



## **Bath Clean Air Plan**

Bath and North East Somerset Council

### **Stated Preference Survey Report**

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## Bath Clean Air Plan

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## Contents

<b>1.</b>	<b>Introduction.....</b>	<b>2</b>
1.1	Overview of the Study .....	2
1.2	Purpose of this Report.....	3
1.3	Report Structure.....	3
<b>2.</b>	<b>Survey Design.....</b>	<b>5</b>
2.1	Overview.....	5
2.2	Questionnaire Structure .....	5
2.3	Screening Questions.....	5
2.4	Vehicle Questions .....	6
2.5	Frequency of driving to the centre of Bath .....	6
2.6	Clean Air Zone: Introduction .....	6
2.7	Clean Air Zone Exercise 1 .....	6
2.8	Clean Air Zone Exercise 2.....	7
2.9	Questionnaire Assessment.....	8
2.10	Demographic questions.....	8
2.11	Questionnaire versions.....	8
<b>3.</b>	<b>Implementation and Sampling.....</b>	<b>9</b>
3.1	Implementation and Sampling .....	9
3.2	Testing Surveys .....	10
3.3	Survey Pilot.....	10
3.4	Quotas Achieved.....	10
3.5	Ineligible respondents .....	10
3.6	Sample profile.....	11
<b>4.</b>	<b>Data Checks and Cleaning.....</b>	<b>16</b>
4.1	Sense Checks.....	16
4.2	Logic Checks .....	19
4.3	Summary .....	20
<b>5.</b>	<b>Stated Preference Analysis and Results.....</b>	<b>21</b>
5.1	Segmentation.....	21
5.2	Factoring.....	21
5.3	Weighting.....	21
5.4	Exercise 2 Model and Results (Pay Charge or Replace Vehicle) .....	22
5.5	Exercise 1 Model and Results: (Pay Charge or Changing Travel Behaviour).....	24
5.6	Combined Model.....	26
<b>6.</b>	<b>Summary .....</b>	<b>29</b>

**Appendix A. Survey Questionnaire**

**Appendix B. Model Detailed Analysis**

## Acronyms and Abbreviations

AQMA	Air Quality Management Area
AQAP	Air Quality Action Plan
AQO	Air Quality Objective
B&NES	Bath and North East Somerset
BCC	Bristol City Council
CAZ	Clean Air Zone
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
EU	European Union
EV	Electric Vehicle
HGV	Heavy Goods Vehicle
JAQU	Joint Air Quality Unit
LA	Local Authority
LGV	Light Goods Vehicle
NO <sub>x</sub>	Nitrogen Oxides
NO <sub>2</sub>	Nitrogen Dioxide
SP	Stated Preference

## 1. Introduction

Poor air quality is the largest known environmental risk to public health in the UK<sup>1</sup>. Investing in cleaner air and doing more to tackle air pollution are priorities for the EU and UK governments, as well as for Bath and North East Somerset Council (B&NES). B&NES has monitored and endeavoured to address air quality in Bath, and wider B&NES, since 2002. Despite this, Bath has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO<sub>2</sub>) and these are predicted to continue until 2025 without intervention.

In 2017 the government published a UK Air Quality Plan for Nitrogen Dioxide<sup>2</sup> setting out how compliance with the EU Limit Value for annual mean NO<sub>2</sub> will be reached across the UK in the shortest possible time. Due to forecast air quality exceedances, B&NES, along with 27 other Local Authorities, was directed by Minister Therese Coffey (Defra) and Minister Jesse Norman (DfT) in 2017 to produce a Clean Air Plan (CAP). The Plan must set out how B&NES will achieve sufficient air quality improvements in the shortest possible time. In line with Government guidance B&NES is considering implementation of a Clean Air Zone (CAZ), including both charging and non-charging measures, in order to achieve sufficient improvement in air quality and public health.

Jacobs has been commissioned by B&NES to produce an Outline Business Case (OBC) for the delivery of the CAP; a package of measures which will bring about compliance with the Limit Value for annual mean NO<sub>2</sub> in the shortest time possible in Bath. The OBC assesses the shortlist of options set out in the Strategic Outline Case<sup>3</sup>, and proposes a preferred option including details of delivery. The OBC forms a bid to central government for funding to implement the CAP.

This document is written to support the OBC and details the Stated Preference surveys undertaken to determine localised response rates of car or van drivers to a potential charging zone.

### 1.1 Overview of the Study

In order to help understand travel behaviour within the zone and how this could change should charging be introduced, a survey of those who drive in the proposed zone was conducted using stated preference techniques. The survey also collected information on respondents' demographics and existing vehicle replacement plans.

The extent of the proposed CAZ presented in the survey is depicted in Figure 1-1. Some minor changes have since been made to the zone boundary as a result of the engagement process and design constraints.

<sup>1</sup> Public Health England (2014) Estimating local mortality burdens associated with particular air pollution.

<https://www.gov.uk/government/publications/estimating-local-mortality-burdens-associated-with-particulate-air-pollution>

<sup>2</sup> <https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017>

<sup>3</sup> Bath and North East Somerset Council Clean Air Plan: Strategic Outline Case, March 2018

[http://www.bathnes.gov.uk/sites/default/files/siteimages/Environment/Pollution/strategic\\_outline\\_case\\_bath\\_28.03.2018\\_with\\_annexes.pdf](http://www.bathnes.gov.uk/sites/default/files/siteimages/Environment/Pollution/strategic_outline_case_bath_28.03.2018_with_annexes.pdf)

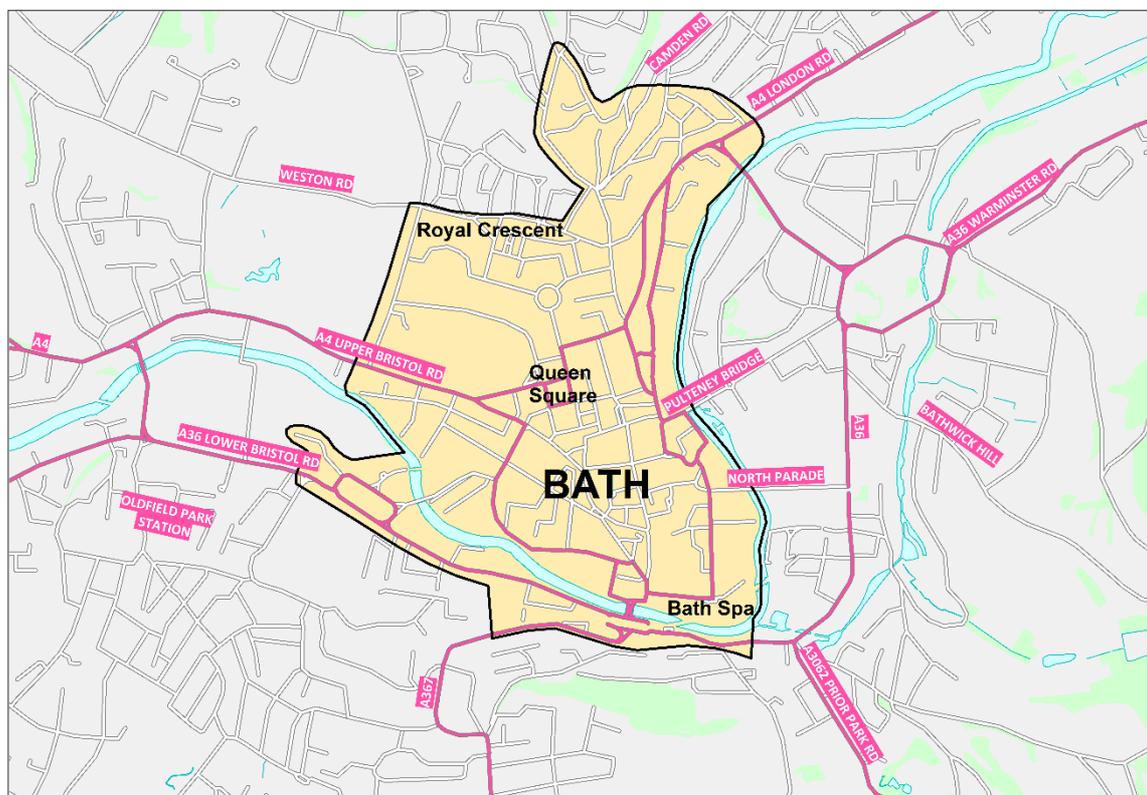


Figure 1-1: Small Clean Air Zone<sup>4</sup>

The main focus of the survey was on motorists who own and drive a car or van that does not comply with the limits in Defra's CAZ Framework<sup>5</sup>, specifically:

- Petrol vehicles with emissions standards earlier than Euro 4/IV (approximately registered pre-2006); and
- Diesel vehicles with emissions standards earlier than Euro 6/VI (approximately registered pre-2015).

The survey period was conducted between 10 May and 11 June 2018

## 1.2 Purpose of this Report

This report summarises the key stages in the development and implementation of the web-based stated preference questionnaire used to collect the data.

It also provides an overview of the data processing, final results and conclusions from the conducted study.

## 1.3 Report Structure

The report covers the following sections:

- **Survey Design:** provides an overview of the key stages in the development of the stated preference survey.
- **Implementation and Sampling:** describes the data collection and sampling methodologies.

<sup>4</sup> © Crown Copyright 2018. License number 100023334

<sup>5</sup> Clean Air Zone Framework, Principles for setting up Clean Air Zones in England, Department for Environment Food & Rural Affairs & Department for Transport, May 2017

- **Data Checks and Cleaning:** describes sense and logic checks, and the data cleaning process.
- **Stated Preference Analysis and Results:** describes the methods to analyse the stated preference exercises and an overview of the results from these.
- **Conclusion:** summary of the headline results and conclusions from the survey.

## 2. Survey Design

### 2.1 Overview

The survey was conducted among residents of Bath and North East Somerset Council and the surrounding Local Authorities. Participants were obtained from an online market research panel allowing the survey to be targeted at a representative sample (age, gender) of the resident population.

Initial screening questions then limited the main survey to those who have recently driven within the proposed clean air zone boundary in a car or light van (under 3.5 tonnes) that does not comply with the standards, which are:

- Petrol vehicles with emissions standards earlier than Euro 4/IV (approx. registered pre-2006); and
- Diesel vehicles with emissions standards earlier than Euro 6/VI (approx. registered pre-2015).

Vehicles which meet the standards of the CAZ framework, and therefore would not be charged within a CAZ (barring potential exemptions), are referred to as 'compliant' vehicles within the remainder of this report, and vice versa for 'uncompliant' vehicles.

The questionnaire collected information on the most recent trips of drivers of non-compliant vehicles within the affected zone and how the drivers may respond to various levels of proposed charge. The questionnaire also collected information on the vehicle replacement plans in terms of timescales and likely type of vehicle.

To identify the behavioural changes, two exercises were included in the questionnaire, testing responses to possible charges. All of the data was collected using an online questionnaire.

Exercise 1 provided a number of possible actions the respondent might have taken if charging had been in place the last time they drove in the CAZ. One of the options was continuing to use their current vehicle to make the journey and pay the charge.

The purpose of Exercise 2 was to work out whether the respondent would replace the vehicle with a compliant one if CAZ charging is implemented. The respondent had a choice between two options: either continue to pay the charge or replace their vehicle.

The questionnaire used to test responses to the potential CAZ in Bristol was used as a basis to design the questionnaire used in this study. The Bristol CAZ survey had, in turn, been based on the London Ultra Low Emission Zone stated preference survey, conducted for Transport for London by Steer Davies Gleave.

### 2.2 Questionnaire Structure

A summary of the questionnaire is provided in this section. The full survey can be found in Appendix A of this document.

### 2.3 Screening Questions

The questionnaire started with a series of screening questions in order to exclude all non-eligible participants early in the process. The screening was based on the following criteria:

- Home postcode;
- Age of the respondent (to check whether he/she is eligible to drive);
- Vehicle type;
- Registration date;
- Decision making over vehicle replacement;
- Vehicle fuel type; and

- Frequency of travel to CAZ.

This was used to ensure that only people who drive a non-compliant car or LGV within the CAZ at least once every 6 months, make the decision about its replacement and live in B&NES, Bristol, South Gloucestershire, North Somerset or selected wards in Somerset and Wiltshire Local Authority (LA) areas were included in this survey.

## 2.4 Vehicle Questions

This section included questions about the respondent's current vehicle, including size and age of the vehicle, as well as the number of additional vehicles in the household (if any). The information about the additional vehicles in the household was required to work out if any of these were compliant and if the respondent is likely to use it to travel in/through the zone in light of the introduction of the charging scheme.

The section also collected information on the vehicle replacement plans, including planned timescales for replacing the vehicle, as well as expected age, size and fuel type of the replacement vehicle. These questions are all asked before any mention of the proposed clean air charge to avoid this information influencing these choices.

## 2.5 Frequency of driving to the centre of Bath

This question was asked to measure the overlap between driving in central Bath and Bristol, where a Clean Air Zone is also being considered.

## 2.6 Clean Air Zone: Introduction

This section started with an introduction to the Clean Air Zone and the proposed charging scheme. This is the first time within the survey that the concept of a Clean Air Zone is mentioned.

The question about the compliancy of additional vehicles available in the household (if any) was also asked in this section.

This section collected information on the purpose of the most recent journey the respondent had made to the study zone.

## 2.7 Clean Air Zone Exercise 1

The next section consisted of an exercise to help understand the possible short-term behaviour of the respondent assuming CAZ charging is introduced. For this exercise the respondent was asked to choose between several possible alternatives in relation to their most recent journey:

- Making the same journey using your own vehicle and paying the charge (varies by scenario);
- Making the same journey but using a different mode (e.g. public transport, cycle, walk);
- Not making the journey;
- Changing destination to avoid the charging area;
- Changing route to avoid the charge; and
- Making the same journey but using a compliant vehicle available in your household. (only included if respondent had indicated they had access to such a vehicle).

Asking specifically for the most recent journey is intended to obtain a split of different journey purposes rather than just asking about the most frequent trip the respondent makes in the zone.

The exercise consisted of four different scenarios where the only difference was the charge level. Half the sample were shown one set of 4 charges and the other half of the sample were shown another set of 4 charges; thus, across the survey, 8 charge levels were tested.

The different charge levels for Exercise 1 are summarised in Table 2-1.

**Table 2-1: Exercise 1 Charge Levels**

Charge (£)	
Subgroup 1	Subgroup 2
£5.00	£3.00
£7.00	£6.00
£9.50	£8.00
£12.50	£10.50

## 2.8 Clean Air Zone Exercise 2

The second exercise concerned the potential long-term behaviour assuming CAZ charging was in place.

The only options provided in this exercise were to either continue paying the charge when travelling in/through CAZ using the current vehicle, or to replace the vehicle with a compliant one at a given hypothetical cost. The respondents were asked to assume that this cost was sufficient to replace their vehicle with a compliant one and to set aside any considerations about their current vehicle type and replacement plans.

The purpose of this exercise was to establish whether the respondent is likely to switch to a compliant vehicle assuming a CAZ is in place, and how this decision would vary depending on the charge level/vehicle replacement cost.

For this exercise respondents had to complete six different scenarios. The difference between the scenarios was the combination of charge level and replacement cost. Across the survey 12 scenarios were assessed, 6 to each half of the sample, the combinations are shown in Table 2-2 below:

**Table 2-2: Exercise 2 Charge Levels**

Subgroup 1		Subgroup 2	
Charge (£)	Replace (£)	Charge (£)	Replace (£)
£3.00	£9,000	£5.00	£10,000
£4.00	£3,000	£6.00	£1,000
£10.00	£10,000	£6.00	£6,000
£9.00	£2,000	£8.00	£5,000
£11.00	£6,000	£12.00	£8,000
£7.00	£8,000	£13.00	£4,000

## 2.9 Questionnaire Assessment

In the next section the respondent was asked to provide their assessment of the survey, covering topics such as:

- Complexity of the survey;
- Clarity of descriptions and explanations used in the questionnaire; and
- Practicality of the vehicle replacement costs.

It also allowed for the respondent to expand on why they had found the exercise difficult to complete or why the vehicle replacement costs seemed very unrealistic should they have selected these responses.

## 2.10 Demographic questions

The last section collected demographic information about the respondent, including employment status, occupation, household income, gender, ethnicity and disabilities.

This information is useful to analyse the demographic make-up of the sample and its representativeness, potential demographic related variances in response to the charge zone as well as assist in the segmentation of the results for use in the transport modelling.

The questionnaire finishes with an open-ended question which gives an opportunity for the respondent to provide any comments about the survey or the topic itself.

## 2.11 Questionnaire versions

There were 2 versions of the questionnaire each containing different levels of charge. The version assigned was randomly selected so that each version was completed by approximately half of the respondents.

To further avoid order bias, the order in which charge levels and charge levels/replacement costs were presented in Exercises 1 and 2 was randomised.

### 3. Implementation and Sampling

#### 3.1 Implementation and Sampling

Crystal Market Research worked with Jacobs throughout the survey development and implementation process. The questionnaire used for the City of Bristol CAZ was reviewed and adapted for the purposes of the study in Bath. The online version of the questionnaire was programmed by Indiefield – to be usable on all types of device.

The survey participants were recruited using a market research panel held by Indiefield. A panel is a database of people who have ‘signed up’ to take part in market research studies and receive a small payment for doing so. They have provided contact, demographic, behavioural and ownership details about themselves that enables targeting of relevant types of people for a particular survey

For this survey a representative sample of the Indiefield panel living in the LA areas, based on quotas for gender and age (17-34, 35-54, 55+) using 2011 Census data, was contacted by email and invited to take part in the survey. Each participant was offered a small financial incentive to complete the survey. The panel sample was contacted in batches and email reminders were sent out to those who had not responded. Each invitation email contained a questionnaire link with a unique ID that was possible to open only once, thereby preventing an individual questionnaire from being completed multiple times.

Clicking on the survey link took invites to a series of ‘screening’ questions (as described in section 2.3) to establish whether or not they met the requirements for completing the main questionnaire. To be eligible to complete the main questionnaire the respondent had to:

- Live in B&NES, Bristol, South Gloucestershire, North Somerset or selected Somerset and Wiltshire wards;
  - Be aged 17+;
  - Drive a car or LGV that is non-compliant under the Defra CAZ Framework;
  - Be a joint or sole decision maker over the replacement of that vehicle; and
  - Drive in the clean air zone in Bath at least once every 6 months.
- The target completion rate for respondents driving into the CAZ was 1100

Table 3-1 below summarises the target splits by Local Authority for the required questionnaire completion rate. Initial targets were calculated from 2011 travel to work Census data with minor adjustments during the survey based on the eligibility rates (i.e. the % of initial respondents passing the screening questions).

**Table 3-1: Target Splits by Local Authority**

Local Authority	Number of Respondents	Proportion
<b>B&amp;NES</b>	570	52%
<b>Bristol</b>	70	6%
<b>South Gloucestershire</b>	20	2%
<b>North Somerset</b>	90	8%
<b>Somerset</b>	110	10%
<b>Wiltshire</b>	240	22%
<b>Total</b>	<b>1100</b>	<b>100%</b>

The survey was targeted at a representative sample (of age and gender) to the population of panel members.

### 3.2 Testing Surveys

The questionnaire underwent internal testing prior being sent to the survey panel. The key focus of the tests was to check:

- The sequence and logic of the questions;
- That the screening out process worked correctly;
- The randomisation of scenarios worked for all of the exercises; and
- No technical issues occur during the completion of the survey.

### 3.3 Survey Pilot

As this survey was based upon the recently completed Bristol CAZ survey it was deemed unnecessary to undertake a specific pilot of the Bath survey.

### 3.4 Quotas Achieved

The survey was conducted between the dates of 10 May and 11 June 2018 with a total of 1160 questionnaires completed from a target of 1100.

Table 3-2 provides a summary of the target and achieved sample sizes.

**Table 3-2: Local Authority Targets and Achieved Sample**

Local Authority	Target	%Target	Actual	%Actual
<b>B&amp;NES</b>	570	52%	540	47%
<b>Bristol</b>	70	6%	131	11%
<b>South Gloucestershire</b>	20	2%	29	3%
<b>North Somerset</b>	90	8%	90	8%
<b>Somerset</b>	110	10%	133	11%
<b>Wiltshire</b>	240	22%	237	20%
<b>Total</b>	<b>1100</b>	<b>100%</b>	<b>1160</b>	<b>100%</b>

### 3.5 Ineligible respondents

Of the respondents who opened the link only 31% were eligible to complete the full questionnaire. Figure 3-1 shows the proportion that were eliminated at each of the screening questions.

Notable reasons for elimination were: not driving a car or van (18% of those starting the questionnaire), vehicle too new (32%) and not driving in the zone either at all, or within the last 6 months (11%). When interpreting these numbers, care should be taken to note that the questions were asked in order and only up until the point that the respondent was found to be ineligible. Thus, of those eliminated because their vehicle was already compliant, a number may have also not driven in the zone.

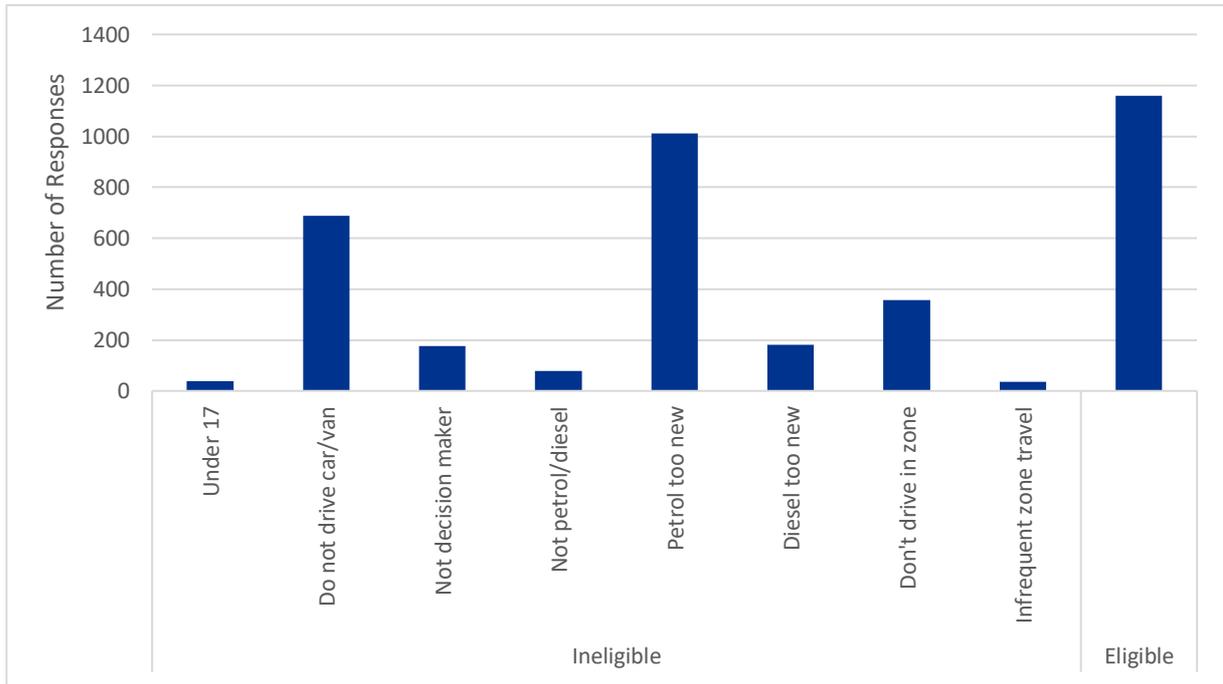
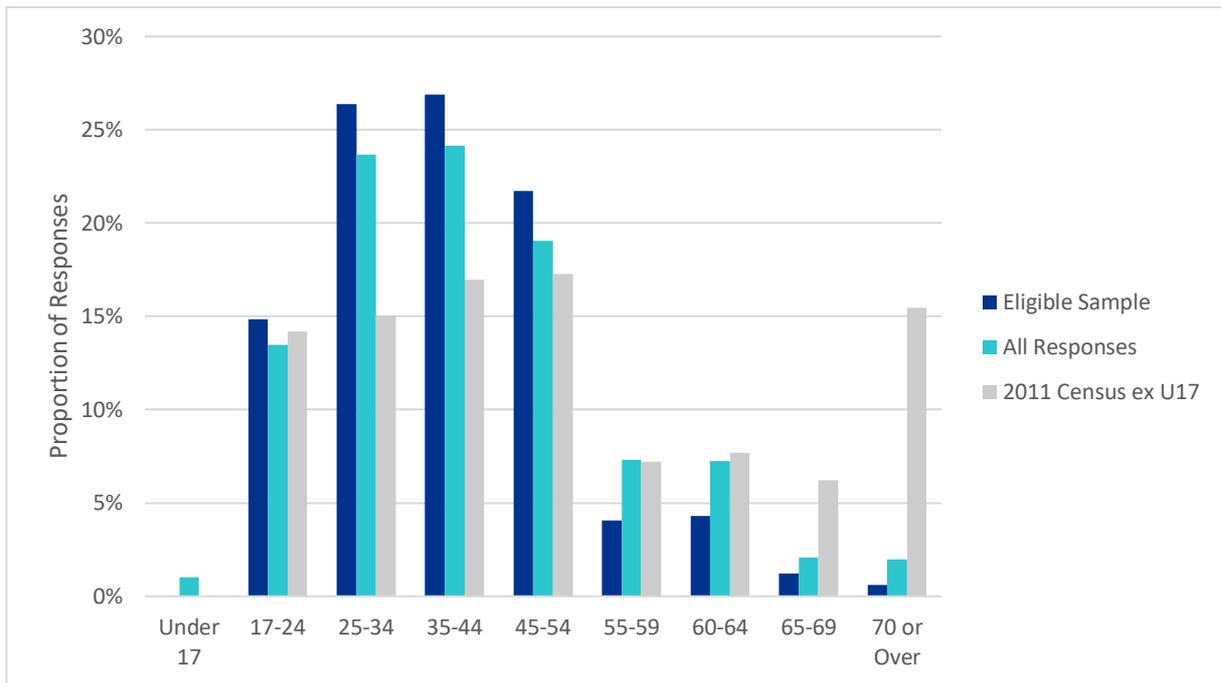


Figure 3-1: Ineligible Respondents

### 3.6 Sample profile

The split of respondents in each individual age group both before and after screening questions is presented in Figure 3-2. Approximately 90% of the eligible sample falls within the age range of 17 to 54, with the highest proportion of respondents in age group 35-44 followed closely by age group 25-34. The age profile of the sample is also compared with both age profile of the eligible area according to the 2011 Census (with under 17s excluded).



**Figure 3-2: Respondents by Age Group**

The screening process skews the sample towards younger people. It is thought that there could be two main drivers behind this. First, younger people are more likely to be economically active and therefore travel within the zone more often. Secondly, older people have a number of potential reasons to be less likely to be eligible. The demographic tends to be wealthier and therefore may be more likely to already have a compliant vehicle and also have more attractive alternatives such as free bus travel.

Comparing the profile of pre-screening responses to the age profile of residents in 2011 shows a further skew towards ages 25-45 and away from those over 65. This is likely in part due to the online nature of the panel. Though emails were targeted at a representative sample, there is likely still a limitation in the response rate/engagement from older demographics.

Given the low eligibility rates amongst these ages noted, it is considered that the impact of this on the final results is limited with, at most, 90 more respondents in the younger age bands and correspondingly fewer in the eldest two.

Participants were asked about the fuel type of their vehicle and, as can be seen in Figure 3-3, a higher share of respondents had a petrol vehicle.

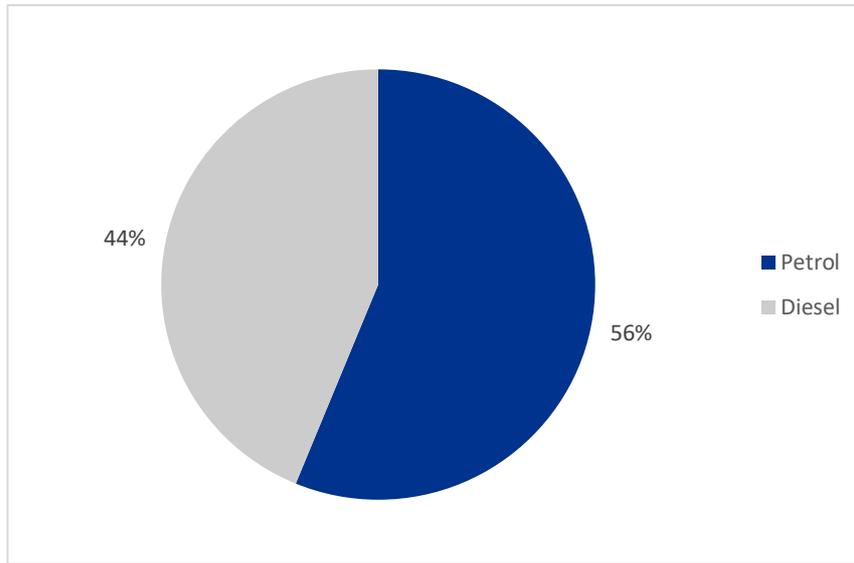


Figure 3-3: Respondent's Non-Compliant Vehicles by Fuel Type

Figure 3-4 and Figure 3-5 show that majority of the respondents (70%) were in full-time employment in a range of different occupations.

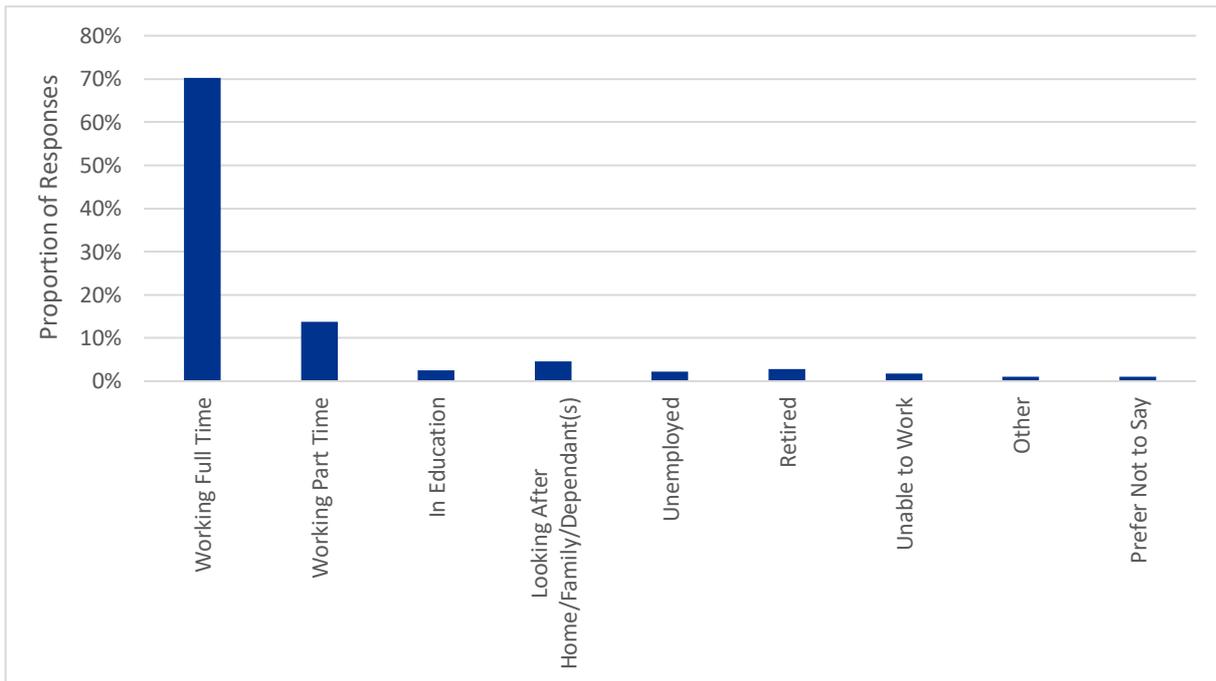
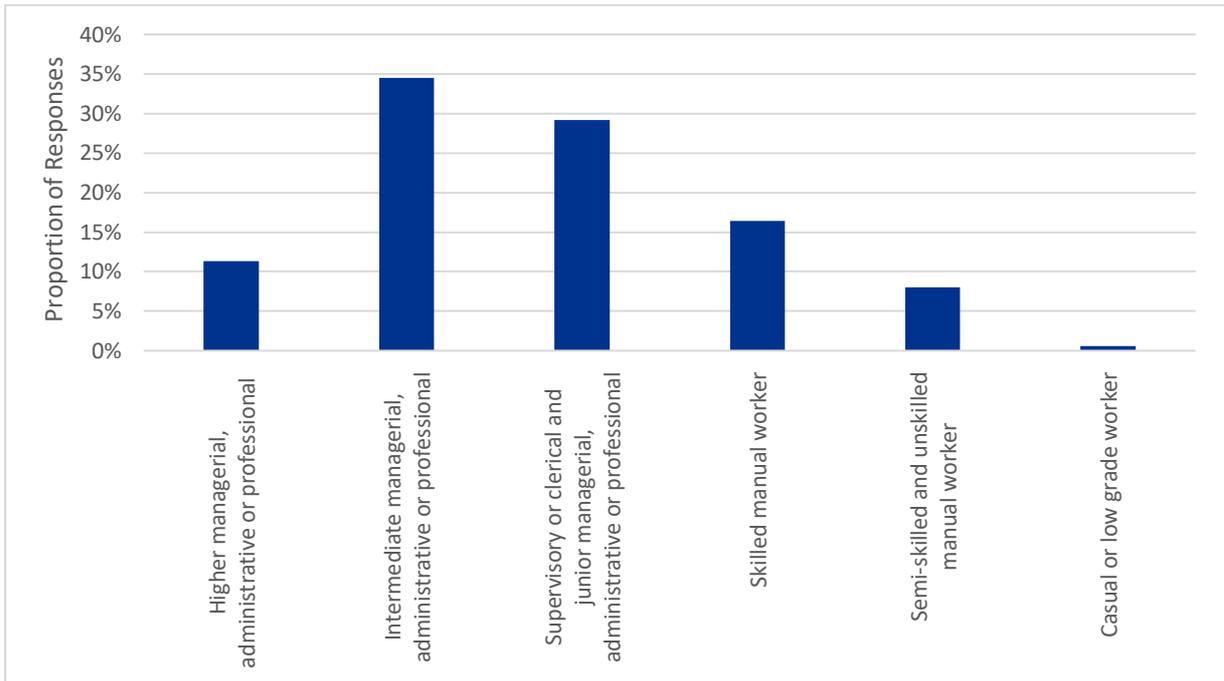
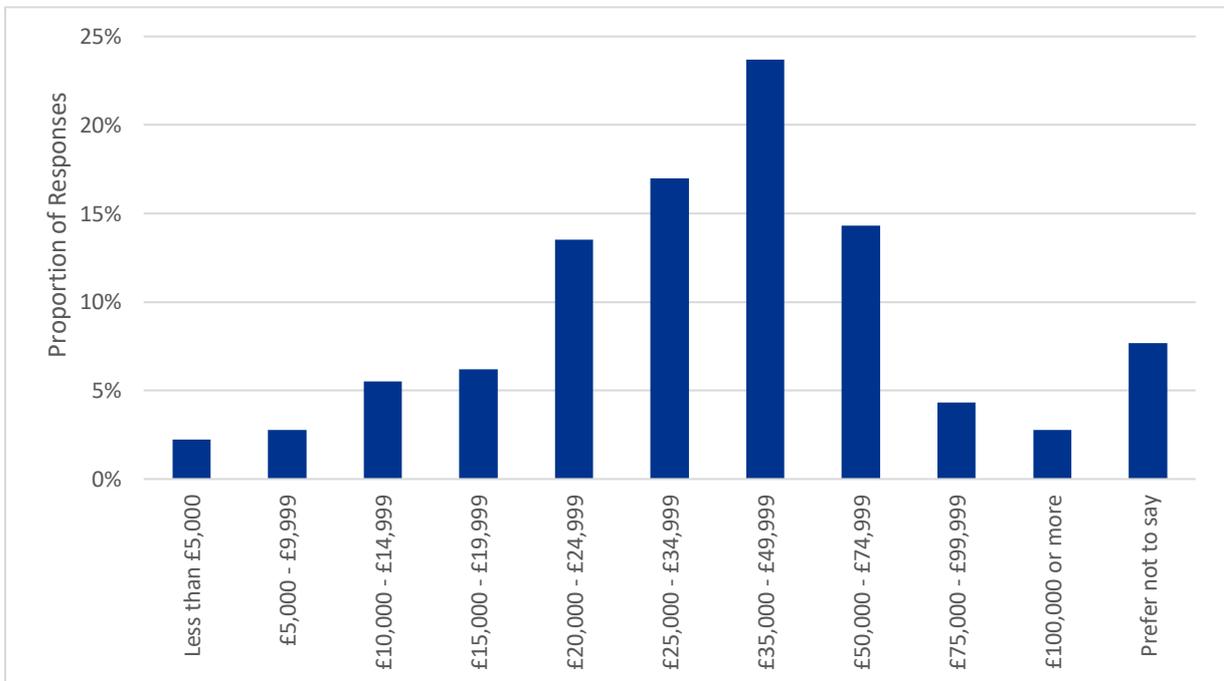


Figure 3-4: Number of Respondents by Employment Status



**Figure 3-5: Number of Respondents by Occupation**

The income profile of respondents is shown in Figure 3-6. The £35,000-£49,999 household income band has the highest number of respondents, with most between £20,000 and £74,999.



**Figure 3-6: Household Income Distribution**

Figure 3-7 shows a relatively broad mix of trip purposes were sampled by the survey. Travel for leisure/entertainment and shopping were the joint largest at approximately 21% of the trips taken each.

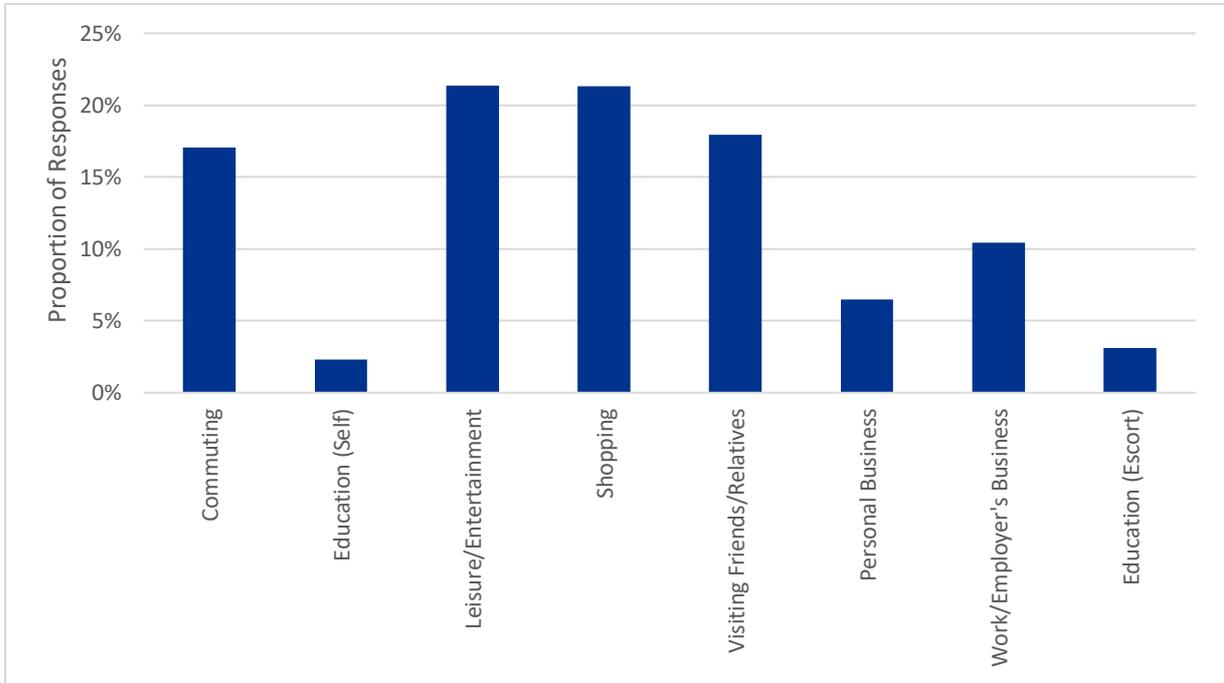


Figure 3-7: Trip Purposes Sampled

## 4. Data Checks and Cleaning

The data collected via the online survey underwent a number of sense and logic checks in order to discard any non-sensical data.

Rather than excluding a questionnaire on specific automated criteria, a series of checks were set up to flag a subset of the responses for further investigation. The internal consistency of each questionnaire was then manually assessed and a decision made on whether to discard the record. This section discusses the aspects considered in this process.

### 4.1 Sense Checks.

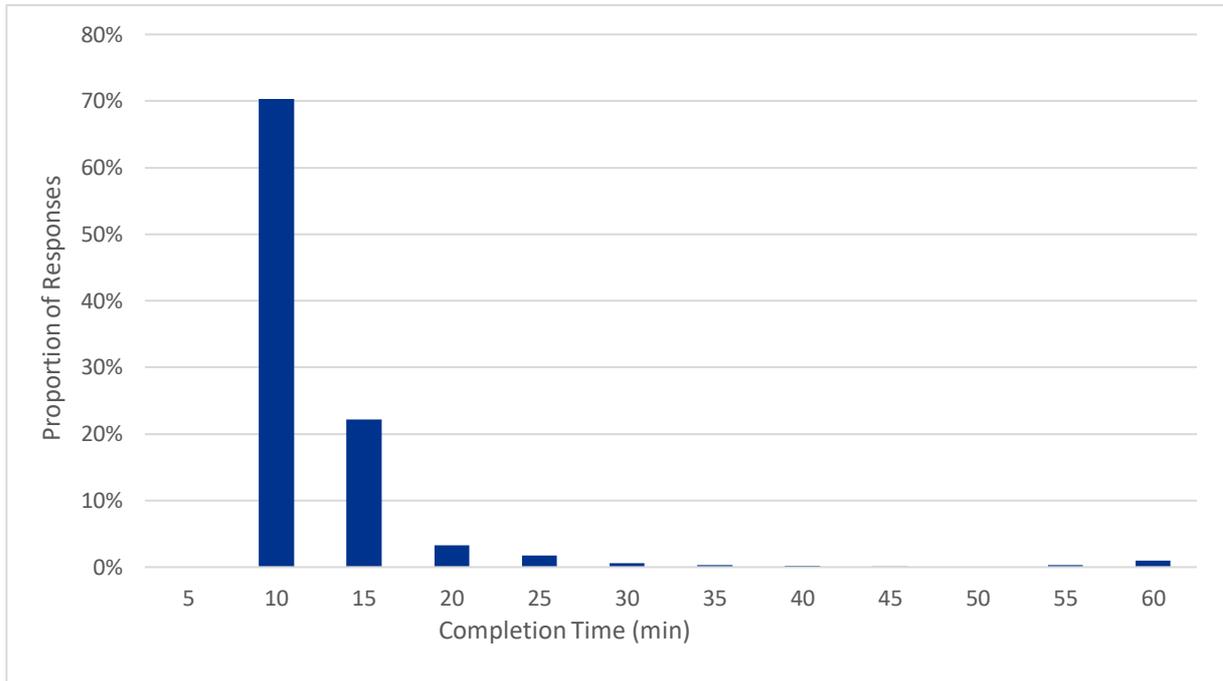
The following aspects were considered in detail during the sense checks of questionnaires:

- Questionnaire completion time;
- Respondent's assessment of the survey;
- Overall logic of the responses; and
- Answers to open ended questions.

Questionnaire completion times were analysed in more detail to identify the amount of time considered to be sufficient to complete the questionnaire. The questionnaires completed outside the identified time range were checked in more detail for overall logic of the responses as these can indicate a questionnaire filled in without much thought or in a distracted manner.

- Out of 1160 questionnaires completed:
- 135 questionnaires were completed in 7 minutes or less;
- 18 were completed in 35 minutes or more.

Figure 4-1 below provides a summary of the completion times for all of the questionnaires collected as part of the study. Long completion times were likely due to a respondent completing part of the survey and then returning to it later.



**Figure 4-1: Questionnaire Completion Time (min)**

The design of the questionnaire allowed for the respondent’s assessment of:

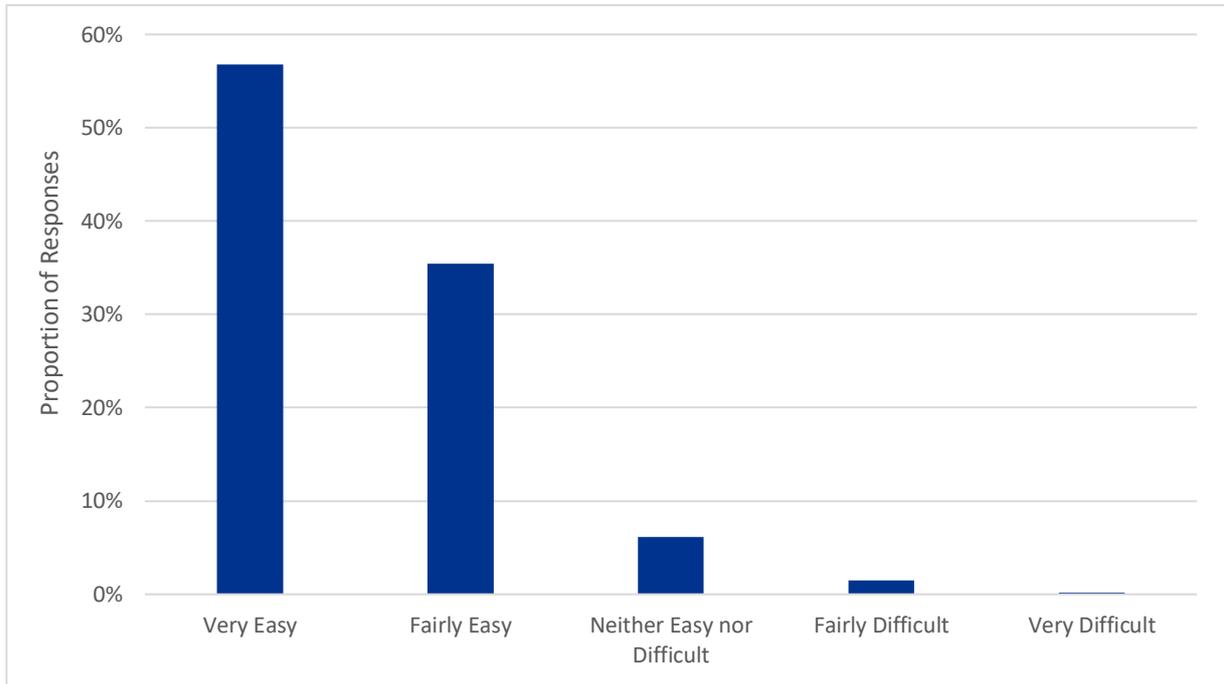
- Overall difficulty of the survey;
- Clarity of the definitions and explanations; and
- Practicality of vehicle trade-in (replacement) costs.

If the respondent found either of the Exercises particularly difficult or the vehicle replacement costs very unreasonable, there was an option to provide reasoning in a comment box.

The questionnaires where the respondent found the stated preference exercise too difficult to complete, the definitions and explanations very unclear or the vehicle replacement too unrealistic, were analysed in more detail. It was considered that the responses provided in such questionnaires might not be sufficiently accurate.

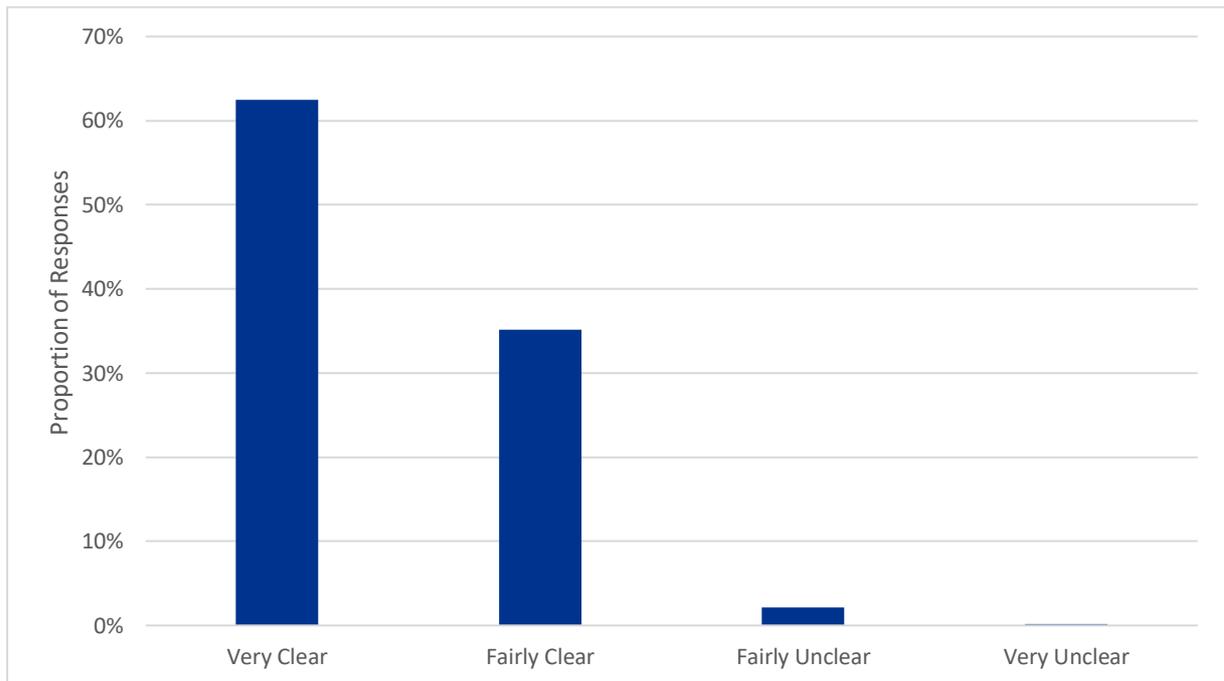
- From 1160 respondents that completed the stated preference questionnaire:
- 2 respondents found the exercise very difficult;
- 2 respondents found the survey explanations and definitions very unclear; and
- 76 respondents considered the replacement costs very unrealistic.

Figure 4-2 below provides the proportion of responses by the perceived difficulty of the questionnaire for the survey prior to any data cleaning or elimination.



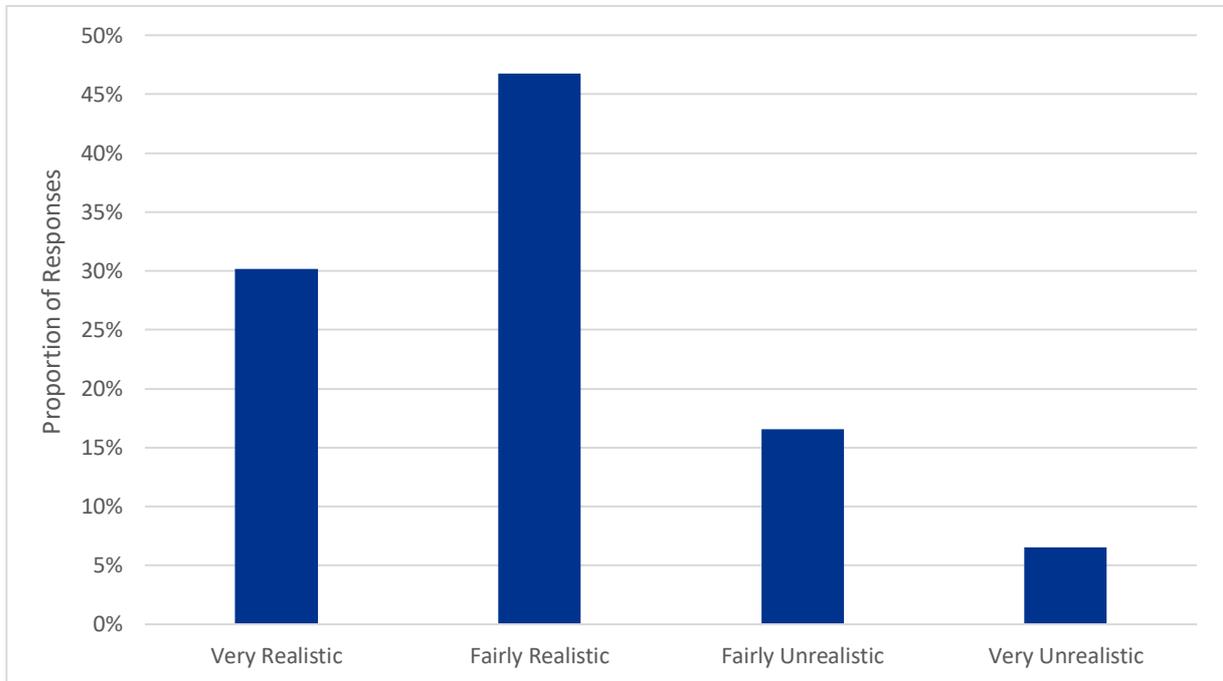
**Figure 4-2: Assessment of the Questionnaire Difficulty**

Figure 4-3 shows the number of responses by perceived clarity of the explanations and definitions used in the stated preference questionnaire for the survey prior to any data cleaning or elimination.



**Figure 4-3: Assessment of the Clarity of the Explanations and Definitions**

Figure 4-4 shows the perceived realism of vehicle replacement costs for the survey prior to any data cleaning or elimination.



**Figure 4-4: Practicality of the Vehicle Trade-in (Replacement) Costs**

If a respondent chose to pay the CAZ charge at all levels at Exercise 1 they were asked to explain why. Likewise, if, at Exercise 2, a respondent always chose to pay the charge or always chose to replace their vehicle, regardless of charge level/ replacement cost, they were asked to give an explanation.

At the end of the survey the respondents also had an option to provide general comments on the topic of the survey or the questionnaire itself. Any questionnaires containing non-sensical or highly emotional written answers or comments were investigated in more detail to assess the overall logic of the responses. In addition, further checks were done for the questionnaires where the respondent seemed particularly biased towards or against the CAZ scheme, to see if this might have had an impact on the responses to exercises.

The key factor in the sense checks was the internal consistency of each questionnaire. Some of these checks included the relation between:

- Respondent's occupation and household income;
- Residential postcode and frequency of travel to a particular zone;
- Travel purpose and frequency of travel; and
- Near-identical record data indicating duplicate submission.

## 4.2 Logic Checks

To review the responses to exercises 1 and 2 some logic checks were used to remove illogical responses that suggested the respondent either did not understand the questionnaire or was not thinking about the answers and selecting responses at random.

### 4.2.1 Exercise 1: Pay charge vs behaviour change

For the short term response exercise, responses were flagged where the respondent had suggested they would pay a more expensive CAZ charge but change behaviour for a cheaper CAZ charge.

#### 4.2.2 Exercise 2: Pay charge vs replace vehicle

For the second exercise, where the respondent had selected a mix of choices, (i.e. to pay the charge to some combinations of charge and cost but replace vehicle to others), the average replacement cost per charge was computed for both the 'pay charge' and 'replace vehicle' responses. If this average value was higher for the 'replace vehicle' responses then the record was discarded from consideration as this suggests the respondent would be prepared to pay the charge for relatively high charges to low replacement costs and vice versa.

Consider the following two hypothetical responses to Subgroup 2:

**Table 4-1: Example of Exercise 2 Logic Check**

Charge (£)	5	6	6	8	12	13
Replacement Cost (£)	10,000	1,000	6,000	5,000	8,000	4,000
Average replacement cost per charge (£)	2,000	167	1,000	625	667	308
Respondent 1 decision	Pay charge	Replace	Pay charge	Replace	Replace	Replace
Respondent 2 decision	Pay charge	Pay charge	Replace	Pay charge	Pay charge	Pay charge

For respondent 1, the average 'replacement cost per charge' of the choices to pay the charge are 1,500 while for upgrading it is 442, the difference of 1058 is therefore positive and the questionnaire is not discarded. This is reflected in the answers; respondent 1 has consistently chosen to pay the charge when it is relatively cheaper (e.g. first column) but replace the vehicle when the charge is relatively expensive (second column).

Respondent 2, meanwhile has an average of 753 for the selections to pay the charge and 1,000 for replacing the vehicle. The difference is therefore a negative, -247. This is reflected in the answers, particularly the second and third columns: for the same £6 charge respondent 2 has elected to replace the vehicle if it would cost them £6,000 but not if it only cost £1,000. Data for this participant would not be included in the final analysis for exercise 2.

Surveys that were excluded in this manner were not excluded from other analysis providing the responses were otherwise logical. This is considered reasonable as the hypothetical and somewhat unintuitive nature of exercise 2 means a respondent may not understand fully what is being asked for but is still able to provide accurate answers to the rest of the survey.

### 4.3 Summary

As the result of the process, 110 (10.5%) questionnaires out of 1160 were removed entirely from the final dataset. A further 95 records were removed from consideration for Exercise 2. This process has ensured that a potentially erroneous data is removed from the sample and is not relied upon when extracting results from the survey data.

## 5. Stated Preference Analysis and Results

This section presents an overview of the segmentation, factoring and weighting applied to the data. It then discusses the type of statistical model used for each of the exercises and then presents and discusses the final statistical models as used to inform in the transport modelling. As part of the factoring and weighting process, significance testing of a number of potential variables was undertaken. For brevity, the detail and outputs for this are not included in this section of the report and instead can be found in Appendix B of this report.

### 5.1 Segmentation

To align with the transport modelling work being undertaken to forecast the impact of a charging clean air zone, statistical models from the survey data were produced in three segments:

- All trips - used for the response of Cars to the CAZ
- Employer's Business - used to provide information for the response of LGVs.

### 5.2 Factoring

For the creation of statistical models from the results, responses were factored by the reported frequency of travel in the proposed zone. This serves as a method of transforming the units of the sample from that of unique users into non-compliant car trips into the zone.

This reflects that a 'typical' daytime 5 days a week commuter within the zone who chooses to change mode leads to a one vehicle reduction in flows in both the AM and PM peaks. Someone who only works one day a week, however, will only result in a reduction of 0.2 vehicles when considering an 'average weekday'.

Significance testing indicated that, without factoring, reported frequency is a significant predictor in response to the zone, particularly regarding the choice to replace the vehicle. This is unsurprising as a more frequent traveller will incur the charge more often and therefore replacing the vehicle becomes better value for money. With factoring the influence of reported frequency was considerably reduced though not eliminated.

### 5.3 Weighting

After factoring by reported frequency, the sample is weighted by trip purpose and fuel type when developing the statistical models. The purpose of this is to better fit the profile of trips in the zone as it is not possible to ensure the survey targets or returns a representative sample of fuel types or trip purposes in the zone.

#### 5.3.1 Purpose

The validated 2014 Base Year GBATH model splits cars into 5 user classes covering the following 3 travel purposes:

- Work (Commuting)
- Employer's Business
- Other

By using select link analysis, the proportion of these travelling within the proposed zone can be assessed and used as weighting targets for the survey data as shown in Table 5-1.

**Table 5-1: Proportions and Weighting for Trip Purpose**

Purpose	2014 GBATH	Exercise 1 Sample	Exercise 1 Weighting	Exercise 2 Sample	Exercise 2 Weighting
Work (Commuting)	45%	34%	1.34	35%	1.28
Employer’s Business	6%	13%	0.46	13%	0.47
Other	49%	53%	0.92	52%	0.94

### 5.3.2 Fuel

The target split of non-compliant petrol and diesel cars in the zone was taken from the ANPR survey conducted for the project. The outcome of this is shown in Table 5-2.

**Table 5-2: Proportions and Weighting for Fuel Type**

Fuel	ANPR	Sample	Exercise 1 Weighting
Petrol	33%	56%	0.59
Diesel	67%	44%	1.53

### 5.3.3 Home Origin/Income

The significance of Home Origin (considered as distance of the respondent’s Post Code from the proposed zone) and household income were also considered. Analysis indicated that while Home Origin only had a small influence over the responses, the influence of income was clear. However, there is little reliable data to serve as a basis for weighting, particularly when considered in the context of who actually travels in the zone (rather than the resident population). As such it was chosen to not attempt to use any weighting or segmentation for either of these variables. Details and outputs from this process can be found in Appendix B of this report.

## 5.4 Exercise 2 Model and Results (Pay Charge or Replace Vehicle)

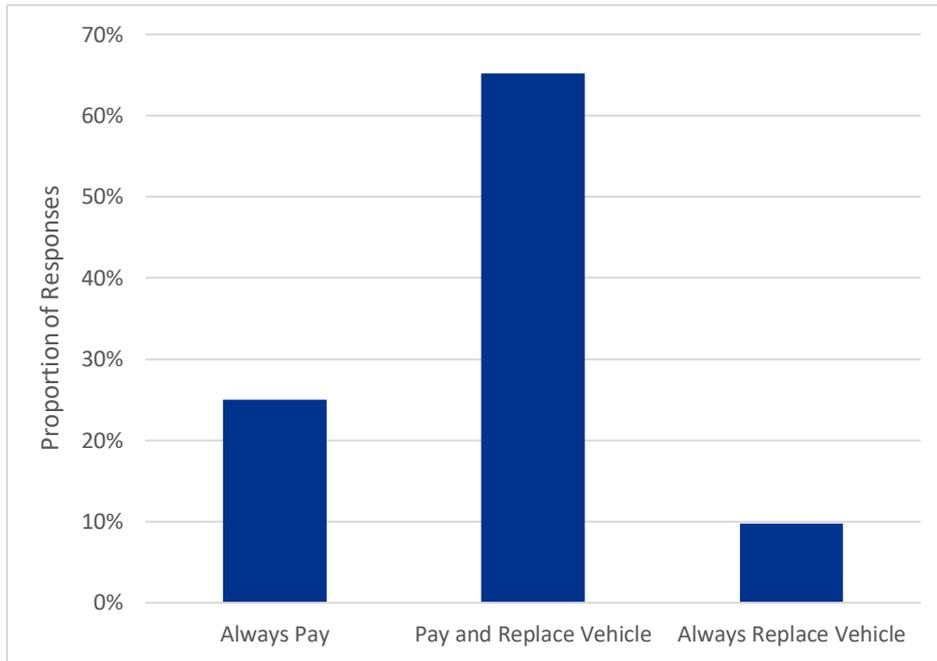
In the final combined statistical model, the choice made in Exercise 2 is considered first and also makes use of a more simple form of logistical regression as it considered just two choices. As such it is appropriate to consider it first in this report.

The second exercise presents a series of choices between paying the charge or upgrading the vehicle to a compliant one for a certain hypothetical cost. Each respondent was presented with one of two sets of six combinations of CAZ charge and replacement costs.

### 5.4.1 Trading – non-trading bias

As discussed in the survey design, the range of price options was developed with the intention that a majority of people would provide a mix of answers to their six sets of choices with relatively even minorities responding that they would either always replace vehicle or always pay the charge.

Figure 5-1 shows the proportion of traders and non-traders in the responses to Exercise 2.



**Figure 5-1: Answer split to Exercise 2**

The sample shows that most respondents provide a mix of choices with only small proportions choosing to always replace the vehicle or to always pay. Over twice as many elected to always pay which indicates a somewhat lower willingness to replace the vehicle compared to the data gathered for the London ULEZ. A possible explanation for this is the comparatively lower wage levels in the region.

**5.4.2 Statistical Model Form and Fitting**

Since Exercise 2 considers a binary choice of either paying the charge or replacing the vehicle, logistical regression was used to develop models of this choice. This will produce a best fit log function that will predict the likely split between paying the charge or replacing the vehicle for a given combination of charge and replacement cost.

**5.4.3 Results**

Model coefficients are reported for a model considering the probability of choosing to pay the charge of the following form:

$$P(\text{charge}) = \frac{1}{1 + e^{-(\text{Const} - \text{coef}C \times \text{Charge} - \text{coef}Up \times \text{Upgrade} \dots \text{etc})}}$$

Further it should be noted that the model coefficients are on the basis that the replacement cost is in units of £000's.

Table 5-3 shows the derived model parameters for the Bath CAZ.

**Table 5-3: Exercise 2 Model Parameters for Bath CAZ (All sample, weighted by purpose & fuel type n=955)**

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Constant	0.188317	0.098808	1.905882	0.056665		
Charge	-0.13668	0.009634	14.18722	1.1E-45	-0.15556	-0.1178
Replace	0.177612	0.010055	17.66355	8E-70	0.157904	0.19732

It can be seen that the coefficient for the charge is negative while for replacing the vehicle it is positive. This makes sense as both a lower charge and a higher replacement cost means it is more likely that someone will pay the charge.

In this case, with a £1 charge and £1000 replacement cost, the model predicts that 54% will pay the charge while at £10 charge and £10,000 replacement cost the model predicts that 64% will pay the charge.

Based on this model, a prediction of the compliance rate for any given charge and replacement cost assumption can be established. For example, the chart in Figure 5-2 shows the surface indicating the proportion who continue to pay the charge predicted by the model across the range of charges and replacement costs considered.

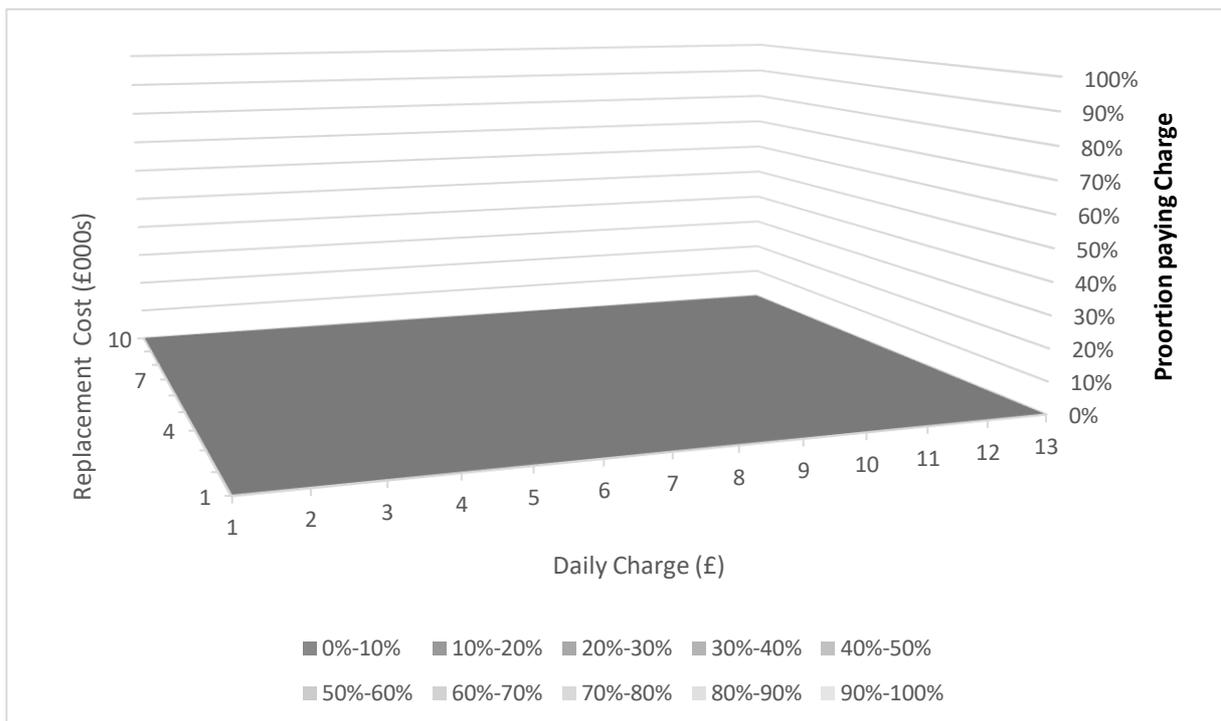


Figure 5-2: Exercise 2 Model (All sample, weighted by purpose & fuel type)

### 5.5 Exercise 1 Model and Results: (Pay Charge or Changing Travel Behaviour)

The first exercise asked respondents whether, for their most recent journey, if a CAZ was in place, they would have paid the charge or made a change in behaviour that would avoid the charge. Each respondent was presented with one of two sets of four charge levels for the proposed zone and for each charge the respondent was given 5 or 6 choices:

- Pay the charge and travel as before;
- Make the same journey but by a different mode;
- Not have made the journey;
- Made the same journey purpose but changed the destination (e.g. someone could shop elsewhere);
- Made the same journey but changed route to avoid the zone, and;
- Made the same journey but switched to another compliant vehicle in their household (this option was only shown if they had previously indicated such a vehicle existed).

### 5.5.1 Model Form and Fitting

As there is only a single variable here, the proposed daily charge, it is possible to use simple interpolation between the surveyed charge values. However, because participants were asked only half of the charge values, there are differences due to sampling error between the two sets of response that can cause unrealistic marginal changes between each 50p increase in charge.

For example, if those presented with the charges in Subgroup 1 (Table 2-1) had a somewhat higher willingness to pay the charge then simple interpolation may find the proportion paying the charge decreases more slowly between £5 and £6 than between £6 and £7 but then slower again above £7.

When looking at smaller sub samples (e.g. employer’s business trips only), the random error can be sufficiently large that parts of the scale can show an increasing rate of payment with increasing daily charge which is clearly illogical.

Given this it is considered that undertaking a multinomial logistic regression will provide a more consistent statistical model for use in predicting the response to various charge levels.

Multinomial logistic regression is a generalisation of the binomial model used in Exercise 2 above to be able to consider more than two choices. It handles this by fitting and combining binomial models of one specific choice (or reference outcome) against each other choice in turn.

### 5.5.2 Results

The model has the following form:

$$P(Y) = \frac{e^{\beta_{0Y} + \beta_{1Y}C}}{\sum_{k=1}^K e^{\beta_{0k} + \beta_{1k}C}}$$

where  $P(Y)$  is the probability of choice  $Y$ ,  $C$  is the charge and  $\beta_{0Y}$  and  $\beta_{1Y}$  are the coefficients for choice  $Y$ . In the divisor,  $\beta_{0k}$  and  $\beta_{1k}$  are the coefficients for each possible choice  $k$  in turn.

Table 5-4 shows the coefficients for the fitted model. In this case, paying the charge is selected as the reference outcome and hence has coefficients of zero. The selection of which choice is the reference outcome has no impact on the final model.

**Table 5-4: Exercise 1 Model Coefficients for Bath CAZ (All sample, weighted by purpose & fuel type n=1050)**

Outcome	Pay Charge	Change Mode	Not Travel	Change Destination	Change Route	Switch Vehicle
Constant	0	-2.71257	-3.79251	-3.43558	-2.78628	-5.42522
Charge	0	0.470254	0.484575	0.453766	0.479127	0.470978

Figure 5-3 shows the output of this model across the range of surveyed charges. Results are presented for the whole sample, factored by frequency and weighted by purpose of trips travelling within the zone in the Base GBATH model and by fuel type to observed ANPR splits.

The graph shows a notable decrease in the propensity to pay the charge as the charge increases. The alternative response to the introduction of charging for the majority of the respondents was either to use a different mode or change the destination to avoid the charging area.

It can be noted how the propensity to use a different mode, to change route or to not travel increases with the increase in charge level. The number of respondents considering changing destination or switching vehicle is more proportional throughout the charge levels.

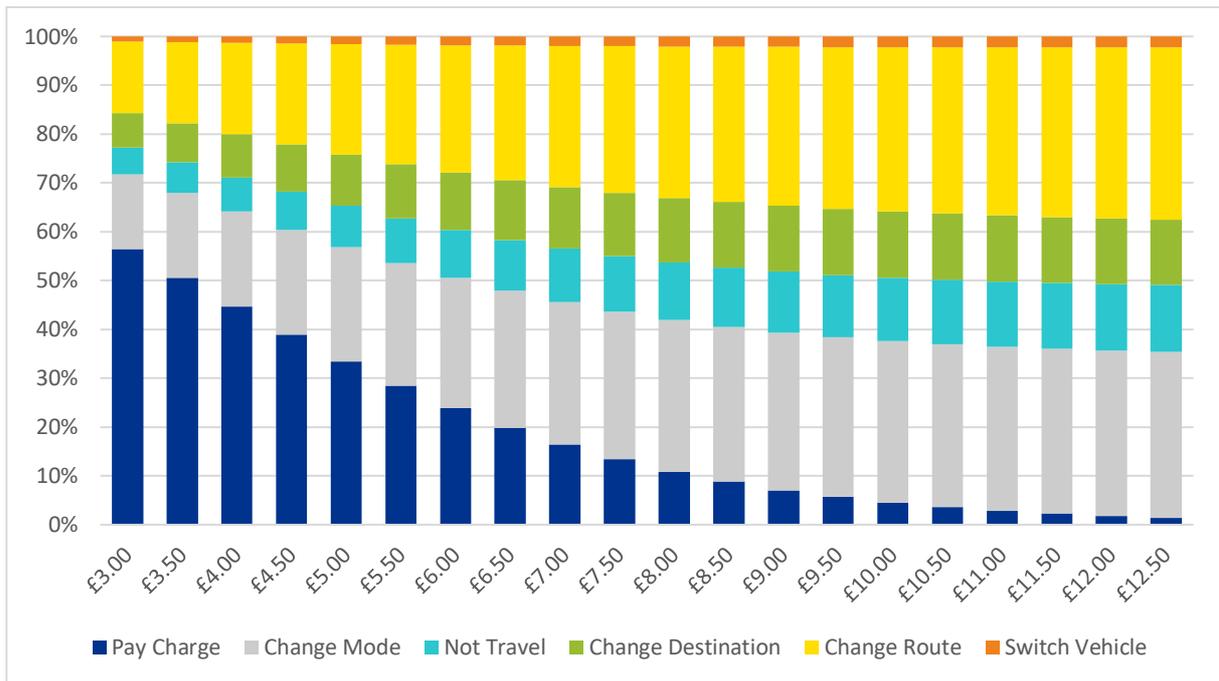


Figure 5-3: Exercise 1 Responses for Bath CAZ (All sample, weighted by purpose & fuel type, n=1050)

## 5.6 Combined Model

To estimate the overall response to different levels of charge the models can be combined as follows:

The choice from Exercise 2 is applied first on the basis that people who can afford or choose to replace their vehicle are assumed to do so.

The remaining proportion that are predicted by Exercise 2 to pay the charge are then split by the Exercise 1 results, with splits between the charge levels asked in Exercise 1 estimated by interpolation.

A plot of the output from the combined model is shown in Figure 5-4 for the full sample for the replacement cost of £4,685 that has been assumed in the modelling for a typical car replacement. The replacement cost is based on a combination of industry data on the most common car purchases, ANPR data and current market prices of vehicles. Derivation of these costs are discussed in more detail in OBC-16 Primary Behavioural Response Calculation Methodology, in Appendix E of this OBC.

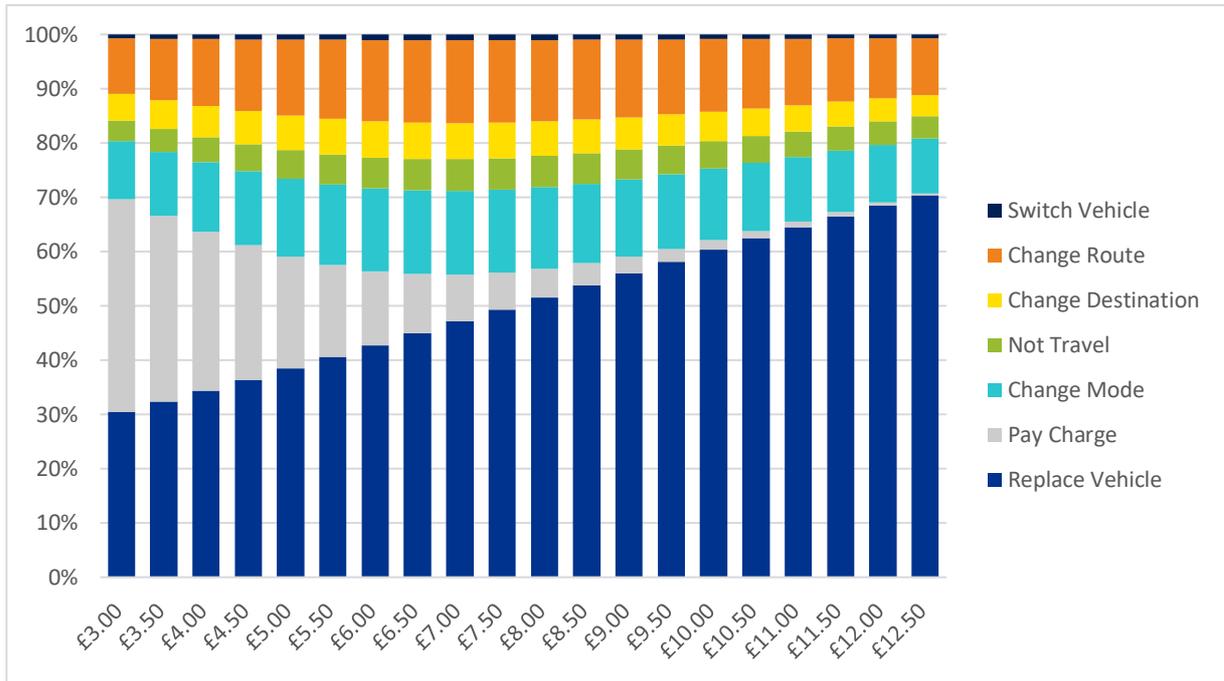


Figure 5-4: Combined Model for Full Sample (All sample, weighted by purpose & fuel type, n = 1050/955)

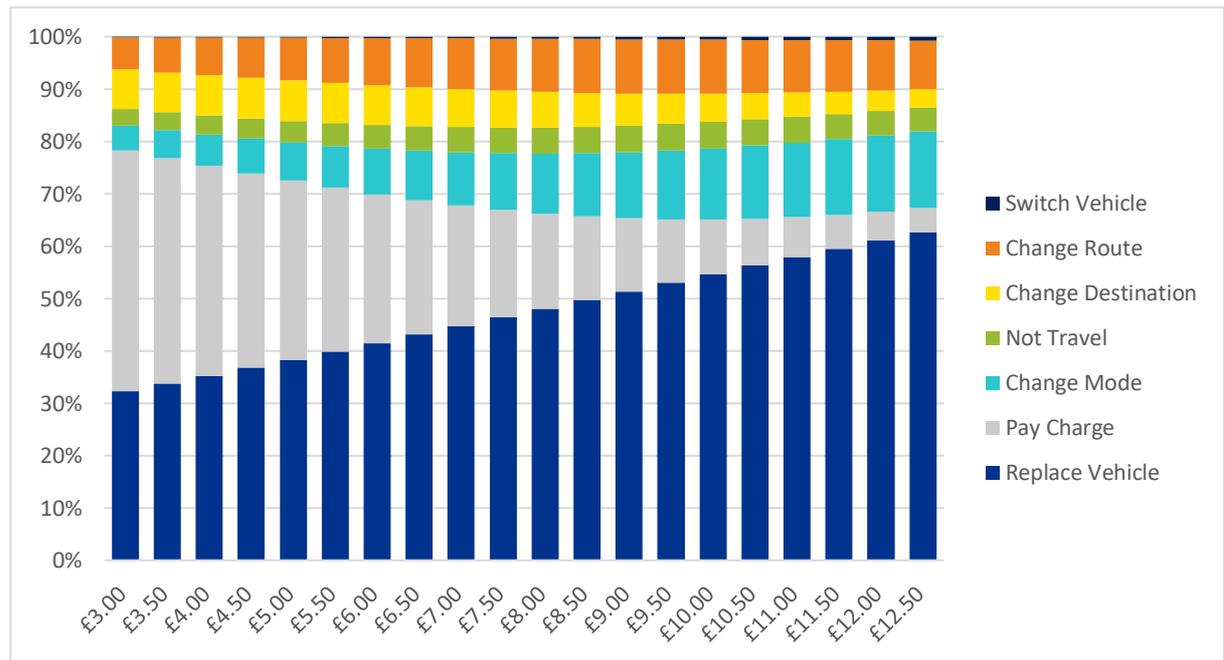


Figure 5-5: Combined Model for Employer's Business (All sample, weighted by purpose & fuel type, n=106/90)

Figure 5-5 meanwhile shows the model for the employer's business sub sample with the calculated van replacement cost of £5,768

In the all sample model, at the lowest £3 charge, 35% replace the vehicle, 37% pay the charge, 1% are able to switch to an existing compliant vehicle while 10% change mode, 5% travel elsewhere, 9% change route and 4% cancel the trip. At the highest £12.50 charge, 67% replace the vehicle with only 0.5% paying the charge while 11% change mode, 4% travel elsewhere, 12% change route and 5% cancel the trip.

The employer's business sub-sample generally shows a stronger willingness to pay the charge though as in the full sample, at the highest charge, very few (5%) are still willing to do so.

This greater willingness to pay the charge is likely a result that a significant proportion of those travelling on employer's business are able to pass the charge onto their employer so do not perceive the cost as much as if it were coming from their own pocket. It may also reflect the nature of a number of employer's business trips meaning that changing mode or destination are not practical alternatives. It should be noted though that some drivers on employer's business will incur the charge themselves and, combined with the relatively small sample size, these figures should be taken with some caution.

## 6. Summary

A survey was undertaken between 10 May and 11 June 2018 of 1160 residents of B&NES and the surrounding Local Authorities who had recently driven within the proposed CAZ in a car or light van considered non-compliant under the Defra Framework. The survey responses went through a cleaning and checking process leaving 1050 responses for analysis.

Along with a number of demographic and other relevant questions, the survey consisted of two stated preference exercises where the participant was asked to consider their last trip within the CAZ and if they would have made a different choice as a result. The first exercise asked whether they would have made the same trip again and paid the charge, or have taken one of five alternative actions to avoid the charge such as travel by a different mode or change route.

The second exercise asked whether, if a CAZ was in place, the user would either pay the charge whenever they travelled in the zone, or to spend money upgrading their vehicle to a compliant one that would not incur the charge. The exercises asked about a range charge levels and assumed replacement costs.

Statistical models were fitted to the data from each exercise and were then combined into two single models. One for trips of all purposes and one for Employer's Business trips only. These models are then used with average replacement costs to extract response rates to inform the traffic modelling of the proposed Clean Air Zone. This process is discussed OBC-16 Response Rates Technical Note.

## Appendix A. Survey Questionnaire

## Driving in Bath Survey

### WELCOME

Good (morning/afternoon/evening). Thank you for your interest in our project.

This is an online survey that will take a maximum of 15 minutes to complete. It's an important topic concerning a local issue that could be very relevant to you.

Please note that all personal data will be processed in accordance with the principles of good information handling contained in the Data Protection Act 1998 and the EU General Data Protection Regulation when it comes into force in May 2018. We will not sell this information to any other persons or organisations, and you will receive no marketing material as a result of completing this questionnaire.

[START SURVEY >](#)

---

Q1 What is your **FULL** home postcode?

[CONTINUE >](#)

If invalid postcode then: Unfortunately, you are not eligible to complete the questionnaire. Thank you for your time. *Close*

---

Thank you.

Your reference is xxxxx.

If you experience any problems completing the survey and wish to contact us please quote this reference.

[CONTINUE >](#)

---

### QUESTIONNAIRE 1

Before we start the survey, we need to ask you a few screening questions to make sure you are eligible to complete the survey.

Q2 Which age group do you fall into?

1. Under 17
2. 17-24
3. 25-34
4. 35-44
5. 45-54
6. 55-59
7. 60-64
8. 65-69
9. 70 or over

[NEXT](#)

*If under 17 then:* Unfortunately, only people aged 17 or over are eligible to complete the questionnaire. Thank you for your time. *Close.*

---

**Q4a** Do you drive a car or light van (including camper van, pick-up truck)? If you drive more than one vehicle, please answer in relation to the vehicle you **normally** drive.

1. Car
2. Light van (under 3.5 tonnes)
3. No

NEXT

*If 'no' then:* This survey is for people who drive a car or van so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. *Close.*

---

**Q4b** Are you the person who solely or jointly makes decisions concerning the replacement of your vehicle?

1. Yes
2. No

NEXT

*If 'no' then:* This survey is for people who take the decision about replacing their vehicle so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. *Close.*

---

**Q5** What type of fuel does the vehicle you normally drive use?

1. Petrol
2. Diesel
3. Electric/plug-in
4. Hybrid
5. Gas/LPG
6. Other

NEXT

*If not petrol or diesel then:* This survey is focussed on petrol and diesel vehicles, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. *Close.*

---

**Q6a/b** How old is your vehicle?

*For petrol:*

1. Pre 2006
2. 2006 or more recent

*If 2006 or more recent, then:* This survey is focussed on older vehicles, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. *Close.*

*For diesel:*

1. Pre 2015
2. 2015 or more recent

NEXT

*If 2015 or more recent, then: This survey is focussed on older vehicles, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. Close*

---

## SCREENING

Q7 In the past 6 months have you used this vehicle to drive within, through, or in/out of the area of Bath shown in yellow on the map below?

1. Yes
2. No

*Map of Zone*

## NEXT

*If 'no' then: This survey is focussed on trips in, through or in/out of this area, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. Close.*

---

Q8a In general, how often do you use your vehicle in this area of Bath?

1. 6-7 days a week
2. 5 days a week
3. 3-4 days a week
4. 2 days a week
5. 1 day a week
6. About once a fortnight
7. About once a month
8. About once every 2 months
9. About once every 4-5 months
10. About once every 6 months
11. Less often

## NEXT

*If 'less often' then: This survey is focussed on people who have used a vehicle in this area in the last 6 months, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. Close.*

---

Q8b In general, how often do you use your vehicle in Bristol city centre?

1. 6-7 days a week
2. 5 days a week
3. 3-4 days a week
4. 2 days a week
5. 1 day a week
6. About once a fortnight
7. About once a month
8. About once every 2 months
9. About once every 4-5 months

- 10. About once every 6 months
- 11. Less often/never

PREV [NEXT](#)

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## YOUR VEHICLE

### Q9 What type of vehicle do you drive?

1. Mini car (e.g. Peugeot 108, Skoda Citigo, Citroen C1)
2. Small car (e.g. Ford Fiesta, Opel Corsa, Nissan Micra, Renault Clio, Toyota Yaris)
3. Medium car (e.g. Volkswagen Golf, Skoda Octavia, Toyota Corolla, Ford Focus, BMW 1 Series)
4. Large car (e.g. Mazda 6, Kia Optima, Audi A5, Toyota Avensis)
5. Executive (e.g. Audi S7, Mercedes-Benz E-Class, Toyota Avalon, BMW 5-series)
6. People carrier (MPV) (e.g. Kia Carens, Citroen C4 Picasso, SEAT Alhambra)
7. Sports utility vehicle (SUV) (e.g. Volkswagen Tiguan, BMW X6, Kia Sorento, Land Rover)
8. Sports car (e.g. Audi TT, BMW i8, Aston Martin Vanquish)
9. Light van (e.g. light van under 3.5 tonnes, camper van, pick-up truck)
0. Other (please state)

PREV [NEXT](#)

---

### Q10a Are there any other vehicles in this household that you can use?

1. Yes
2. No

PREV [NEXT](#)

---

### Q10b How many other vehicles could you use? \_\_\_\_\_

PREV [NEXT](#)

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### Q11 How many years old is the vehicle you normally drive? \_\_\_\_ (years)

### Q12 When do you expect to replace this vehicle?

1. Within the next 2 years (by 2020)
2. Within the next 3 years (by 2021)
3. Within the next 4 years (by 2022)
4. Within the next 5 years (by 2023)
5. I have no specific plans right now – *skip to Zone Preparation Questions*

PREV [NEXT](#)

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### Q13 How old do you expect your replacement vehicle will be?

1. It will be a new vehicle
2. 1-2 years old
3. 3-4 years old
4. 5+ years old
5. Don't know

### Q14 What type of fuel do you expect your replacement vehicle will use?

1. Petrol

2. Diesel
3. Electric/plug-in
4. Hybrid
5. Gas/LPG
6. Other
7. Don't know

#### Q15 What do you expect will be the type of your replacement vehicle?

1. Mini car (e.g. Peugeot 108, Skoda Citigo, Citroen C1)
2. Small car (e.g. Ford Fiesta, Opel Corsa, Nissan Micra, Renault Clio, Toyota Yaris)
3. Medium car (e.g. Volkswagen Golf, Skoda Octavia, Toyota Corolla, Ford Focus, BMW 1 Series)
4. Large car (e.g. Mazda 6, Kia Optima, Audi A5, Toyota Avensis)
5. Executive (e.g. Audi S7, Mercedes-Benz E-Class, Toyota Avalon, BMW 5-series)
6. People carrier (MPV) (e.g. Kia Carens, Citroen C4 Picasso, SEAT Alhambra)
7. Sports utility vehicle (SUV) (e.g. Volkswagen Tiguan, BMW X6, Kia Sorento, Land Rover)
8. Sports car (e.g. Audi TT, BMW i8, Aston Martin Vanquish)
9. Light van (e.g. light van under 3.5 tonnes, camper van, pick-up truck)
1. Other (please state)
10. Don't know

PREV [NEXT](#)

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## CLEAN AIR ZONE

Bath and North East Somerset Council has been told by Central Government to improve air quality in Bath in the shortest time possible. In response to this, the introduction of a charging Clean Air Zone covering the yellow area of Bath shown in the map below is currently being considered. Within this zone any trip made by a petrol vehicle registered before 2006 or a diesel vehicle registered before 2015 would be required to pay a daily charge. Newer vehicles would be considered 'compliant' with the emissions standards and would not have to pay. For the purposes of this survey it should be assumed there would be no exemptions for non-compliant vehicles (e.g. for local residents). The daily charge would cover multiple journeys in one day.

*Map of Zone*

PREV [NEXT](#)

---

*If yes at Q10*

Q16 You mentioned that there were other vehicles in your household that you could use for the journeys you make in or into the zone shown on the map. Are any of those vehicles compliant with the emissions standards described in the previous screen?

1. Yes
2. No
3. Don't know

PREV [NEXT](#)

---

Q17 You mentioned that you have made a journey in/through the yellow area shown in the map below in the last 6 months. Thinking about the most recent journey you made here, what was the main reason for this journey?

1. Travel to/from work (commuting)
2. Travel to/from college (as a student)
3. Travel for leisure /entertainment
4. Shopping
5. Travel to visit friends or relatives
6. Travel for personal business (e.g. doctor's, bank appointment)
7. Travel for business reasons (but not commuting)
8. Taking children to/from education or activity

Map of Zone

PREV NEXT

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## CLEAN AIR ZONE EXERCISE 1

In this section we would like you to think about what you would have done if a Clean Air Zone was in place in the yellow area. We will show you 4 different Clean Air Zone charging prices and, for each, you will be asked which travel option you would have chosen for your most recent journey in or through the area, which you said was ... (**answer at Q17**).

Please consider your answers carefully.

Map of Zone

Q18 Thinking about your most recent journey driving in or through the area, what would you have done, assuming a Clean Air Zone was in place?

### \* Clean Air Zone daily charge £5

1. Made the same journey using your own vehicle and paid a **£5** charge
2. Made the same journey but using a different mode (e.g. park & ride, public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

### \* Clean Air Zone daily charge £7

1. Made the same journey using your own vehicle and paid a **£7** charge
2. Made the same journey but using a different mode (e.g. park & ride, public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

### \* Clean Air Zone daily charge £9.50

1. Made the same journey using your own vehicle and paid a **£9.50** charge
2. Made the same journey but using a different mode (e.g. park & ride, public transport, cycle, walk)
3. Would not have made this journey

4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

\* **Clean Air Zone daily charge £12.50**

1. Made the same journey using your own vehicle and paid a **£12.50** charge
2. Made the same journey but using a different mode (e.g. park & ride, public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

*Note: on screen the options appear horizontally not vertically. The 4 price points should be shown in a random order.*

*Only show option 6 if Q16 = yes*

PREV [NEXT](#)

---

*If say will pay for all 4 price points ask:*

**Q19 You selected to pay the charge for each of the price points. Could you please tell us why?**

PREV [NEXT](#)

---

## CLEAN AIR ZONE EXERCISE 2

In this section, we would like you to again think about what you might do assuming a Clean Air Zone was in place in the yellow area.

We will show you 6 scenarios where you will be asked to choose between continuing to use your current vehicle and paying a Clean Air Zone charge, or replacing it with a compliant vehicle (these are petrol vehicles registered in or after 2006 or diesel vehicles registered in or after 2015).

In each scenario there is a different combination of daily charge and vehicle upgrade cost to choose between. The upgrade cost is the amount you would have to pay for a compliant vehicle, over and above the amount you sold your current vehicle for.

*Map of Zone*

Please treat these as hypothetical scenarios. For each question, assume the two choices shown are the only options available to you. You do not need to consider the value of your existing or replacement vehicle – assume the upgrade cost is sufficient.

For example, you may want to consider this in terms of costs per year such as:

- with a daily charge of £5, 4 journeys per week for 46 weeks would cost £920 per year
- a vehicle upgrade cost of £5,000 over five years would be £1,000 per year.

If required, an on-line calculator can be found here (the link will open a new tab).

Please think carefully about your answers.

### Q21 If the Clean Air Zone was in place which option would you choose in the following 6 scenarios?

\* **£3 charge or £9,000 upgrade:**

1. Use current vehicle and pay a daily charge of **£3** when you drive in/through the zone
2. Change to a compliant vehicle for an upgrade cost of **£9,000** and pay **no** charge when you drive in/through the zone

\* **£4 charge or £3,000 upgrade:**

1. Use current vehicle and pay a daily charge of **£4** when you drive in/through the zone
2. Change to a compliant vehicle for an upgrade cost of **£3,000** and pay **no** charge when you drive in/through the zone

\* **£10 charge or £10,000 upgrade:**

1. Use current vehicle and pay a daily charge of **£10** when you drive in/through the zone
2. Change to a compliant vehicle for an upgrade cost of **£10,000** and pay **no** charge when you drive in/through the zone

\* **£9 charge or £2,000 upgrade:**

1. Use current vehicle and pay a daily charge of **£9** when you drive in/through the zone

2. Change to a compliant vehicle for an upgrade cost of **£2,000** and pay **no** charge when you drive in/through the zone

\* **£11 charge or £6,000 upgrade:**

1. Use current vehicle and pay a daily charge of **£11** when you drive in/through the zone

2. Change to a compliant vehicle for an upgrade cost of **£6,000** and pay **no** charge when you drive in/through the zone

\* **£7 charge or £8,000 upgrade:**

1. Use current vehicle and pay a daily charge of **£7** when you drive in/through the zone

2. Change to a compliant vehicle for an upgrade cost of **£8,000** and pay **no** charge when you drive in/through the zone

*Note: the six scenarios should be in random order*

PREV [NEXT](#)

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*If say will pay for all 6 options ask:*

Q23 You selected to pay the charge in each of the scenarios. Could you please tell us why?

PREV [NEXT](#)

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*If say will change to a compliant vehicle for all 6 options ask:*

Q24 You selected to change to a compliant vehicle in each of the scenarios. Could you please tell us why?

PREV [NEXT](#)

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## YOUR ASSESSMENT OF THE SURVEY

Q25 Please tell us what you thought of this survey. How easy or difficult did you find it?

1. Very easy
2. Fairly easy
3. Neither easy nor difficult
4. Fairly difficult
5. Very difficult

PREV [NEXT](#)

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*If Q25 is 'Very difficult'*

Q26 You said you found the exercise very difficult. Could you please tell us why?

*Blank response allowed*

PREV [NEXT](#)

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Q27 Were the descriptions and explanations clear to you?

1. Very clear
2. Fairly clear
3. Fairly unclear
4. Very unclear

Q28 How realistic were the upgrade costs?

1. Very realistic
2. Fairly realistic
3. Fairly unrealistic
4. Very unrealistic

PREV [NEXT](#)

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*If Q28 is or 'Very unrealistic'*

Q29 You said you found the upgrade costs very unrealistic. Could you please tell us why?

*Allow blank response*

PREV [NEXT](#)

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## About You

Q30 Please indicate your employment status.

1. Working full time
2. Working part time
3. In education
4. Looking after home/family/dependent(s)
5. Unemployed
6. Retired
7. Unable to work
8. Other
9. Prefer not to say

PREV [NEXT](#)

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*If working full or part time then ask Q30, else skip to Q32*

Q31 Which of the following best describes your occupation?

1. Higher managerial, administrative or professional
2. Intermediate managerial, administrative or professional
3. Supervisory or clerical and junior managerial, administrative or professional
4. Skilled manual worker
5. Semi-skilled and unskilled manual worker

6. Casual or low grade worker

---

Q32 Which category corresponds to your annual HOUSEHOLD income? (before tax)

1. Less than £5,000
2. £5,000 - £9,999
3. £10,000 - £14,999
4. £15,000 - £19,999
5. £20,000 - £24,999
6. £25,000 - £34,999
7. £35,000 - £49,999
8. £50,000 - £74,999
9. £75,000 - £99,999
10. £100,000 or more
11. Prefer not to say

PREV [NEXT](#)

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Q33 Which ethnic group do you consider you belong to?

1. White – British
2. White – Irish
3. White – Eastern European
4. Any Other White Background
5. Dual Heritage – Black Caribbean
6. Dual Heritage – Black African
7. Dual Heritage – Asian
8. Dual Heritage – Chinese
9. Dual Heritage – White
10. Dual Heritage – Any Other Mixed Background
11. Asian or Asian British - Indian
12. Asian or Asian British – Pakistani
13. Asian or Asian British – Bangladeshi
14. Asian or Asian British – Chinese
15. Asian or Asian British – Any Other Asian Background
16. Black or Black British – Caribbean
17. Black or Black British – African
18. Black or Black British – Any Other Black Background
19. Other Ethnic Group – Arab
20. Other Ethnic Group – Any Other Background
21. Gypsy or Traveller – Romany Gypsy
22. Gypsy or Traveller – Irish Traveller
23. Gypsy or Traveller – Any Other Gypsy or Traveller Group
24. xiv. Other Ethnic Group
25. xv. Prefer not to say

PREV [NEXT](#)

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Q34 Are you ...?

1. Male
2. Female
3. Something else
4. Prefer not to say

Q35 Is your gender different to the gender you were assigned at birth?

- 1. Yes
- 2. No
- 3. Prefer not to say

---

Q36 Do you consider yourself to be a disabled person? (i.e. do you have physical or mental impairment which limits your ability to travel and/or carry out day to day activities?)

- 1. Yes
- 2. No
- 3. Prefer not to say

PREV [NEXT](#)

*If ii, then skip to Q38*

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Q37 Are you a Blue Badge holder?

- 1. Yes
- 2. No

PREV [NEXT](#)

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Q38 Do you have any further comments about this topic or the survey itself? If you have no further comments, please select 'No comments'. *This question is limited to 400 characters*

- 1. No comments
- 2. Yes

PREV [NEXT](#)

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Q996 And finally, if we need to, can we contact you again?

- Yes
- No

PREV [NEXT](#)

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At what email address would you like to be contacted?

PREV [NEXT](#)

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Thank you very much for completing this questionnaire. We appreciate your time and effort.

DONE

This survey has been completed successfully. Thank you once again.

## Appendix B. Model Detailed Analysis

### B.1 Significance of Variables

In the process of creating the statistical models, the significance of a number of variables was considered to establish their potential impact upon the responses. Each variable considered is discussed in the following section.

#### B.1.1 Trip Frequency

Participants were asked to set out how frequently they drive within the zone, in order to assess whether trip frequency alters the responses to the CAZ. To test the significance of trip frequency, responses were split into 3 bands: 3 or more days a week, 1 or 2 days a week and less often than weekly and were given values of 1 to 3 accordingly.

Logistic regression models (of the same type used for the analysis presented within the main report) were then fitted for both exercises and the parameters are shown in Table B-1 and Table B-2. With very low p values ( $p < 0.05$  generally being used as an indicator of significance), it is clear that frequency is a predictor of likelihood to choose between paying the charge, not travelling or changing destination. It does not, however, appear to make much difference when considering change the route, switching vehicle or changing mode. This makes sense as less frequent trips are often less critical and thus it is more likely than changing the destination or cancelling the trip entirely is an option

**Table B-1: Exercise 1 Model Parameters (All sample, weighted by purpose & fuel type)**

Response		Coeff.	Z	p-value
Change Mode	Intercept	-2.723	14.1	0.998161374
	Charge	0.457	20.1	
	Frequency	0.000	0.0	
Not Travel	Intercept	-4.551	18.6	1.33227E-14
	Charge	0.456	17.7	
	Frequency	0.578	7.7	
Change Destination	Intercept	-3.918	16.9	5.60296E-11
	Charge	0.408	16.2	
	Frequency	0.480	6.6	
Change Route	Intercept	-2.477	13.4	0.276876869
	Charge	0.441	20.1	
	Frequency	0.067	1.1	
Switch Vehicle	Intercept	-5.374	11.7	0.185498618
	Charge	0.431	9.5	
	Frequency	0.189	1.3	

With very low p values ( $p < 0.05$  generally being used as an indicator of significance), it is clear that frequency is a predictor of likelihood to choose between paying the charge, not travelling or changing destination. It does not, however, appear to make much difference when considering change the route, switching vehicle or changing

mode. This makes sense as less frequent trips are often less critical and thus it is more likely than changing the destination or cancelling the trip entirely is an option.

**Table B-2: Exercise 2 Model Parameters (All sample, weighted by purpose & fuel type)**

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Const	-0.3896	0.117715	3.309704	0.000934		
Charge	-0.12179	0.009689	12.56973	3.1E-36	-0.14078	-0.1028
Replace	0.166475	0.010088	16.50267	3.51E-61	0.146704	0.186247
Frequency	0.355319	0.034742	10.22738	1.5E-24	0.287226	0.423412

From the exercise 2 results it is clear that, as would be expected, reported frequency of travel is a significant predictor of the choice between upgrading the vehicle and paying the charge. For a more frequent traveller into the zone it is relatively better value to replace the vehicle.

There is no reliable data available for weighting frequency of trip, however it was considered that, to accurately assess the impact upon the zone that the survey should be weighted or factored by the reported frequency of travel within the zone. The response of someone who travels daily in the zone will have a much larger impact that someone who travels weekly.

After factoring by frequency, the significance of the reported frequency was rechecked and this is shown in Table B-3 and Table B-4.

**Table B-3: Exercise 1 Frequency Significance Test (All sample, factored by frequency, weighted by purpose & fuel type)**

Response		Coeff.	Z	p-value
Change Mode	Intercept	-2.667	13.2	0.709964985
	Charge	0.470	20.0	
	Frequency	-0.037	0.4	
Not Travel	Intercept	-4.468	17.3	9.36214E-06
	Charge	0.487	17.5	
	Frequency	0.485	4.4	
Change Destination	Intercept	-3.832	15.6	0.007899861
	Charge	0.455	16.9	
	Frequency	0.292	2.7	
Change Route	Intercept	-2.955	14.5	0.186421179
	Charge	0.480	20.4	
	Frequency	0.127	1.3	
Switch Vehicle	Intercept	-5.373	10.5	0.862741724
	Charge	0.471	9.6	
	Frequency	-0.042	0.2	

**Table B-4: Exercise 2 Frequency Significance Test (All sample, factored by frequency, weighted by purpose & fuel type)**

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Const	-0.19504	0.118847	1.641071	0.100783		
Charge	-0.13767	0.009701	14.19124	1.04E-45	-0.15668	-0.11865
Replace	0.178865	0.010061	17.77866	1.03E-70	0.159147	0.198584
Frequency	0.291057	0.050399	5.774993	7.7E-09	0.192275	0.389838

With this factoring the significance of frequency, while not eliminated, is much reduced. In Exercise 1 there is now only a strong significance between the choice of paying the charge or not travelling at all. In Exercise 2 it is still considered a significant predictor though less strong. This drop in significance is reflected in the lower Z value and large spread in the confidence interval.

It is therefore considered that the decision to factor by reported frequency is justified and though, not perfect, is sufficient without an additional source of data for weighting.

### B.1.2 Home Origin

To test the significance of home origin, processing in GIS was undertaken in order to calculate the crow fly distance between the centroid of the reported home postcode and the closest point on the boundary of the proposed zone (this value is treated as 0 for those living in the zone).

As for the trip frequency test, responses were split into 3 bands, those within 5km of the zone, those between 5 and 15 km and those further than 15km. The distance values were chosen such that numbers of responses in each band were similar.

Logistic regression modelling was again undertaken and the results are shown in Table B-5 and Table B-6. In Exercise 1 the distance from the zone has some significance in the choice between paying, not travelling and switching vehicle show some though it is far weaker than that of the charge and there is considerable variance in the summarised data. The 95% confidence levels in the coefficients are correspondingly wide (0.14 – 0.48 and 0.02-0.68), it is therefore considered that there is little value in including this in the modelling as there is both significant uncertainty and the impact on the final transport modelling is negligible.

**Table B-5: Exercise 1 Home Origin Significance Test (All sample, factored by frequency, weighted by purpose & fuel type)**

Response		Coeff.	Z	p-value
Change Mode	Intercept	-2.599	12.6	0.397011281
	Charge	0.470	20.0	
	Distance	-0.059	0.8	
Not Travel	Intercept	-4.422	16.1	0.000442828
	Charge	0.486	17.4	
	Distance	0.306	3.5	
Change Destination	Intercept	-3.563	14.0	0.443475932
	Charge	0.454	16.8	
	Distance	0.064	0.8	
Change Route	Intercept	-2.711	13.0	0.580078629
	Charge	0.479	20.4	
	Distance	-0.039	0.6	
Switch Vehicle	Intercept	-6.142	11.2	0.039671669
	Charge	0.472	9.6	
	Distance	0.346	2.1	

In Exercise 1 the distance from the zone has some significance in the choice between paying, not travelling and switching vehicle show some though it is far weaker than that of the charge and there is considerable variance in the summarised data. The 95% confidence levels in the coefficients are correspondingly wide (0.14 – 0.48 and 0.02-0.68), it is therefore considered that there is little value in including this in the modelling as there is both significant uncertainty and the impact on the final transport modelling is negligible.

**Table B-6: Exercise 2 Home Origin Significance Test (All sample, factored by frequency, weighted by purpose & fuel type)**

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Const	0.32116	0.122198	2.628187	0.008584		
Charge	-0.13668	0.00967	14.13391	2.35E-45	-0.15563	-0.11773
Replace	0.177654	0.010024	17.72216	2.83E-70	0.158007	0.197302
Distance	-0.06823	0.037097	1.839363	0.065862	-0.14094	0.004474

In Exercise 2 no significance is shown, this does not seem surprising as it makes sense that the choice between upgrading or paying the charge is dominated by frequency of travel in the zone and once that is taken into account, distance is of limited relevance.

### B.1.3 Income

As for the other tests, results were grouped into three bands based on reported home income. These bands were: less than £25,000; £25,000 to £49,999 and £50,000 or greater and were chosen to produce similar proportions in each band. The outcome of this test is shown in Table B-7 and Table B-8.

**Table B-7: Exercise 1 Income Significance Test (All sample, factored by frequency, weighted by purpose & fuel type)**

Response		Coeff.	Z	p-value
Change Mode	Intercept	-2.198	10.2	0.000151449
	Charge	0.476	19.6	
	Income	-0.295	3.8	
Not Travel	Intercept	-2.678	9.9	9.88072E-09
	Charge	0.476	16.5	
	Income	-0.569	5.7	
Change Destination	Intercept	-2.663	10.4	6.42885E-05
	Charge	0.453	16.4	
	Income	-0.370	4.0	
Change Route	Intercept	-2.219	10.2	4.65075E-05
	Charge	0.478	19.5	
	Income	-0.321	4.1	
Switch Vehicle	Intercept	-6.633	10.9	0.002943939
	Charge	0.458	9.1	
	Income	0.587	3.0	

**Table B-8: Exercise 2 Income Significance Test (All sample, factored by frequency, weighted by purpose & fuel type)**

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
<b>Const</b>	0.237884	0.126155	1.885652	0.059342		
<b>Charge</b>	-0.13771	0.009721	14.16633	1.48E-45	-0.15676	-0.11866
<b>Replace</b>	0.17324	0.010066	17.2109	2.2E-66	0.153512	0.192969
<b>Income</b>	-0.00431	0.040195	0.107335	0.914523	-0.0831	0.074467

As would be expected, income is a significant influence in the choice between paying the charge and alternative travel choices with lower income individuals more likely to attempt to avoid paying the charge in some manner. Less expected is the relatively weak effect on the willingness to use public transport.

The lack of significance in the choice between upgrading and paying the charge is also less expected. It is thought that this could be a result of the relatively high income sample that travels in the proposed Bath zone – once a certain level of disposable income is available, it does not seem likely that further income is going to change the weighing up of upgrading the vehicle against paying the charge. Further experimentation with the definition of the bands found that there appears to be greater sensitivity to the pay charge vs replace vehicle choice amongst the lowest income levels with such individuals being more likely to pay the charge. However it should be noted that the sample size of this adjusted lower income band is limited and thus statistically significant conclusions cannot be drawn.

The test of significance of household income is provided primarily for information. The GBATH model used for the modelling work does not separate users by income and no suitable target weights for the users of compliant vehicles that travel within the proposed zone has been identified.