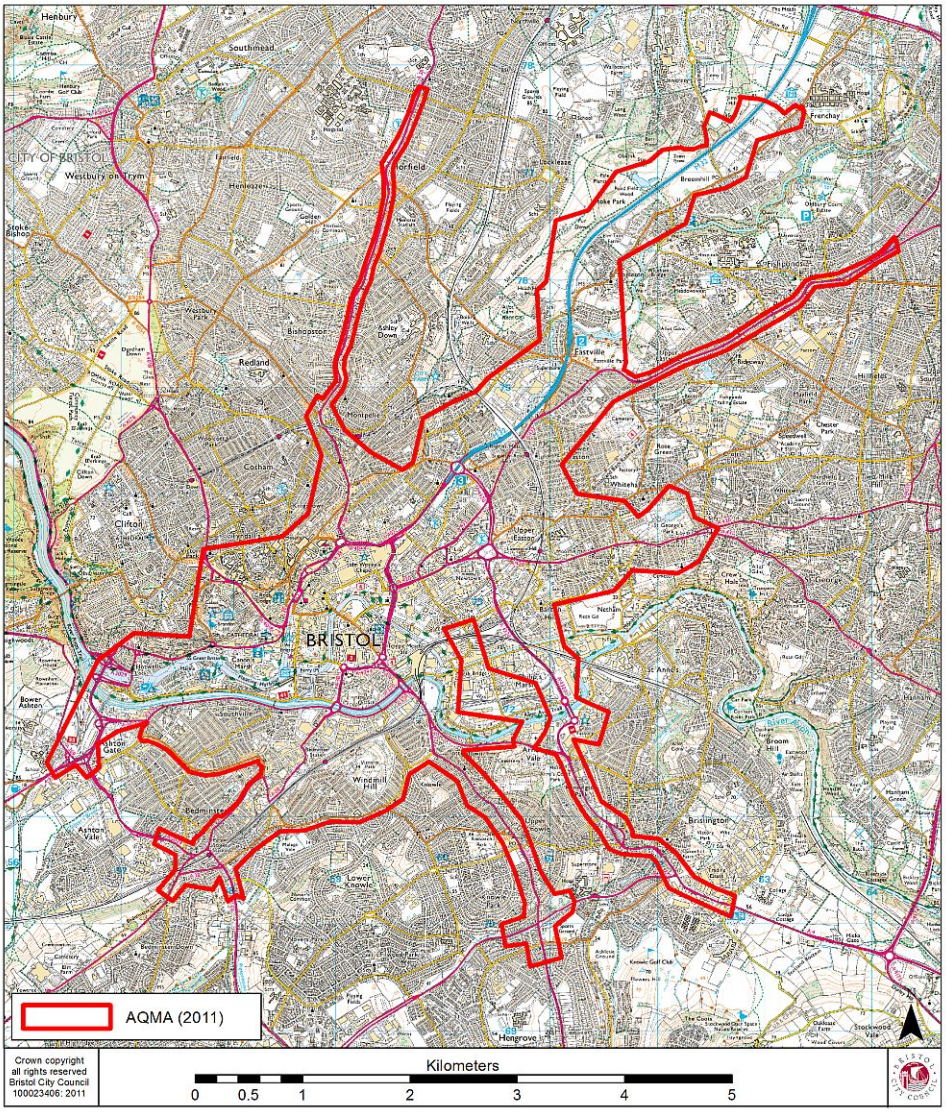
Appendix A1: Further essential detail on Proposal

Background to Air Quality in Bristol

1. Air pollution is a long standing problem in Bristol, and all UK cities. In Bristol an Air Quality Management Area (AQMA) was declared in 2001 because of breaches in the legal standards for levels of nitrogen dioxide (NO_2). The level of nitrogen dioxide is limited under UK and EU law because of the impacts it has on human health.

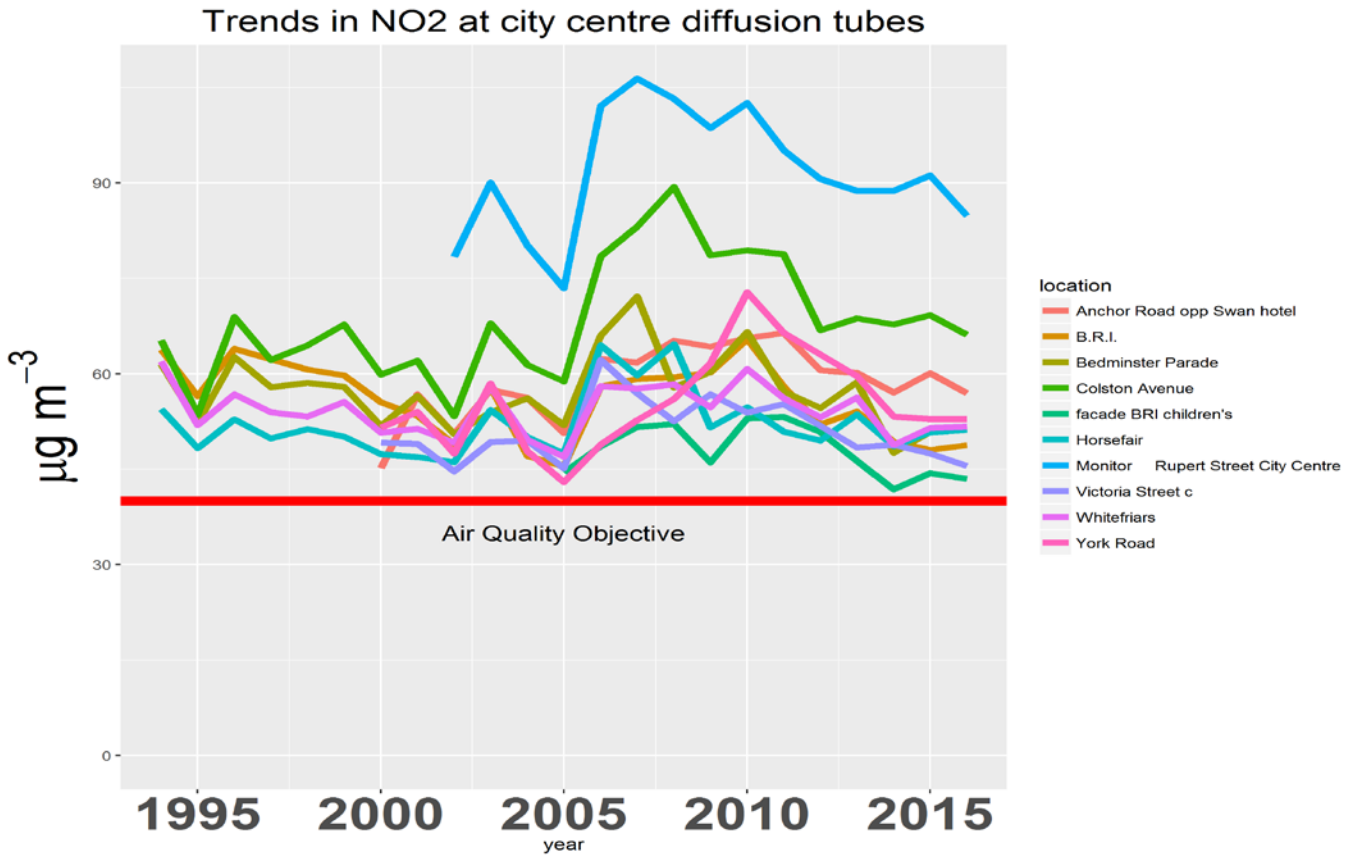
2. This AQMA (shown in Figure 1) covers the whole central area of the city and all the major arterial routes. Approximately 100,000 people live within the AQMA and it also includes the central employment, leisure and shopping districts, major hospitals and dozens of schools and therefore many more people are exposed to the air pollution in their daily lives. There are also two small AQMAs in South Gloucestershire in Kingswood \ Warmley and Staple Hill.

Figure 1: Bristol's Existing Air Quality Management Area



3. Levels of nitrogen dioxide (NO_2) are affected by the weather and can change significantly from year to year. However looking at the overall tgeneral trend of nitrogen dioxide pollution in the city we can see no significant improvement in pollution levels, which remain above the legal limit values. Figure 2 shows monitoring results for central Bristol.

Figure 2: Trends in NO_2 at city centre monitoring sites



4. During the last 20 years, Bristol and the West of England have grown economically and in terms of population, and more people are travelling on our roads and into the city centre. Increases in walking, cycling and public transport has balanced the increase in travel, so that car traffic on the roads has remained stable.

5. Bristol City Council has a statutory duty to develop an Air Quality Action Plan – our Clean Air Action Plan. The key purpose of this is to improve air quality so that we reduce the impact on population health and to achieve the UK legislative requirements for nitrogen dioxide levels.

6. The Corporate Strategy 2017 - 22sets out a commitment to develop an action plan and improve air quality.

7. In November 2016, Full Council unanimously supported a motion calling upon the council to develop an air quality action plan, to implement a Clean Air Zone and to update Council on progress. The full text of that motion can be found at: https://democracy.bristol.gov.uk/documents/g254/Printed%20minutes%2008th-Nov-2016%2018.00%20Full%20Council.pdf?T=1

8. The Mayor reported back on the overall progress in response to that motion at

Full Council on 18th July 2017.
https://democracy.bristol.gov.uk/documents/g2700/Public%20reports%20pack%2018th-Jul-2017%2018.00%20Full%20Council.pdf?T=10

UK Plan and new Statutory Requirements on Bristol City Council

9. Bristol has had a long standing duty to monitor and assess air pollution and to work towards compliance with the air quality objectives.

10. On 26th July 2017 the Government published its UK Plan for tackling roadside nitrogen dioxide concentrations. We are studying this and the technical guidance to understand the implications for Bristol.

11. In addition, Thérèse Coffey MP Parliamentary Under Secretary of State for the Environment Department for the Environment Food & Rural Affairs made a Direction which applies to Bristol City Council and 23 other local authorities. The Environment Act 1995 (Feasibility Study for Nitrogen Dioxide Compliance) Air Quality Direction 2017 requires that Bristol City Council:

    - Undertake a Feasibility Study to identify the option which will deliver compliance with legal limits for nitrogen dioxide, by 31 March 2018 at the latest.
    - Set out the case for change and the first stage in identifying, exploring, analysing and developing options for measures which the local authority will implement to deliver compliance in the shortest possible time, with indicative costs for those, by 31 March 2018 at the latest.

Identify the preferred option for delivering compliance in the shortest possible time, and setting out value for money considerations and implementation arrangements b

Bristol's Clean Air Action Plan

12. The Mayor has established a Mayoral Working Group on Air Pollution, which will work closely with the Congestion Task Group. The Working Group is chaired by Councillor Fi Hance. It has already received expert advice from Council Officers and external experts on air pollution, transport and public health matters.

13. This approach allows for an integrated approach to planning improvements in air quality which will be set out in a Clean Air Action Plan.

14. The Clean Air Action Plan being developed will align with the transport plans being created at the West of England and a Bristol City Council level and with the proposal emerging from the Congestion Task Group. A detailed project timetable will be developed with the creation of this action plan, including involvement of the council's scrutiny function.

15. Bristol's plan will include action on:

    - Strengthening the planning system to avoid air quality problems from new developments, including energy generation plants, and to plan for new forms of clean transport such as electric vehicles which will need new charging infrastructure.
    - Reducing the impact of freight vehicles in the city, building on the

success of the Freight Consolidation Centre that was set up by the City Council in 2004 using European Union funding. Bristol City Council has supported this service and is working with the Operators, DHL for the service to continue without council funding from November 2017.

- Working in partnership to bring an entirely clean bus fleet in Bristol. This could include applying for further funding from Government for bus retrofitting to reduce emissions from older buses.
- Improving the taxi fleet by working with operators to implement the new licensing policy. This will include exploring future Government funding opportunities to help taxi drivers make the transition to clean vehicles whilst maintaining a public service and their own livelihoods.
- Encouraging the adoption of Electric Vehicles. This includes investing existing funding in grants for businesses to install charge points, a doubling of the number of electric vehicle charge points in the city to make it even easier for drivers to re-charge their cars, and an increase in electric council fleet vehicles.
- Working with Government to secure the investment the city needs to accelerate the transition to clean transport fuels.
- Consideration of the contribution to air pollution from non-transport sources, such as industry and combustion for the heating of buildings.
- Changing traffic management to improve air quality.

These measures will complement the action in the transport plans for the city which will look to reduce air pollution in the city.

16. The plan will also consider proposals for a Clean Air Zone.

Clean Air Zones (CAZ)

17. The new policy instrument created by government is the Clean Air Zone.

18. The Government's vision is:

> *"Clean Air Zones improve the urban environment to support public health and the local economy, making cities more attractive places to live, work, do business and spend leisure time. They support cities to grow and transition to a low emission economy thus ensuring these benefits are sustainable for the long term."*

19. The Government's draft framework for clean air zones states:

> *"A Clean Air Zone defines an area where targeted action is taken to improve air quality and resources are prioritised and coordinated in order to shape the urban environment in a way that delivers improved health benefits and supports economic growth.*
>
> *Clean Air Zones aim to address all sources of pollution, including nitrogen dioxide and particulate matter, and reduce public exposure to them using a range of measures tailored to the particular location.*
>
> *Within a Clean Air Zone there is also a particular focus on measures to accelerate the transition to a low emission economy. This will ensure improvements are ongoing and sustainable, support future development*

and decouple local growth from air pollution.

Clean Air Zones bring 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."

20. Clean Air Zones fall into two categories:

- **Non-charging Clean Air Zones** – These are defined geographic areas used as a focus for action to improve air quality but does not include the use of charge based access restrictions.
- **Charging Clean Air Zones** – These are zones where, in addition to the above, vehicle owners are required to pay a charge to enter, or move within, a zone if they are driving a vehicle that does not meet the particular standard for their vehicle type in that zone.
- Some vehicles are exempt from a charge. Exempted vehicles are defined by their EURO class – a designation which relates to their emissions of key pollutants. EURO 6 \ VI diesel vehicles and EURO 4 \ IV petrol vehicles would be exempt from charges. EURO 6 \ VI vehicles are generally registered after 2014, while EURO 4 \ IV vehicles are those usually registered after 2006. Zero or "Ultra Low" emissions vehicles such as electric vehicles would also be exempt.

Clean Air Zone Feasibility Study

21. Bristol City Council and South Gloucestershire Council have secured £498k of government funding to undertake a feasibility study into a Clean Air Zone. BCC is the lead authority.

22. A project board has been established to develop the Clean Air Action Plan including the service directors of planning, public health and transport from BCC and a representative of South Gloucestershire Council. This group has also considered the scope of the Clean Air Zone feasibility study and has agreed the brief to consultants in consultation with the Mayor and Cllr Hance.

23. Consultants CH2M have been commissioned to undertake the CAZ feasibility study and the University of the West of England Air Quality Management Unit has been appointed to act as independent expert advisor to the city council.

24. The feasibility work is taking place in three phases:

1. Definition of options – May to August 2017

Analysis (and collection) of data and use of existing modelling tools to sift a long list of options and determine which should be taken forward for more detailed analysis.

2. Assessment of options – August to November 2017

Detailed traffic and air quality modelling of 4 options, including basic assessment of economic impacts and scheme costs

3. Detailed assessment of final option – December 2017 – February 2018

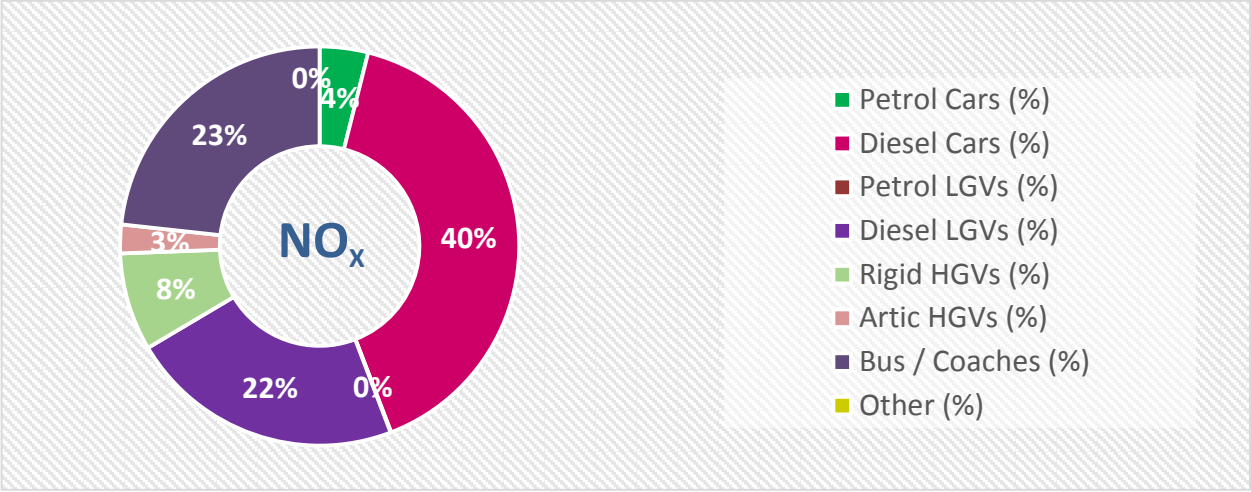
This assessment will include consideration of the financial, health, transport, social, economic and environmental aspects of the scheme. Special consideration will be given to assessing the effects on:

- Low income households living in the central areas and the outer areas of the city who may have different transport needs
- Small businesses, in particular those that are currently heavily reliant on diesel transport, such as tradespeople
- Buses, taxi and private hire businesses and services, including any potential impacts on fares

An equalities impact assessment will also be undertaken.

25. The initial feasibility work gathering information has calculated the proportion of Nitrogen Oxides (NOx) emissions from vehicles in the centre of Bristol, calculated from the vehicle movements in the transport model, and the latest vehicle emission figures provided by Defra. This shows that diesel vehicles contribute around 96% of the total NOx emissions. The term NOx describes oxides of nitrogen, which are emitted from tailpipes and includes nitrogen dioxide and also nitric oxide, which is oxidised over time to become nitrogen dioxide.

Figure 3: Proportion of NOx emissions by vehicle class in central Bristol



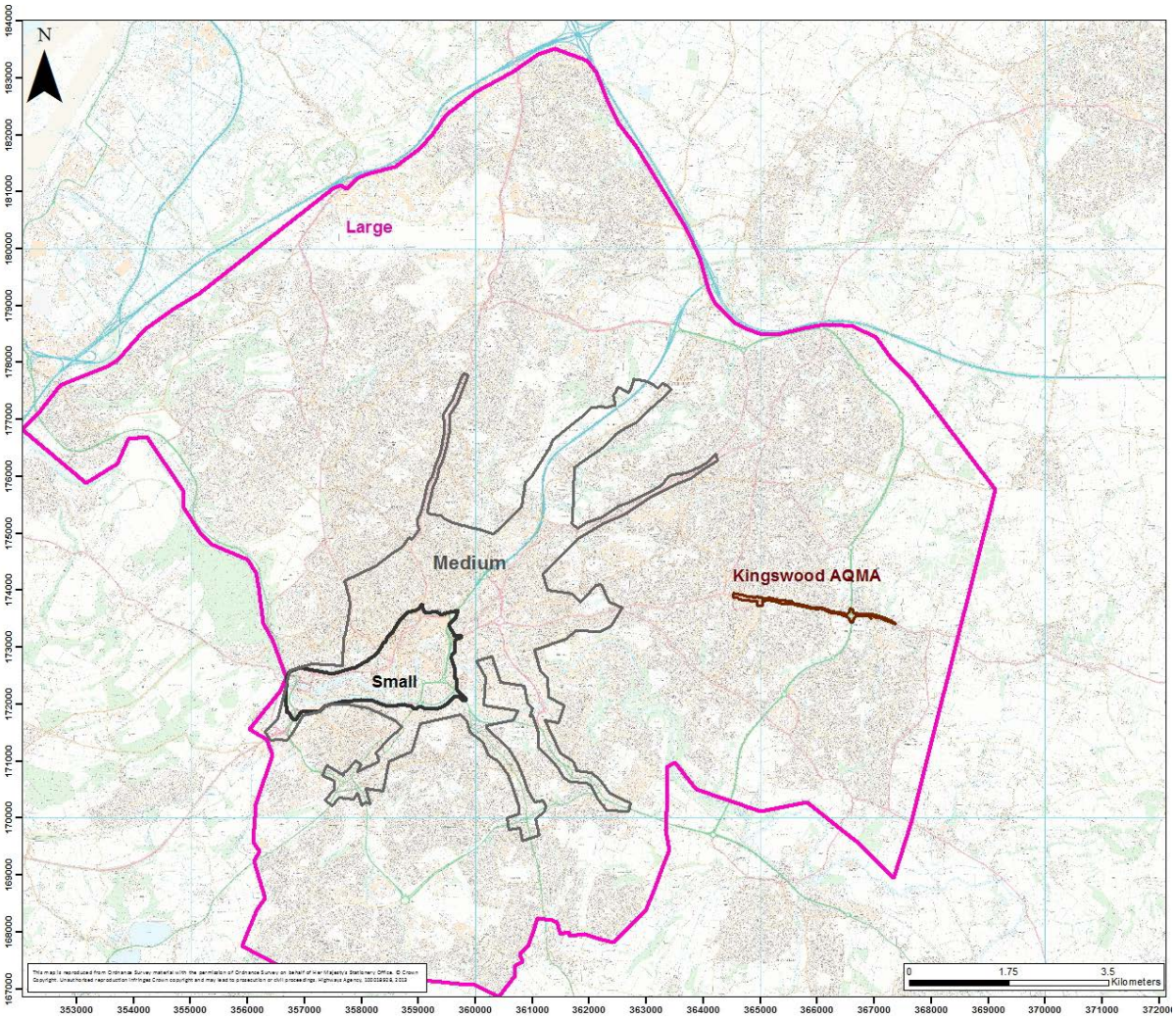
26. Phase 1 of the study developed an initial long list of options which has been considered by the Mayoral Air Pollution Working Group. This was created from considering a range of geographical areas and a range of types of CAZ.

    1. Geographical area (shown on Figure 4)
        - "Small" – Bristol City Centre
        - "Medium" – with three variations:
            - The Bristol Air Quality Management Area (AQMA)
            - Bristol AQMA + Kingswood-Warmley AQMA combined
            - Bristol AQMA + Kingswood-Warmley AQMA separate
        - "Large" – The Bristol/South Gloucestershire continuous urban area
    2. CAZ Classes which include vehicle types as set out by the Government:

- Class A non-charging – buses, coaches, taxis, private hire vehicles
- Class A charging – buses, coaches, taxis, private hire vehicles
- Class B charging – buses, coaches, taxis, private hire vehicles and HGVs
- Class C charging – buses, coaches, taxis, private hire vehicles, HGVs and LGVs
- Class D charging – buses, coaches, taxis, private hire vehicles, HGVs, LGVs and cars

The Government's proposals for Clean Air Zones specify this clustering of vehicles into different classes and do not give flexibility for local authorities to vary this.

Figure 4: Potential geographical areas used for assessment of long list of options



27. It should be noted that the geographical area of the Bristol AQMA is complex and in taking forward the future modelling of these options the boundary will be reviewed and simplified where practicable. It may not be necessary to extend the CAZ to the full extent of the AQMA along some of the arterial routes in order to achieve compliance along the whole route.

28. The Consultants have evaluated the long list of options against a set of criteria, some of which were given greater weight than others. These are shown in Table 1.

Table 1: Evaluation Criteria and Weightings

ID	Evaluation Criteria	Priority
1	**Deliver compliance with NO2 air quality objective within CAZ in the shortest possible timescales**	**Very High**
2	**Deliver compliance with NO2 air quality objective outside of CAZ**	**Very High**
3	Provide equity across different vehicle types and trip purposes	Low
4	Compliance with Defra Draft CAZ framework	High
5	**Mitigate financial impact on low income households**	**Very High**
6	**Improve health of low income households**	**Very High**
7	Economic effect	Medium
8	**Improve public health**	**Very High**
9	Delivery timescale risks of procurement	Low
10	Likelihood of revenue equating to implementation/operational costs	High
11	Upfront capital required for scheme	Medium
12	Risk of financial penalty to the Council/s	Low
13	Public acceptability	Medium
14	Political acceptability	Medium
15	Mobilisation period	Medium

29. Each of the long list of options was assessed by the consultants, making the best use of available modelling tools and data, in order to compare the **relative** merits of each option. The assessments are not sufficiently detailed to demonstrate that the options proposed are feasible and/or effective solutions to the air quality problems in Bristol and South Gloucestershire but are sufficient to determine which options have the highest chance of success, and are worthy of more detailed investigation.

30. The Consultants have recommended the following 4 Clean Air Zone options are taken forward for more detailed investigation in the next stage of the feasibility study;

- **Medium sized, CAZ Class C** (i.e. Bristol AQMA including all vehicles except cars)
- **Medium sized CAZ Class D** (i.e. Bristol AQMA including all vehicles)
- **Small sized, CAZ Class C** (i.e. Bristol City Centre including all vehicles except cars)
- **Small sized, CAZ Class D** (i.e. Bristol City Centre including all vehicles)

31. In addition we intend to assess other measures to improve air quality which could complement a CAZ and bring us closer to compliance than a CAZ alone and form part of the wider Clean Air Action Plan.

32. The options for Class A (including only buses, coaches, taxis, and private hire

vehicles) and Class B (including only buses, coaches, taxis, private hire vehicles and HGVs) are not recommended for further detailed modelling. This is because the initial assessment concludes that they would not lead to a significant improvement in air quality nor achieve compliance with the legal air quality standards in large parts of the AQMA. Typically the Class A and B options would improve average NO_2 levels at monitoring sites in the zones by up to 5%, compared to 10-15% for Class C and 30-35% for Class D.

33. The large CAZ options which cover the Bristol/South Gloucestershire continuous urban area is assessed as having the greatest benefits for air quality, however, it is not recommended to take forward the large options, because:

- They include significant parts of the city where air quality meets the legal standards and would affect journeys wholly within those areas and therefore risk not being consistent with the National government CAZ framework. This would potentially negatively affect central government funding for a scheme.
- The large area schemes would have a greater effect on more low income households.
- The large area schemes would have much higher implementation and operating costs and would require longer transition arrangements, limiting their effectiveness.

34. The medium options which include the Kingswood-Warmley AQMA are not recommended for detailed modelling because the initial assessment indicates that a small or medium CAZ in Bristol would impact sufficient trips travelling through the South Gloucestershire Council AQMA's to achieve compliance there.

Appendix A2: Environment Act 1995 (Feasibility Study for Nitrogen Dioxide Compliance) Air Quality Direction 2017

On the 27th July 2017 Thérèse Coffey MP Parliamentary Under Secretary of State for the Environment Department for the Environment Food & Rural Affairs made the a Direction to Bristol City Council and some other local authorities, extract of which are below.

ENVIRONMENT ACT 1995

Environment Act 1995 (Feasibility Study for Nitrogen Dioxide Compliance) Air Quality Direction 2017

The Secretary of State, in exercise of the power conferred by section 85(5) of the Environment Act 1995(a), gives the following direction.

(a) In accordance with section 85(6) a copy of this direction will be published in the London Gazette.
The Secretary of State makes this direction having determined that it is necessary in order to meet obligations placed upon the UK under the EU Ambient Air Quality Directive(b).

Requirement to take certain steps
3. Each of the specified authorities must complete the specified activities by the dates specified in Schedule 2.

Activity	**Description of activity**	**Deadlines**
Undertake as part of the UK plan for tackling roadside nitrogen dioxide concentrations 2017, a Feasibility Study in accordance with the HM Treasury's Green Book approach, to identify the option which will deliver compliance with legal limits	Initial Plan: Setting out the case for change and the first stage in identifying, exploring, analysing and developing options for measures which the local authority will implement to deliver compliance in the shortest possible time, with indicative costs for those	As soon as possible and by 31 March 2018 at the latest.
As above	Final Plan: Identifying the preferred option for delivering compliance in the shortest possible time, and setting out value for money considerations and implementation arrangements	As soon as possible and by 31 December 2018 at the latest.

Bristol Clean Air Zone Feasibility Study: Option Sifting - Draft

Prepared for

Bristol City Council and South Gloucestershire Council

26 July 2017

Contents

Table(s)

Figure(s)

Appendices

Document history

673846.CD.55.01 Bristol Clean Air Zone Feasibility Study

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4	26/07/17	Final – with minor amendments	Gordon Allison, Chris Bushell, Luke Farrugia, Karan Monga, Stephen Alexander	Becky Lloyd	Paul Bufton

Acronyms and Abbreviations

ANPR	Automatic Number Plate Recognition
AQMA	Air Quality Management Area
BCC	Bristol City Council
CAZ	Clean Air Zone
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
EFT	Emission Factor Toolkit
GBATS4M	Greater Bristol Area Transport Study v4M
HGV	Heavy Goods Vehicle
IMD	Indices of Multiple Deprivation
JTS	Joint Transport Plan
JSP	Joint Spatial Plan
LGV	Light Goods Vehicle
RAG	Red-Amber-Green
SGC	South Gloucestershire Council
WPL	Workplace Parking Levy

Introduction

1.1 Overview of Study

CH2M has been commissioned jointly by Bristol City Council (BCC) and South Gloucestershire Council (SGC) to assess the feasibility of a Clean Air Zone (CAZ) within the greater Bristol area. The study seeks to identify a CAZ which could bring about compliance with the European Limit Value for annual mean nitrogen dioxide in the shortest time possible in Bristol and South Gloucestershire.

The UK has in place legislation passed down from the European Union, to ensure that certain standards of air quality are met, by setting limit values on the concentrations of specific air pollutants. In common with many EU member states, the EU limit value for annual mean nitrogen dioxide is breached in the UK and there are significant and on-going breaches of the nitrogen dioxide limit value in Bristol and South Gloucestershire. The UK government is taking steps to remedy this breach in as short a time as possible. Within this objective, the government is currently consulting on a Draft UK Air Quality Plan and a Clean Air Zone Framework, both published in May 2017. The latter document provides the expected approach for local authorities when implementing and operating a Clean Air Zone.

In November 2016 Defra/DfT invited applications from local authorities for grant money to deliver projects which develop and/or implement measures to improve local air quality. BCC and SGC jointly submitted a bid for a CAZ feasibility study and were awarded funding in March 2017.

The feasibility study will be delivered in three phases;

1. **Definition of options** - analysis (and collection) of data and use of existing modelling tools to sift the long list of options and determine which should be taken forward for more detailed analysis.
2. **Assessment of options** - detailed traffic and air quality modelling of up to 5 options, including basic assessment of economic impacts and scheme costs.
3. **Detailed assessment of final option** - assessment of implementation/operation costs and economic benefits of scheme including transport, air quality, public health and wider impacts.

1.2 Purpose of This Report

This report sets out the results of the assessment undertaken in phase 1 of the feasibility study. It provides a summary of the options considered, the assessment criteria, the method of assessment and the performance of each option against the assessment criteria. Based on the assessments undertaken a recommendation is provided of the four options to be considered in greater detail in phase 2 of the study.

Overview of Assessment

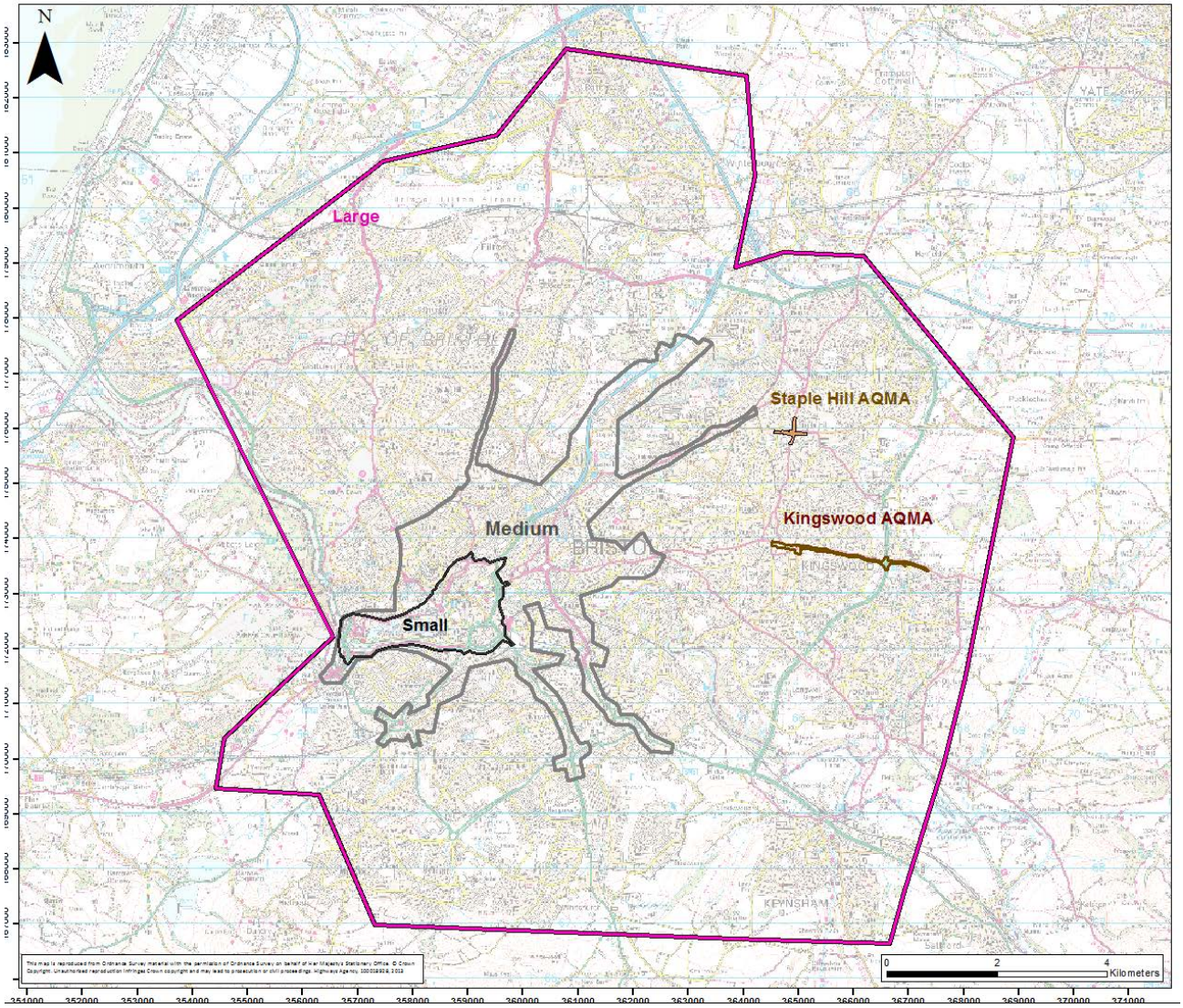
2.1 Options Assessed

In total 26 options have been considered including variations in geographical scope and CAZ Class. The first 25 options are all possible combinations of five geographical scopes and five classes of CAZ. The geographical scopes assessed are;

1. Large - the Bristol urban area within the boundary of the M4 and M5 and excluding areas within B&NES and NSC.
2. Medium - BCC AQMA
3. Medium - BCC & SGC Kingswood-Warmley AQMA combined
4. Medium - BCC & SGC Kingswood-Warmley AQMA separate
5. Small - within the Inner Ring Road

Figure 2-1 shows the boundary of each zone assessed. These are anticipated to evolve throughout the length of the study.

Figure 2-1: Initial CAZ geographies



The CAZ classes assessed were as defined in the Defra/DfT's Clean Air Zone Framework. The framework sets out which vehicles are affected by each CAZ class and what the minimum Euro standards are for each vehicle type. The five CAZ classes assessed are;

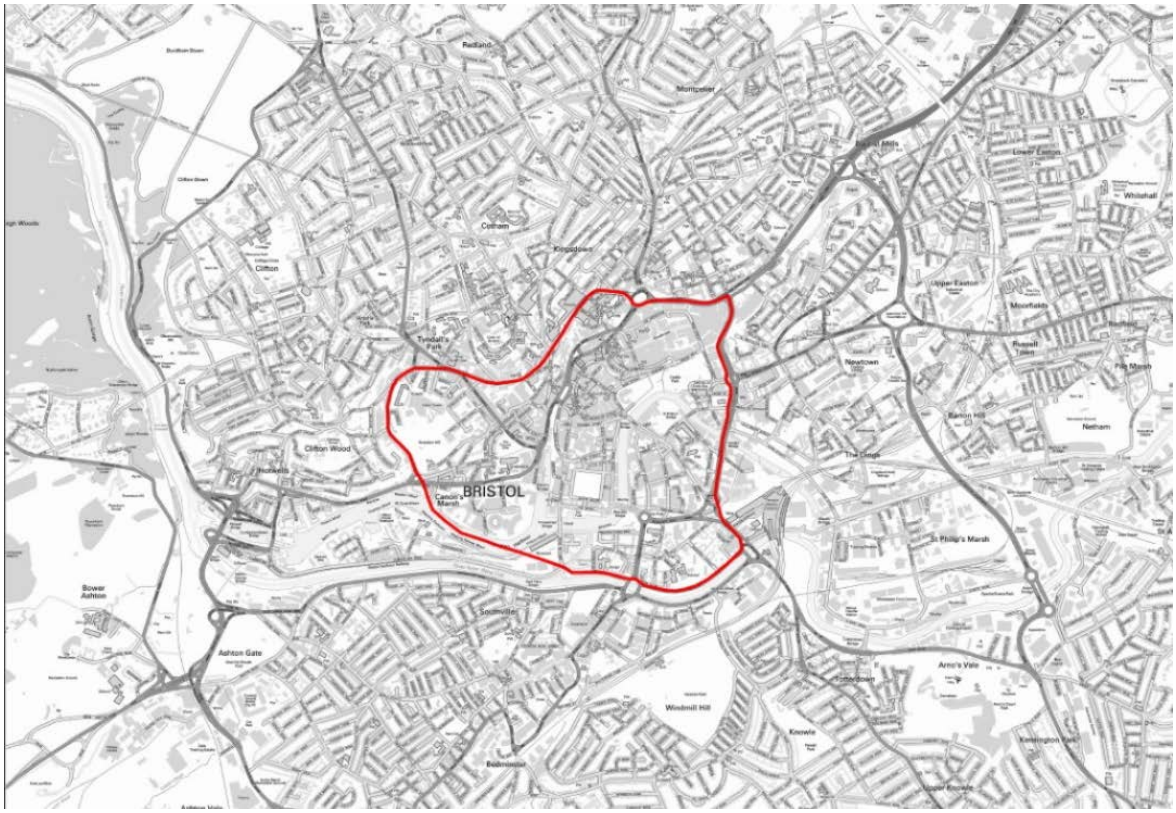
1. Class A non-charging – buses, coaches, taxis, private hire vehicles

2. Class A charging – buses, coaches, taxis, private hire vehicles
3. Class B charging – buses, coaches, taxis, private hire vehicles and HGVs
4. Class C charging – buses, coaches, taxis, private hire vehicles, HGVs and LGVs
5. Class D charging – buses, coaches, taxis, private hire vehicles, HGVs, LGVs and cars

Two Class A zones are included within the options assessed, one charging and one non-charging, as per the Defra CAZ Framework. Both classes of CAZ apply to the same vehicle classes (buses, coaches, taxis and private hire vehicle) but where a charging zone applies a charge for a movement within a certain boundary, a non-charging zone uses franchising and licensing agreements to promote changes to cleaner vehicles.

The 26th option is an alternative scheme to a CAZ incorporating a congestion charge and a workplace parking levy in central Bristol. This scheme has not been directly assessed by CH2M. The scores provided for this option are either on the basis of professional judgement or taken from Atkins report 'West of England Joint Transport Study – Options for Fiscal Measures', 20th March 2017. In this option a workplace parking levy would be applied across Bristol including the entirety of Bristol City Council's authority area and parts of South Gloucestershire within the boundaries of the M4 and M5. The congestion charge zone would be applied across the area shown in Figure 2-2 below.

Figure 2-2: JTS Congestion Charge Zone



The options assessed are set out in Table 2-1 overleaf.

Table 2-1: Summary of Options Assessed and Option ID's

Geography / CAZ Class	A - non-charging	A - charging	B- charging	C - charging	D - charging
Large	1	2	3	4	5
Medium - BCC AQMA	6	7	8	9	10
Medium - BCC & SGC Kingswood-	11	12	13	14	15

Geography / CAZ Class	A - non-charging	A - charging	B- charging	C - charging	D - charging
Warmley AQMA combined					
Medium - BCC & SGC Kingswood-Warmley AQMA separate	16	17	18	19	20
Small	21	22	23	24	25
Option 26 – JTS WPL and congestion charge zone					

2.2 Assessment Criteria

A number of evaluation criteria have been defined for a Bristol CAZ against which each of the options has been assessed. The evaluation criteria have been defined using the five case model approach set out in the DfT's guidance on 'Transport Business Cases' (2013) as a framework. The five cases are;

- **Strategic** – assessment of the case for change that fits with wider public policy objectives
- **Economic** – assessment of the value for money
- **Commercial** – assessment of the commercial viability of the proposal
- **Financial** – assessment of the affordability of the proposal
- **Management** – assessment of whether the proposal is achievable

The evaluation criteria defined within each of the five cases reflect the items of most importance to the scheme. The evaluation criteria are;

Strategic

1. Deliver compliance with NO2 air quality objective within CAZ in the shortest possible timescales
2. Deliver compliance with NO2 air quality objective outside of CAZ
3. Provide equity across different vehicle type and trip purpose
4. Compliance with Defra Draft CAZ framework

Economic

5. Mitigate financial impact on low income households
6. Improve health of low income households
7. Economic effect
8. Improve public health

Commercial

9. Delivery timescale risks of procurement

Financial

10. Likelihood of revenue equating to implementation/operational costs
11. Upfront capital required for scheme
12. Risk of financial penalty to the Council/s

Management

13. Public acceptability
14. Political acceptability
15. Mobilisation period

An additional criterion was included as part of the assessment; 'Consistent with broader transport and planning policies'. This has is not included within the overall scoring system, for reasons explained later in this report, but is assessed on a qualitative basis for all CAZ options.

2.3 Scoring System

A scoring system was devised for the option assessment which provides a score of Low (3), Medium (2) or High (1) for each option against each evaluation criteria. The options have been scored relatively within each evaluation criteria; a score of high does not necessarily indicate a negative impact, just that of all the options considered it is among the worst performing (and vice versa for low).

Each evaluation criteria was given a priority level of either Low (1), Medium (2), High (3), or Very High (4). These priority scores were multiplied with the RAG score to give an overall score for each option. The priority score of each evaluation criteria is summarised in Table 2-1 below.

Table 2-2: Priority of Evaluation Criteria

Cases	ID	Evaluation Criteria	Priority
Strategic	1	Deliver compliance with NO2 air quality objective within CAZ in the shortest possible timescales	Very High
	2	Deliver compliance with NO2 air quality objective outside of CAZ	Very High
	3	Provide equity across different vehicle types and trip purposes	Low
	4	Compliance with Defra Draft CAZ framework	High
Economic	5	Mitigate financial impact on low income households	Very High
	6	Improve health of low income households	Very High
	7	Economic effect	Medium
	8	Improve public health	Very High
Commercial	9	Delivery timescale risks of procurement	Low
Financial	10	Likelihood of revenue equating to implementation/operational costs	High
	11	Upfront capital required for scheme	Medium
	12	Risk of financial penalty to the Council/s	Low
Management	13	Public acceptability	Medium
	14	Political acceptability	Medium
	15	Mobilisation period	Medium

2.4 Assessment Methodology

The methodology used to assess the CAZ options has been designed to make best use of available modelling tools and data in order to compare the relative merits of each option. The assessments provided in this report are not sufficient evidence to demonstrate that the options proposed are feasible and/or effective solutions to the air quality problems in Bristol and South Gloucestershire but are sufficient to determine which options have the highest chance of success, and are worthy of more detailed investigation.

The GBATS4M 2021 SATURN Highway model was used to undertake initial approximate tests of vehicle trip responses to the implementation of option 10 (Medium Class D CAZ) and Option 25 (Small Class D CAZ). The results from these tests informed analysis against a number of the evaluation criteria.

The GBATS4M model was updated in 2013 by CH2M, including a complete highway network update and partial update of the trip matrices with new origin-destination data focussing on central Bristol. The model is considered to be the best local model for testing strategic schemes of this kind. The GBTAS4M suite of models includes a demand model and a public transport model, as well as the SATURN Highway model. However, The SATURN highway model was used for these initial tests, due to the complexity of the responses within a CAZ, the current structure of the variable demand model and level of detail required for the sifting exercise.

The expected responses to the implementation of a CAZ have been taken from the 'Draft UK Air Quality Plan for tackling nitrogen dioxide' May 2017, Table 4.4, as shown below. This data is based on stated preference surveys undertaken by Defra, and was gauged to be the most relevant available response data at the time. It will be reviewed in further detail in the next stage of the study. However, it is unlikely that the use of different response rates would change the conclusions of the sifting process since, in particular, the combined proportions for the responses that will result in fewer trips by non-compliant vehicles, namely 'Cancel journey / change mode' and 'Replace vehicle', account for over 70% for all vehicle types and over 80% for four out of the five vehicle types. If these proportions were lower, it would further emphasise the need for class C or D CAZ rather than class A or B which would cover fewer vehicle types.

Figure 2-3: Table 4.4 from the Draft UK Air Quality Plan for tackling Nitrogen Dioxide – Technical Report

Table 4.4: Proportions of non-compliant trips by response to the presence of a CAZ

	Cars	LGVs	HGVs	Buses	Coaches
Pay charge	7%	20%	9%	0%	16%
Avoid zone	7%	8%	0%	0%	0%
Cancel journey / change mode	21%	8%	9%	6%	13%
Replace vehicle	64%	64%	83%	94%	72%

The GBATS4M model was used to model these responses using the following methodology:

1. Pay Charge – no change to the model, however an initial indication of revenue levels was estimated from the type and number of vehicles making trips within the CAZ cordon, the percentage of non-compliant vehicles and the anticipated level of charging.
2. Avoid Zone – a charge was applied to each inbound link to replicate the percentage change of non-compliant cars and LGV's within the CAZ (HGV's not included since 'Avoid zone' response is 0%);

3. Cancel journey / change mode – this was modelled by reducing the number of trips made by non-compliant vehicles to/from the CAZ area and within it, to replicate the percentage change from the reference case; and
4. Replace Vehicle – no change to the model, however calculations were carried out using model outputs to determine the links which would be affected by the percentage change from non-compliant to compliant vehicles from the reference case.

Assessment of Options

3.1 Consistency with Broader Transport Strategies

3.1.1 Background and Context

Bristol City Council and the wider West of England local authorities are embarking on an ambitious programme of transport and planning policy reform underpinned by the emerging Joint Transport Strategy (JTS) and Joint Spatial Plan (JSP). As a result is it necessary to assess how the various options will align with and support the realisation of the strategic objectives contained with the emerging policy documentation.

The key strategic themes and principles of the existing policies overlap with several of the evaluation criteria used for this assessment, including those related to air quality improvements, benefits to the economy, social inclusion and public health benefits. In essence an assessment of consistency with current policy combines the scores from these other evaluation criteria, balancing out the positive and negatives. For this reason, it proved challenging to assess this in a way which provided any real differential between options and so it has not been included in the RAG scoring system. It remains important to demonstrate the level of consistency of each proposed CAZ with the existing policies and hence this criterion has been assessed qualitatively for all CAZ option as discussed below.

3.1.2 Method of Assessment

A review of the JTS and JSP consultation documents reveal a number of strategic objectives, with some consistency across both policy documents. Given the similarities between the objectives underpinning both the JTS and JSP, these objectives can be condensed into three broad themes of objectives as described below, against which the CAZ options can be assessed:

- Economic:
  - Improving transport economic efficiency, related to journey time, delay and reliability enhancements.
  - Safeguarding existing economic activity and promoting economic development to unlock new additional economic activity.
- Environmental:
  - Reducing emissions and coverage of West of England AQMAs.
  - Promoting mode shift to more sustainable modes of transport.
- Social:
  - Promoting social inclusion, equality and affordability.
  - Enhancing quality of life and standards of public health.

3.1.3 High Level Assessment

3.1.3.1 Economic

There are two constituent elements influencing the economic theme of policy objectives; the impact of the options in terms of transport economic efficiency (reflecting congestion relief and reduction in journey times) and the impact on existing/new economic activity. On balance, the two constituent elements have a broadly neutral impact across all options as those options that produce transport economic efficiency improvements most are likely to support existing and future economic activity least (and vice versa).

3.1.3.2 Environmental

Emissions are likely to reduce most in a CAZ with wider geographies and more vehicle classes incorporated, since this maximises the number of polluting trips affected by the CAZ. Similarly, a wider geography and inclusion of more vehicle types within the CAZ is likely to produce the greatest mode shift to more sustainable modes. Further, a wider geographical extent for CAZ would include more of the locations known to exceed current EU limits for nitrogen dioxide within the Bristol and South Gloucestershire AQMAs. Overall, alignment with the environmental theme of policy objectives is therefore greatest for options that cover a larger geography and encompass more types of vehicles.

3.1.3.3 Social

There are two constituent parts influencing the social theme of policy objectives; the impact on social inequality, particularly low income groups, and the impact on public health. The smallest CAZ boundary with the narrowest definition of vehicle class (Class A) will minimise the impact on low income groups. This is because a small proportion of low income households reside in the tight geographical boundary set by the small CAZ definition and few households use vehicles that fall into the narrowest definition of vehicle class. However, public health improvements are likely to be greatest where emissions are reduced most significantly and mode shift to sustainable modes is highest. This is the case in a CAZ with the widest geography and all vehicle classes incorporated. On balance, the two constituent elements influencing the social theme of policy objectives have a broadly neutral impact across all options, as those options that support affordability and social inclusion most are likely to produce lower levels of public health improvements (and vice versa).

3.1.3.4 Aggregate Assessment

From the perspective of environmental and public health policy drivers, options that use the largest CAZ boundary and target all vehicle classes (Class D) are likely to perform best. Equally, such options are likely to have the largest positive impact in terms of transport economic efficiency. However, these positive impacts are likely to be balanced out by equally notable impacts on the area's economic output as well as the impact of charging on vulnerable low income household.

Options with smaller geographical extents and a narrower definition of vehicle class will minimise such dis-benefits but will also have relatively small impacts in terms of environment, public health and mode shift policy drivers. As a result, there is no sharp contrast between the performances of CAZ options in terms of consistency with broader transport and planning policies.

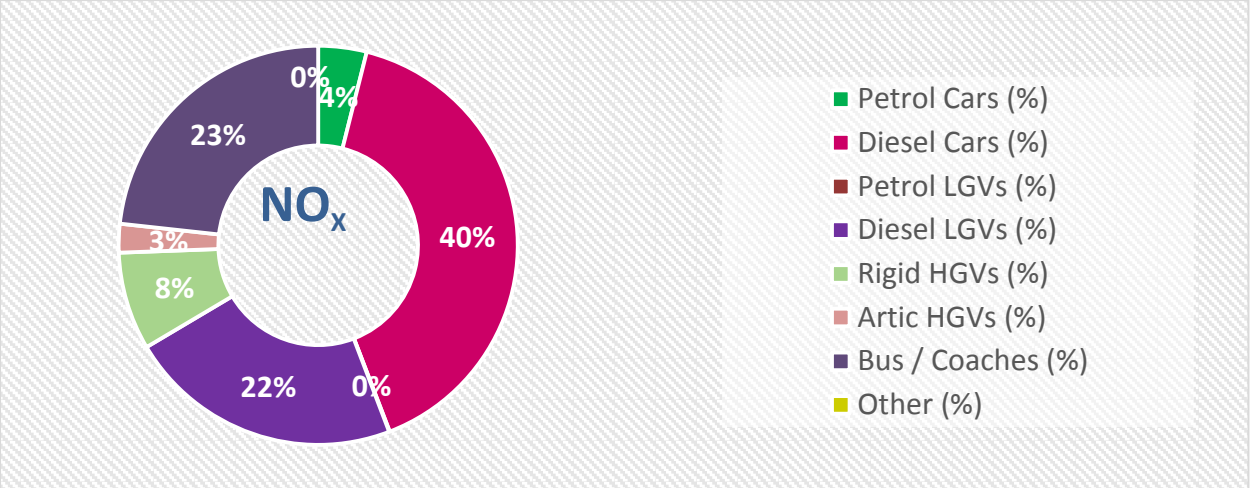
It should be noted that Option 26 'WPPL & Congestion Charging' is a scheme taken directly from the JTS. Therefore, this option is considered to be entirely consistent with broader transport and planning policies and does not feature in the more detailed analysis across strategic policy themes provided below.

3.2 Strategic Evaluation Criteria

3.2.1 Evaluation Criteria 1: Deliver compliance with NO2 air quality objective within CAZ in the shortest possible timescales

The current air quality situation in Bristol is presented in the form of a map in Appendix A showing measurements of nitrogen dioxide at locations within the city, in the Bristol City Council and South Gloucestershire areas. Emissions of NOx from vehicles, which are the cause of high roadside NO2 concentrations, are dependent on the type of vehicle. Figure 3-1 shows the proportion of NOx emissions by the vehicle fleet in the centre of Bristol, calculated from the vehicle movements in the Bristol model, and the latest vehicle emission figures provided by Defra specifically for work contributing to the National Air Quality Plan. This shows that diesel vehicles contribute around 96% of the total.

Figure 3-1: Proportion of NOx emissions by vehicle class in central Bristol



The traffic forecast to be on the roads in Bristol in 2019 has been analysed to understand whether it is theoretically possible for a CAZ to reduce emissions sufficiently to meet the air quality standard for nitrogen dioxide. This was done using standard methods as far as possible, and by applying some assumptions regarding how the vehicle fleet would change with the different categories of Clean Air Zone in place. The proportion of existing compliant monitoring locations (where NO2 concentrations were within EU limit) was determined from existing data, and then the likely impact of each CAZ class was used to forecast how many of these locations would become complaint with the introduction of a CAZ. The results of this analysis are shown in Figure 3-2 and Figure 3-3. The first graph demonstrates that although the number of compliant monitoring sites increases with each CAZ Class type, a Class D zone is needed to approach compliance. The second graph, which shows the % change in NO2 concentrations with each CAZ class, demonstrates that class C makes substantial improvements to the NO2 concentrations although it does not reduce them sufficiently to be achieve compliance.

Figure 3-2: Assessment of compliance at monitoring sites with classes of Clean Air Zone

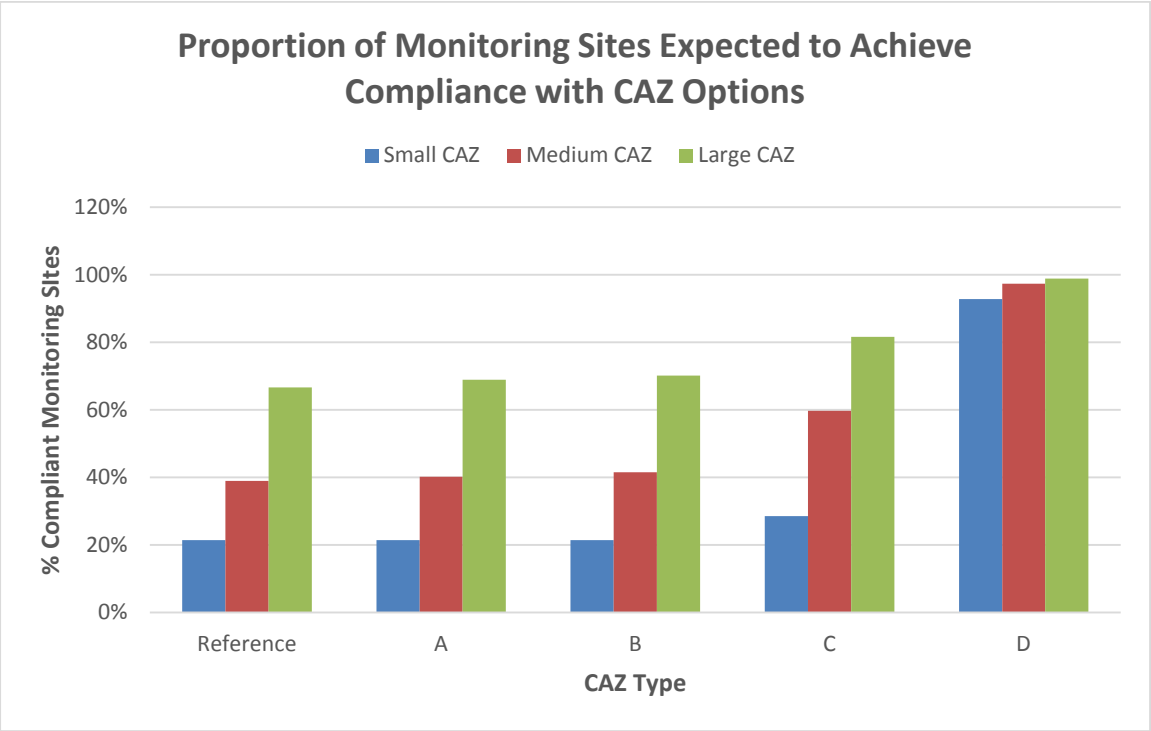
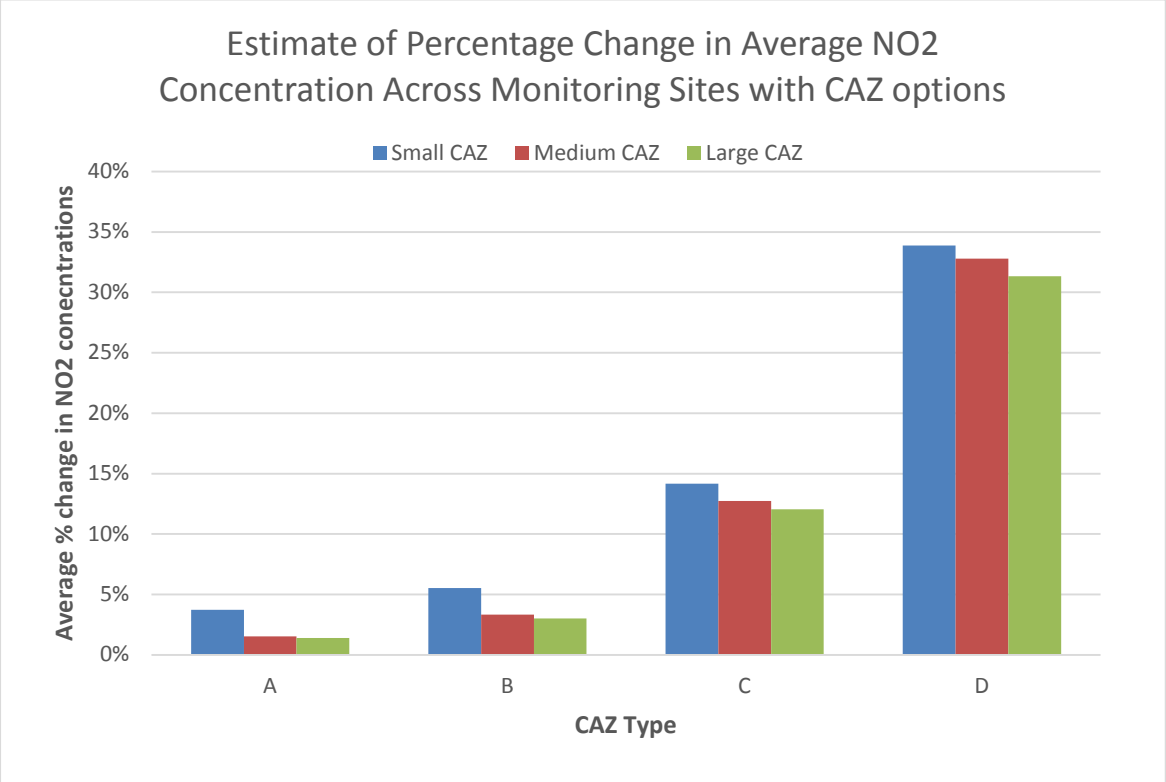


Figure 3-3: Assessment of change in NO2 concentrations at monitoring sites with classes of Clean Air Zone



The best performing options against Evaluation Criteria 1 are Class D zones since these have the greatest potential to achieve compliance at the existing monitoring sites. However, none of the CAZ options assessed are shown to be able to remove all non-compliant measurements, and it should not be assumed that an option shown as 'green' will achieve compliance with the air quality standard across Bristol. Class C zones show significant potential for addressing the Evaluation Criteria but all other classes of CAZ show little potential.

The JTS scheme, option 26, has not been tested explicitly. However, it is anticipated that the reduction in traffic within the congestion charging zone would improve the air quality, but the timescale for its delivery is not sufficiently clear to determine that it could deliver compliance in the 'shortest possible time'.

SGC AQMA's

The impact of a CAZ within the two SGC AQMA's in Kingswood-Warmley and Staple Hill has also been considered. The level of exceedance above the EU limit in these AQMA's is not large in comparison to many measurements in Bristol city centre. It is anticipated that the gradual improvement in the vehicle fleet may mean that these areas achieve compliance by the time a CAZ could be implemented (assumed to be 2019) without local intervention. In addition, the modelling undertaken indicates that a CAZ in central Bristol would impact sufficient trips travelling through the SGC AQMA's to achieve compliance in these areas.

3.2.2 Evaluation Criteria 2: Deliver compliance with NO2 air quality objective outside of CAZ

This Evaluation Criteria has been set to evaluate the potential for unintended worsening of air quality outside of a CAZ, caused by traffic re-routing to avoid the zone, and the intended improvements of air quality outside of zones, by the cleaner traffic transiting into the zone.

These impacts are anticipated to be most pronounced in a Class D zone and so this Evaluation Criteria has been evaluated for Class D zones using the GBATS4M traffic model. The model enables us to understand the overall impact of a CAZ on NOx emissions using the responses set out in the 'Draft UK Air Quality Plan for tackling nitrogen dioxide' May 2017 and Defra's Emissions Factor Toolkit (EFT), with assumptions made as to how non-compliant vehicles up-grade to compliant vehicles. The effect of the responses on vehicle emission patterns is compared with the 'do nothing' scenario in maps in Appendix B for the Small and Medium CAZ geographies.

The Small zone shows reductions in emissions outside of the zone on most links due to improvements in the fleet, but some links show increased emissions due to re-routing of non-compliant vehicles to avoid the zone. The adverse effect of re-routing is less for the Medium zone, and the benefits due to fleet improvements are greater. The implications from these tests are used to evaluate the other classes of zone.

3.2.3 Evaluation Criteria 3: Provide equity across different vehicle type and trip purpose

The assessment of each CAZ option against this Evaluation Criteria has focused on the vehicle types included within the CAZ and the likely trip purposes of these vehicles. Clearly, the more vehicle types included within a CAZ, the greater equity is achieved, and so a Class A CAZ scores poorly in comparison to a Class D.

A Class A zone includes only buses, coaches, taxis and private hire vehicles. This is anticipated to primarily affect leisure trips but also some commuting or business related trips. CAZ Classes B and C include goods vehicles in addition to those included within Class A, and so increase the impact on trips associated with businesses. In particular, the inclusion of LGVs may disproportionately impact small and medium sized businesses who rely on the use of their vehicles to operate their business. A Class D CAZ includes all vehicle types and hence has the most equitable impact.

3.2.4 Evaluation Criteria 4: Compliance with Defra Draft CAZ framework

The 'DfT/Defra Clean Air Zone Framework', May 2017, sets out the classes and standards of CAZ that would be acceptable for implementation. These are summarised in section 2.1 of this report. All CAZ options assessed apply one of these CAZ Classes and as such are in compliance with this part of the Clean Air Zone Framework.

In addition, the Clean Air Zone Framework sets out minimum requirements which any CAZ should meet including the expectation that it should 'be in response to a clearly defined air quality problem, seek to address and continually improve it and ensure this is understood locally'. The Framework also states that 'A Clean Air Zone designed in line with the principles in this framework will give an additional advantage to an authority bidding for competitive central government funding'. Hence, any CAZ which is not in compliance with the minimum requirements reduces the likelihood of central funding being obtained. The compliance of each proposed CAZ geography with this statement has been assessed below.

The large CAZ geography assessed includes substantial parts of Bristol where there are no known air quality exceedances and therefore is not entirely in compliance with the Clean Air Zone Framework minimum requirements. This places an additional risk against this option related to opportunities to obtain central government funding. In contrast, the medium geography is defined by the AQMA boundaries and therefore is clearly in response to an existing air quality problem. Similarly, the smallest geographical boundary is a subsection of the medium one and hence only includes areas where there is an evidenced air quality issue.

SGC AQMA's

The implementation of a CAZ which includes either of the two AQMA's in South Gloucestershire, at Kingswood-Warmley and Staple Hill, needs seperate analysis to determine whether it meets these minimum requirements. These two areas have existing exceedances of NO2 but they are not significantly above the EU limit and therefore only minor improvements are required for these areas to become complaint with the EU limits. Initial analysis using Defra's EFT suggests that these problems would be resolved naturally, through vehicle upgrades, by the point in time that a CAZ could be implemented (assumed to be 2019). Therefore, it is likely that upon reaching the point of implementation a CAZ that included the SGC AQMA's within its boundary, the CAZ would no longer be in response to a known air quality problem.

3.3 Economic Evaluation Criteria

3.3.1 Evaluation Criteria 5: Mitigate financial impact on low income households

Implementation of CAZ has the potential to disproportionately penalise vulnerable groups in society, depending on the geographic location, scale and the structure of vehicle compliance standards. In line with HM Treasury Green Book recommendations, any public-sector intervention must consider the differential impacts of proposals on vulnerable groups, including low income groups.

For the purpose of this study, low-income groups are defined as those communities in Bristol that fall within the bottom 30% of lower super output areas (LSOAs) nationally in terms of income deprivation. Various indicators reveal that such low-income groups are economically disadvantaged across a number of metrics and could be particularly susceptible to the introduction of CAZ charging.

From an occupational status perspective, residents in low income areas have a higher tendency (38%) to work in unskilled professions/low income occupations (e.g. administrative, primary activities, sales). This is significantly higher than the proportion of residents working in similar occupations across the rest of Bristol/South Gloucestershire (25%). The reverse is the case for high value occupations (e.g. managerial, senior, associate occupations), with 31% of residents in low income areas employed in such occupations compared to 46% elsewhere. The contrast between low and high value jobs undertaken by residents within the low-income areas and residents outside is demonstrated in the Figures C.1 and C.2 in Appendix C to this report.

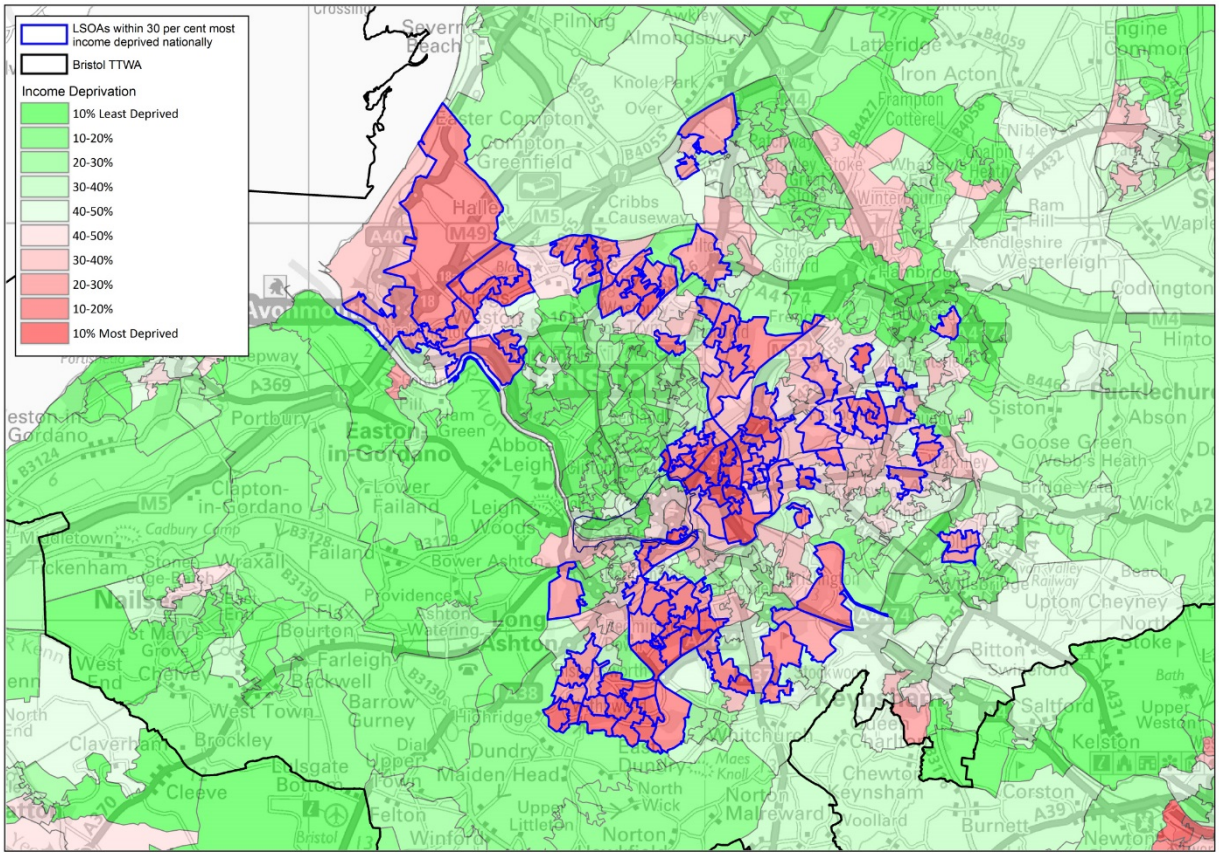
At the same time, a disproportionately high number of residents in low-income areas are employed in the transport and construction industries (5% and 8% respectively, compared to 4% and 7% for residents across other areas in Bristol and South Gloucestershire). This is demonstrated in Figure C.3 appended to this report. Employees in these sectors typically require access to or use of a vehicle to perform day-to-day tasks. This increases their exposure to public health issues resulting from emissions but also implies they are more likely to be exposed to CAZ charges, particularly if working for small businesses or as self-employed workers which is common in the transport and construction sectors.

Further, Journey to Work data reveals 51% of all commuting trips from low-income areas are made as car drivers, rising to 58% when taxi and car passenger modes are also included. This implies a significant proportion of commuters from low-income areas could be exposed to CAZ charges. Figure C.4 appended to this report demonstrates that some low-income areas provide a significant number of car driver commuters to Bristol city centre specifically.

In light of these indicators, it is appropriate to consider the differential impacts of the various CAZ options on low income groups in particular.

The primary focus of equality and social inclusion is around how affordable the scheme will be for low income groups in Bristol and South Gloucestershire. Firstly, the distribution of low income groups in Bristol has been determined through analysis of the Indices of Multiple Deprivation (2015) 'Income Domain' to demonstrate which CAZ geographies incorporate specific concentrations of income-deprived communities. Figure 3-4 maps the distribution of low income households, and demonstrates that whilst Bristol and the wider West of England region is considered to be a relatively affluent location in the UK, there are significant areas with high levels of income deprivation, particularly to the north and north west of Bristol City Centre and South Bristol in general. Indeed, 39% of all LSOAs in Bristol fall within the bottom 30% of LSOAs nationally, based on income deprivation. These areas lie within the 'Medium' and 'Large' CAZ geographies, suggesting that a higher proportion of low-income households are likely to be affected by these options that propose wider boundaries.

Figure 3-4: Distribution of low-income households across Bristol and the West of England (source: Indices of Multiple Deprivation, 2015)



Where low-income groups are disproportionately exposed to a CAZ, residents may suffer from affordability issues. Affordability issues are likely to be a material factor under Class D CAZ options, as a significant proportion of private vehicles will not be compliant with CAZ rules under such conditions and will therefore be charged.

Analysis of car ownership and fleet statistics in low-income areas reveals that a high proportion, 37%, of households do not own a car, compared to 23% across Bristol and South Gloucestershire as a whole and 18% in the non-low income areas. That said, for those households in low-income households that do own a car, 69% of vehicles are not compliant with the Class D regulations for the clean air zones (i.e. Euro 4+ Petrol, Euro 6 Diesel). The prevalence of non-compliance is significantly higher in low-income areas than in other areas of Bristol/South Gloucestershire, as highlighted in Figure C.5 appended to this report. This suggests that car owners in the low-income areas are more likely to be impacted by CAZ proposals as their vehicles would not be compliant with standards. Moreover, those within the low-income areas may not be able to afford to purchase a compliant vehicle. Therefore, existing car owners in low-income areas are likely to be disproportionately penalised by CAZ proposals.

These findings are borne out by 2011 Census data reported in Table 3-1 which demonstrates that the quantum of low-income households who own cars increases in absolute terms and as a proportion of all car-owning households as CAZ geographical boundaries extend. This suggests that more low-income households could suffer from affordability issues under options that propose a wider geographical extent for the CAZ.

Table 3-1: CAZ impacts on low-income households, car ownership patterns

Geography	All Hholds	All Hholds with Cars	Total Low Income Hholds	Low-Income Hholds with cars	As % of All Low Income Hholds	As % of All Hholds with Cars
Small CAZ	53,189	34,898	15,355	8,898	58%	25%
Medium CAZ (Bristol)	203,395	158,356	77,642	56,798	73%	36%
Medium CAZ (Combined)	231,971	184,666	92,116	69,752	76%	38%
Large CAZ	599,088	516,277	257,032	210,794	82%	41%

Similar patterns are found when analysing journey to work data for low-income groups in Bristol. The quantum of low-income commuters who travel to work as car drivers increases in absolute terms and as a proportion of all car-owning households as CAZ geographical boundaries extend. As above, this suggests that more low-income households could suffer from affordability issues surrounding the commuting patterns under options that propose a wider geographical extent for the CAZ.

Table 3-2: CAZ impacts on low-income households, journey to work patterns

Geography	Low-Income JtW: All Modes	Low-Income JTW: Car Drivers	Low Income JtW: Car Driver Mode Share	BCC/SGC JtW: All Modes	BCC/SGC JtW: Car Drivers	BCC/SGC Jtw: Car Driver Mode Share
Small CAZ	531	147	28%	5,888	1,541	26%
Medium CAZ (Bristol)	21,663	7,997	37%	52,322	19,300	37%
Medium CAZ (Combined)	22,522	8,537	38%	62,962	26,728	42%
Large CAZ	74,727	38,324	51%	290,966	160,430	55%

As a result, the best performing options from the perspective of minimising equality and social inclusion issues are those options which propose a smaller geography and those options that do not seek to extend the CAZ charge to private vehicles (i.e. all Classes other than D).

Option 26 performs poorly as a workplace parking levy and congestion charge does not differentiate between road users' ability to pay and that could have wide geographic coverage affecting a large number of vulnerable, low-income households.

3.3.2 Evaluation Criteria 6: Improve health of low income households

To evaluate the effect of reduced emissions on public health, the annual emissions of NOx within each CAZ was assessed to understand the potential for reductions in ambient concentrations and human exposure. Options which cover a larger geographical area, and restrict a greater proportion of the vehicle fleet, will provide the greatest benefits in terms of public health. However, the analysis in the previous section of this report highlights that low-income households are likely to be disproportionately exposed to pollutants due to the types of vehicles they drive, the locations in which they live and the type of jobs that they undertake. To capture this impact, the public health effects of each option on low income households has been assessed separately to general public health impacts.

3.3.3 Evaluation Criteria 7: Economic effect

A CAZ has the potential to have significant impacts on Bristol's economy. Evidence from congestion zones and other forms of charging in other locations (e.g. London) suggest that implementation of such schemes can have a range of positive and negative implications on local economies. Overall, London's experience with its congestion zone suggests a broadly neutral impact of the scheme on economic and business activity once all positive and negative effects are combined. Given the complex economic impacts reported elsewhere and the distinct range of options proposed for Bristol's CAZ, it is appropriate to consider how each option could complement or weaken the local economy in Bristol.

Two broad types of economic impacts are considered in this assessment:

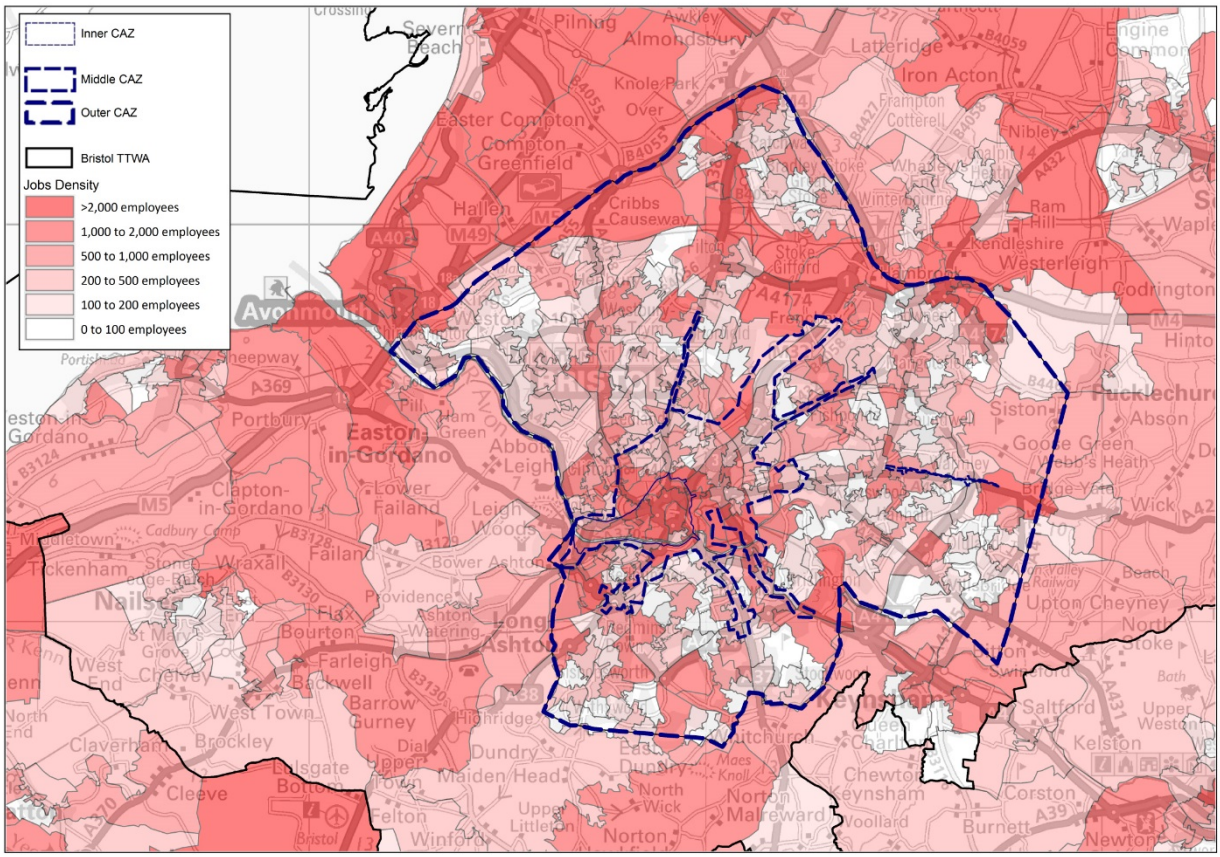
- Transport economic efficiency impacts: related to journey time, delay and reliability enhancements.
- 'Real' Economy Impacts: related to safeguarding existing economic activity and promoting economic development to unlock new additional economic activity.

Transport economic efficiency analysis is typically undertaken as part of conventional WebTAG-compliant economic appraisal for transport business cases. For this project, such detailed analysis is not proposed until short-listed options are taken forward to the next stage. Therefore, to inform the shortlisting process, a high-level review of modelling outputs describing network-wide performance under each option has been undertaken to identify which options have the potential to support enhancements to transport economic efficiency most significantly. This review, combined with CH2M's professional experience, indicates that vehicle delay/journey times/congestion would be lowest where the CAZ is implemented over the widest geographical area. Similarly, these metrics are likely to be most favourable where a wider definition of vehicles are subjected to CAZ charging. The volume of traffic and non-compliant road-users would increase as geographic scale and types of vehicle targeted increases. As such, options with wider coverage would have the largest impact in terms of reducing congestion and improving journey times, vehicle delay and reliability.

'Real' economy impacts relate to change in metrics such as the number of jobs and gross value added (GVA), which are key indicators of economic activity and economic growth. Such impacts are increasingly being considered within the strategic case of transport business cases rather than being formally incorporated into DfT-compliant economic appraisals. The assessment of potential real economy impacts across CAZ options is underpinned by the assumption that implementation of CAZ could reduce the attractiveness of Bristol as a location to work and do business.

Figure 3-5 presents the distribution of jobs across Bristol and the wider West of England sub-region. The mapping demonstrates high concentrations of employment in Bristol City Centre, which will feature in all CAZ geographical extents. Further, there is a high density of jobs in the North Fringe which features in the large CAZ area only, and there are other significant, localised areas of high employment distributed across the sub-region which feature prominently in the medium and large CAZ areas.

Figure 3-5: Distribution of employment across Bristol and the West of England (source: Business Register and Employment Survey, 2015)



Within this context, it is unsurprising that the scale of existing economic activity potentially affected by CAZ boundaries increases with geographic coverage of CAZ, as shown in Figure 3-2. The analysis demonstrates that nearly all economic activity in Bristol local authority area and a significant portion of economic activity in South Gloucestershire could be affected by implementation of the CAZ.

Table 3-3: Summary of jobs and GVA within each geographical boundary

Geography	Jobs	GVA (per annum)
Small CAZ	57,595	£3,456,726,563
Medium CAZ (Bristol)	139,025	£7,932,400,889
Medium CAZ (Kingswood-Warmley)	7,985	£412,270,472
Medium CAZ (Bristol & Kingswood-	147,010	£8,344,671,360
Large CAZ	324,275	£17,428,759,142

Further, a number of strategic development sites feature in the Large CAZ geographical area, including Filton Enterprise Area, Emersons Green Enterprise Area and Temple Quarter Enterprise Zone. Whilst the latter site also features in the Small and Medium CAZ areas, Filton and Emersons Green only feature in the Large CAZ. In addition, the nature of proposed activity at Filton and Emersons Green (including hi-tech manufacturing) means users of these sites will be more susceptible to CAZ charging, particularly HGVs and LGVs supporting business operations at these sites.

Taken together, this evidence suggests that from a 'real' economy impacts perspective, those options which propose a tighter geographical boundary and minimise the potential for vehicle non-compliance are likely to pose less of a threat to existing and future economic activity in Bristol.

As noted, the case study evidence from London suggests that the net effect of congestion charges and similar interventions on economic activity is neutral overall. This is borne out in the high level analysis above, which suggests there may be a trade-off between transport economic efficiency impacts and 'real' economy impacts, with those options that induce improvements to transport economic efficiency potentially putting 'real' economy metrics (jobs/GVA) at risk and vice versa. In effect, schemes with a wider geographical coverage and wider definition of vehicles subject to the CAZ charging could lead to most beneficial impacts in terms of journey time savings but the most detrimental impacts from an employment and GVA uplift perspective. Conversely, schemes with a narrow geographical coverage and narrow definition of vehicles subject to the CAZ will have more limited positive effects on journey times and congestion, but a more limited negative impact on the attractiveness of Bristol as a place to do business also.

Stronger conclusions can be drawn regarding Option 26. In addition to a congestion charge, this option proposes a workplace parking levy which could be highly unattractive to existing and prospective businesses and may not be well received by current and potential future employees who would perceive the levy as an additional charge.

This conclusion appears to be stronger than findings of recent reports into the impact of implementing a Worplace Parking Levy. For example, Atkins (2017) technical note on 'Options for Fiscal Measures' in the West of England, building on Mott MacDonald's 2016 study in Bath, concluded that a Workplace Parking Levy would have a relatively limited impact on traffic demand because most employers would not pass the charge on to their staff. This analysis assumes that total travel demand is fixed meaning schemes such as a workplace parking levy would result in mode shift rather than a reduction in travel demand.

However, a workplace parking levy would act as an additional financial burden for the business community. This burden would either be digested internally by businesses, passed on to employees or passed on to consumers. Therefore, the levy is likely to have a detrimental impact on economic activity as either businesses, employees or consumers will incur additional costs. From a business perspective, these additional costs could reduce the attractiveness of the business environment in Bristol. The additional burden may deter business entry to an affected area or catalyse business exit, which would have subsequent impacts on economic activity. Similarly, employees and consumers might choose to work/consume in other locations to avoid the imposition of the workplace parking levy. Therefore, it is possible that a levy could reduce travel demand rather than just encouraging mode shift, meaning the quantum of economic activity is reduced in affected areas.

Therefore, in comparison to the CAZ options, option 26 achieves a low score in terms of maximising benefit to the economy.

3.3.4 Evaluation Criteria 8: Improve public health

There are two core elements to the assessment of public health impacts:

- Impacts associated with changes in air quality/emissions;
- Impacts associated with mode shift to sustainable travel modes.

To evaluate the effect on public health with reductions in emissions, the exposure to air pollutants (NO2 and PM10 and PM2.5) are assumed to be directly related to the gross emissions from vehicles. Health experts now believe that there is no threshold for harm from NO2 and particulate matter and hence the EU limit has less significance here. Improvements in public health are anticipated with reduced emissions regardless of compliance with the legal standard. To evaluate the options, the annual emissions of NOx within each CAZ was assessed to understand the potential for reductions in ambient concentrations and human exposure. Options which cover a larger geographical area, and restrict a greater proportion of the vehicle fleet, will provide the greatest benefits in terms of public health.

The health impacts associated with mode shift have been estimated based on transport modelling outputs which predict the extent of mode shift to sustainable transport induced across each option. In particular, the analysis focusses on mode shift to walking and cycling, which has positive health impacts by increasing physical activity, resulting in reduced risk of premature death and reduced absenteeism from work. The scale of uplift in these modes can act as a proxy for the health impacts of an option, with greater uplift in walking and cycling associated with greater health impacts.

The transport modelling demonstrates that those options with wider coverage in terms of geographic extent and inclusion of vehicle types (i.e. Large CAZ and Vehicle Class D options), will achieve the greatest level of mode shift to walking and cycling. This is because greater volumes of traffic will be affected by CAZ under these conditions, inducing a greater degree of mode shift.

3.4 Commercial Evaluation Criteria

3.4.1 Evaluation Criteria 9: Delivery timescale risks of procurement

A significant commercial risk for a CAZ is the ability to deliver an effective service for monitoring and managing of the CAZ within a defined timescale. This risk exists for all proposed CAZ options and relies upon adopting a suitable approach to design, procurement, supplier selection and implementation of the chosen solution. Currently, monitoring of a CAZ can only be done effectively through the use of technology, specifically that which identifies the vehicle registration mark (VRM, commonly known as the 'number plate') of all vehicles entering and/or moving within the CAZ.

The procurement approach for the CAZ (e.g. open tender) is likely to be the same, or similar, regardless of the chosen CAZ option. The key determining factors for risks related to procurement and installation of a CAZ system within the identified timescale are the number of ANPR cameras required and the associated signage and road markings to be installed. The central system, being largely unaffected by the extent of the CAZ, is less of an issue in terms of deliverability. The larger the number of ANPR cameras needed, and the greater volume of signage required, the longer time period will be needed for:

- CAZ system designers to determine locations and provide designs for each boundary and intra-zone ANPR camera and all associated road signage and road markings;
- CAZ system supplier(s) to manufacture and supply the ANPR cameras;
- CAZ system supplier(s) (or the camera installer(s), if different) to install, test and commission the cameras;
- road signage suppliers to manufacture and supply the required signage; and
- civils works contractors to install signage and road markings, as well as any other associated physical changes to the road network (e.g. road/junction realignment, barriers).

Each of the identified CAZ areas was examined to determine the extent of roadside equipment (i.e. ANPR cameras) and road signage/markings needed to provide effective monitoring of vehicles entering and moving within the CAZ and to ensure that drivers were made aware when they were about to enter the CAZ or were inside it. As the central system is largely unaffected by the different scale of each CAZ, it was assumed that the same central system would be used in all cases.

A direct correlation was then made between the volume of cameras and road signage/markings needed and the delivery risk (red/amber/green) whereby the greater the volume needed, the greater the risk.

It was determined that the small CAZ required the lowest volume of cameras and road signage/markings from all options and therefore carries the lowest delivery risk. In comparison, both the medium and large zones require a considerable volume of cameras and road signage/markings and therefore carry a considerably higher delivery risk.

Nonetheless, the small CAZ still requires a notable volume of ANPR cameras, and the design of each ANPR camera and signage/lining location could take some time to determine for these zones. A delivery risk exists for all proposed CAZ options - albeit to different degrees depending on the size of CAZ area - such that the CAZ may not be fully covered by ANPR cameras by the time that it is scheduled to commence operation. This would result in fewer contravening vehicles being identified as well as the potential for deliberate avoidance of the cameras, thus reducing the effectiveness of the CAZ in reducing emissions. The only alternative would require a delay to commencement of CAZ operations in order to implement all required ANPR cameras.

3.5 Financial Evaluation Criteria

3.5.1 Evaluation Criteria 10: Likelihood of revenue equating to implementation/operational costs

Defra's Clean Air Zone Framework states that the level of charging for a CAZ should not be set in order to raise revenue, however any excess revenue above the costs of operation should be 're-invested to facilitate the achievement of local transport policies and these should aim to improve air quality and support the delivery of the ambitions of the zone'. This Evaluation Criteria focuses on the likelihood of raising sufficient revenue to cover implementation costs, including operational costs, but it is acknowledged that any additional revenue could be used to support sustainable transport initiatives or measures which reduce vehicle emissions.

Testing affordability of CAZ requires understanding the revenue potential of various options considered and comparing these with likely capital and operational costs. Detailed revenue modelling has not been undertaken yet, but CH2M's professional experience suggests that potential revenue would be highest where the CAZ is implemented over the widest geographical area and encompasses the widest definition of vehicles which are subjected to CAZ charging. This is likely to be because the volume of traffic and non-compliant road-users would increase as geographic scale and scale of vehicle types targeted increases.

The capital and operational costs for implementing the CAZ are primarily driven by size of the geography, with larger charging zones envisaged to have higher implementational and annual operational costs. These costs are not expected to be sensitive to the vehicle categories since enforcement would be required across the same geographic coverage regardless of the CAZ Class. In addition, relative to their geographic scale and vehicle coverage, similar costs will be incurred for both charging and non-charging options to properly enforce the CAZ. Whilst the purpose of the equipment installed under charging options will be to enforce the charge, the focus under non-charging options is to enforce the change in vehicle type established through quality partnerships and licensing agreements.

Considering the flows and revenue potential, the option with smallest geography and all vehicle categories appears to have the largest potential to recover capital and ongoing costs. This suggests that the option could be affordable and financially viable. Due to considerably higher capital and operational costs for options which cover larger geographies, their financial viability is reduced even when all vehicle categories are includes.

Excluding vehicle categories from charging mechanisms, which would reduce the potential revenue, also reduces the affordability of option with smallest geography. In case of larger geographies, such exclusions could make options financially unviable, where the council would not be able to recover all capital and operational costs through the proposed charging mechanism. On a similar note, all non-charging options, with no revenue potential, would be financially unviable.

3.5.2 Evaluation Criteria 11: Upfront capital required for scheme

The number and location of ANPR cameras is critical to the effective monitoring and identification of vehicles entering and moving within the CAZ. This requires an ANPR camera at each point of entry into the CAZ (referred to herein as the "boundary camera") as well as ANPR cameras within the CAZ (referred to herein as an "intra-zone" camera) to identify those vehicles that move within the CAZ and thus will not be detected by the boundary cameras.

The CAZ options assessed vary in the size of geographical area covered and in the type of vehicles that charges apply to (e.g. buses, HGVs, LGVs). Vehicle type is not considered a key factor in determining the type and scale of a CAZ system, as the same number and type of ANPR cameras would need to be located within the CAZ in order to identify those that are non-compliant. The key factor in determining the scale of a CAZ system is the nature and extent of the road network entering and bounded by the CAZ. The more entry points into the CAZ, the more boundary cameras are required to provide vehicle monitoring; similarly, the more complex the road network within the CAZ, the more intra-zone cameras are needed to capture vehicles moving within it.

Besides ANPR cameras, consideration has been given to costs associated with road signs, road markings, back-office operational costs, maintenance, communication links, power supply and publicity requirements. The number of ANPR cameras required, and the associated costs related to road signage and road markings, make up a significant proportion of the overall cost of a CAZ and these elements are heavily influenced by the geographic size of the CAZ. All other aspects of the cost generally remain similar irrespective of CAZ scale. Hence, the number of ANPR cameras is the most critical factor in determining the total capital required for a CAZ.

Each of the identified CAZ areas was examined to determine the extent of roadside equipment (i.e. ANPR cameras) and road signage/markings needed to provide effective monitoring of vehicles entering and moving within the CAZ and to ensure that drivers were made aware when they were about to enter the CAZ or were inside it.

The method for determining the number and location of ANPR cameras for each CAZ was based on a desktop (Google Earth©) analysis of the road network and analysis of link flow. To establish the number of boundary cameras all roads entering the CAZ boundary were identified and the number of cameras required was determined based on the number of traffic lanes that needed to be monitored.

Establishing the number of intra-zone cameras had to be undertaken from a more holistic view point since the larger zones would require extensive analysis to properly identify all locations where a camera is required. Where possible, such as in the small CAZ, a straightforward process was used to identify key locations where the majority of intra-zone movements can be captured. For the medium and large zones a simple correlation was made between the traffic flow of road links within the CAZ and the number of ANPR cameras estimated to monitor each link. It was assumed that only those links with an AADT (Annual Average Daily Traffic) flow exceeding 6,800 vehicles, reflecting the links carrying the highest quartile of AADT flow, would require intra-zone cameras.

A summary of the approximate number of ANPR cameras required and anticipated level of costs for each geographic scope of CAZ is provided below in Table 3-4.

Table 3-4: Summary of ANPR cameras required and approximate capital costs

	Number of ANPR Cameras	**Approximate Capital Cost**
Small CAZ	146	£5m - £10m
Medium CAZ	1091	£50m - £60m
Large CAZ	2734	£100m - £150m

Depending on boundary of the final recommended option, it may be necessary to implement some additional traffic management to restrict alternative movements around the CAZ. The level of work required, and associated costs, are unknown at this stage.

Based on this analysis it is expected that the largest zone would require significantly larger upfront investment from BCC/SGC to implement a CAZ compared to the medium and small geographies. The increase in cost as the geography widens is unlikely to be proportional to the scale of the improvement in terms of concentration levels.

3.5.3 Evaluation Criteria 12: Risk of financial penalty to the Council/s

This Evaluation Criteria captures the potential risk that financial penalties could be enforced by the EU on the UK government in response to ongoing exceedances of the legal limit of NO2. This risk is minimised by options which improve the concentrations within Bristol to below the legal limits.

Analysis undertaken has demonstrated that it is unlikely that any of the options assessed will be sufficient to rectify exceedances in all locations. However, CAZ Class D has the highest potential to achieve compliance and this reduces as vehicle types are removed from the CAZ (in Classes C through to A). The small geography assessed is unlikely to reduce this risk significantly since there are of number of known exceedances outside of the boundary where concentrations would not be significantly reduced by the CAZ. The large and medium geographies include all known exceedances and so have a greater potential to reduce this risk.

3.6 Management Evaluation Criteria

3.6.1 Evaluation Criteria 13: Public acceptability

To date, very little public engagement or consultation exercises have been undertaken in relation to implementing a CAZ in Bristol. Hence the scoring of each option against this Evaluation Criteria has been undertaken by assessing the likely response from the public based on the proportion of the population included within the CAZ, and the types of vehicles and trips impacted by the CAZ. Particular focus has been given to the impact on businesses (discussed in section 3.3.2) and low income areas (discussed in section 3.3.1).

CAZ options which exclude HGV, LGV and car trips have a minimal impact on businesses and also on low income groups and so are likely to be the most well received by the public. Those options which include car trips, Class D, are anticipated to provoke the strongest public reaction.

The large CAZ geography covers the majority of the city, and so includes the greatest proportion of the population increasing the potential for public opposition. It also has the highest potential to impact on low income groups and businesses since it's wide geographic coverage incorporates a larger number of both.

The public acceptability of the JTS scheme has been judged based on the responses to the JTS public consultation which included a question regarding using financial incentives to manage demand and raise funds to deliver the JTS vision. The question was worded in a fairly technical manner which may account for the 30% of 572 participants who responded as 'neither agree or disagree' with the proposal. Of the remaining participants 40% responded positively and 30% responded negatively. Relative to other CAZ options, the JTS scheme is likely to be poorly received since it directly targets businesses through the workplace parking levy, and applies to all vehicle types driving through the centre of Bristol.

3.6.2 Evaluation Criteria 14: Political acceptability

Politicians are elected to represent the public in local and national government. As such, the political acceptability of a CAZ scheme is intrinsically linked to the public acceptability. However, there is mounting pressure on the UK government to tackle the issue of air quality in the UK and particularly in urban areas where the associated damage to public health is most pronounced. The 'Draft UK Air Quality Plan for tackling nitrogen dioxide' May 2017, places much of the responsibility for implementing measures to effectively reduce concentrations of harmful pollutants in the hands of local authorities. In addition, in November 2016 a motion was proposed by the Green party at the full Council meeting entitled 'Clean air now for Bristol' which promoted urgent action to tackle air quality including the implementation of a Clean Air Zone in Bristol. This motion was passed, indicating some local political acceptance of the need for a Clean Air Zone and its urgent implementation. In addition, a petition entitled 'Let Bristol Breathe Clean Air' accumulated 4370 signatures by May 2017, well above the limit of 3,500 after which a full council debate can be requested. The petition included reference to the implementation of CAZs in other cities and stated that 'Bristol should not be left behind'.

Accounting for all these elements, it is anticipated that those schemes most likely to accumulate public acceptance may be better received by local politicians.

3.6.3 Evaluation Criteria 15: Mobilisation period

BCC and SGC anticipate implementing a CAZ in 2019 in order to achieve compliance with the EU limit value for annual mean nitrogen dioxide in the shortest time possible. It is likely that the challenges associated with designing and implementing the large CAZ geography would make this a difficult target to achieve. Comparatively, the implementation of the small and medium CAZ geographies would be simpler, though not without challenges within this timeframe.

The JTS scheme is anticipated to be implemented in 2020 at the earliest.

5.1 Summary of RAG Assessment

A summary of the RAG scoring for each Evaluation Criteria is provided in Table 5-1 overleaf.

The following numerical values have been allocated to each RAG score;

- Dark Blue - 1
- Mid Blue- 2
- Light Blue - 3

The following numerical values have been allocated to the priority of each Evaluation Criteria;

- Very High priority - 4
- High priority - 3
- Medium priority - 2
- Low priority - 1

An overall score for each option has been calculated by multiplying the RAG score allocated to each Evaluation Criteria with the priority score and summing across all Evaluation Criteria. The overall score for each option is provided in the final row of Table 5-1 overleaf.

Table 5-1: Summary of RAG scoring for all Options

Cases	ID	Evaluation Criteria	Option																							
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Strategic	1	Deliver compliance with NO2 air quality objective within CAZ in the shortest possible timescales																										
	2	Deliver compliance with NO2 air quality objective outside of CAZ																										
	3	Provide equity across different vehicle types and trip purposes																										
	4	Compliance with Defra Draft CAZ framework																										
Economic	5	Mitigate financial impact on low income households																										
	6	Improve health of low income households																										
	7	Economic effect																										
	8	Improve public health																										
Commercial	9	Delivery timescale risks of procurement																										
Financial	10	Likelihood of revenue equating to implementation/operational costs																										
	11	Upfront capital required for scheme																										
	12	Risk of financial penalty to the Council/s																										

Management	13	Public acceptability																												
	14	Political acceptability																												
	15	Mobilisation period																												
Overall Score			79	79	70	79	78	74	74	79	82	81	68	68	73	76	75	68	68	73	76	75	79	79	77	81	86	75		

5.2 Recommendations

Based on the analysis provided within this report, and the overall scores resulting from the RAG assessment, the following four CAZ options are recommended to be taken forward for more detailed investigation in the next stage of the feasibility study;

- Option 9 – Medium (BCC AQMA) geography, CAZ Class C
- Option 10 – Medium (BCC AQMA) geography, CAZ Class D
- Option 24 – Small geography, CAZ Class C
- Option 25 – Small geography, CAZ Class D

Appendix A: NO2 Measurements

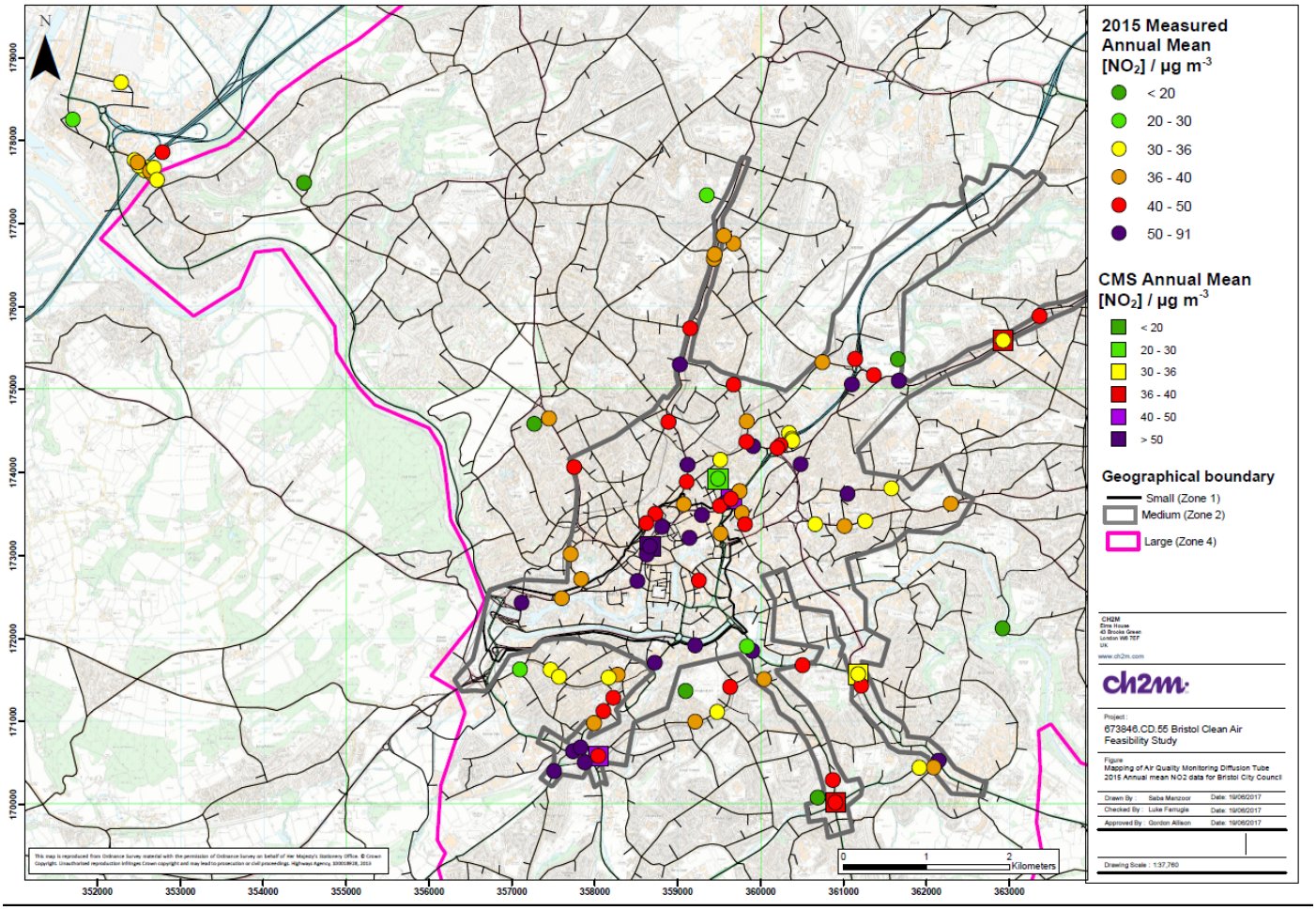


Figure A1. NO2 in Bristol: 2015

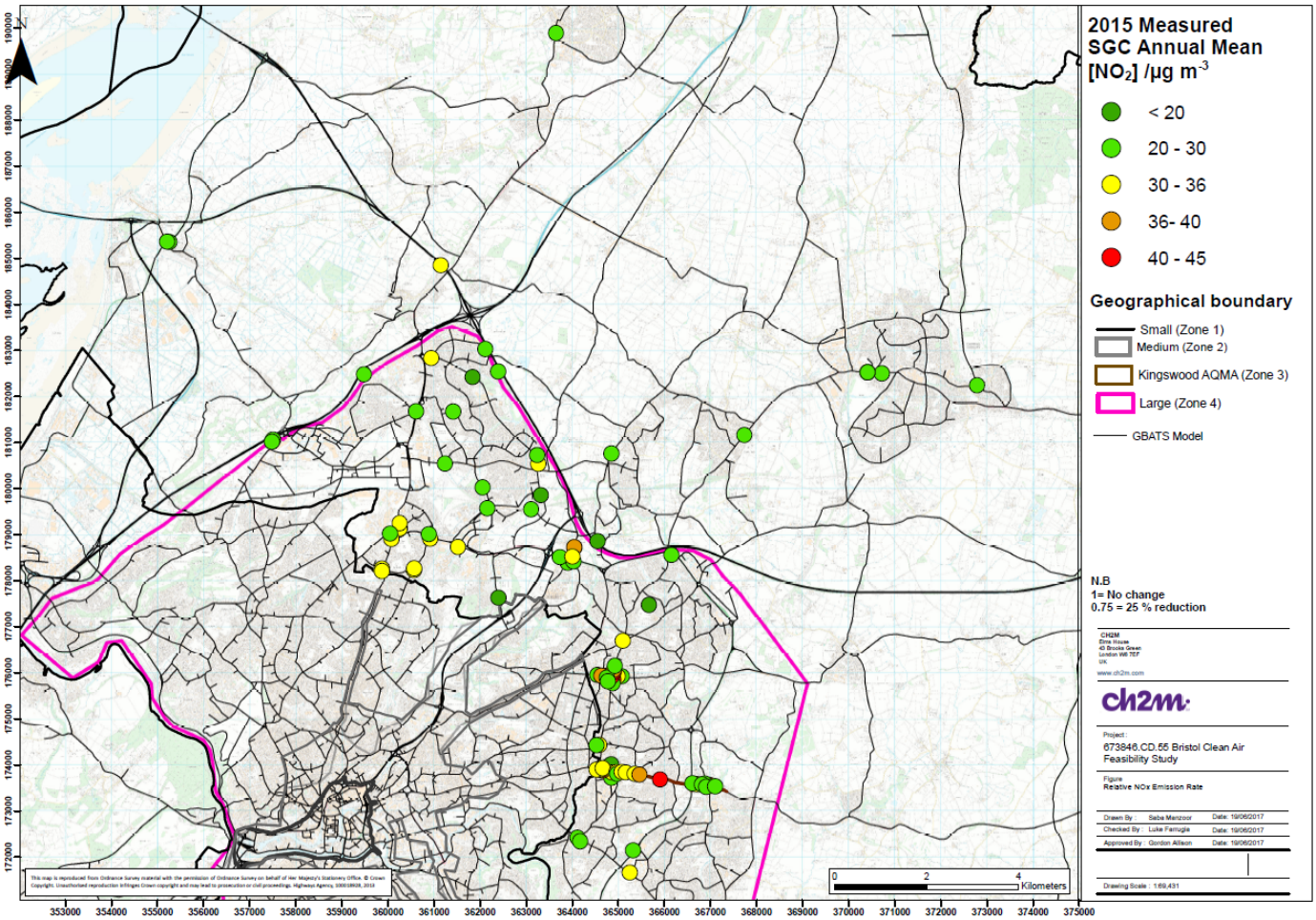


Figure A2. NO2 in South Gloucestershire: 2015

Appendix B: Changes in emissions from CAZ class D

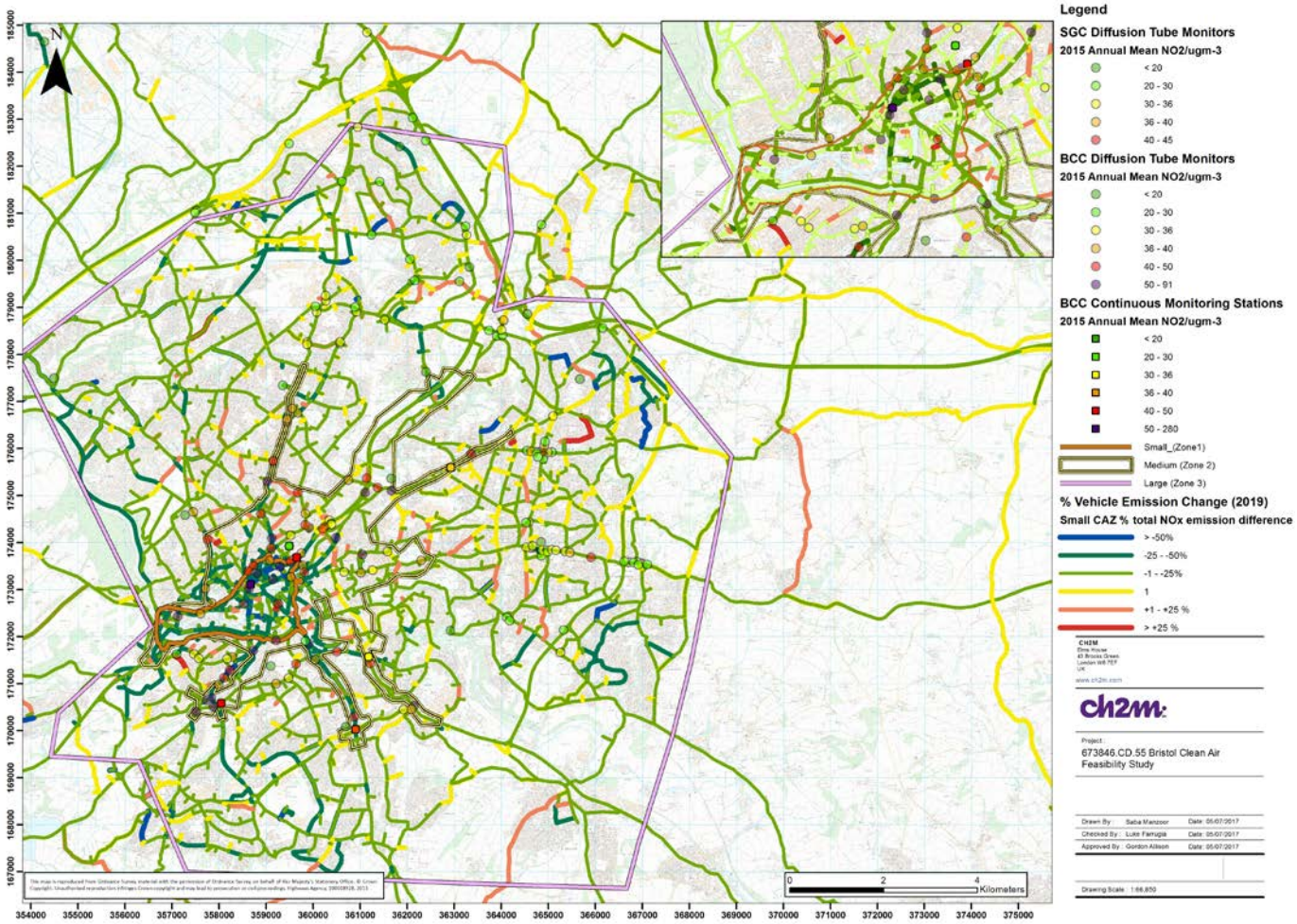


Figure B1. Changes in emissions: Small Zone

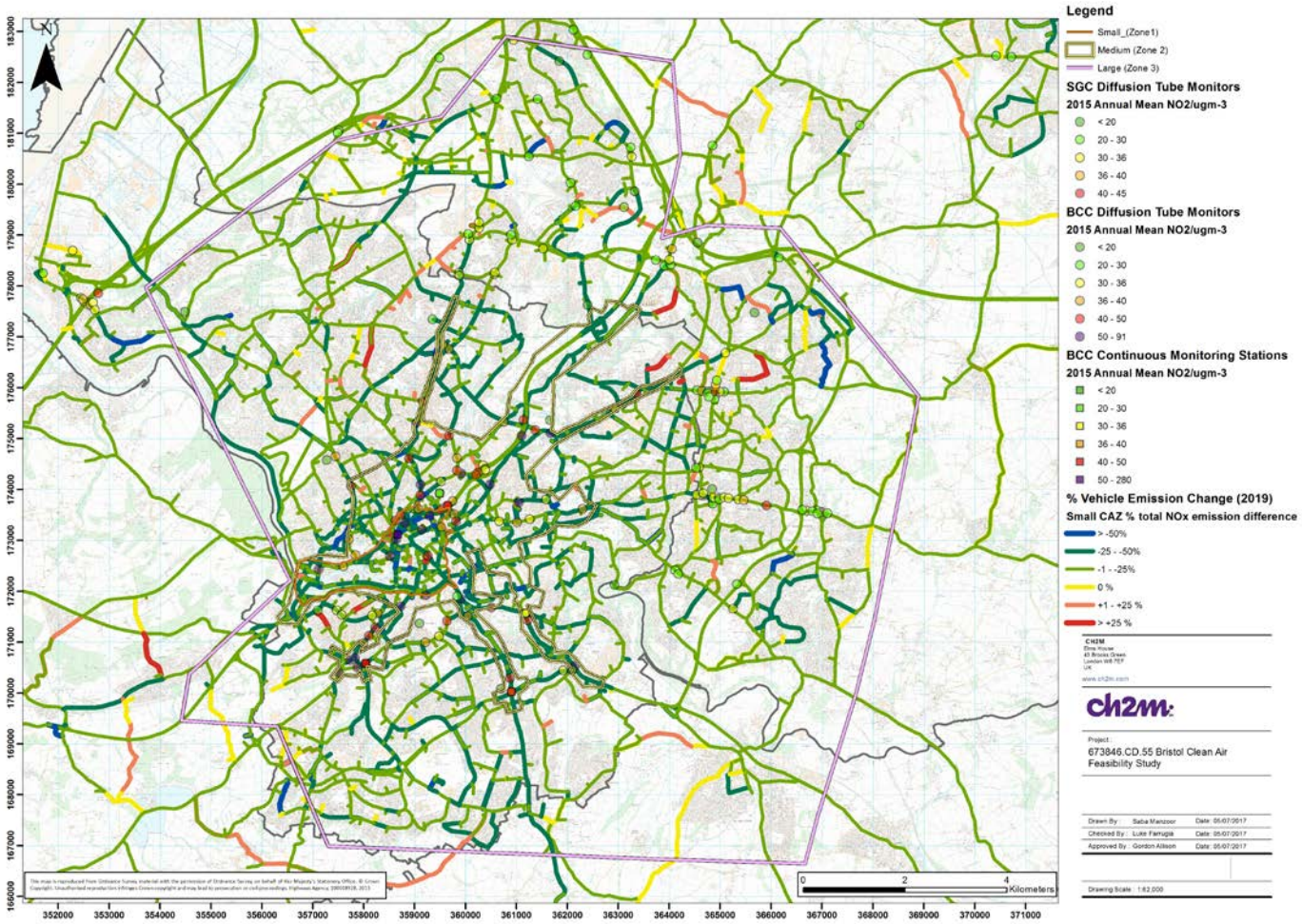


Figure B1. Changes in emissions: Medium Zone

Appendix C: Socio-economic Mapping

Figure C.1 – Residents in High Value Jobs

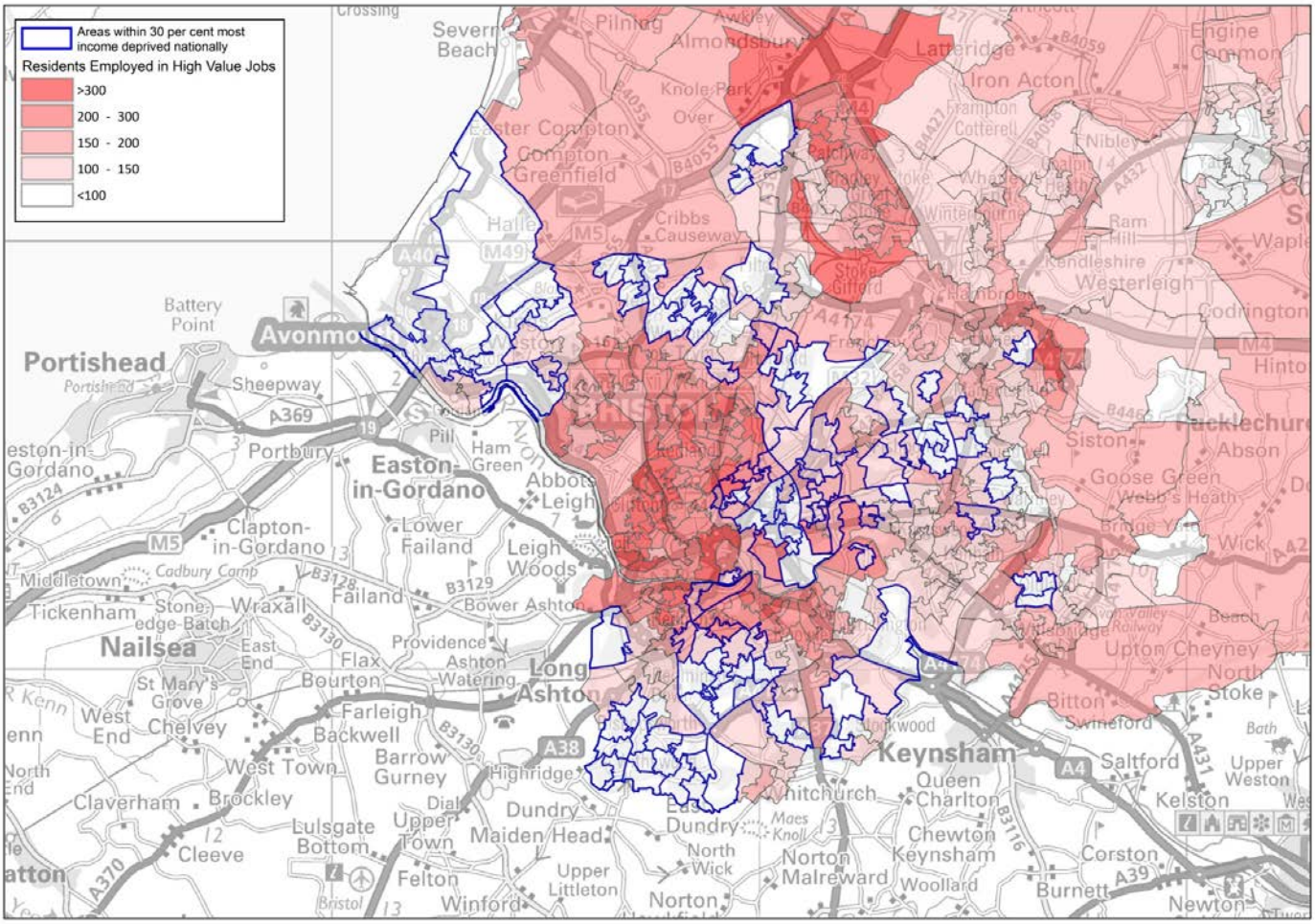


Figure C.2 – Residents in Low Income Jobs

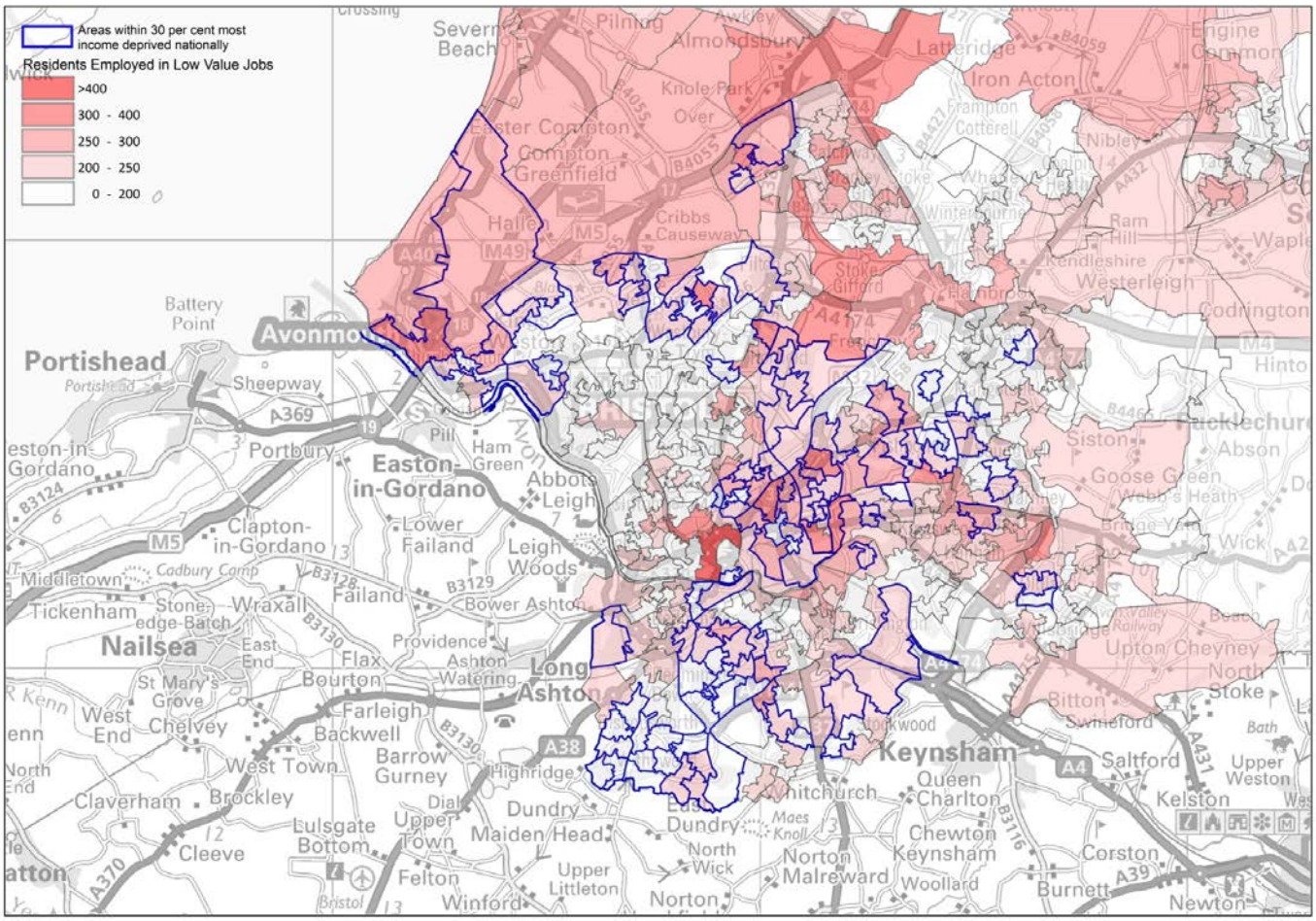


Figure C.3 – Residents employed in Transport and Construction Jobs

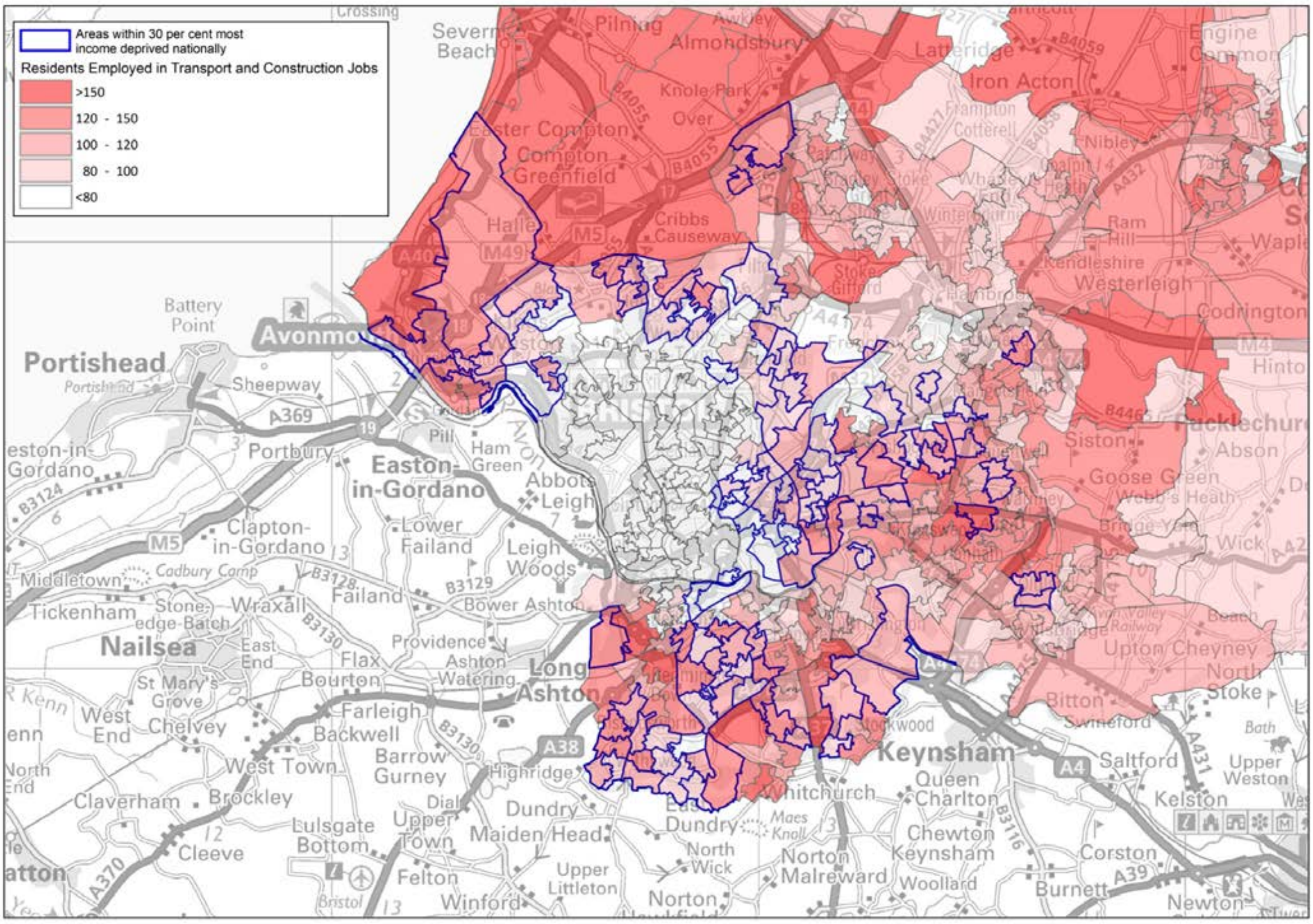


Figure C.4 – Car Journeys to Workplaces in the City Centre

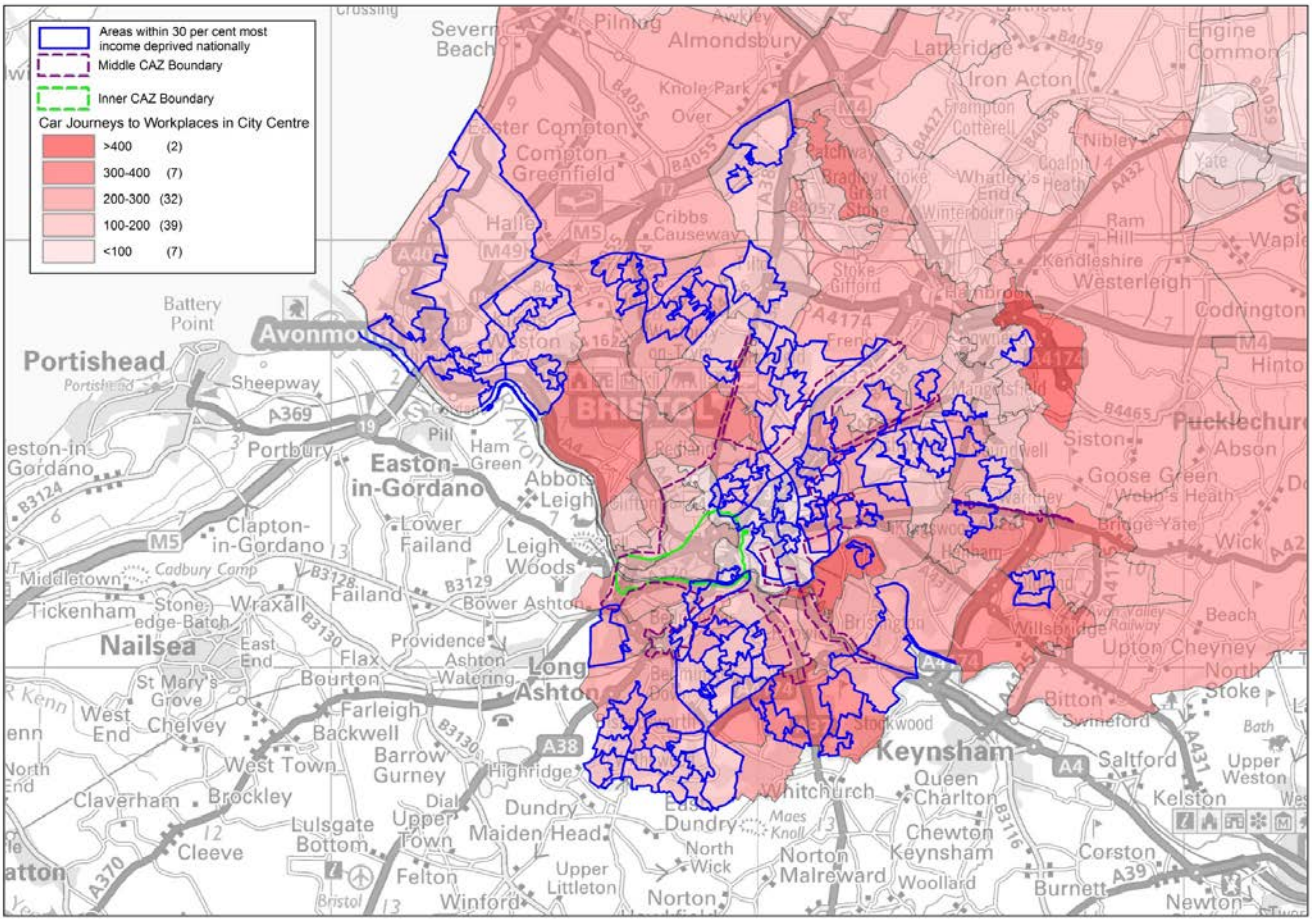
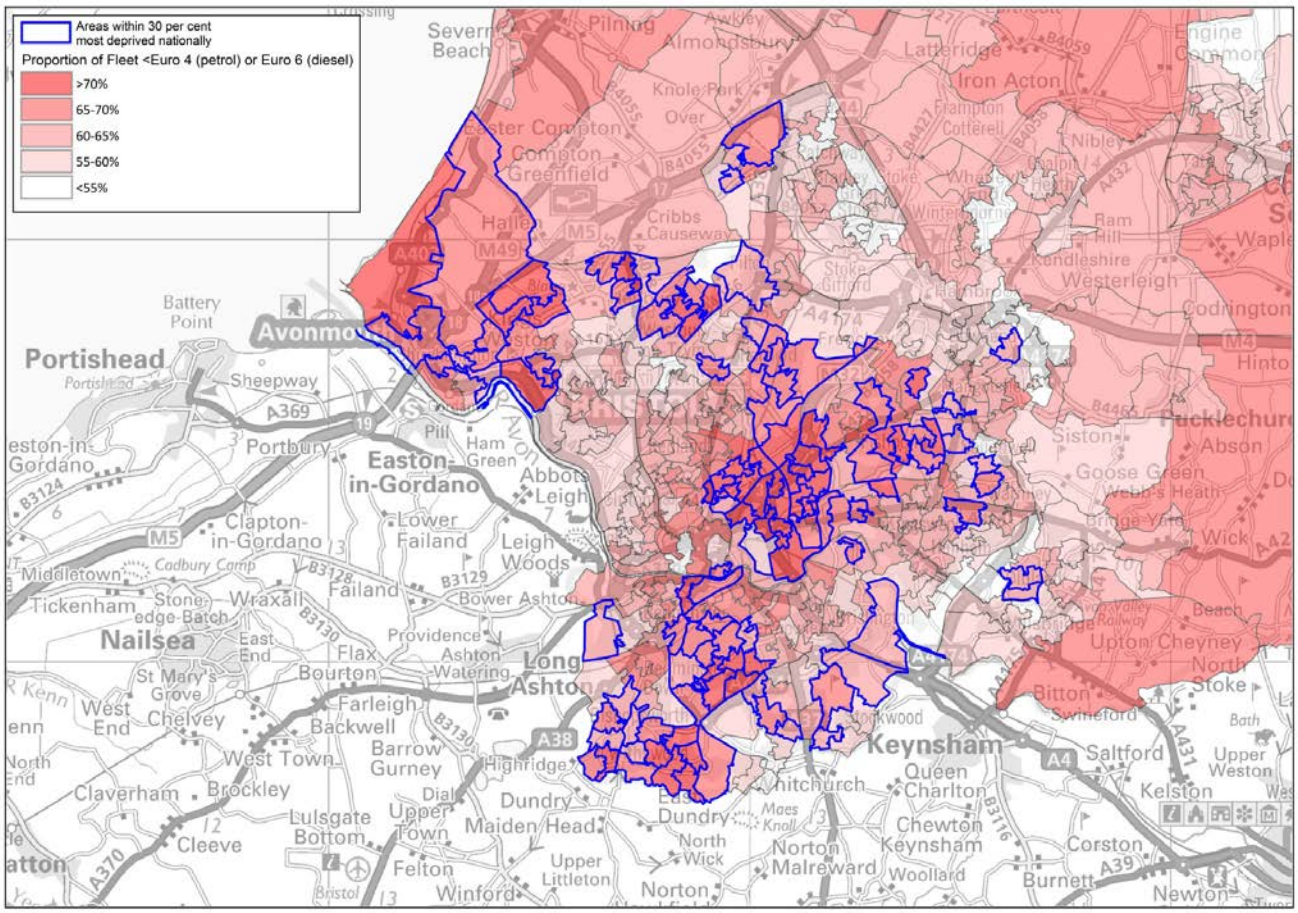


Figure C.5 – Proportion of Fleet <Euro 4 (petrol) and Euro 6 (diesel)
Data supplied by Engineering and Physical Research Council funded M.O.T project (code: EP/K000438/1)



Appendix B: Details of Consultation

a. Internal consultation:

Consultation with officers and the elected member responsible for air quality has taken place through the Mayoral Air Pollution Working Group (MAPWG). In addition proposals will be brought to the Mayoral Congestion Working Group for consultation with a range of road user stakeholders. Scrutiny have identified Air Quality as one of their priority topics for the Scrutiny Work Programme and officers will work with the Lead Councillors to plan appropriate scrutiny involvement in this process.

b. External consultation:

Stakeholders will be consulted on emerging proposals, including through the Mayor's congestion working group, as part of the feasibility study. Public consultation will be included in any proposals brought forward for a Clean Air Zone, following the feasibility study.

Other options considered:

Bristol City Council is required to develop an Air Quality Action Plan. In doing this we are examining a wide range of measures to improve air quality. This will take into account the Government National Air Quality Action Plan and related guidance and also the guidance produced by the National Institute for Health and Care Excellence (NICE) on *Air pollution: outdoor air quality and health.*

The draft Government National Air Quality Action Plan requires local authorities to pursue all options that can significantly reduce air pollution prior to consideration of a charging CAZ. An option for congestion charging and a workplace parking levy has been included in the consultant's brief to ensure that this requirement of the plan is met.

Appendix D: Risk management / assessment

The risks associated with the implementation of the decision to select options for detailed modelling:							
No.	RISK Threat to achievement of the key objectives of the report	INHERENT RISK (Before controls)		RISK CONTROL MEASURES Mitigation (ie controls) and Evaluation (ie effectiveness of mitigation).	CURRENT RISK (After controls)		RISK OWNER
		Impact	Probability		Impact	Probability	
1	Public and/or stakeholders object to the principle of a CAZ or to undertaking of feasibility work	High	Medium	Consultation with key stakeholders	Medium	Medium	Alex Minshull
2	The options selected for detailed modelling do not result in options which can deliver the necessary improvements in air quality	Medium	Medium	Robust analysis of all factors relevant to a CAZ	Low	Low	Alex Minshull

The risks associated with not implementing the decision to select options for detailed modelling:							
No.	RISK Threat to achievement of the key objectives of the	INHERENT RISK (Before controls)		RISK CONTROL MEASURES Mitigation (ie controls)	CURRENT RISK (After controls)		RISK OWNER
		Impact	Probability		Impact	Probabilit	
1	Delay of the feasibility study and potential breach of grant agreement with Government	High	Medium	Consultation with senior officers, elected member and Mayor and liaison with Government funders.	Low	Low	Alex Minshull

Appendix E: Equalities Impact Assessment

Public sector equality duties:
The decision being taken at this stage is to approve the options to be studied, not the implementation of the CAZ. Consideration of the health, social and equalities impacts forms a key part of the later phases of the feasibility study and an equalities impact assessment will be completed.

Appendix F: Eco- Impact Assessment

Eco impact assessment
The decision being taken is to undertake a feasibility study only. The study will consider the impacts of the implementation of a clean air zone on air quality and provide that information for decision makers. Any decision to implement a clean air zone will be subject to a separate decision and eco-impact assessment. Environmental assessment of the proposed measure is an intrinsic component of the scheme.

Access to information (background papers):
UK Government Air Quality Action Plan
https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017
National Institute for Health and Care Excellence (NICE) on Air pollution: outdoor air quality and health. https://www.nice.org.uk/guidance/ng70