to the introduction of the London Low Emission Zone (LEZ), an impact monitoring report noted that HGV owners with large fleets serving large geographical areas tended to react by conducting an in-depth analysis of how they organised their transport activities. Fleets were then redistributed so that the newest and cleanest vehicles were used in the Greater London region, while older vehicles were operated in zones without charging schemes. HGV owners with smaller fleets or those serving smaller geographical areas were not able to adapt by redistributing their fleet. These businesses needed to put money aside ahead of time in order to purchase newer vehicles or retrofit existing vehicles. Where these options were not feasible due to financial constraints, these businesses rented newer vehicles, paid the charge or left the market[9].

49. O-licence data can be used to provide an alternative estimate of the number of goods vehicle operators and goods vehicles operating in the Bradford area (Both LGV and HGV operators). In the database for the North-East of England, there are 976 O-licences operating within the “BD” Bradford postcode. Of these, the vast majority of licences have 1-25 vehicles associated with them (Figure 10). This indicates that the vast majority of freight vehicle operators operating within Bradford are smaller businesses and hence are more at risk.

50. The main sectors served by HGVs are retail distribution, wholesale distribution and construction. Some HGV dependent businesses include warehouses, garages, depots, recycling plants, wholesale distributors and manufacturers.

[9] Cecilia Cruz and Antoine Montenon, “Implementation and impacts of low emission zones on freight activities in Europe: Local schemes versus national schemes”,

Figure 8: Number of O-licences operating within BD postcodes, by vehicle fleet size



51. The main sectors served by HGVs are retail distribution, wholesale distribution and construction. Some HGV dependent businesses include warehouses, garages, depots, recycling plants, wholesale distributors and manufacturers.

52. The risk for smaller coach operators may also be exaggerated by the nature of the customers they serve. If smaller coach operators are more likely to serve regular routes within the city (e.g. school buses), they will have a lower capacity to pass costs through to their customers. This is because the total cost passed through per customer will be much higher than a national operator, which sees a greater variance in its customer base. Some larger coach operators, such as National Express, have policies requiring its coach operators to use vehicles that are no more than seven years old, and would therefore be relatively well-positioned to adapt to the implementation of a charging zone[10]. In addition, some commuter services run by national operators, especially those on long-distance service lines, may be able to re-route their services to avoid passing through a charging zone.

53. The disproportionate impact on smaller businesses is shared by public consultation respondents. Although 64% of respondents expressed the opinion that a CAZ would have a negative impact on larger businesses, 75% believed there would be a negative impact on small businesses and sole traders. Therefore, although respondents expect a negative impact on businesses of all sizes, the greater concern for smaller firms is clear.

54. Bradford district has 17,620 businesses, the majority of which are small and medium-sized enterprise (SME) businesses, i.e. employing less than 250 people. Of businesses operating in the district, 27 employ more than 250 people, and 17,593 are SMEs. It should

[10] Jacobs, "Ultra Low Emission Zone: Integrated Impact Assessment", and associated documents, prepared for Transport for London, October 2014, https://consultations.tfl.gov.uk/environment/air-quality-consultation-phase-3b/user_uploads/integrated-impact-assessment.pdf, accessed 24/04/2018.

be noted that this may be an over-estimation of the number of SMEs for a number of reasons:

- Businesses that are part of a larger group that employ people nationally and internationally should not be considered as SMEs.
- Businesses employing fewer than 250 people but with turnovers exceeding €50 million should not be considered as SMEs.

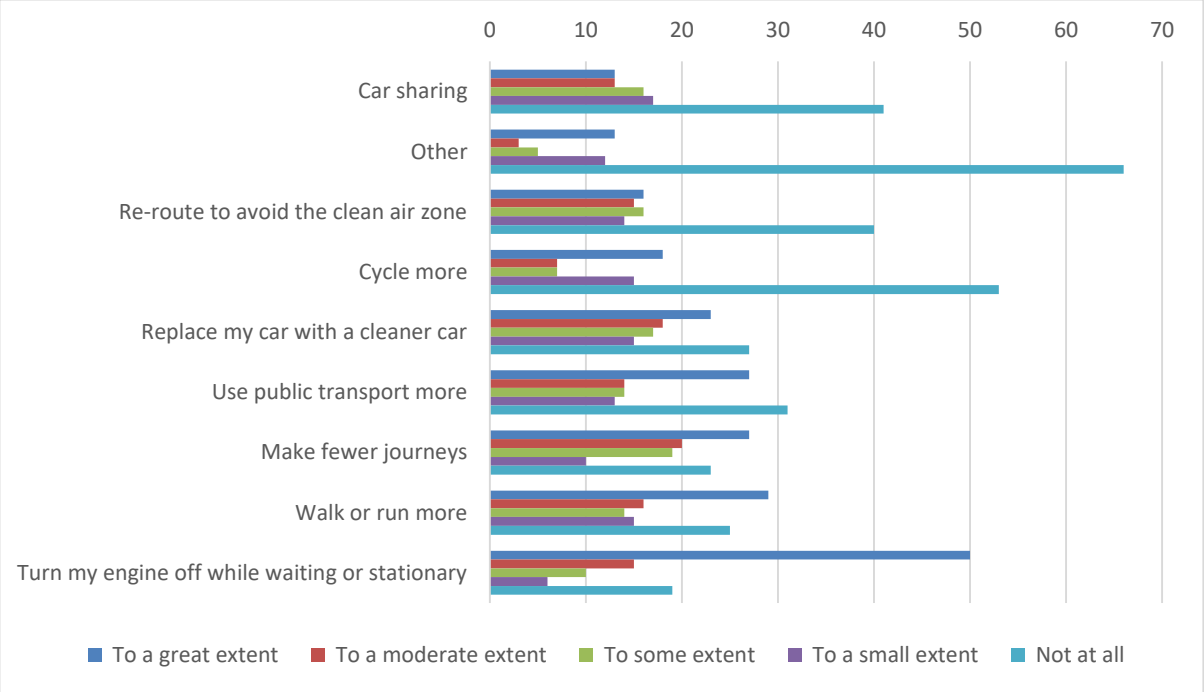
Nevertheless, this information is useful for highlighting the extent to which SMEs will be impacted by the CAZ.

Affordability for Households

55. The preferred option is based on the implementation of a type C CAZ plus additional complementary measures which does not charge private vehicles for entering the CAZ or any other sections of the public road network. The impacts of the scheme on private households are therefore most likely to stem from indirect costs associated with the inflation of the cost to use a public transport service or increased fuel usage due to an increase in traffic on routes which might divert non-compliant commercial vehicles around the CAZ.

56. The Stated Preference survey asked the public if they believe they will change their travel modal choices after the introduction of the proposed CAZ. Figure 9 details the results from the SP survey question.

Figure 9: Public response to a question regarding how they may react to the implementation of a non-charging CAZ



57. Figure 9 shows that a significant number of respondents would not change their current behaviour to another travel choice for each option presented. However, 50% did state that they would stop idling whilst waiting and between 20 – 30% advised that they would replace their car with a cleaner vehicle, use public transport more, make fewer journeys, or walk or run more. Slightly less respondents also stated that they would cycle more (18%).

58. In summary the CAP will not charge private vehicles for entering the CAZ, however it may result in citizens becoming more conscious about their impact on local air quality that will lead to a behavioural change. To support those wishing to reduce their impact on local air quality, the local, regional and national authorities must ensure that public transport and travel infrastructure (e.g walking and cycling lanes) are accessible and fit for purpose.

Additional Impacts of Covid-19

59. The Covid-19 pandemic has placed additional pressure on the local economy in Bradford. The main impacts are summarised below. The full details can be found in Appendix 2 of the Distributional Analysis (Appendix 12).

Table 11: Qualitative Assessment of Covid-19 impacts on demographic groups

GROUP	Qualitative Assessment – Summary
General Business	Whilst tech firms have done well, most groups are expecting a financial loss. Brexit may exacerbate the effects. Some may cease trading as government support ends
SMEs	96% of businesses responding to the survey were SMEs, most businesses in Bradford are SMEs. Access due to social distancing will cause drops in revenues and may affect public transport. Access to funding for active travel may mitigate to an extent
SMEs with high dependence on access to address	Retail and hospitality are likely to be the worst affected. Whilst CAZ will not limit access in itself any extra costs will be on top of losses incurred during the pandemic
SMEs with ability to work remotely	Large companies that have staff working from home are less likely to be affected by CAZ, however SMEs and sole traders such as builders, plumbers and other trades are likely to have had reduced revenue due to the pandemic and this will affect their ability to upgrade vehicles
Taxis	National and local lockdowns have had a catastrophic effect on taxi trade incomes. Local data shows that for private hire there has been over 60% reduction in business with only a 1/3 of drivers able to work at all. With

GROUP	Qualitative Assessment – Summary
	individual incomes reduced by 80%. By September 2020 business levels had slowly increased to ~70% of previous. These reductions will impact drivers ability to upgrade their vehicles to meet CAZ and licensing standards.
Large businesses	These companies will have had similar experiences to SMEs but are more likely to have a cash reserve to help absorb the short-term costs of the pandemic
Bus and Coach	Social distancing has limited seating capacity. Whilst these costs have been subsidised by government, going forward it is likely that public transport use may still be reduced for the mid to longer term affecting revenues and the ability to upgrade or retrofit services.
Households	Household incomes are affected by the impacts on all the groups above in terms of potential loss of employment and added costs for goods and services. As the CAZ does not charge private vehicles it is less likely to affect household incomes directly.

The impact of covid-19 on the economy has also been modelled in the air quality model as a sensitivity test in accordance with JAQU guidance. The assumption was made that fleet upgrade was delayed by one year to reflect the reduced ability to upgrade due to a worse economic outlook. The test indicated that the slower renewal of the fleet leads to increases in NO2 concentrations on all links in the model domain (average 3.3%, min = 1.8%, max = 4.7%). This leads to Census ID 8580 (Shipley Airedale Road) becoming non-compliant in 2022 (NO2 = 41.8 ug/m3) with the CAZ C +.

Distributional impacts of improved air quality

60. This analysis has explored the distributional impacts of the preferred option on different social groups, the economic impacts on businesses and private households and the likely effects on the number of accidents and volume of noise generated on the modelled road network. Table 9 details the overall impact on each assessment undertaken.

Table 12: Overall impact assessment for each impact category

Distributional impact	Assessment
Air Quality	✓✓✓
Businesses affordability	X

Distributional impact	Assessment
Household affordability	-
Accidents	-
Noise	-
Accessibility	-
X X X: significant negative impact; X X: negative impact X: some negative impact; -- no overall impact; ✓ some positive impact; ✓✓: positive impact; ✓✓✓: significant positive impact.	

61. Results from the air quality model has indicated that the implementation of the preferred option is likely to improve air quality, on average in LSOAs which lie within the modelled domain, meaning all residents are likely to benefit from the scheme regardless of their demographic grouping. The distributional analysis has found that the changes in levels of NO_2 pollutant are equally distributed across different demographic groups and that the most deprived areas gain the biggest benefits.

Impacts on local businesses

62. Results from the consultation survey undertaken with local businesses with a fleet suggest that a large portion of businesses within Bradford are likely to be small or medium sized enterprises (SMEs), with a significant proportion of their fleet to be either a diesel HGV or diesel LGV. A significant number of businesses also stated that their entire current fleet would not be compliant with the proposed criteria for entering the preferred options clean air zone, with many businesses stating their preference for an exemption from the CAZ charges. The main conclusion drawn from this section is that local businesses will need to be supported by the local authority for the preferred option to be implemented without having a severe impact on the local economy.

Impacts on private households

63. The preferred option does not place any restrictions on the use of private vehicles and therefore private households are not likely to incur any direct economic costs, however this benefit might be offset by increased cost to those who use public transport prior to the CAZ being introduced. It will important that there is close liaison and support provided to operators to ensure this does not happen.

Impact on traffic related noise and accidents

64. Analysis of the changes in annual average daily travel and vehicle speed extracted from the WSP transport model has found that the preferred option is likely to reduce AADT on the majority of road-links used within its model without increasing the average speed by more than 10km/hr. Two sections of the rural road network are predicted to increase in AADT by more than 10% of the comparison do minimum model. These sections of road

were found to be in rural locations where injuries to pedestrians were unlikely, the road links were also straight lengths of surface which suggests road users are likely to have good visibility of approaching vehicles. No evidence was found to suggests that the preferred option is likely to increase the noise generated by vehicles using the road network.

Impacts on travel times

65. This assessment has found that the implementation of the preferred option is not likely to have a significant impact on travel times to a central amenity.

Section 4: Cost Benefit Analysis Appraisal

Introduction

66. The Economic Analysis study was undertaken following JAQU's guidance on the baseline and CAZ C+ Clean Air Plan. This is addition to previous Cost Benefit Analysis (CBA). carried out during OBC on the short list of options which identified the preferred CAZ C+ option.

67. The full CBA report can be found in Appendix 17, Table 13 below is a summary of the modelling techniques employed in the assessment.

Table 13: Impact Categories and Model Mapping

Impacts	CAZ C +
Upgrade costs	✓ **- Ricardo Economic Model**
Implementation	✓ **- Ricardo Economic Model (based on CCC data)**
Welfare loss (rule of half) (Cost changes for altered trips)	✓ **- Ricardo Economic Model**
Air quality	✓ **- Ricardo Economic Model**
Time (Cost changes for unaltered trips)	✓ **- TUBA**
OPEX/Fuel/CO_2 (vehicle movements)	✓ **- TUBA**
OPEX/Fuel/CO_2 (vehicle upgrades)	✓ **- Ricardo Economic Model**
User Charge Revenue	✓ **- Ricardo Economic Model**
Indirect Tax Revenues	✓ **-TUBA**

Impacts assessed

68. Any scheme to tackle air quality will impact different parts of the environment, economy and society. The economic analysis seeks to quantify and value as many of these impacts as possible given the time, resource and modelling methodologies available. JAQU's guidance sets the basis for the scope of impacts to be assessed for a Charging Scheme appraisal. (See Table 14).

Table 14: Impact Description and Mapping

Impact name	Description	JAQU reference
Upgrade costs	The impact on those vehicles owners that respond to Charging Scheme. These are the upfront costs for vehicle owners associated with switching from a non-compliant to a compliant vehicle. This encompasses the vehicle scrappage cost and the consumer welfare impact as described in the JAQU guidance.	'Vehicle scrappage costs' and 'Consumer welfare impact' for 'upgrade vehicle response'
Operating cost impacts	Those savings or additional costs that can result from Charging Scheme or "Plus" measures. This includes both changes in fuel consumption and the associated cost and change in operating and maintenance costs. This can come about through additional distances travelled (handled by transport modelling) or change in vehicle type (handled by REE model).	'Fuel switch costs'
Implementation costs (Investment and Operating Costs)	Cost of upfront and ongoing activity and assets required to implement, monitor and enforce the Charging Scheme, and other "Plus" measures.	'Government costs'
Air quality emissions	The impact on affected populations by a change in NO_x and $PM_{2.5}$ emissions as a result of Charging Scheme and "Plus" measures.	'Health and environmental impact'
Greenhouse Gas impacts	The impact on affected populations by a change in greenhouse gas emissions that result from Charging Scheme and other "Plus" measures. This can come about through additional distances travelled or change in vehicle type.	'Greenhouse Gas impacts'
Travel Time	The impact of the Charging Schemes and other "Plus" measures on traffic flow and the subsequent impact on travel time experienced by affected populations.	'Traffic flow impact'
User Charges	The cost to road users from paying the CAZ charges. This category includes for impact on consumer welfare associated with the user not being able to take their first preference. E.g. in the case of 'cancelled' journeys, the vehicle user will not be able to undertake the activity planned at the destination (e.g. shopping trip to city centre). The vehicle user will miss out on the happiness / value that they would have gained	'Consumer welfare impact'

Impact name	Description	JAQU reference
	from that trip, which is captured by this impact category.	
User Charge Revenues	The revenue generated through charging the non-compliant cars to travel through the CAZ. This should have no net impact on the model.	'Government costs'
Indirect Tax Revenues	The impact on revenues generated by the VAT, excises and duties levied on goods and services. This should have no net impact on the model.	'Government costs'

Modelling years

69. There are three key years used in the modelling work, as set out in 12 below. The base modelling year is 2018 as this allows use of the latest air quality and transport data. The future baseline is modelled for the assumed implementation year in 2022, while 2027 is also modelled to establish the year of natural compliance (i.e. in the absence of a CAZ). Any interim years required will be generated through interpolation or projection rather than direct model tests.

70. The appraisal period for the economic modelling is 2022-2031, a 10 year period from implementation year, as per JAQU Guidance.

Table 15: Model years and appraisal period

Year	Description
2018	**Base year** – using latest available data on air quality and traffic.
2022	**Implementation year** – latest date when the scheme is assumed to be in place, if it is required in Bradford.
2027	**Post implementation year** – reference case in year identified in previous modelling as compliance being achieved.
2022-2031	**Appraisal period -** 10 years (from date that local implementation is estimated to begin)

Section 5: Results

Summary of Results

71. The Ricardo Model and TUBA results have been provided in Table 16. This table details the expected value from each variable which has been calculated over the 10-year appraisal period (2022-2031)

72. The overall NPV has been calculated at **-£11,200,000**

Table 16: Monetised impacts associated with option scenario (cumulative discounted impact (PV) and NPV from 2022-31 (10-year appraisal period) (2020 prices)

Impacts	Variable	CAZ C+
Upgrade costs	Total upgrade costs	-£31,300,000
Additional vehicle costs	Road fuel costs	£19,000,000
	Road vehicle opex	-£3,930,000
	Road CO2 value*	£8,290,000
AQ Impacts		£15,700,000
Implementation costs		-£14,500,000
Welfare Loss	Welfare costs	-£1,590,000
User Revenue (+/-)	Cost to households/businesses	-£32,100,000
User Revenue (+/-)	Benefit to public administration	£32,100,000
Indirect Taxation (+/-)	Cost to public administration	-£3,150,000
Indirect Taxation (+/-)	Benefit to households/businesses	£3,150,000
Additional Trip costs*	Road vehicle opex (inc fuel costs)	-£3,250,000
	Road CO_2 value	**£530,000**
	Travel time	-£150,000
	TOTAL NPV	**-£11,200,000**

Notes: +ve values denote benefit / -ve values denote costs; all impacts are in 2020 prices; all impacts are discounted to 2020. * The results from the TUBA were calculated in 2010 prices and have been converted to 2019 prices using the Bank of England inflation converter. 2020 prices have not been included in this instance as the BoE converter provides a comprehensive conversion and the data for 2020 will not be available until January 2021. Significant changes however are not expected between the 2019 and 2020 price year.

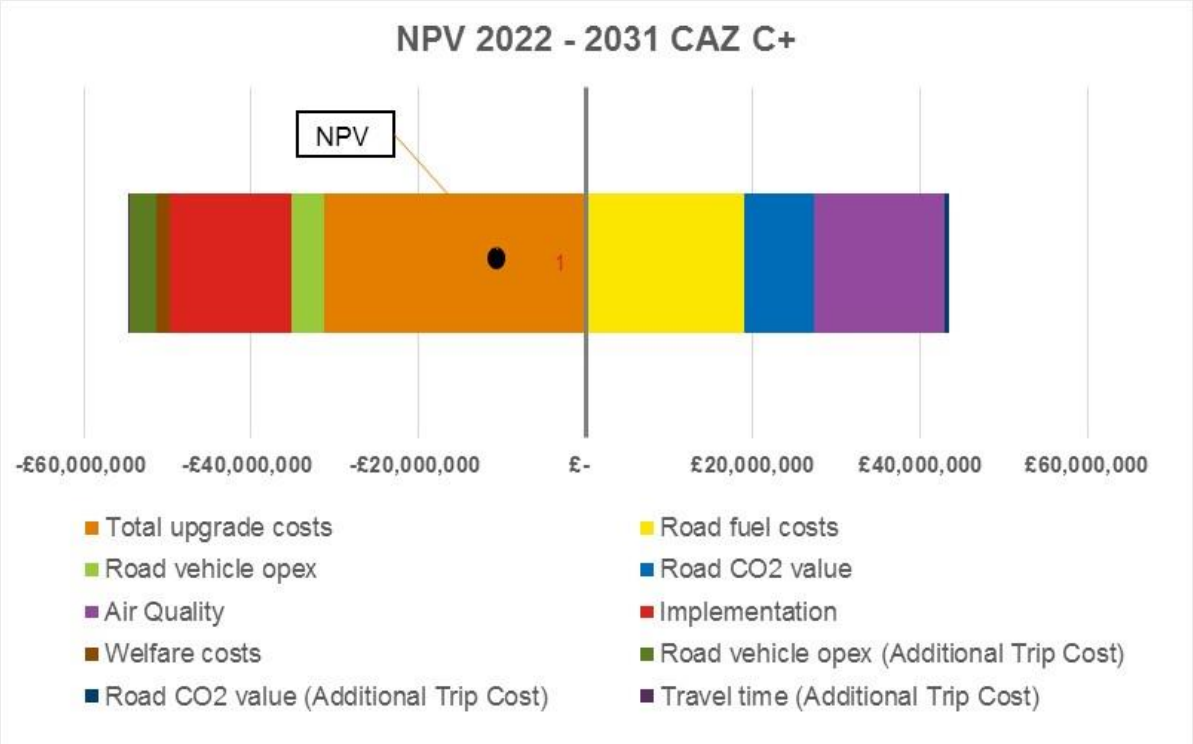
73. In addition to the overall NPV of all measures associated with the CAZ C+, the Ricardo model has separately modelled the expected NPV of taxi upgrades. The results are shown in the table below.

Table 17: Monetised impacts associated with option scenario (cumulative discounted impact (PV) and NPV from 2022-31 (10-year appraisal period) (2019 prices) for taxi upgrades

Impacts	Variable	CAZ C+
Upgrade costs	Total upgrade costs	-£15,500,000
Additional vehicle costs	Road fuel costs	-£231,000
	Road vehicle opex	£1,010,000
	Road CO2 value*	£187,000
Total		**-£14,500,000**

74. The NPV calculations are summarised below:

Figure 10: Summary of NPV Calculation



CBA Findings

75. The CBA gives a negative NPV, this is in line with other cities who have undertaken similar CAZ studies. The cost of the CAP will be supported by government funding and these calculations do not take into account that support. The largest cost is that of

upgrading vehicles, however this is substantially offset by the savings in fuel costs associated with the use of cleaner more efficient vehicles. The air quality damage costs are almost £15.7m in total, these costs mainly comprise of health cost savings. The added benefit of the improvements in health such as productivity increases and quality of life benefits are also not included.

76. In conclusion the negative NPV does not negate the legal imperative to achieve compliance of the air quality objectives in the City. It also does not capture the improvements to health, wellbeing and the environment that will be achieved through a shift to a low emission economy.

Summary of Key Points and Conclusions

77. The traffic and air quality modelling undertaken by Bradford MDC indicates that a CAZ C+ will be sufficient to ensure compliance with NO2 concentration limits in the shortest possible time.

78. The Cost Benefit Analysis (CBA) forecasts that that the CAZ C plus additional measures, mitigation and exemptions would generate an NPV of -£11,200,000. This means that although the quantified health based savings are significant (at £15.7m), and there are additional benefits in terms of reduced CO2, reduced fuel costs, and vehicle operating costs, these benefits are outweighed by the projected costs to the public, BDMDC and government. This in line with other CAZ studies.

79. The analysis presented in this Economic Case has been carried out in accordance with JAQU guidance and Green Book principles however it also rests on some key assumptions, some of which are uncertain. Additionally, there are a number of potentially significant health and non-health impacts that have not been quantified or monetised.

80. The distributional impacts appraisal shows that the biggest improvements in air quality are in the most deprived communities, with a significant positive impact across the entire population.

81. The distributional impacts appraisal also looked at the change in NO_2 pollutant at sensitive receptors. The results from this analysis found that on average, receptors whether located inside or outside the CAZ were predicted to benefit from lower annual average NO_2 concentrations. With the biggest benefits at schools (as many are in roadside locations).

82. The CAZ C+ will impact on businesses and these impacts will be greatest for local SMEs who are less able to internalise costs. These impacts can be offset to a significant extent by a tailored package of grants and exemptions offering support where it is needed most.