Bristol Clean Air Plan

Bristol City Council

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Bristol Clean Air Plan

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Contents

Acronyms and Abbreviations

AADT	Annual average daily traffic
ANPR	Automatic Number Plate Recognition
ATC	Automatic traffic count
AQMA	Air Quality Management Area
BCC	Bristol City Council
CAP	Clean Air Plan
CAZ	Clean Air Zone
CO_2	Carbon Dioxide
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
EFT	Emission Factor Toolkit
GBATS	Greater Bristol Area Transport Study
HGV	Heavy Goods Vehicle
IMD	Indices of Multiple Deprivation
JAQU	Joint Air Quality Unit
LGV	Light Goods Vehicle
NO_2	Nitrogen Dioxide
NTM	National Transport Model
NTEM	National Trip End Model
OBC	Outline Business Case
PT	Public Transport
(Web)TAG	Transport Analysis Guidance
VDM	Variable Demand Model
VRN	Vehicle Registration Number
(Web)TAG	Transport Analysis Guidance

1. Introduction

1.1 Background

Poor air quality is the largest known environmental risk to public health in the UK[1]. Investing in cleaner air and doing more to tackle air pollution are priorities for the EU and UK governments, as well as for Bristol City Council (BCC). BCC has monitored and endeavoured to address air quality in Bristol. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until around 2030 without intervention.

In 2017 the government published a UK Air Quality Plan for Nitrogen Dioxide[2] setting out how compliance with the EU Limit Value for annual mean NO_2 will be reached across the UK in the shortest possible time. Due to forecast air quality exceedances, BCC, along with 27 other Local Authorities, was directed by Minister Therese Coffey (Defra) and Minister Jesse Norman (DfT) in 2017 to produce a Clean Air Plan (CAP). The Plan must set out how BCC will achieve sufficient air quality improvements in the shortest possible time. In line with Government guidance, BCC is considering the implementation of a Clean Air Zone (CAZ), including both charging and non-charging measures, in order to achieve sufficient improvement in air quality and public health.

Jacobs has been commissioned by BCC to produce an Outline Business Case (OBC) for the delivery of the CAP; a package of measures which will bring about compliance with the Limit Value for annual mean NO_2 in the shortest time possible in Bristol. The OBC assesses the shortlist of options set out in the Strategic Outline Case, and proposes a preferred option including details of delivery. The OBC forms a bid to central government for funding to implement the CAP.

1.2 Purpose of this Report

This report sets out the transport modelling forecasting undertaken to assess the baseline and option scenarios.

A draft version of this report was published in January 2019, which supported the draft economic case that was also published at this time. Since this report, further work has been undertaken to develop the scheme options, and this work is reported in the Option Assessment Report, appended to the OBC.

[1] Public Health England (2014) Estimating local mortality burdens associated with particular air pollution. https://www.gov.uk/government/publications/estimating-local-mortality-burdens-associated-with-particulate-air-pollution
[2] https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017

2. Scope of Assessment

2.1 Model extent

The SATURN highway model covers the city of Bristol, South Gloucestershire, North Somerset and Bath and North East Somerset within the limits of the Greater Bristol area in the simulation network, with the remaining parts of these authorities included within the buffer network. The Bristol SATURN highway model extent is shown in Figure 2-1.

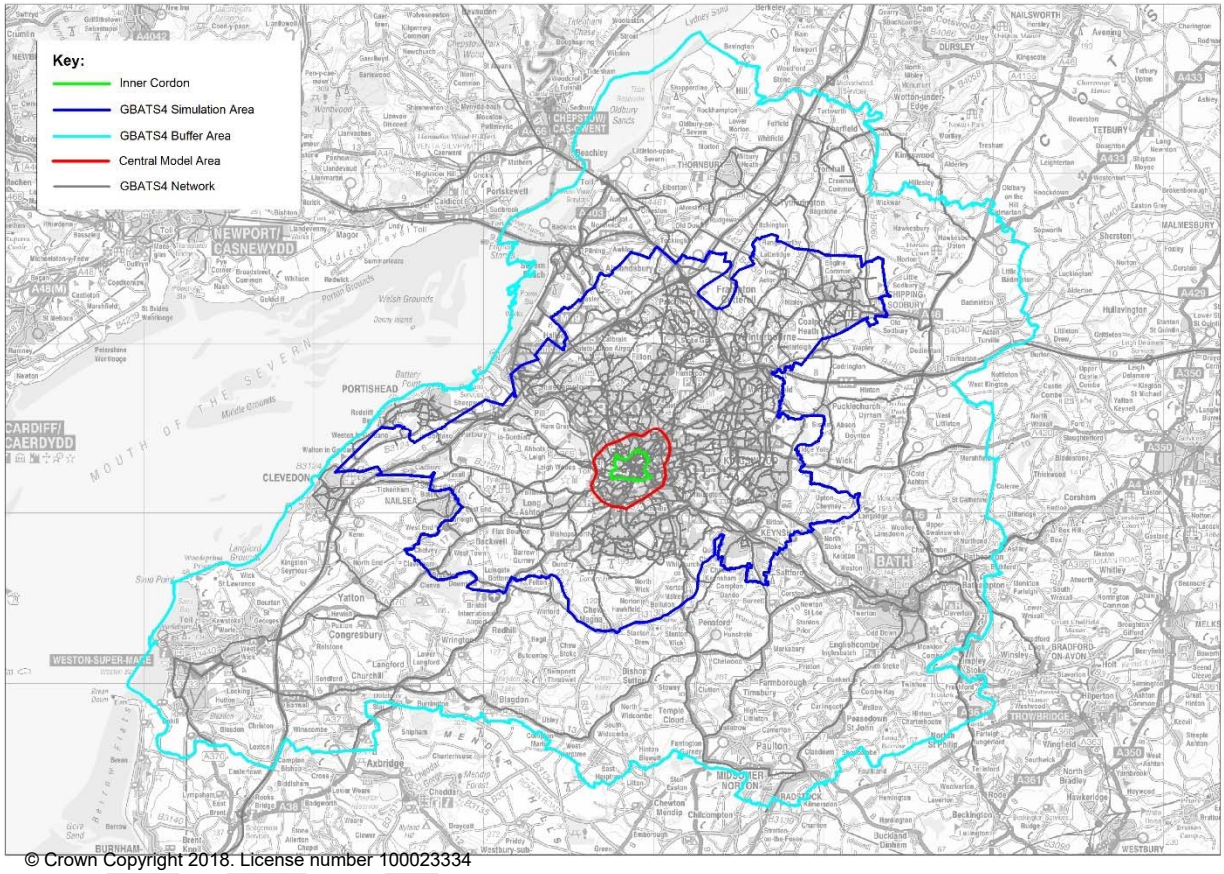


Figure 2-1: Bristol Model Extent

2.2 Time periods

The GBATS4M Demand Model represents trip-based movements across Bristol and the surrounding area for a weekday 12-hour period (07:00-19:00). The GBATS4M SATURN Highway model represents vehicle-based movements across the city for the weekday morning peak hour (08:00-09:00), an average inter-peak hour (10:00-16:00) and an evening peak hour (17:00-18:00).

2.3 Model Years

The air quality model base year is 2015 since more recent air quality data was not available at the time the base year air quality model was developed, and in 2016 there was a significant amount of disruption from roadworks in the city (related to the metrobus scheme) which prevented some monitoring data from being collected and altered the typical travel patterns across the city.

The target compliance year was estimated using the model runs of each of the options undertaken within the Strategic Outline Case, and an understanding of the time taken to deliver each proposed scheme. This assessment has suggested that the year of compliance could be as early as 2021. Hence the modelled year is

2021. A 2031 model has also been developed, to assess the impact of the CAZ 10 years after the initial modelled forecast year.

2.4 CAZ Boundary

Figure 2-2 shows the CAZ boundary options of the Small and Medium boundary.

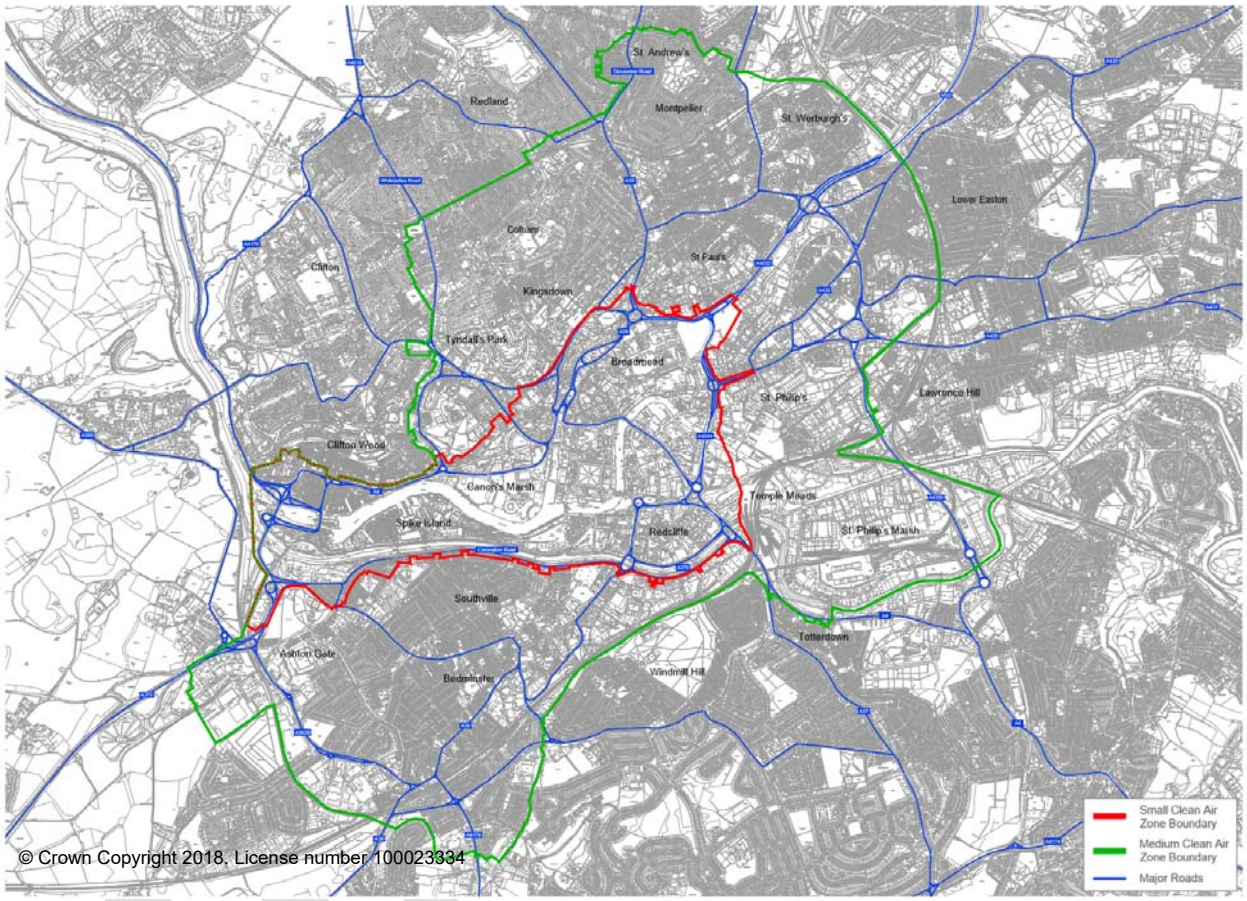


Figure 2-2: Bristol Small and Medium area CAZ geographies

3. Modelling methodology

This modelling methodology summarises the detailed methodology found in OBC-23 Local Plan Transport Modelling Methodology Report (T3) in Appendix E of the OBC, and its appended technical notes, bringing together an overview of all the components of how the baseline and option testing has been carried out using the GBATS4M Transport Model.

3.1 Base and Baseline

3.1.1 Model Development

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

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

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

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

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

Joint Spatial Plan growth has not been included in the development of the 2021 and 2031 baseline models as it is not sufficiently certain, in terms of the WebTAG criteria, to be included.

The 2021 Baseline highway model developed has been adapted to be able to model the implementation of a charging CAZ. The matrices have been split by compliance for each user class using the surveyed Automatic Number Plate Recognition (ANPR) data.

3.1.2 ANPR Data

The 2017 ANPR surveys were undertaken in July and the analysis (including tabulated data) and use are discussed fully in the ANPR Data Analysis and Application technical note which is appended to the Local Plan Transport Modelling Methodology Report (T3). A summary is provided here.

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

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

and assessment year models, worked back to 2015 and projected forward to 2021 and 2031 using WebTAG projections for changes in fuel type splits.

Matrix Compliance / Fuel Type Splits

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

- Split the Car user classes into Car and Taxi user classes;
- Split the HGV user class into HGV and Coach user classes;
    - Split Taxi, LGV, HGV and Coach matrices into compliant and non-compliant using the time period splits; and
    - Further split the car user classes in two different ways, to test a charging CAZ scheme and a diesel car ban scheme respectively, as follows:
      - split into compliant / non-compliant
      - split into non-diesel / diesel cars.

Post-Processing

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

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

Euro Standard Splits

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

3.1.3 2015 Base Compliance Splits

The base year compliance splits have been determined from the 2017 ANPR data worked back to 2015 using the EFT national euro standard splits. The ANPR Data Analysis and Application technical note (appended to the OBC), Chapter 3, details this process and the outputs. Table 3-1 shows the projected 2015 compliance data by time period.

Table 3-1: 2015 Compliance Splits by Time Period, Medium CAZ Cordon

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

3.1.4 2021/2031 Baseline Compliance Splits

The fleet projection tool within the EFT version 8, the latest published at the time of commencing the modelling, has been used to project the euro standard splits from the 2017 ANPR data to the Baseline year of 2021. Sensitivity testing against the most recent EFT v9.1 has been undertaken and this is covered in the Analytical Assurance Statement and Sensitivity Testing Report. The ANPR Data Analysis and Application technical note (appended to the Local Plan Transport Modelling Methodology Report (T3)) details this process and the outputs. The forecast compliance splits by vehicle type for 2021 are summarised in Table 3-2 and the forecast compliance splits for 2031 are summarised in Table 3-3. It should be note that the EFT does not go beyond 2030, therefore 2030 was used as a proxy for 2031.

Table 3-2: 2021 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	72.7%	27.3%	71.4%	28.6%	72.0%	28.0%
LGV	58.0%	42.0%	63.1%	36.9%	58.2%	41.8%
HGV rigid	73.9%	26.1%	72.5%	27.5%	66.7%	33.3%
HGV artic	85.7%	14.3%	86.4%	13.6%	85.2%	14.8%
HGV	76.6%	23.4%	75.6%	24.4%	72.6%	27.4%
Taxi	66.0%	34.0%	66.0%	34.0%	66.0%	34.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	68.8%	31.2%	69.6%	30.4%	70.6%	29.4%
Total	70.6%	29.4%	70.7%	29.3%	70.9%	29.1%

Table 3-3: 2031 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	98.2%	1.8%	98.1%	1.9%	98.2%	1.8%
LGV	97.0%	3.0%	97.6%	2.4%	97.0%	3.0%
HGV rigid	98.8%	1.2%	98.7%	1.3%	98.3%	1.7%
HGV artic	99.4%	0.6%	99.5%	0.5%	99.4%	0.6%
HGV	99.0%	1.0%	98.9%	1.1%	98.7%	1.3%
Taxi	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Total	98.1%	1.9%	98.2%	1.8%	98.2%	1.8%

It should be noted that the taxi and bus compliance splits for both 2021 and 2031 are based on data obtained by BCC and First Bus.

3.1.5 Fuel Type Splits

The 2017 ANPR fuel splits for cars and LGVs have been adjusted to 2015 using the change over time in the latest WebTAG databook fuel split table. These were applied to the traffic link data extracted from the model runs during post-processing. Table 3-4 shows the fuel type splits obtained from the 2015 calculations.

Table 3-4: Fuel Type Splits (2015)

Vehicle Category	Proportion		
	Petrol	Diesel	Electric
Cars	55.21%	44.74%	0.04%
LGVs	0.80%	99.15%	0.05%

The ANPR fuel splits have been projected forward to 2021 and 2031, using the change over time in the WebTAG databook fuel split table. An additional adjustment has been made to car fuel splits due to identification by BCC of an increase in petrol taxis replacing diesel. These were applied to the traffic link data extracted from the model runs via post-processing before input to the EFT and for splitting the car matrices when modelling the diesel ban scenario. Table 3-5 shows the fuel type splits from the 2021 and 2031 projected ANPR data.

Table 3-5: Fuel Type Splits (2021 and 2031)

Vehicle Category	2021			2031		
	Petrol	Diesel	Electric	Petrol	Diesel	Electric
Cars	52.95%	46.71%	0.34%	56.33%	42.21%	1.46%
LGVs	0.37%	99.49%	0.14%	0.17%	99.69%	0.14%

3.2 Clean Air Zone Option Testing

3.2.1 Assessment Scenarios

The scenarios reported here that have bene tested in the Transport Model are as follows:

Option 1:

- Medium Area Class C (charging non-compliant buses, coaches, taxis, HGVs and LGVs);

- Diesel car scrappage scheme;
- HGV exclusion on links within the city centre with exceedances as follows:
  - Park Row/Upper Maudlin St/Marlborough St, Rupert Street, Lewins Mead, Baldwin Street;
- Close of Cumberland Road inbound to general traffic;
- M32 Park and Ride with bus lane inbound;
- Holding back traffic to the city centre through the use of existing signals; and
- 8-hour car diesel exclusion on Park Row/Upper Maudlin Street and Marlborough Street.

Medium CAZ D + Option 1: As Option 1 but includes charging non-compliant cars.

Option 2: 8-hour small area diesel car exclusion (7am – 3pm)

Hybrid Option: Option 1 + Option 2.

The response rates modelled for these CAZ options are outlined below and have been modelled within the GBATS SATURN highway model using the methodology outlined in Chapter 3, section 3.2.1. The boundaries of the CAZ are shown in Figure 2-2.

3.2.2 Primary Behavioural Responses

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

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

3.2.3 Secondary Behavioural Responses

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

The replace vehicle secondary response for a diesel car ban over a small area assumes that the non-compliant diesel car owners will replace their vehicle with a compliant petrol car.

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

3.2.4 Stated Preference Surveys

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

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

The SP survey was also used to determine the responses to the diesel car ban. First, since, the SP survey only covered trips made by those with non-compliant vehicles it was necessary to check the applicability of the responses to Euro 6 diesels. Testing of the reported age of the vehicle owned showed no significant differences in the responses for any of the user classes and thus it is considered acceptable to use these responses for Euro 6 diesels. As paying the charge isn't an option with the ban this response was removed.

The structure, implementation and outcomes of the survey are provided fully in OBC-28 Stated Preference Survey Report, in Appendix F of the OBC.

3.2.5 Upgrade Costs

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

The methodology for calculating the upgrade costs for all vehicle type is discussed fully in OBC-26 Primary Behavioural Response Calculation Methodology in Appendix E of the OBC.

3.2.6 Proposed Charge Rates

The methodology for determining the proposed charge rates for all vehicle type is discussed fully in OBC-26 Primary Behavioural Response Calculation Methodology in Appendix E of the OBC and Table 3-6 shows the final proposed charges. The charges were initially set for Cars, taxis and LGVs so that the responses of avoid zone, change mode / cancel journey and replace vehicle combined roughly equated to the combined JAQU CAZ responses. These charges were found to be insufficient to bring about compliance and so testing with higher charges was undertaken. Above a certain level there are diminishing returns to further increases and so the final proposed charges arrived at were at this point. These are shown in Table 3-6 for the Medium sized charging zone.

Table 3-6: Bristol CAZ Proposed Charges

Charge Vehicle Class	Charge per day	CAZ Class
Cars	£9.00	D only
Taxis	£9.00	C & D
LGVs	£9.00	C & D
HGVs	£100.00	C & D
Buses	£100.00	C & D
Coaches	£100.00	C & D

Calculated Response Rates

The methodology for calculating the primary response rates for each Option is discussed fully in OBC-26 Bristol Clean Air Plan: Primary Behavioural Response Calculation Methodology in Appendix E of the OBC and is summarised in the Local Plan Transport Modelling Methodology Report (T3).

Table 3-7 shows the final primary behavioural response rates by vehicle type for Option 1.

Table 3-7: Final Primary Behavioural Response Rates for Option 1

Response	Cars Low Income	Cars Medium Income	Cars High Income	Cars Employers Business	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	0.0%	0.0%	0.0%	0.0%	4.1%	15.9%	8.8%	0.0%	17.8%
Avoid Zone	0.0%	0.0%	0.0%	0.0%	0.0%	19.2%	4.3%	0.0%	0.0%
Cancel Journey / Change Mode	0.0%	0.0%	0.0%	0.0%	0.0%	2.6%	4.3%	6.4%	11.4%
Replace Vehicle	0.0%	0.0%	0.0%	0.0%	95.9%	62.2%	82.6%	93.6%	70.8%

Table 3-8 shows the final primary behavioural response rates by vehicle type for Medium CAZ D + Option 1.

Table 3-8: Final Primary Behavioural Response Rates for Medium CAZ D + Option 1

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

Table 3-9 shows the 8hr diesel car ban primary response rates.

Table 3-9: 8-hour Diesel Car Ban Primary Response Rates

Response Rate	Cars Low-High Inc			Cars Emp Bus		
	AM	IP	PM	AM	IP	PM
Pay Charge	NA	NA	NA	NA	NA	NA
Avoid Zone	15.44%	14.56%	0.00%	17.47%	14.56%	0.00%
Cancel Journey / Change Mode	21.03%	21.85%	15.74%	23.79%	23.52%	22.18%
Replace Vehicle	43.04%	19.45%	31.54%	58.74%	58.07%	54.75%
Time of Day Choice	20.49%	31.94%	0.00%	0.00%	0.00%	0.00%

The primary response rates for the Hybrid Option are as follows:

- Cars – as per Option 2, as shown in Table 3-9; and
- All other vehicle types – as per Option 1, as shown in Table 3-7.

3.2.7 Traffic Management Measures

The identified traffic management measures to improve air quality have been modelled with three of the emerging options, Option 1, Medium CAZ D + Option 1 and the Hybrid Option. The methodology is described in detail in the Local Plan Transport Modelling Methodology Report (T3), Chapter 5.

3.2.8 Scrappage Scheme

The scrappage scheme methodology included in Option 1 is described in detail in the Local Plan Transport Modelling Methodology Report (T3), Chapter 5.

3.3 Links to Air Quality Model

The links from the transport model to the air quality model are outlined in the Local Plan Transport Modelling Methodology Report (T3), Chapter 8. Link-based traffic flows, by compliance / fuel type from the highway model are fed through to the air quality model in a format compatible with the EFT, after undergoing post-processing of the model outputs.

4. Base Year Outputs

4.1 Model Checks

The highway model outputs were checked for the following:

- The 6-user class and 16-user class matrix totals have been compared for each year, to maintain the same level of trips within the model. This check showed that the process was done correctly;
- The post-processing final compliance splits have been compared to the target splits; and
- Base year validation / calibration has been checked to ensure it has not been affected by the compliance splitting process.

After the matrices were split out (from 6 to 16 user classes) as described in the preceding chapter, the 16 revised highway matrices were re-assigned within the SATURN model. Following this, a check was carried out on the base year model, to ensure that the ANPR data had been applied within the model as intended. The vehicle compliance splits across both the small and medium model cordons were checked against the target values from the ANPR data. Table 4-1 and Table 4-2 show the target and modelled compliance rates as well as differences for each user class and time period (AM, IP (inter-peak) and PM) for the Small and Medium cordons respectively. These results show only very minor differences and hence are deemed acceptable.

Table 4-1: 2015 Small Cordon Compliance Splits

Vehicle	AM					IP					PM				
	Target		Model		Difference	Target		Model		Difference	Target		Model		Difference
Category	%	value	%	value		%	value	%	value		%	value	%	value	
Cars	36%	6,756	36%	6,756	0	35%	4,583	35%	4,578	-5	35%	6,972	36%	6,982	10
LGV	1%	23	1%	24	1	1%	30	1%	29	-1	1%	18	1%	19	1
HGV	26%	341	26%	341	0	25%	424	25%	424	0	23%	168	22%	167	0
Taxi	14%	97	14%	97	0	11%	94	11%	95	0	13%	139	13%	139	1
Coach	20%	17	20%	17	0	21%	30	21%	30	0	22%	41	21%	41	0
Total		7,234		7,236	2		5,162		5,157	-5		7,338		7,349	11

Table 4-2: 2015 Medium Cordon Compliance Splits

Vehicle	AM					IP					PM				
	Target		Model		Difference	Target		Model		Difference	Target		Model		Difference
Category	%	value	%	value		%	value	%	value		%	value	%	value	
Cars	36%	10,934	36%	10,934	0	35%	7,609	35%	7,600	-9	35%	11,755	35%	11,772	17
LGV	1%	37	1%	39	2	1%	50	1%	49	-1	1%	32	1%	34	2
HGV	26%	753	26%	753	0	25%	844	25%	845	1	23%	258	23%	258	0
Taxi	14%	158	14%	158	0	11%	158	11%	158	0	13%	229	13%	229	1
Coach	20%	39	20%	39	0	21%	61	21%	61	0	22%	63	22%	63	0
Total		11,920		11,923	3		8,722		8,713	-9		12,336		12,355	19

This the assignment of the 6-user class model was compared against the assignment of the 16-user class model, to ensure that the model had not been adversely affected. Table 4-3 shows the validation / calibration summary results for the AM, IP and PM highway assignments for the 6-user class and 16-user class user class models.

Table 4-3: Calibration / Validation Summary Results (UC6 is original model, UC16 is revised model)

Time	% Links GEH <5			DMRB Link Criteria		
Period	UC6	UC16	Diff	UC6	UC16	Diff
AM	90%	90%	0%	88%	88%	0%
IP	88%	89%	1%	89%	90%	1%
PM	87%	86%	-1%	89%	87%	-3%

The results show that overall there are no significant differences between the UC6 and UC16 models. In a few cases there are more significant differences on particular links which have been investigated. These are not critical to the CAZ scheme so are deemed acceptable.

The same level of checking was not required when the model was split by fuel type since the process had been established and thoroughly checked in relation to splits by compliance.

5. Baseline Forecast Outputs

5.1 Model Checks

The 2021 Baseline outputs have been checked to ensure that the input compliance splits are carried through to the outturn results provided for the air quality modelling. The following have been checked:

- The 6-user class and 16-user class matrix totals have been compared for each year, to maintain the same level of trips within the model. This check showed that the process was done correctly;
- The 2015 to 2021 and 2031 matrix totals have been compared to check growth has been applied correctly and compliance changes over time. Table 5-1 shows the changes by user class for 2015 and 2021 while Table 5-2 shows the changes by user class for 2021 and 2031; and
- The post-processing final compliance splits have been compared to the target.

Table 5-3 and

Table 5-4 show the daily target and modelled proportions of compliant vehicles for 2021 and 2031 respectively.

Table 5-1: Matrix Totals by User Class (2015-2021)

User Class	Description	2015			2021			2021 - 2015 % Difference		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
Total	Total	144727	126810	135991	150195	132698	140871	3.8%	4.6%	3.6%
UC1	Car Low Income Compliant	8880	6134	9717	18568	13196	20636	109.1%	115.1%	112.4%
UC2	Car Low Income Non-Compliant	15718	11544	17811	6524	4930	7478	-58.5%	-57.3%	-58.0%
UC3	Car Medium Income Compliant	12986	8938	14182	27176	19259	30157	109.3%	115.5%	112.6%
UC4	Car Medium Income Non-Compliant	22986	16821	25994	9548	7196	10929	-58.5%	-57.2%	-58.0%
UC5	Car High Income Compliant	9064	6038	9707	18939	13007	20618	109.0%	115.4%	112.4%
UC6	Car High Income Non-Compliant	16043	11363	17792	6654	4860	7472	-58.5%	-57.2%	-58.0%
UC7	Car Employers Business Compliant	3390	3923	2028	7123	8478	4326	110.1%	116.1%	113.3%
UC8	Car Employers Business Non-Compliant	6000	7382	3717	2503	3167	1568	-58.3%	-57.1%	-57.8%
	Car total	**239792**	**198953**	**236940**	**247231**	**206792**	**244055**	**3.1%**	**3.9%**	**3.0%**
UC9	Taxi Compliant	420	434	592	2461	3232	3736	485.8%	644.9%	530.5%
UC10	Taxi Non-Compliant	3233	4335	4945	1268	1665	1924	-60.8%	-61.6%	-61.1%
	Taxi total	**3653**	**4768**	**5537**	**3728**	**4897**	**5660**	**2.1%**	**2.7%**	**2.2%**
UC11	LGV Compliant	30	34	25	10040	12451	8385	33288%	36223%	33399%
UC12	LGV Non-Compliant	15007	17107	12490	7270	7281	6022	-51.6%	-57.4%	-51.8%
	LGV total	**15037**	**17142**	**12515**	**17310**	**19733**	**14407**	**15.1%**	**15.1%**	**15.1%**
UC13	HGV Compliant	6602	6547	2600	23105	23656	10196	250.0%	261.3%	292.2%
UC14	HGV Non-Compliant	22481	23623	10941	7058	7635	3848	-68.6%	-67.7%	-64.8%
	HGV total	**29083**	**30170**	**13541**	**30163**	**31290**	**14044**	**3.7%**	**3.7%**	**3.7%**
UC15	Coach Compliant	278	391	545	1348	1868	2525	385.4%	378.0%	363.4%
UC16	Coach Non-Compliant	1612	2197	2904	611	816	1052	-62.1%	-62.9%	-63.8%
	Coach total	**1889**	**2588**	**3449**	**1959**	**2684**	**3577**	**3.7%**	**3.7%**	**3.7%**

Table 5-2: Matrix Totals by User Class (2021-2031)

User Class	Description	2021			2031			2031 - 2021 % Difference		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
Total	Total	150195	132698	140871	162665	146133	152347	8.3%	10.1%	8.1%
UC1	Car Low Income Compliant	18568	13196	20636	26313	19380	29451	41.7%	46.9%	42.7%
UC2	Car Low Income Non-Compliant	6524	4930	7478	482	375	540	-92.6%	-92.4%	-92.8%
UC3	Car Medium Income Compliant	27176	19259	30157	38485	28302	43030	41.6%	47.0%	42.7%
UC4	Car Medium Income Non-Compliant	9548	7196	10929	705	548	789	-92.6%	-92.4%	-92.8%
UC5	Car High Income Compliant	18939	13007	20618	26754	19091	29412	41.3%	46.8%	42.7%
UC6	Car High Income Non-Compliant	6654	4860	7472	490	370	539	-92.6%	-92.4%	-92.8%
UC7	Car Employers Business Compliant	7123	8478	4326	10133	12434	6202	42.3%	46.7%	43.4%
UC8	Car Employers Business Non-Compliant	2503	3167	1568	186	241	114	-92.6%	-92.4%	-92.7%
	Car total	**247231**	**206792**	**244055**	**266215**	**226876**	**262423**	**7.7%**	**9.7%**	**7.5%**
UC9	Taxi Compliant	2461	3232	3736	3979	5337	6038	61.7%	65.1%	61.6%
UC10	Taxi Non-Compliant	1268	1665	1924	0	0	0	-100.0%	-100.0%	-100.0%
	Taxi total	**3728**	**4897**	**5660**	**3979**	**5337**	**6038**	**6.7%**	**9.0%**	**6.7%**
UC11	LGV Compliant	10040	12451	8385	20466	23475	17034	103.8%	88.5%	103.1%
UC12	LGV Non-Compliant	7270	7281	6022	633	577	527	-91.3%	-92.1%	-91.3%
	LGV total	**17310**	**19733**	**14407**	**21099**	**24052**	**17560**	**21.9%**	**21.9%**	**21.9%**
UC13	HGV Compliant	23105	23656	10196	31643	32793	14688	37.0%	38.6%	44.1%
UC14	HGV Non-Compliant	7058	7635	3848	320	365	193	-95.5%	-95.2%	-95.0%
	HGV total	**30163**	**31290**	**14044**	**31963**	**33158**	**14882**	**6.0%**	**6.0%**	**6.0%**
UC15	Coach Compliant	1348	1868	2525	2076	2844	3790	54.0%	52.3%	50.1%
UC16	Coach Non-Compliant	611	816	1052	0	0	0	-100%	-100%	-100%
	Coach total	**1959**	**2684**	**3577**	**2076**	**2844**	**3790**	**6.0%**	**6.0%**	**6.0%**

Overall, the total trips increase in 2021 compared to 2015 and an increase in 2031 compared to 2021. It also shows that the number of compliant vehicles increases over time and the number of non-compliant vehicles decreases, which is the pattern expected.

Table 5-3: 2021 Target and Modelled Average Compliance

Vehicle Type	Target Compliance	Modelled Compliance
Car / Taxi	72%	73%
LGV	60%	61%
HGV	75%	76%
Coach	70%	71%

Table 5-4: 2031 Target and Modelled Average Compliance

Vehicle Type	Target Compliance	Modelled Compliance
Car / Taxi	98%	98%
LGV	97%	97%
HGV	99%	99%
Coach	100%	100%

5.1.1 Highway Network Statistics

The highway model network statistics have been extracted for the base year, and two forecast years. Table 5-5 shows a comparison between 2015 and 2021. The highway model network statistics comparing 2021 and 2031 are shown in Table 5-6.

Table 5-5: 2015 and 2021 Highway Network Statistics

Measure	2015			2021			2021 - 2015		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	7533.7	4679.1	7596.7	7831.8	4887	7643.5	4.0%	4.4%	0.6%
OVER-CAPACITY QUEUES	1416.5	34.2	1510.4	1379.3	28.9	1015.2	-2.6%	-15.5%	-32.8%
LINK CRUISE TIME	18585.6	14577.1	18736.2	19521	15326.6	19735.1	5.0%	5.1%	5.3%
(FREE FLOW	17861.1	14223.6	18194	18908	14981.7	19139.2	5.9%	5.3%	5.2%
DELAYS	724.4	353.5	542.1	613.1	345	595.8	-15.4%	-2.4%	9.9%
TOTAL TRAVEL TIME	27535.7	19290.5	27843.3	28732.2	20242.6	28393.8	4.3%	4.9%	2.0%
TRAVEL DISTANCE	1157050	931627.8	1186111	1209098	975838.8	1239478	4.5%	4.7%	4.5%
OVERALL AVERAGE SPEED	42	48.3	42.6	42.1	48.2	43.7	0.2%	-0.2%	2.6%
MONETARY TOLLS	442.7	326.3	559	501.6	413.3	599.8	13.3%	26.7%	7.3%
TOTAL TRIPS LOADED	127221	108295	126388.4	132039.6	113495.5	130922.7	3.8%	4.8%	3.6%

Table 5-6: 2021 and 2031 Highway Network Statistics

Measure	2021			2031			2031 - 2021		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	7831.8	4887	7643.5	8925	5601.1	8567.9	14.0%	14.6%	12.1%
OVER-CAPACITY QUEUES	1379.3	28.9	1015.2	2114.8	67.9	1531.6	53.3%	134.9%	50.9%
LINK CRUISE TIME	19521	15326.6	19735.1	21021	17009.7	21170.3	7.7%	11.0%	7.3%
(FREE FLOW	18908	14981.7	19139.2	20271.8	16518.2	20398.1	7.2%	10.3%	6.6%
DELAYS	613.1	345	595.8	749.1	491.5	772.2	22.2%	42.5%	29.6%
TOTAL TRAVEL TIME	28732.2	20242.6	28393.8	32060.8	22678.7	31269.8	11.6%	12.0%	10.1%
TRAVEL DISTANCE	1209098	975838.8	1239478	1298403	1084563	1329883	7.4%	11.1%	7.3%
OVERALL AVERAGE SPEED	42.1	48.2	43.7	40.5	47.8	42.5	-3.8%	-0.8%	-2.7%
MONETARY TOLLS	501.6	413.3	599.8	548.5	491	675.7	9.4%	18.8%	12.7%
TOTAL TRIPS LOADED	132039.6	113495.5	130922.7	143426.1	125784.5	141792.8	8.6%	10.8%	8.3%

6. Option Assessment Forecasts

6.1.1 Compliance Splits

The compliance splits at the cordon level of Option 1 for 2021 and 2031 are shown in Table 6-1 and Table 6-2 respectively. The compliance splits at the cordon level of Option 2 for 2021 and 2031 are shown in Tables 6-3 and 6-4 respectively. The compliance splits at the cordon level of Medium CAZ D + Option 1 for 2021 and 2031 are shown in The compliance splits results show that Option 2 increases the percentage compliance of cars from 72% in the 2021 Baseline to 80% due to diesel cars being banned over an 8-hour time period and petrol cars being more prevalent within the city centre. The compliance splits for the other vehicle types remains unchanged from the baseline as Option 2 does not target these vehicles.

The effect of the CAZ in 2031 is negligible as most vehicles are compliant in 2031.

Table 6-5 and

Table 6-6 respectively. The compliance splits at the cordon level of the Hybrid Option for 2021 and 2031 are shown in Table 6-7 and Table 6-8 respectively.

Table 6-1: 2021 Option 1 - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	77.0%	23.0%	77.0%	23.0%	77.0%	23.0%
LGV	88.9%	11.1%	88.9%	11.1%	88.9%	11.1%
GV	93.5%	6.5%	93.5%	6.5%	93.5%	6.5%
Taxi	98.5%	1.5%	98.5%	1.5%	98.8%	1.2%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	94.4%	5.6%	94.3%	5.7%	94.7%	5.3%

Table 6-2: 2031 Option 1 - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	98.3%	1.7%	98.3%	1.7%	98.3%	1.7%
LGV	99.2%	0.8%	99.2%	0.8%	99.2%	0.8%
HGV	99.7%	0.3%	99.7%	0.3%	99.7%	0.3%
Taxi	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%

The compliance splits results show that Option 1 slightly increases the percentage of compliant of cars in 2021 from 72% in the Baseline to 77% in Option 1. This is due to the scrappage scheme in 2021. The compliance splits for the other vehicle types has also seen an increase in the percentage of compliant vehicles due to a CAZ C. This figure accounts for switching of non-complaint vehicles to compliant, but also the infilling of

compliant trips into the CAZ zone when non-compliant trips are removed as part of the cancel trip / change mode response.

The effect of the CAZ in 2031 is negligible as most vehicles are compliant in 2031.

Table 6-3: 2021 Option 2- Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars*	80.2%	19.8%	80.2%	19.8%	80.2%	19.8%
LGV	61.0%	39.0%	61.0%	39.0%	61.0%	39.0%
HGV	75.6%	24.4%	75.6%	24.4%	75.6%	24.4%
Taxi	66.0%	34.0%	66.0%	34.0%	66.0%	34.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	68.8%	31.2%	69.6%	30.4%	70.6%	29.4%

Table 6-4: 2031 Option 2 - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars*	99.0%	1.0%	99.0%	1.0%	99.0%	1.0%
LGV	97.3%	2.7%	97.3%	2.7%	97.3%	2.7%
HGV	99.7%	0.3%	99.7%	0.3%	99.7%	0.3%
Taxi	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%

The compliance splits results show that Option 2 increases the percentage compliance of cars from 72% in the 2021 Baseline to 80% due to diesel cars being banned over an 8-hour time period and petrol cars being more prevalent within the city centre. The compliance splits for the other vehicle types remains unchanged from the baseline as Option 2 does not target these vehicles.

The effect of the CAZ in 2031 is negligible as most vehicles are compliant in 2031.

Table 6-5: 2021 Medium CAZ D + Option 1 - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	97.0%	3.0%	97.0%	3.0%	97.0%	3.0%
LGV	88.7%	11.3%	88.7%	11.3%	88.7%	11.3%
HGV	93.2%	6.8%	93.2%	6.8%	93.2%	6.8%
Taxi	97.6%	2.4%	98.1%	1.9%	97.7%	2.3%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	93.6%	6.4%	93.6%	6.4%	94.0%	6.0%

Table 6-6: 2031 Medium CAZ D + Option 1 - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	99.8%	0.2%	99.8%	0.2%	99.8%	0.2%
LGV	99.2%	0.8%	99.2%	0.8%	99.2%	0.8%
HGV	99.7%	0.3%	99.7%	0.3%	99.7%	0.3%
Taxi	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%

The compliance splits results show that the Medium CAZ D + Option 1 increases the average compliance from 72% in the 2021 Baseline to 97%. This figure accounts for switching of non-complaint vehicles to compliant, but also the infilling of compliant trips into the CAZ zone when non-compliant trips are removed as part of the cancel trip / change mode response.

The effect of the CAZ in 2031 is only marginal, where the average compliance changes from 99% in the Baseline to 100% with the CAZ.

Table 6-7: 2021 Hybrid Option - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	80.2%	19.8%	80.2%	19.8%	80.2%	19.8%
LGV	87.3%	12.7%	87.3%	12.7%	87.3%	12.7%
HGV	92.4%	7.6%	92.4%	7.6%	92.4%	7.6%
Taxi	98.4%	1.6%	98.5%	1.5%	98.8%	1.2%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	94.3%	5.7%	94.3%	5.7%	94.7%	5.3%

Table 6-8: 2031 Hybrid Option - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	99.0%	1.0%	99.0%	1.0%	99.0%	1.0%
LGV	99.1%	0.9%	99.1%	0.9%	99.1%	0.9%
HGV	99.7%	0.3%	99.7%	0.3%	99.7%	0.3%
Taxi	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%

The compliance splits results show that the Hybrid Option increases the percentage compliance of cars from 72% in the 2021 Baseline to 80% in line with Option 2. The compliance splits for the other vehicle types has also seen an increase in the percentage of compliant vehicles due to a CAZ C in line with Option 1.

The effect of the CAZ in 2031 is negligible as most vehicles are compliant in 2031.

6.1.2 Euro Standard Splits

The Euro Standard splits for the Baseline, Option 1, Option 2, Medium CAZ D+ Option 1 and the Hybrid Option for 2021 and 2031 are shown in Table 6-9 and

Rigid HGV					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	0.00	0.00	0.00	0.00	0.00
4Euro III	0.02	0.00	0.02	0.00	0.00
5Euro IV	0.05	0.00	0.05	0.00	0.00
6Euro V_EGR	0.05	0.00	0.05	0.00	0.00
7Euro V_SCR	0.15	0.01	0.15	0.01	0.01
8Euro VI	0.73	0.98	0.73	0.98	0.98
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	0.00
12Euro V EGR + SCRRF	-	-	-	-	0.00
Artic HGV					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	0.00	0.00	0.00	0.00	0.00
4Euro III	0.01	0.00	0.01	0.00	0.00
5Euro IV	0.01	0.00	0.01	0.00	0.00
6Euro V_EGR	0.02	0.00	0.02	0.00	0.00
7Euro V_SCR	0.07	0.00	0.07	0.01	0.00
8Euro VI	0.89	0.99	0.89	0.99	0.99
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	0.11
12Euro V EGR + SCRRF	-	-	-	-	0.43
Buses					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	0.04	-	-	-	-
4Euro III	0.16	-	-	-	-
5Euro IV	0.04	-	-	-	-
6Euro V_EGR	0.02	-	-	-	-
7Euro V_SCR	0.05	-	-	-	-
8Euro VI	0.70	1.00	1.00	1.00	1.00
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	-
12Euro V EGR + SCRRF	-	-	-	-	-
Coaches					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	0.02	0.01	0.02	0.00	0.01
4Euro III	0.07	0.02	0.07	0.01	0.02
5Euro IV	0.03	0.01	0.03	0.00	0.01
6Euro V_EGR	0.02	0.01	0.02	0.00	0.01
7Euro V_SCR	0.07	0.02	0.07	0.01	0.02
8Euro VI	0.79	0.93	0.79	0.98	0.93
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	1.28
12Euro V EGR + SCRRF	-	-	-	-	0.29

Table 6-10 respectively. It should be noted the Euro Standard splits for the four options are those within the CAZ cordon area which the options affect.

Table 6-9: 2021 Euro Standard Splits

Vehicle Type/Fuel Type/Euro Standard	Baseline	Option 1	Option 2	Medium CAZ D+ Option 1	Hybrid Option
Petrol Car					
1Pre-Euro 1	-	-	-	-	-
2Euro 1	-	-	-	-	-
3Euro 2	0.01	0.01	0.01	0.00	0.01
4Euro 3	0.08	0.04	0.08	0.01	0.04
5Euro 4	0.13	0.14	0.13	0.14	0.14
6Euro 5	0.34	0.36	0.34	0.37	0.36
7Euro 6*	0.18	0.19	0.18	0.20	0.19
7Euro 6c*	0.26	0.28	0.26	0.29	0.28
Diesel Car					
1Pre-Euro 1	-	-	-	-	-
2Euro 1	-	-	-	-	-
3Euro 2	0.00	0.00	0.00	0.00	0.00
4Euro 3	0.04	0.02	0.04	0.00	0.02
5Euro 4	0.11	0.05	0.09	0.00	0.05
6Euro 5	0.37	0.38	0.38	0.01	0.38
7Euro 6	0.19	0.22	0.19	0.40	0.22
7Euro 6c*	0.28	0.33	0.29	0.60	0.33
7Euro 6d*	-	-	-	-	-
Petrol LGV					
1Pre-Euro 1	-	-	-	-	-
2Euro 1	0.00	0.00	0.00	0.00	0.00
3Euro 2	0.03	0.03	0.03	0.03	0.03
4Euro 3	0.07	0.06	0.07	0.06	0.06
5Euro 4	0.06	0.06	0.06	0.06	0.06
6Euro 5	0.36	0.37	0.36	0.37	0.37
7Euro 6*	0.33	0.34	0.33	0.34	0.34
7Euro 6c*	0.14	0.14	0.14	0.14	0.14
Diesel LGV					
1Pre-Euro 1	-	-	-	-	-
2Euro 1	-	-	-	-	-
3Euro 2	0.01	0.00	0.01	0.00	0.00
4Euro 3	0.03	0.00	0.03	0.00	0.00
5Euro 4	0.10	0.02	0.10	0.02	0.02
6Euro 5	0.27	0.04	0.27	0.05	0.04
7Euro 6*	0.20	0.31	0.20	0.31	0.31
7Euro 6c*	0.39	0.62	0.39	0.62	0.62
7Euro 6d*	-	-	-	-	-

Rigid HGV					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	0.00	0.00	0.00	0.00	0.00
4Euro III	0.02	0.00	0.02	0.00	0.00
5Euro IV	0.05	0.00	0.05	0.00	0.00
6Euro V_EGR	0.05	0.00	0.05	0.00	0.00
7Euro V_SCR	0.15	0.01	0.15	0.01	0.01
8Euro VI	0.73	0.98	0.73	0.98	0.98
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	0.00
12Euro V EGR + SCRRF	-	-	-	-	0.00
Artic HGV					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	0.00	0.00	0.00	0.00	0.00
4Euro III	0.01	0.00	0.01	0.00	0.00
5Euro IV	0.01	0.00	0.01	0.00	0.00
6Euro V_EGR	0.02	0.00	0.02	0.00	0.00
7Euro V_SCR	0.07	0.00	0.07	0.01	0.00
8Euro VI	0.89	0.99	0.89	0.99	0.99
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	0.11
12Euro V EGR + SCRRF	-	-	-	-	0.43
Buses					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	0.04	-	-	-	-
4Euro III	0.16	-	-	-	-
5Euro IV	0.04	-	-	-	-
6Euro V_EGR	0.02	-	-	-	-
7Euro V_SCR	0.05	-	-	-	-
8Euro VI	0.70	1.00	1.00	1.00	1.00
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	-
12Euro V EGR + SCRRF	-	-	-	-	-
Coaches					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	0.02	0.01	0.02	0.00	0.01
4Euro III	0.07	0.02	0.07	0.01	0.02
5Euro IV	0.03	0.01	0.03	0.00	0.01
6Euro V_EGR	0.02	0.01	0.02	0.00	0.01
7Euro V_SCR	0.07	0.02	0.07	0.01	0.02
8Euro VI	0.79	0.93	0.79	0.98	0.93
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	1.28
12Euro V EGR + SCRRF	-	-	-	-	0.29

Table 6-10: 2031 Euro Standard Splits

Vehicle Type/Fuel Type/Euro Standard	Baseline	Option 1	Option 2	Medium CAZ D+ Option 1	Hybrid Option
Petrol Car					
1Pre-Euro 1	-	-	-	-	-
2Euro 1	-	-	-	-	-
3Euro 2	-	-	-	-	-
4Euro 3	-	-	-	-	-
5Euro 4	0.00	0.00	0.00	0.00	0.00
6Euro 5	0.05	0.05	0.05	0.05	0.05
7Euro 6*	0.04	0.04	0.04	0.04	0.04
7Euro 6c*	0.91	0.91	0.91	0.91	0.91
Diesel Car					
1Pre-Euro 1	-	-	-	-	-
2Euro 1	-	-	-	-	-
3Euro 2	-	-	-	-	-
4Euro 3	-	-	-	-	-
5Euro 4	0.00	0.00	0.00	0.00	0.00
6Euro 5	0.04	0.04	0.04	0.00	0.04
7Euro 6	0.04	0.04	0.04	0.04	0.04
7Euro 6c*	0.19	0.19	0.19	0.20	0.19
7Euro 6d*	0.73	0.73	0.73	0.76	0.73
Petrol LGV					
1Pre-Euro 1	-	-	-	-	-
2Euro 1	-	-	-	-	-
3Euro 2	-	-	-	-	-
4Euro 3	-	-	-	-	-
5Euro 4	0.00	0.00	0.00	-	0.00
6Euro 5	0.02	0.02	0.02	0.02	0.02
7Euro 6*	0.02	0.02	0.02	0.02	0.02
7Euro 6c*	0.96	0.96	0.96	0.97	0.96
Diesel LGV					
1Pre-Euro 1	-	-	-	-	-
2Euro 1	-	-	-	-	-
3Euro 2	-	-	-	-	-
4Euro 3	-	-	-	-	-
5Euro 4	0.00	0.00	0.00	0.00	0.00
6Euro 5	0.03	0.00	0.03	0.00	0.00
7Euro 6*	0.04	0.04	0.04	0.04	0.04
7Euro 6c*	0.12	0.13	0.12	0.13	0.13
7Euro 6d*	0.81	0.83	0.81	0.83	0.83
Rigid HGV					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	-	-	-	-	-
4Euro III	-	-	-	-	-
5Euro IV	0.00	0.00	0.00	0.00	0.00
6Euro V_EGR	0.00	0.00	0.00	0.00	0.00
7Euro V_SCR	0.01	0.00	0.01	0.00	0.00
8Euro VI	0.99	1.00	0.99	1.00	1.00
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	-
12Euro V EGR + SCRRF	-	-	-	-	-

Artic HGV					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	-	-	-	-	-
4Euro III	-	-	-	-	-
5Euro IV	-	-	-	-	-
6Euro V_EGR	0.00	0.00	0.00	0.00	0.00
7Euro V_SCR	0.00	0.00	0.00	0.00	0.00
8Euro VI	1.00	1.00	1.00	1.00	1.00
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	-
12Euro V EGR + SCRRF	-	-	-	-	-
Buses					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	-	-	-	-	-
4Euro III	0.00	-	-	-	-
5Euro IV	-	-	-	-	-
6Euro V_EGR	0.00	-	-	-	-
7Euro V_SCR	0.01	-	-	-	-
8Euro VI	0.98	1.00	1.00	1.00	1.00
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	-
12Euro V EGR + SCRRF	-	-	-	-	-
Coaches					
1Pre-Euro I	-	-	-	-	-
2Euro I	-	-	-	-	-
3Euro II	-	-	-	-	-
4Euro III	-	-	-	-	-
5Euro IV	-	-	-	-	-
6Euro V_EGR	0.00	0.00	0.00	0.00	0.00
7Euro V_SCR	0.01	0.00	0.01	0.00	0.00
8Euro VI	0.98	1.00	0.98	1.00	1.00
9Euro II SCRRF	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	-
12Euro V EGR + SCRRF	-	-	-	-	-

6.1.3 Highway Network Statistics

The highway model network statistics have been extracted for 2021 and 2031 Baseline, Option 1, Option 2, Medium CAZ D+ Option 1 and the Hybrid Option. Table 6-91 shows the statistics for 2021 and Table 6-8 shows the statistics for 2031.

Table 6-91: 2021 Baseline and Schemes Highway Network Statistics

Measure	2021 Baseline			2021 Option 1			2021 Option 2			2021 Option 1 + Medium Area CAZ D			2021 Hybrid Option		
	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM
Transient Queues	7832	4887	7644	7641	4926	7463	7447	4736	7384	7165	4719	7054	7241	4762	7272
Over-Capacity Queues	1379	29	1015	1328	29	897	1099	26	725	964	30	602	1011	21	663
Link Cruise Time	19521	15327	19735	19273	15324	19436	19238	15149	19476	18894	15075	19093	18968	15135	19256
(Free Flow	18908	14982	19139	18689	14984	18873	18643	14813	18900	18334	14744	18554	18403	14804	18706
Delays	613	345	596	585	340	563	595	336	576	560	331	539	565	331	550
Total Travel Time	28732	20243	28394	28242	20279	27796	27784	19912	27584	27023	19824	26749	27220	19918	27191
Travel Distance	1209098	975839	1239478	1196535	975638	1222909	1194668	966863	1226305	1177098	962677	1204849	1181030	966164	1214094
Overall Average Speed	42.10	48.20	43.70	42.40	48.10	44.00	43.00	48.60	44.50	43.60	48.60	45.00	43.30	48.60	44.60
Total Trips Loaded	132040	113496	130923	131031	113296	129861	130277	112090	129511	128757	111346	127702	129268	111890	128805
% Difference from the Baseline:															
Transient Queues				-2.4%	0.8%	-2.4%	-4.9%	-3.1%	-3.4%	-8.5%	-3.4%	-7.7%	-7.5%	-2.5%	-4.9%
Over-Capacity Queues				-3.7%	0.0%	-11.7%	-20.3%	-9.7%	-28.6%	-30.1%	3.5%	-40.7%	-26.7%	-26.3%	-34.7%
Link Cruise Time				-1.3%	0.0%	-1.5%	-1.4%	-1.2%	-1.3%	-3.2%	-1.6%	-3.3%	-2.8%	-1.3%	-2.4%
(Free Flow				-1.2%	0.0%	-1.4%	-1.4%	-1.1%	-1.3%	-3.0%	-1.6%	-3.1%	-2.7%	-1.2%	-2.3%
Delays				-4.6%	-1.5%	-5.5%	-2.9%	-2.6%	-3.4%	-8.7%	-4.2%	-9.5%	-7.9%	-4.1%	-7.7%
Total Travel Time				-1.7%	0.2%	-2.1%	-3.3%	-1.6%	-2.9%	-5.9%	-2.1%	-5.8%	-5.3%	-1.6%	-4.2%
Travel Distance				-1.0%	0.0%	-1.3%	-1.2%	-0.9%	-1.1%	-2.6%	-1.3%	-2.8%	-2.3%	-1.0%	-2.0%
Overall Average Speed				0.7%	-0.2%	0.7%	2.1%	0.8%	1.8%	3.6%	0.8%	3.0%	2.9%	0.8%	2.1%
Total Trips Loaded				-0.8%	-0.2%	-0.8%	-1.3%	-1.2%	-1.1%	-2.5%	-1.9%	-2.5%	-2.1%	-1.4%	-1.6%

Table 6-12: 2031 Baseline and Schemes Highway Network Statistics

Measure	2031 Baseline			2031 Option 1			2031 Option 2			2031 Option 1 + Medium Area CAZ D			2031 Hybrid Option		
	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM
Transient Queues	8925	5601	8568	8603	5678	8365	8522	5508	8262	8557	5657	8306	8188	5551	8123
Over-Capacity Queues	2115	68	1532	1929	122	1412	1684	66	1212	1876	121	1368	1457	111	1162
Link Cruise Time	21021	17010	21170	20797	17008	20889	20799	16829	20950	20773	16988	20843	20554	16813	20743
(Free Flow	20272	16518	20398	20053	16524	20155	20061	16370	20197	20031	16505	20114	19822	16362	20020
Delays	749	492	772	744	484	734	738	459	753	742	483	729	732	451	723
Total Travel Time	32061	22679	31270	31329	22807	30667	31005	22403	30424	31207	22766	30517	30200	22475	30028
Travel Distance	1298403	1084563	1329883	1291438	1084153	1314026	1288772	1071705	1318619	1290221	1083191	1311627	1280748	1070724	1306791
Overall Average Speed	40.50	47.80	42.50	41.20	47.50	42.80	41.60	47.80	43.30	41.30	47.60	43.00	42.40	47.60	43.50
Total Trips Loaded	143426	125785	141793	142504	125668	140820	141759	124386	140450	142345	125525	140636	140836	124270	139789
% Difference from the Baseline:															
Transient Queues				-3.6%	1.4%	-2.4%	-4.5%	-1.7%	-3.6%	-4.1%	1.0%	-3.1%	-8.3%	-0.9%	-5.2%
Over-Capacity Queues				-8.8%	80.3%	-7.8%	-20.4%	-2.2%	-20.8%	-11.3%	77.9%	-10.7%	-31.1%	63.9%	-24.1%
Link Cruise Time				-1.1%	0.0%	-1.3%	-1.1%	-1.1%	-1.0%	-1.2%	-0.1%	-1.5%	-2.2%	-1.2%	-2.0%
(Free Flow				-1.1%	0.0%	-1.2%	-1.0%	-0.9%	-1.0%	-1.2%	-0.1%	-1.4%	-2.2%	-0.9%	-1.9%
Delays				-0.7%	-1.6%	-4.9%	-1.5%	-6.7%	-2.5%	-0.9%	-1.8%	-5.6%	-2.3%	-8.3%	-6.4%
Total Travel Time				-2.3%	0.6%	-1.9%	-3.3%	-1.2%	-2.7%	-2.7%	0.4%	-2.4%	-5.8%	-0.9%	-4.0%
Travel Distance				-0.5%	0.0%	-1.2%	-0.7%	-1.2%	-0.8%	-0.6%	-0.1%	-1.4%	-1.4%	-1.3%	-1.7%
Overall Average Speed				1.7%	-0.6%	0.7%	2.7%	0.0%	1.9%	2.0%	-0.4%	1.2%	4.7%	-0.4%	2.4%
Total Trips Loaded				-0.6%	-0.1%	-0.7%	-1.2%	-1.1%	-0.9%	-0.8%	-0.2%	-0.8%	-1.8%	-1.2%	-1.4%

The 2021 results show that with the introduction of Option 1, the number of trips within the network decreases slightly due to the cancel trip / change mode primary response. As a result, the average speed increases, with moderate decreases in queues and delays across the model area, apart from in the inter-peak where the average speed decreases, due to the car diesel exclusion between Park Street and St. James Barton roundabout, which increases queues.

The 2021 results show that with the introduction of an 8-hour diesel car exclusion in Option 2 also decreases the number of trips within the network but to a greater extent as the option targets cars. This results in average speed increases, with moderate decreases in queues and delays across the model area.

The 2021 results for Medium CAZ D + Option 1 follow the same pattern as Option 1 but the differences are much greater due to the introduction of charging non-compliant cars within the CAZ area.

The 2021 Hybrid Option reduces the number of trips that enter the network to a slightly lesser extent than Medium CAZ D + Option 1 as the impact on cars is reduced due to the diesel ban covering a small area CAZ and only covers an 8-hour time period. As a result, the differences in queues, speeds, etc are less than Medium CAZ D + Option 1.

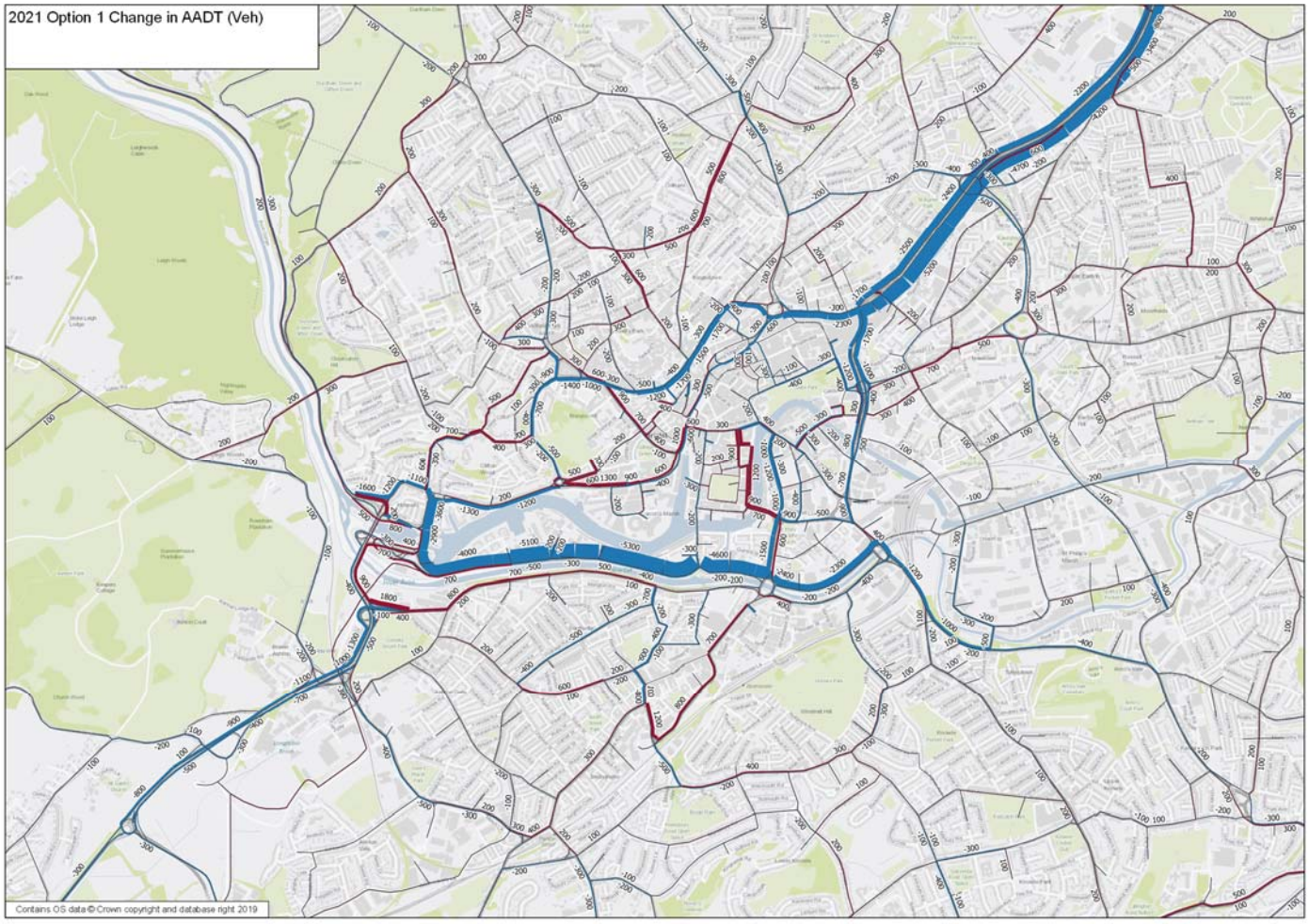
Option 2 and the Hybrid Option have more impact in 2031 than Option 1 and Medium CAZ D + Option 1 due to there being very few non-compliant vehicles in 2031 but a significant proportion of diesels. Therefore 2031 results show that the network performance generally improves with the four options, but Option 2 and the Hybrid Option perform better.

6.1.4 Flow Difference Plots

To show the impact of the CAZ on traffic flows around the Bristol area, flow difference plots have been produced representing the AADT traffic flow change [PCUs] between the 2021 CAZ options and Baseline.

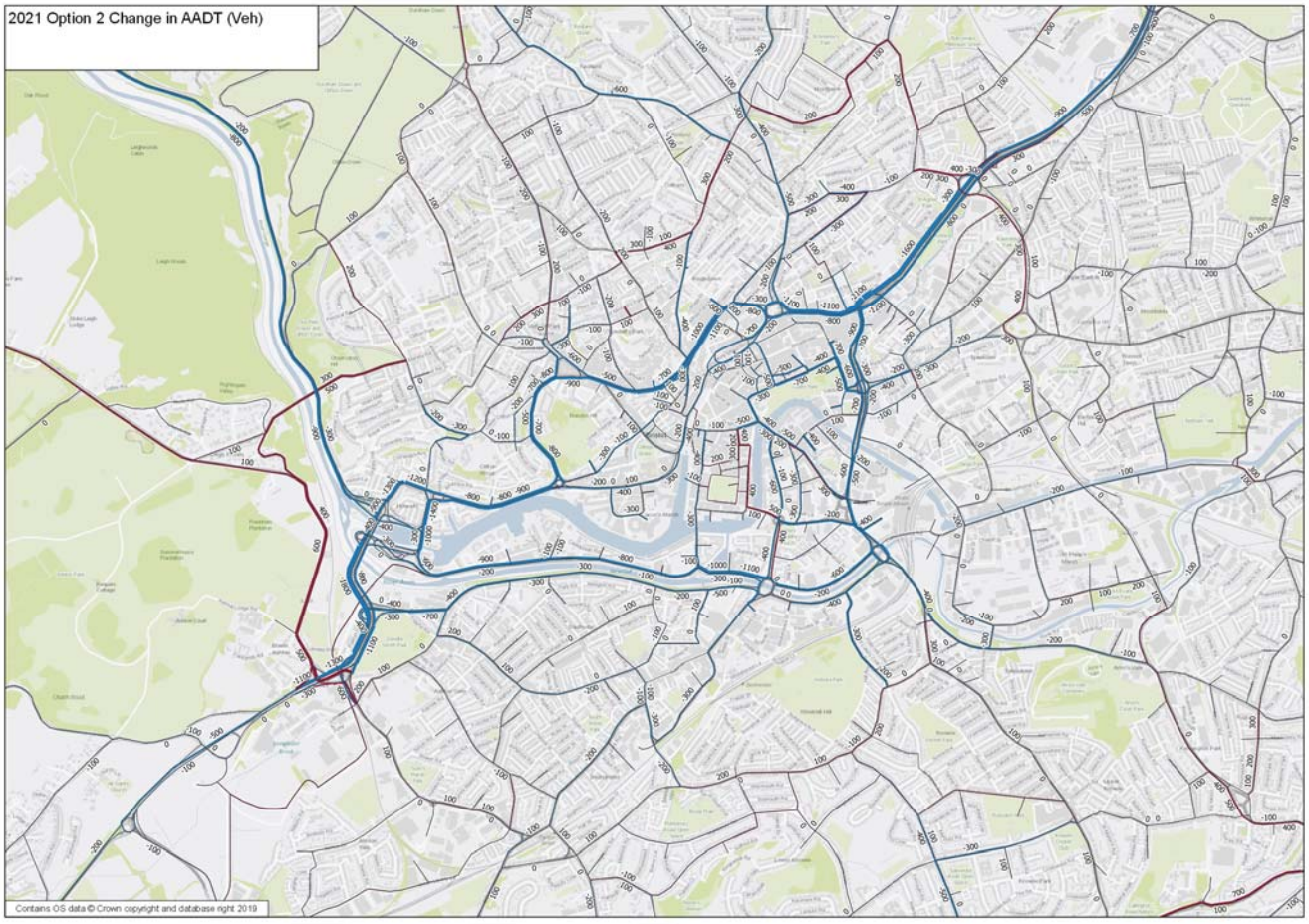
Figures 6.1 to 6.4 show the expected changes in the AADT flows for Option 1, Option 2, Medium CAZ D + Option 1 and the Hybrid Option respectively in the centre of Bristol. Appendix A shows additional difference plots at a greater Bristol area level and also for 2031.

Figure 6.1: 2021 Option 1 - Baseline: AADT



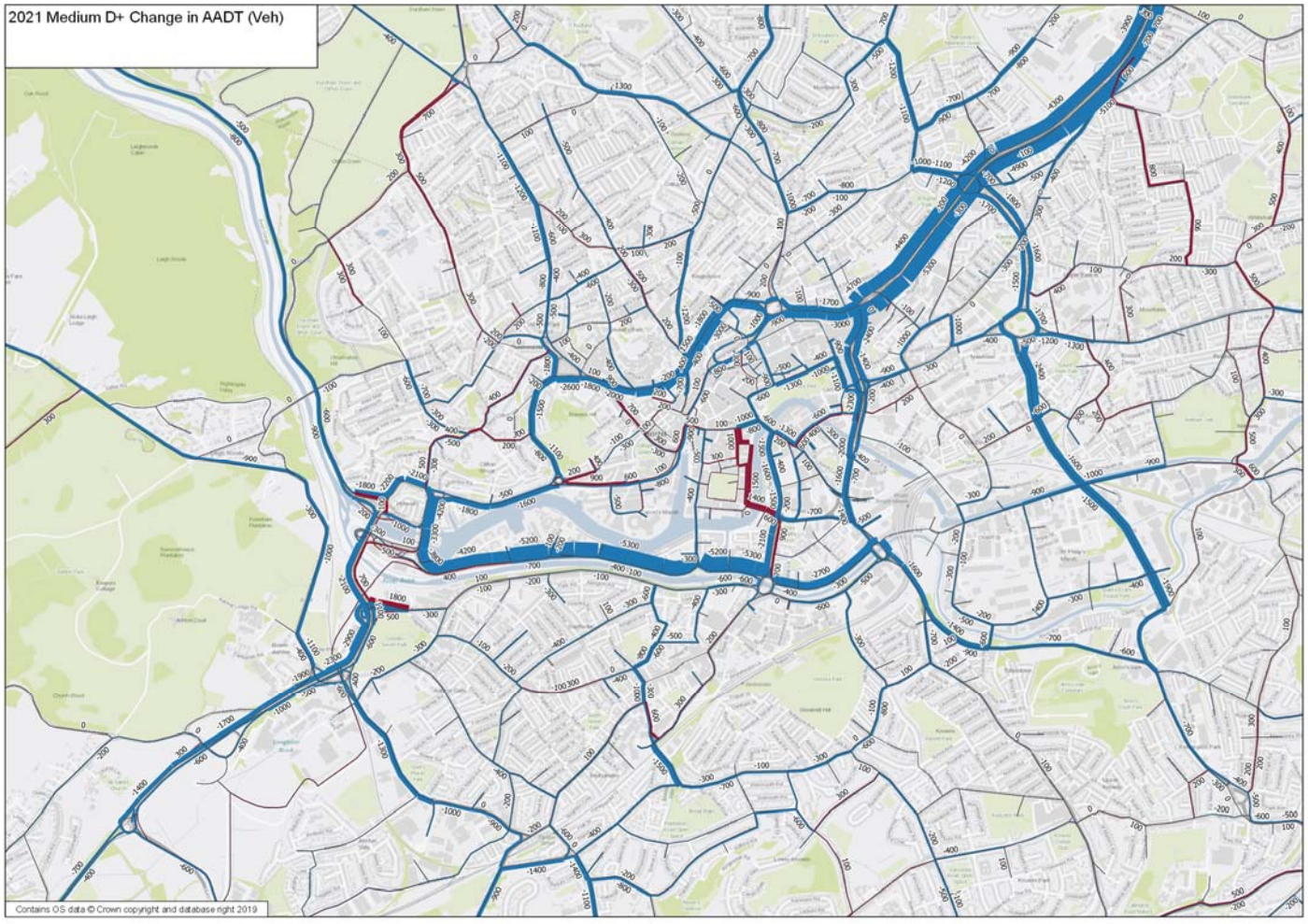
The plot indicates that Option 1 has a targeted traffic flow reduction along the M32 and Cumberland Road, where bus lanes have been implemented, and feeding roads to these links. There are slight increases on some other links within central Bristol, but these are not in areas of air quality exceedances. The introduction of a Medium CAZ C slightly reduces the traffic flow of LGVs and HGVs.

Figure 6.2: 2021 Option 2 - Baseline: AADT



The plot indicates that Option 2 results in a slight overall traffic flow reduction within the Small CAZ area and beyond across an average day. This is because the introduction of an 8-hour car diesel exclusion reduces vehicle traffic accessing the City Centre between 7am-3pm, as well as through traffic using roads in the CAZ. However, it does result in some increases on roads mainly outside of the Small CAZ boundary, as diesel car drivers attempt to avoid the exclusion by using routes around it, namely the A369 and the Clifton Suspension Bridge.

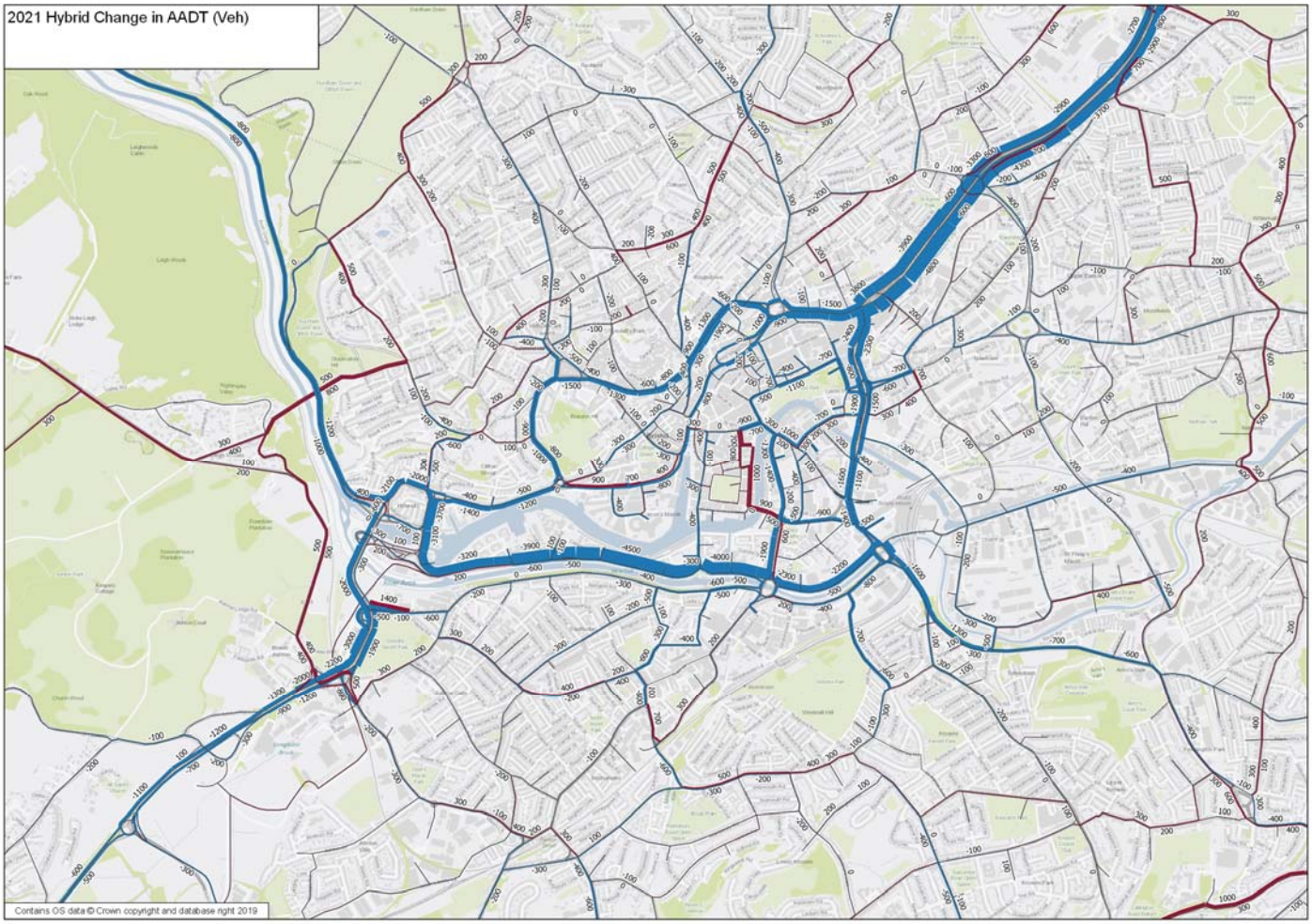
Figure 6.3: 2021 Medium CAZ D + Option 1 - Baseline: AADT



The plot indicates that Medium CAZ D+ Option 1 significantly reduces the traffic from the Baseline in 2021 due to the implementation of bus lanes inbound on the M32 and Cumberland Road, together with the M32 Park and Ride. Also, the introduction of the charge fee reduces vehicle traffic accessing the City Centre, approximately 2000 vehicles per hour, as well as through traffic using roads in the CAZ. However, it does result in some slight increases on roads mainly outside of the CAZ boundary, as non-compliant drivers attempt to avoid the charge by using routes around it. The scale of these potential impacts is considered to be modest, as almost all the changes on links showing increases can be considered as well within normal day-to-day variation in traffic volumes.

With reduced traffic flows in the City Centre, traffic congestion in this central area could be reduced, leading to improvements not only for cars, but also quicker journey times and greater journey time reliability for public transport. This could allow greater punctuality of public transport and increase its attractiveness as an alternative to the car.

Figure 6.4: 2021 Hybrid Option - Baseline: AADT



The Hybrid Option broadly shows the cumulative effects of Options 1 and 2, where there is a targeted traffic flow reduction along the M32 and Cumberland Road and a slight overall traffic flow reduction within the Small CAZ area and beyond across an average day. However, it does result in some increases on roads mainly outside of the Small CAZ boundary, as drivers attempt to avoid the charge/exclusion areas by using routes around it, namely the A369 and the Clifton Suspension Bridge.

6.1.5 Trip Suppression

The potential clean air schemes result in trip suppression, both across the Greater Bristol and surrounding areas and in particular within the clean air zone itself. Tables 6.19 to 6.22 show the trip suppression across the model as a whole for the 2021 Option 1, Option 2, Medium CAZ D + Option 1 and the Hybrid Option, respectively.

Table 6.19: 2021 Option 1: Matrix Totals

User Class	Type	2021 Baseline (cars split by fuel type)				2021 Option 1				2021 Option 1 - Baseline (Diff %)			
		AM	IP	PM	AADT	AM	IP	PM	AADT	AM	IP	PM	AADT
Total	Total	132040	113496	130912	1606322	131194	113342	129902	1599440	-0.64%	-0.13%	-0.77%	-0.43%
UC1	Car Low Inc - Petrol/Electric	12998	9389	14563	151179	12927	9385	14457	150592	-0.54%	-0.05%	-0.73%	-0.39%
UC2	Car Low Inc - Diesel	12094	8737	13551	140672	12029	8733	13452	140126	-0.54%	-0.05%	-0.73%	-0.39%
UC3	Car Med Inc - Petrol/Electric	19023	13704	21283	220895	18884	13696	21099	219829	-0.73%	-0.06%	-0.86%	-0.48%
UC4	Car Med Inc - Diesel	17701	12751	19804	205543	17572	12744	19633	204552	-0.73%	-0.06%	-0.86%	-0.48%
UC5	Car High Inc - Petrol/Electric	13258	9255	14550	151018	13114	9247	14383	149989	-1.08%	-0.09%	-1.15%	-0.68%
UC6	CarHigh Inc - Diesel	12336	8612	13539	140523	12203	8605	13384	139565	-1.08%	-0.09%	-1.15%	-0.68%
UC7	Car Emp - Petrol/Electric	4986	6032	3053	66671	4957	6029	3025	66471	-0.58%	-0.05%	-0.91%	-0.30%
UC8	Car Emp - Diesel	4639	5613	2841	62038	4612	5610	2815	61851	-0.58%	-0.05%	-0.91%	-0.30%
UC9	Taxi - Comp	1480	1650	2134	22727	1480	1651	2134	22726	-0.04%	0.01%	0.00%	0.00%
UC10	Taxi - NonComp	2248	3247	3526	40521	2247	3247	3526	40521	-0.04%	0.01%	0.00%	0.00%
UC11	LGV - Comp	10040	12451	8385	143459	10040	12451	8385	143459	0.00%	0.00%	0.00%	0.00%
UC12	LGV - NonComp	7270	7281	6022	91782	7205	7215	5973	90965	-0.90%	-0.92%	-0.82%	-0.89%
UC13	HGV - Comp	10045	10285	4433	116004	10045	10285	4433	116004	0.00%	0.00%	0.00%	0.00%
UC14	HGV - NonComp	3069	3320	1673	37673	3035	3287	1658	37298	-1.10%	-0.98%	-0.89%	-1.00%
UC15	Coach- Comp	586	812	1098	10896	586	812	1098	10896	0.00%	0.00%	0.00%	0.00%
UC16	Coach - NonComp	266	355	457	4718	258	346	446	4597	-2.91%	-2.60%	-2.36%	-2.58%

Table 6.20: 2021 Option 2: Matrix Totals

User Class	Type	2021 Baseline (cars split by fuel type)				2021 Option 2				2021 Option 2 - Baseline (Diff %)			
		AM	IP	PM	AADT	AM	IP	PM	AADT	AM	IP	PM	AADT
Total	Total	132040	113495	130912	1606322	130277	112090	129511	1586731	-1.34%	-1.24%	-1.07%	-1.22%
UC1	Car Low Inc - Petrol/Electric	12998	9389	14563	151179	12998	9389	14563	151179	0.00%	0.00%	0.00%	0.00%
UC2	Car Low Inc - Diesel	12094	8737	13551	140672	11645	8406	13188	135849	-3.72%	-3.79%	-2.68%	-3.43%
UC3	Car Med Inc - Petrol/Electric	19023	13704	21283	220895	19023	13704	21283	220895	0.00%	0.00%	0.00%	0.00%
UC4	Car Med Inc - Diesel	17701	12751	19804	205543	17034	12251	19252	198282	-3.77%	-3.92%	-2.78%	-3.53%
UC5	Car High Inc - Petrol/Electric	13258	9255	14550	151018	13258	9255	14550	151018	0.00%	0.00%	0.00%	0.00%
UC6	CarHigh Inc - Diesel	12336	8612	13539	140523	11876	8266	13156	135498	-3.73%	-4.01%	-2.83%	-3.58%
UC7	Car Emp - Petrol/Electric	4986	6032	3053	66671	4986	6032	3053	66671	0.00%	0.00%	0.00%	0.00%
UC8	Car Emp - Diesel	4639	5613	2841	62038	4453	5384	2738	59556	-4.02%	-4.08%	-3.63%	-4.00%
UC9	Taxi - Comp	1480	1650	2134	22727	1480	1650	2134	22727	0.00%	0.00%	0.00%	0.00%
UC10	Taxi - NonComp	2248	3247	3526	40521	2248	3247	3526	40521	0.00%	0.00%	0.00%	0.00%
UC11	LGV - Comp	10040	12451	8385	143459	10040	12451	8385	143459	0.00%	0.00%	0.00%	0.00%
UC12	LGV - NonComp	7270	7281	6022	91782	7270	7281	6022	91782	0.00%	0.00%	0.00%	0.00%
UC13	HGV - Comp	10045	10285	4433	116004	10045	10285	4433	116004	0.00%	0.00%	0.00%	0.00%
UC14	HGV - NonComp	3069	3320	1673	37673	3069	3320	1673	37673	0.00%	0.00%	0.00%	0.00%
UC15	Coach- Comp	586	812	1098	10896	586	812	1098	10896	0.00%	0.00%	0.00%	0.00%
UC16	Coach - NonComp	266	355	457	4718	266	355	457	4718	0.00%	0.00%	0.00%	0.00%

Table 6.21: 2021 Medium CAZ D + Option 1: Matrix Totals

User Class	Type	2021 Baseline (cars split by fuel type)				2021 Option 1 + Medium Area CAZ D				2021 Option 1 + Medium Area CAZ D - Baseline (Diff %)			
		AM	IP	PM	AADT	AM	IP	PM	AADT	AM	IP	PM	AADT
Total	Total	132040	113496	130912	1606322	128916	111394	127740	1572098	-2.37%	-1.85%	-2.42%	-2.13%
UC1	Car Low Inc - Petrol/Electric	12998	9389	14563	151179	12436	9000	13954	144821	-4.32%	-4.15%	-4.19%	-4.21%
UC2	Car Low Inc - Diesel	12094	8737	13551	140672	11593	8391	13009	135014	-4.14%	-3.96%	-4.00%	-4.02%
UC3	Car Med Inc - Petrol/Electric	19023	13704	21283	220895	18493	13393	20697	215250	-2.79%	-2.27%	-2.75%	-2.56%
UC4	Car Med Inc - Diesel	17701	12751	19804	205543	17241	12487	19298	200696	-2.60%	-2.07%	-2.56%	-2.36%
UC5	Car High Inc - Petrol/Electric	13258	9255	14550	151018	12946	9125	14219	148106	-2.35%	-1.40%	-2.28%	-1.93%
UC6	CarHigh Inc - Diesel	12336	8612	13539	140523	12070	8509	13258	138099	-2.16%	-1.19%	-2.07%	-1.73%
UC7	Car Emp - Petrol/Electric	4986	6032	3053	66671	4783	5793	2925	63990	-4.07%	-3.96%	-4.18%	-4.02%
UC8	Car Emp - Diesel	4639	5613	2841	62038	4459	5401	2727	59658	-3.89%	-3.78%	-4.00%	-3.84%
UC9	Taxi - Comp	1480	1650	2134	22727	1479	1651	2134	22726	-0.08%	0.02%	0.00%	-0.01%
UC10	Taxi - NonComp	2248	3247	3526	40521	2246	3248	3526	40520	-0.08%	0.02%	0.00%	0.00%
UC11	LGV - Comp	10040	12451	8385	143459	10040	12451	8385	143459	0.00%	0.00%	0.00%	0.00%
UC12	LGV - NonComp	7270	7281	6022	91782	7205	7215	5973	90965	-0.90%	-0.92%	-0.82%	-0.89%
UC13	HGV - Comp	10045	10285	4433	116004	10045	10285	4433	116004	0.00%	0.00%	0.00%	0.00%
UC14	HGV - NonComp	3069	3320	1673	37673	3035	3287	1658	37298	-1.10%	-0.98%	-0.89%	-1.00%
UC15	Coach- Comp	586	812	1098	10896	586	812	1098	10896	0.00%	0.00%	0.00%	0.00%
UC16	Coach - NonComp	266	355	457	4718	258	346	446	4597	-2.91%	-2.60%	-2.36%	-2.58%

Table 6.22: 2021 Hybrid Option: Matrix Totals

User Class	Type	2021 Baseline (cars split by fuel type)				2021 Hybrid Option				2021 Hybrid Option - Baseline (Diff %)			
		AM	IP	PM	AADT	AM	IP	PM	AADT	AM	IP	PM	AADT
Total	Total	132040	113496	130912	1606322	129431	111937	128856	1580976	-1.98%	-1.37%	-1.57%	-1.58%
UC1	Car Low Inc - Petrol/Electric	12998	9389	14563	151179	12927	9385	14494	150710	-0.54%	-0.05%	-0.48%	-0.31%
UC2	Car Low Inc - Diesel	12094	8737	13551	140672	11579	8402	13123	135412	-4.26%	-3.83%	-3.16%	-3.74%
UC3	Car Med Inc - Petrol/Electric	19023	13704	21283	220895	18884	13696	21164	220036	-0.73%	-0.06%	-0.56%	-0.39%
UC4	Car Med Inc - Diesel	17701	12751	19804	205543	16905	12244	19142	197482	-4.49%	-3.98%	-3.34%	-3.92%
UC5	Car High Inc - Petrol/Electric	13258	9255	14550	151018	13114	9247	14454	150211	-1.08%	-0.09%	-0.67%	-0.53%
UC6	CarHigh Inc - Diesel	12336	8612	13539	140523	11742	8259	13066	134747	-4.81%	-4.10%	-3.50%	-4.11%
UC7	Car Emp - Petrol/Electric	4986	6032	3053	66671	4957	6029	3037	66507	-0.58%	-0.05%	-0.53%	-0.25%
UC8	Car Emp - Diesel	4639	5613	2841	62038	4426	5381	2723	59404	-4.61%	-4.13%	-4.16%	-4.25%
UC9	Taxi - Comp	1480	1650	2134	22727	1480	1651	2134	22727	-0.04%	0.01%	0.01%	0.00%
UC10	Taxi - NonComp	2248	3247	3526	40521	2247	3247	3526	40521	-0.04%	0.01%	0.01%	0.00%
UC11	LGV - Comp	10040	12451	8385	143459	10040	12451	8385	143459	0.00%	0.00%	0.00%	0.00%
UC12	LGV - NonComp	7270	7281	6022	91782	7205	7215	5973	90965	-0.90%	-0.92%	-0.82%	-0.89%
UC13	HGV - Comp	10045	10285	4433	116004	10045	10285	4433	116004	0.00%	0.00%	0.00%	0.00%
UC14	HGV - NonComp	3069	3320	1673	37673	3035	3287	1658	37298	-1.10%	-0.98%	-0.89%	-1.00%
UC15	Coach- Comp	586	812	1098	10896	586	812	1098	10896	0.00%	0.00%	0.00%	0.00%
UC16	Coach - NonComp	266	355	457	4718	258	346	446	4597	-2.91%	-2.60%	-2.36%	-2.58%

The results show that Medium Area CAZ D + Option 1 give rise to the greatest trip suppression in 2021.

Tables 6.23 to 6.26 show the trip suppression across the model as a whole for the 2031 Option 1, Option 2, Medium CAZ D + Option 1 and the Hybrid Option, respectively.

Table 6.23: 2031 Option 1: Matrix Totals

User Class	Type	2031 Baseline (cars split by fuel type)				2031 Option 1				2031 Option 1 - Baseline (Diff %)			
		AM	IP	PM	AADT	AM	IP	PM	AADT	AM	IP	PM	AADT
Total	Total	143426	125784	141793	1760767	142678	125735	140864	1755152	-0.52%	-0.04%	-0.66%	-0.32%
UC1	Car Low Inc - Petrol/Electric	14684	10826	16435	172240	14607	10822	16351	171707	-0.53%	-0.04%	-0.51%	-0.31%
UC2	Car Low Inc - Diesel	12112	8930	13556	142067	12041	8926	13475	141564	-0.59%	-0.04%	-0.59%	-0.35%
UC3	Car Med Inc - Petrol/Electric	21476	15810	24013	251671	21337	15803	23846	250662	-0.65%	-0.04%	-0.69%	-0.40%
UC4	Car Med Inc - Diesel	17714	13040	19806	207583	17585	13034	19649	206639	-0.73%	-0.05%	-0.79%	-0.45%
UC5	Car High Inc - Petrol/Electric	14930	10665	16413	171822	14791	10658	16212	170704	-0.93%	-0.06%	-1.23%	-0.65%
UC6	CarHigh Inc - Diesel	12314	8796	13538	141722	12186	8790	13354	140695	-1.04%	-0.07%	-1.36%	-0.72%
UC7	Car Emp - Petrol/Electric	5655	6946	3461	76329	5626	6941	3434	76123	-0.51%	-0.07%	-0.78%	-0.27%
UC8	Car Emp - Diesel	4664	5729	2855	62958	4637	5725	2829	62765	-0.58%	-0.07%	-0.88%	-0.31%
UC9	Taxi - Comp	3692	4846	5567	62487	3691	4846	5568	62487	-0.04%	0.01%	0.01%	0.00%
UC10	Taxi - NonComp	286	491	471	5764	286	491	471	5764	-0.04%	0.01%	0.01%	0.00%
UC11	LGV - Comp	20466	23475	17034	279122	20466	23475	17034	279122	0.00%	0.00%	0.00%	0.00%
UC12	LGV - NonComp	633	577	527	7609	627	572	523	7542	-0.89%	-0.91%	-0.80%	-0.88%
UC13	HGV - Comp	13758	14258	6386	161059	13758	14258	6386	161059	0.00%	0.00%	0.00%	0.00%
UC14	HGV - NonComp	139	159	84	1789	137	157	83	1772	-1.08%	-0.96%	-0.87%	-0.98%
UC15	Coach- Comp	903	1237	1648	16546	903	1237	1648	16546	0.00%	0.00%	0.00%	0.00%
UC16	Coach - NonComp	0	0	0	0	0	0	0	0	0.00%	0.00%	0.00%	0.00%

Table 6.24: 2031 Option 2: Matrix Totals

User Class	Type	2031 Baseline (cars split by fuel type)				2031 Option 2				2031 Option 2 - Baseline (Diff %)			
		AM	IP	PM	AADT	AM	IP	PM	AADT	AM	IP	PM	AADT
Total	Total	143426	125784	141793	1760767	141759	124386	140450	1741710	-1.16%	-1.11%	-0.95%	-1.08%
UC1	Car Low Inc - Petrol/Electric	14684	10826	16435	172240	14684	10826	16435	172240	0.00%	0.00%	0.00%	0.00%
UC2	Car Low Inc - Diesel	12112	8930	13556	142067	11680	8597	13203	137317	-3.56%	-3.73%	-2.60%	-3.34%
UC3	Car Med Inc - Petrol/Electric	21476	15810	24013	251671	21476	15810	24013	251671	0.00%	0.00%	0.00%	0.00%
UC4	Car Med Inc - Diesel	17714	13040	19806	207583	17083	12542	19277	200512	-3.56%	-3.83%	-2.67%	-3.41%
UC5	Car High Inc - Petrol/Electric	14930	10665	16413	171822	14930	10665	16413	171822	0.00%	0.00%	0.00%	0.00%
UC6	CarHigh Inc - Diesel	12314	8796	13538	141722	11884	8457	13176	136899	-3.49%	-3.86%	-2.68%	-3.40%
UC7	Car Emp - Petrol/Electric	5655	6946	3461	76329	5655	6946	3461	76329	0.00%	0.00%	0.00%	0.00%
UC8	Car Emp - Diesel	4664	5729	2855	62958	4489	5503	2756	60544	-3.75%	-3.95%	-3.46%	-3.83%
UC9	Taxi - Comp	3692	4846	5567	62487	3692	4846	5567	62487	0.00%	0.00%	0.00%	0.00%
UC10	Taxi - NonComp	286	491	471	5764	286	491	471	5764	0.00%	0.00%	0.00%	0.00%
UC11	LGV - Comp	20466	23475	17034	279122	20466	23475	17034	279122	0.00%	0.00%	0.00%	0.00%
UC12	LGV - NonComp	633	577	527	7609	633	577	527	7609	0.00%	0.00%	0.00%	0.00%
UC13	HGV - Comp	13758	14258	6386	161059	13758	14258	6386	161059	0.00%	0.00%	0.00%	0.00%
UC14	HGV - NonComp	139	159	84	1789	139	159	84	1789	0.00%	0.00%	0.00%	0.00%
UC15	Coach- Comp	903	1237	1648	16546	903	1237	1648	16546	0.00%	0.00%	0.00%	0.00%
UC16	Coach - NonComp	0	0	0	0	0	0	0	0	0.00%	0.00%	0.00%	0.00%

Table 6.25: 2031 Medium CAZ D +: Matrix Totals

User Class	Type	2031 Baseline (cars split by fuel type)				2031 Option 1 + Medium Area CAZ D				2031 Option 1 + Medium Area CAZ D - Baseline (Diff %)			
		AM	IP	PM	AADT	AM	IP	PM	AADT	AM	IP	PM	AADT
Total	Total	143426	125784	141793	1760767	142519	125591	140677	1753082	-0.63%	-0.15%	-0.79%	-0.44%
UC1	Car Low Inc - Petrol/Electric	14684	10826	16435	172240	14564	10790	16270	171096	-0.82%	-0.33%	-1.00%	-0.66%
UC2	Car Low Inc - Diesel	12112	8930	13556	142067	12018	8904	13426	141187	-0.77%	-0.29%	-0.96%	-0.62%
UC3	Car Med Inc - Petrol/Electric	21476	15810	24013	251671	21297	15776	23786	250163	-0.84%	-0.21%	-0.95%	-0.60%
UC4	Car Med Inc - Diesel	17714	13040	19806	207583	17574	13019	19628	206438	-0.79%	-0.16%	-0.90%	-0.55%
UC5	Car High Inc - Petrol/Electric	14930	10665	16413	171822	14769	10646	16221	170584	-1.08%	-0.17%	-1.17%	-0.72%
UC6	CarHigh Inc - Diesel	12314	8796	13538	141722	12188	8786	13386	140771	-1.03%	-0.12%	-1.12%	-0.67%
UC7	Car Emp - Petrol/Electric	5655	6946	3461	76329	5611	6922	3425	75913	-0.78%	-0.34%	-1.04%	-0.54%
UC8	Car Emp - Diesel	4664	5729	2855	62958	4630	5712	2826	62643	-0.74%	-0.30%	-1.00%	-0.50%
UC9	Taxi - Comp	3692	4846	5567	62487	3691	4846	5566	62481	-0.04%	0.01%	-0.02%	-0.01%
UC10	Taxi - NonComp	286	491	471	5764	286	491	471	5764	-0.04%	0.01%	-0.02%	-0.01%
UC11	LGV - Comp	20466	23475	17034	279122	20466	23475	17034	279122	0.00%	0.00%	0.00%	0.00%
UC12	LGV - NonComp	633	577	527	7609	627	572	523	7542	-0.88%	-0.90%	-0.80%	-0.88%
UC13	HGV - Comp	13758	14258	6386	161059	13758	14258	6386	161059	0.00%	0.00%	0.00%	0.00%
UC14	HGV - NonComp	139	159	84	1789	137	157	83	1772	-1.08%	-0.96%	-0.87%	-0.98%
UC15	Coach- Comp	903	1237	1648	16546	903	1237	1648	16546	0.00%	0.00%	0.00%	0.00%
UC16	Coach - NonComp	0	0	0	0	0	0	0	0	0.00%	0.00%	0.00%	0.00%

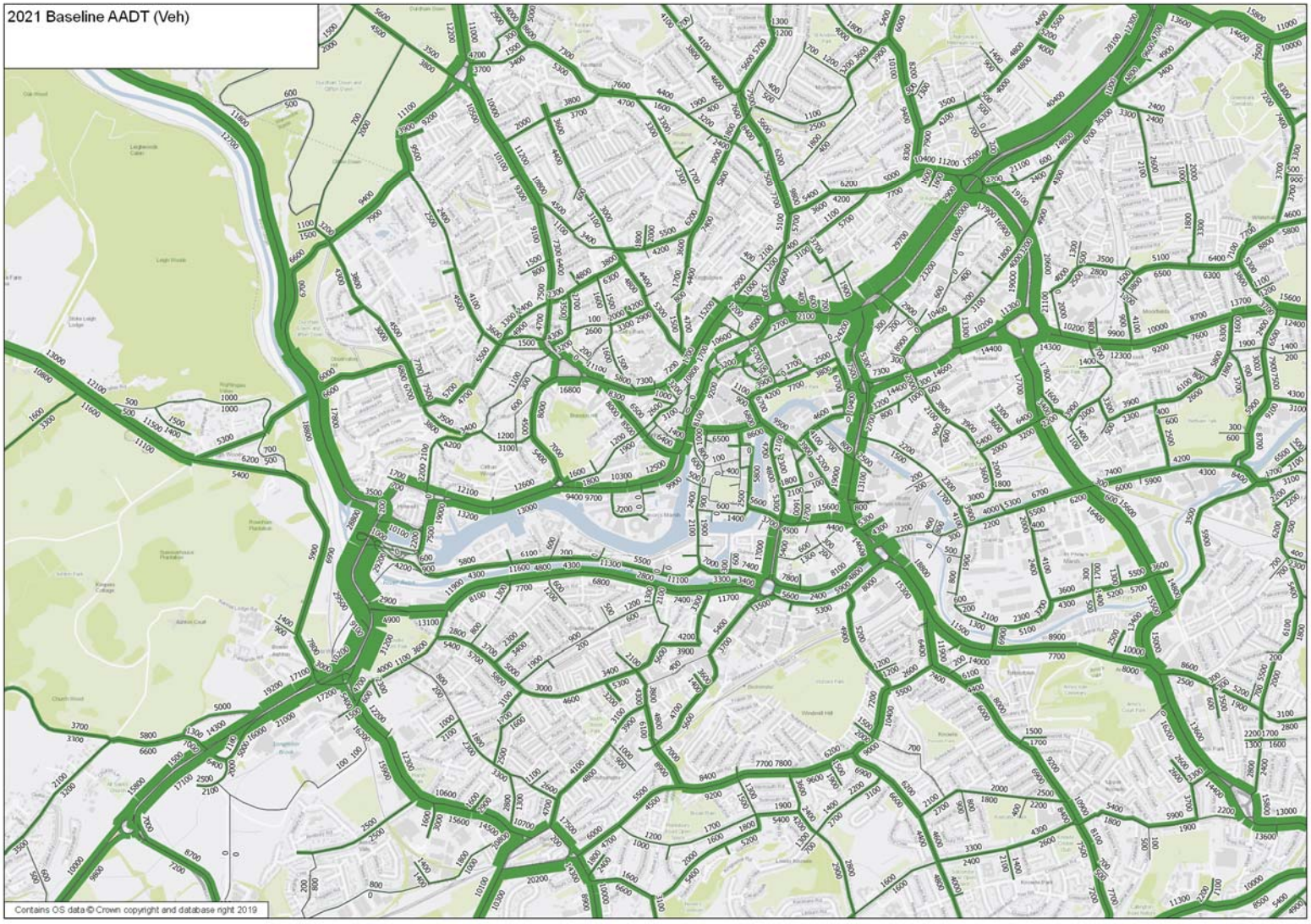
Table 6.26: 2031 Hybrid Option: Matrix Totals

User Class	Type	2031 Baseline (cars split by fuel type)				2031 Hybrid Option				2031 Hybrid Option - Baseline (Diff %)			
		AM	IP	PM	AADT	AM	IP	PM	AADT	AM	IP	PM	AADT
Total	Total	143426	125784	141793	1760767	141010	124336	139833	1737088	-1.68%	-1.15%	-1.38%	-1.34%
UC1	Car Low Inc - Petrol/Electric	14684	10826	16435	172240	14603	10822	16349	171687	-0.55%	-0.04%	-0.52%	-0.32%
UC2	Car Low Inc - Diesel	12112	8930	13556	142067	11613	8593	13132	136860	-4.11%	-3.77%	-3.12%	-3.66%
UC3	Car Med Inc - Petrol/Electric	21476	15810	24013	251671	21329	15803	23887	250763	-0.69%	-0.05%	-0.52%	-0.36%
UC4	Car Med Inc - Diesel	17714	13040	19806	207583	16961	12535	19173	199763	-4.25%	-3.87%	-3.20%	-3.77%
UC5	Car High Inc - Petrol/Electric	14930	10665	16413	171822	14783	10657	16308	170982	-0.98%	-0.07%	-0.64%	-0.49%
UC6	CarHigh Inc - Diesel	12314	8796	13538	141722	11763	8451	13089	136206	-4.47%	-3.93%	-3.32%	-3.89%
UC7	Car Emp - Petrol/Electric	5655	6946	3461	76329	5624	6941	3444	76146	-0.54%	-0.07%	-0.50%	-0.24%
UC8	Car Emp - Diesel	4664	5729	2855	62958	4464	5499	2742	60393	-4.29%	-4.02%	-3.96%	-4.07%
UC9	Taxi - Comp	3692	4846	5567	62487	3691	4846	5566	62481	-0.04%	0.01%	-0.02%	-0.01%
UC10	Taxi - NonComp	286	491	471	5764	286	491	471	5764	-0.04%	0.01%	-0.02%	-0.01%
UC11	LGV - Comp	20466	23475	17034	279122	20466	23475	17034	279122	0.00%	0.00%	0.00%	0.00%
UC12	LGV - NonComp	633	577	527	7609	627	572	523	7542	-0.89%	-0.91%	-0.80%	-0.88%
UC13	HGV - Comp	13758	14258	6386	161059	13758	14258	6386	161059	0.00%	0.00%	0.00%	0.00%
UC14	HGV - NonComp	139	159	84	1789	137	157	83	1772	-1.08%	-0.96%	-0.87%	-0.98%
UC15	Coach- Comp	903	1237	1648	16546	903	1237	1648	16546	0.00%	0.00%	0.00%	0.00%
UC16	Coach - NonComp	0	0	0	0	0	0	0	0	0.00%	0.00%	0.00%	0.00%

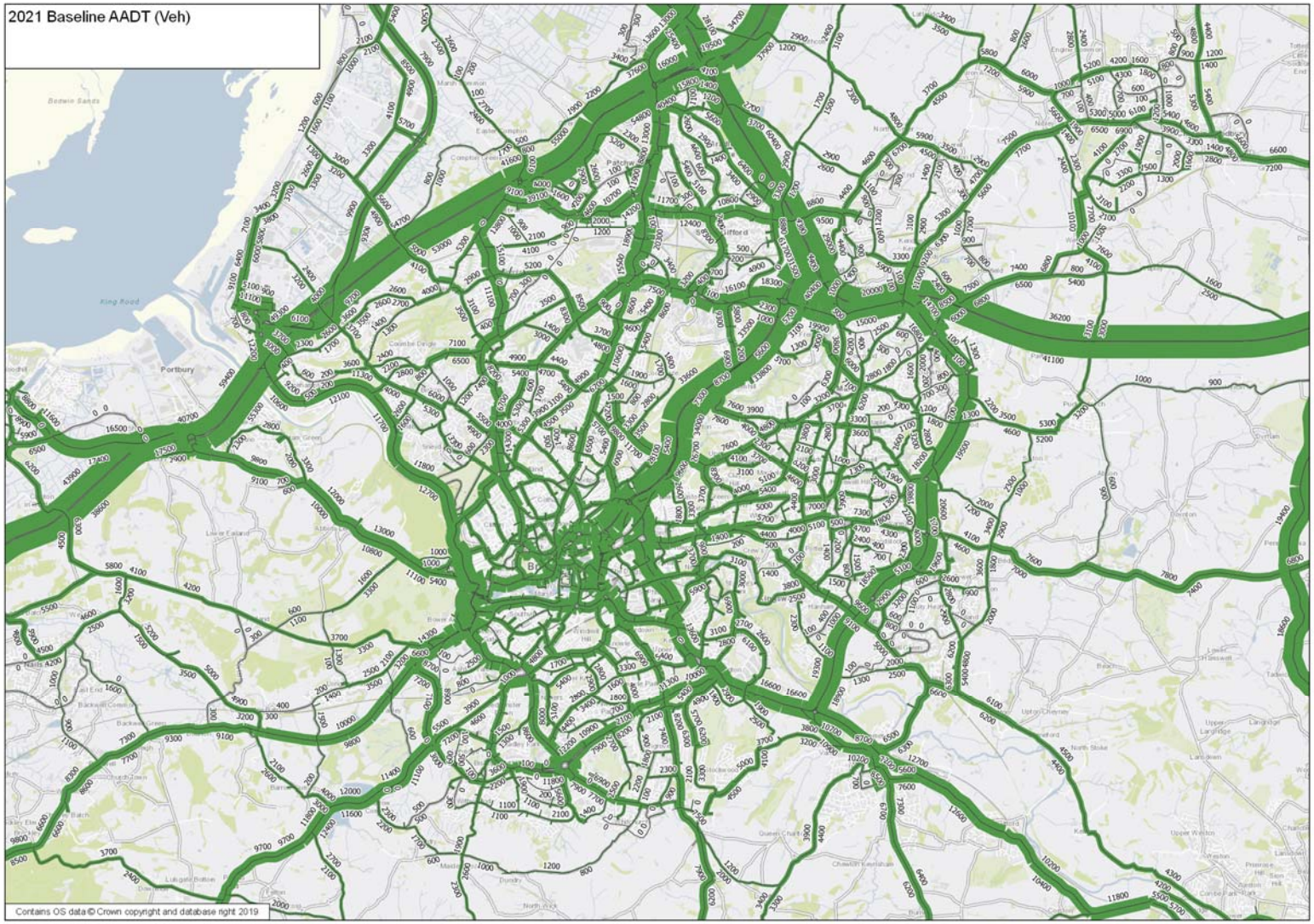
The results show that the Hybrid Option in the greatest trip suppression in 2031 compared to Medium Area CAZ D + Option 1 in 2021. This is due to there being very few non-compliant vehicles in 2031 but a significant proportion of diesels.

Appendix A. AADT Difference Plots

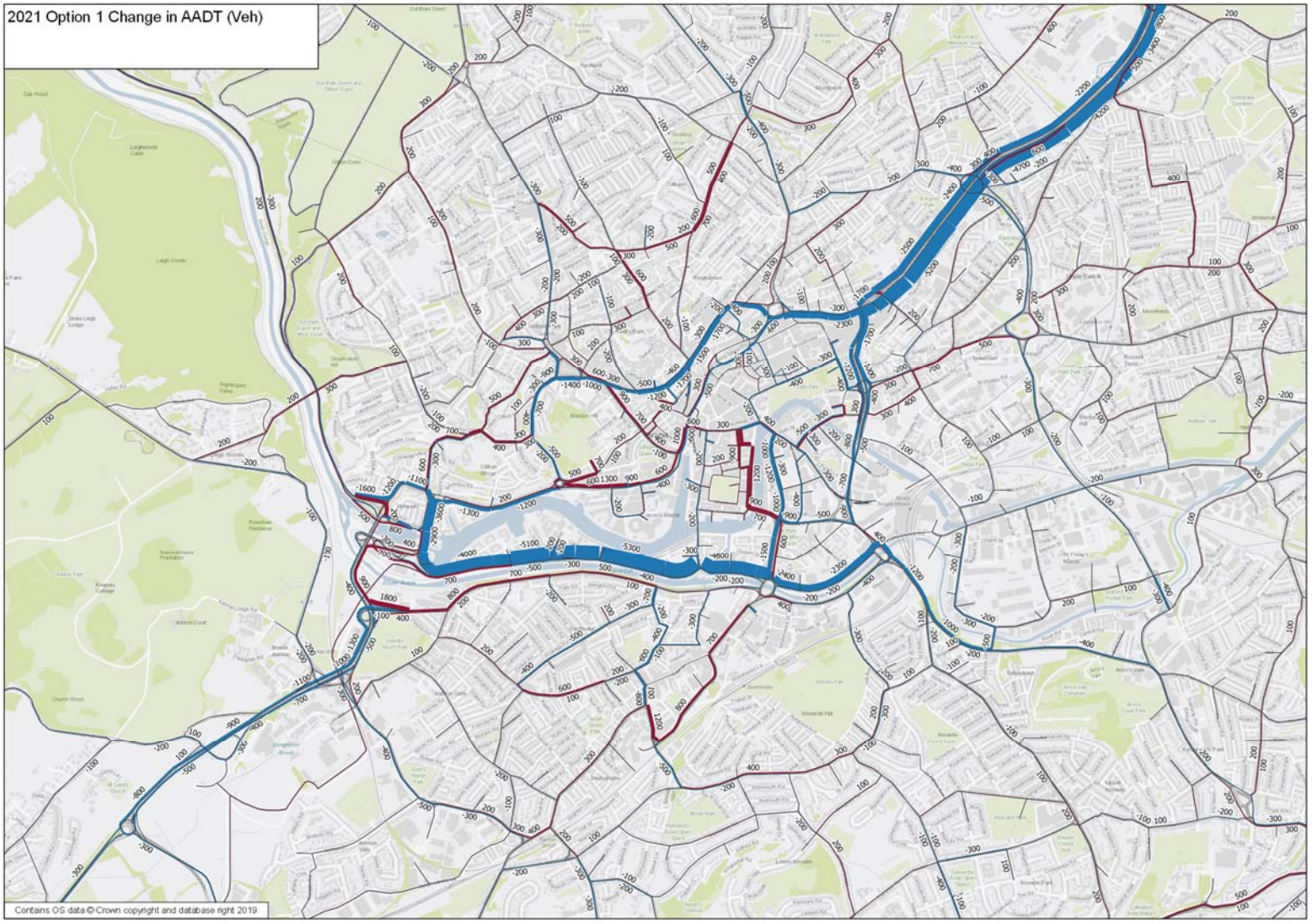
A.1 2021 Baseline: AADT – Central Bristol Area



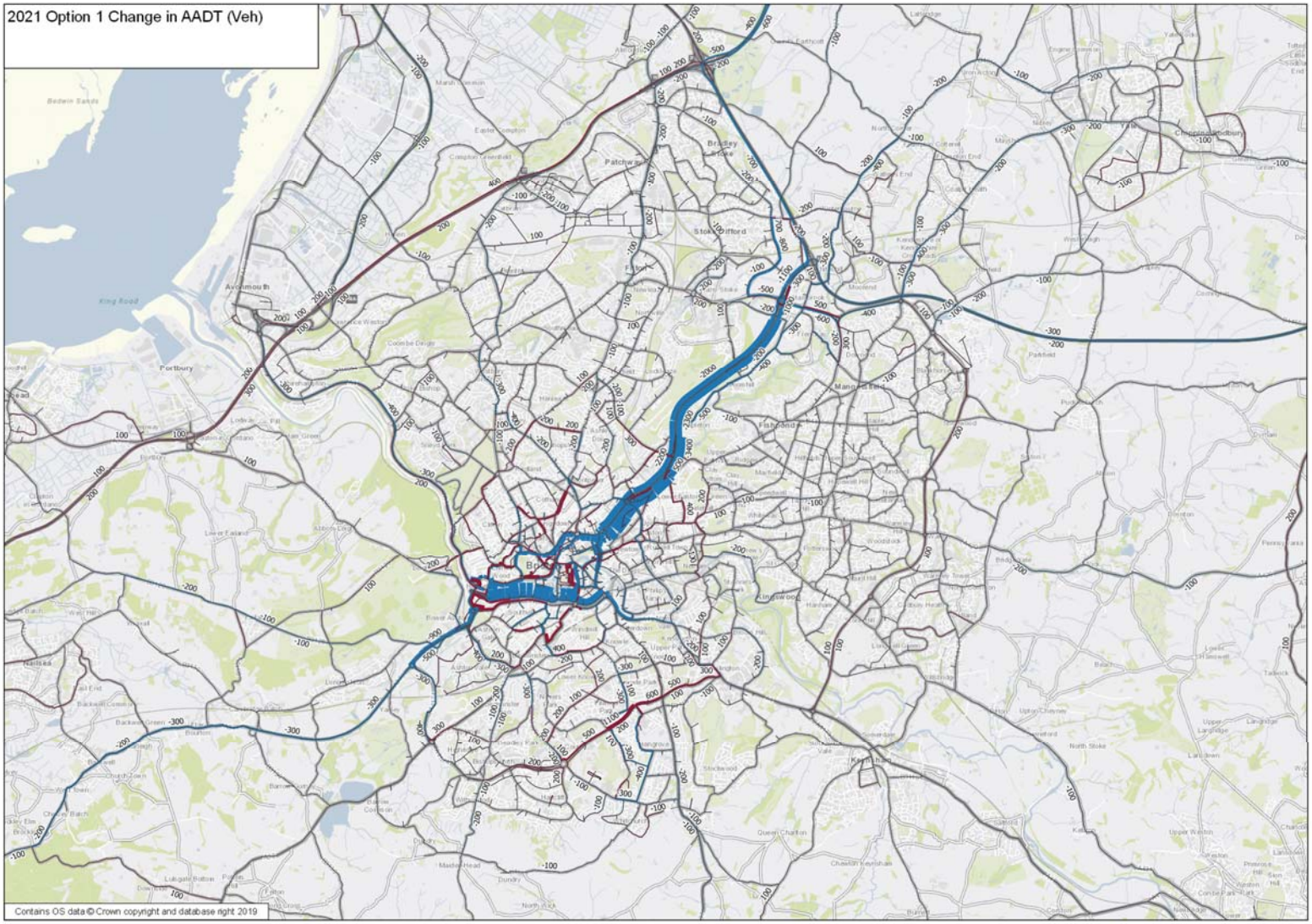
A.2 2021 Baseline: AADT – Greater Bristol Area



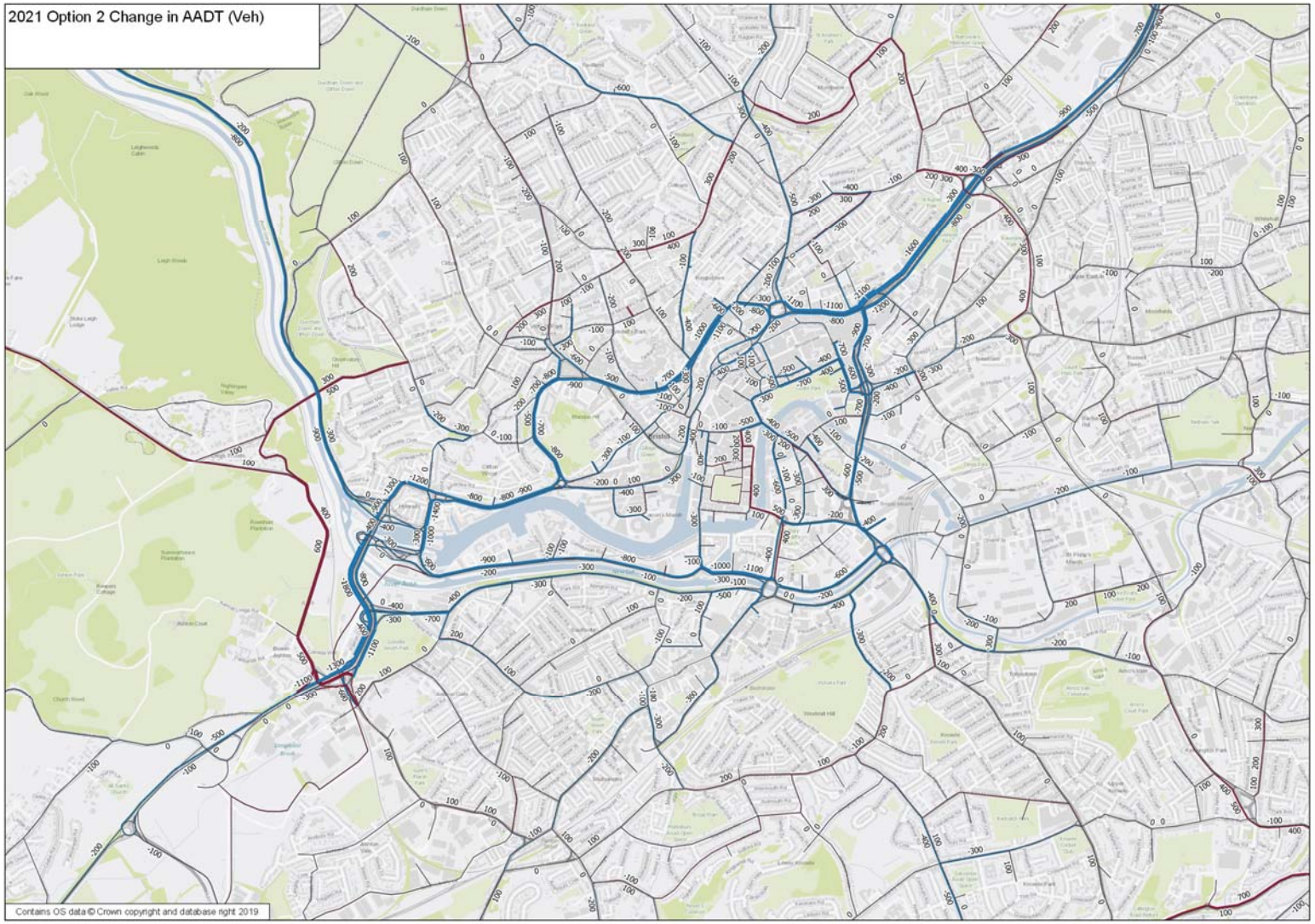
A.3 2021 Option 1 - Baseline: AADT – Central Bristol Area



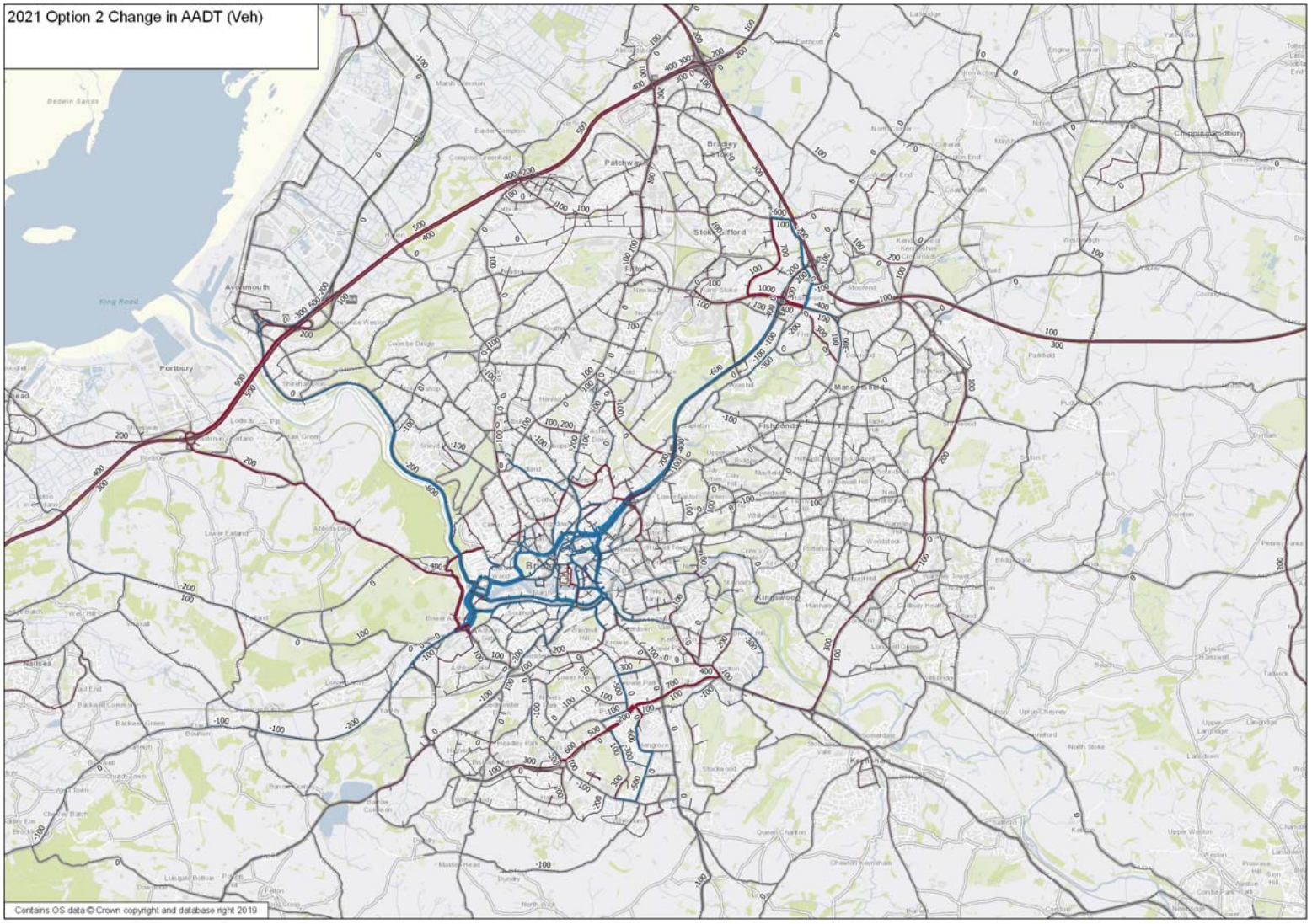
A.4 2021 Option 1 - Baseline: AADT – Greater Bristol Area



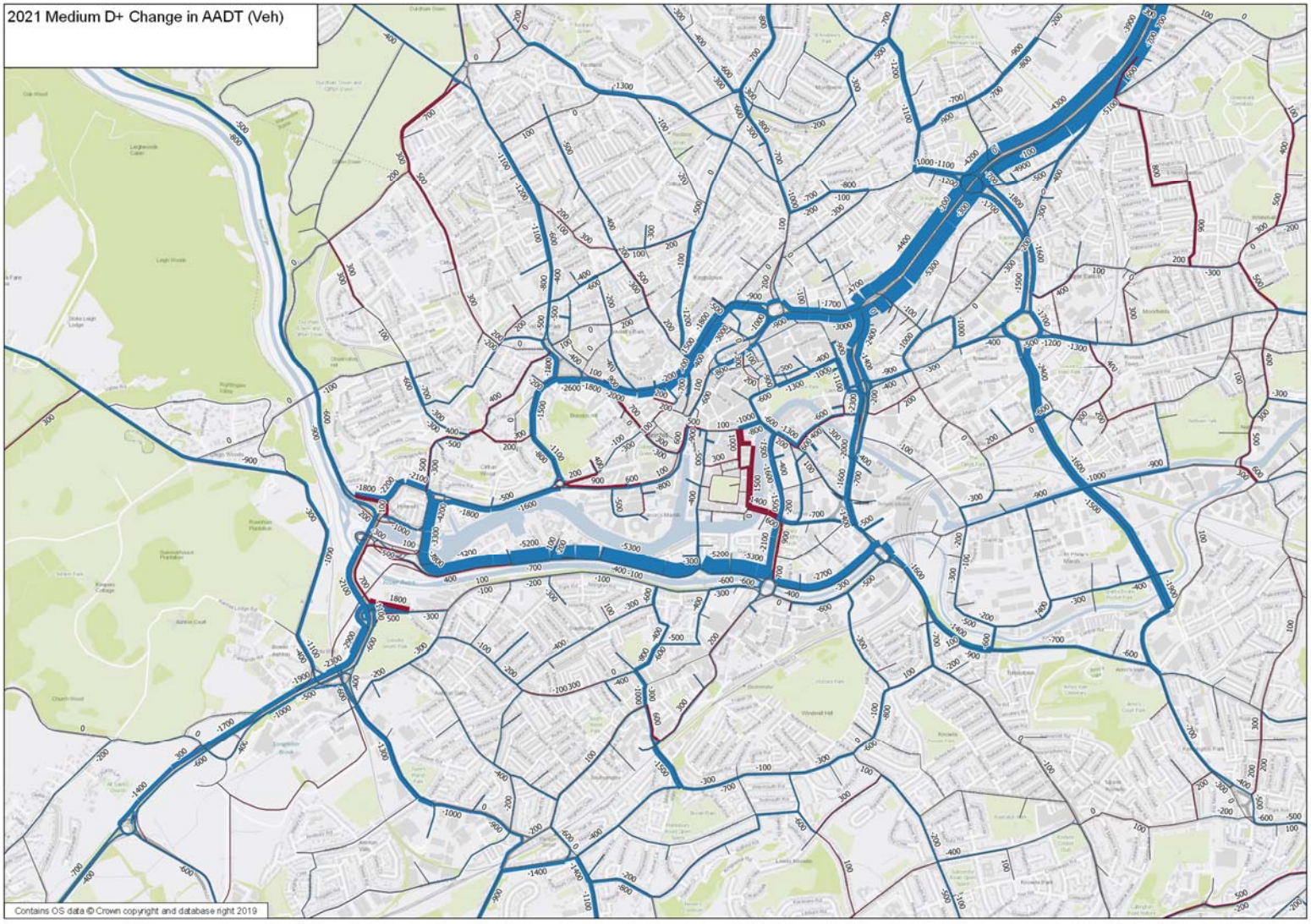
A.5 2021 Option 2 - Baseline: AADT – Central Bristol Area



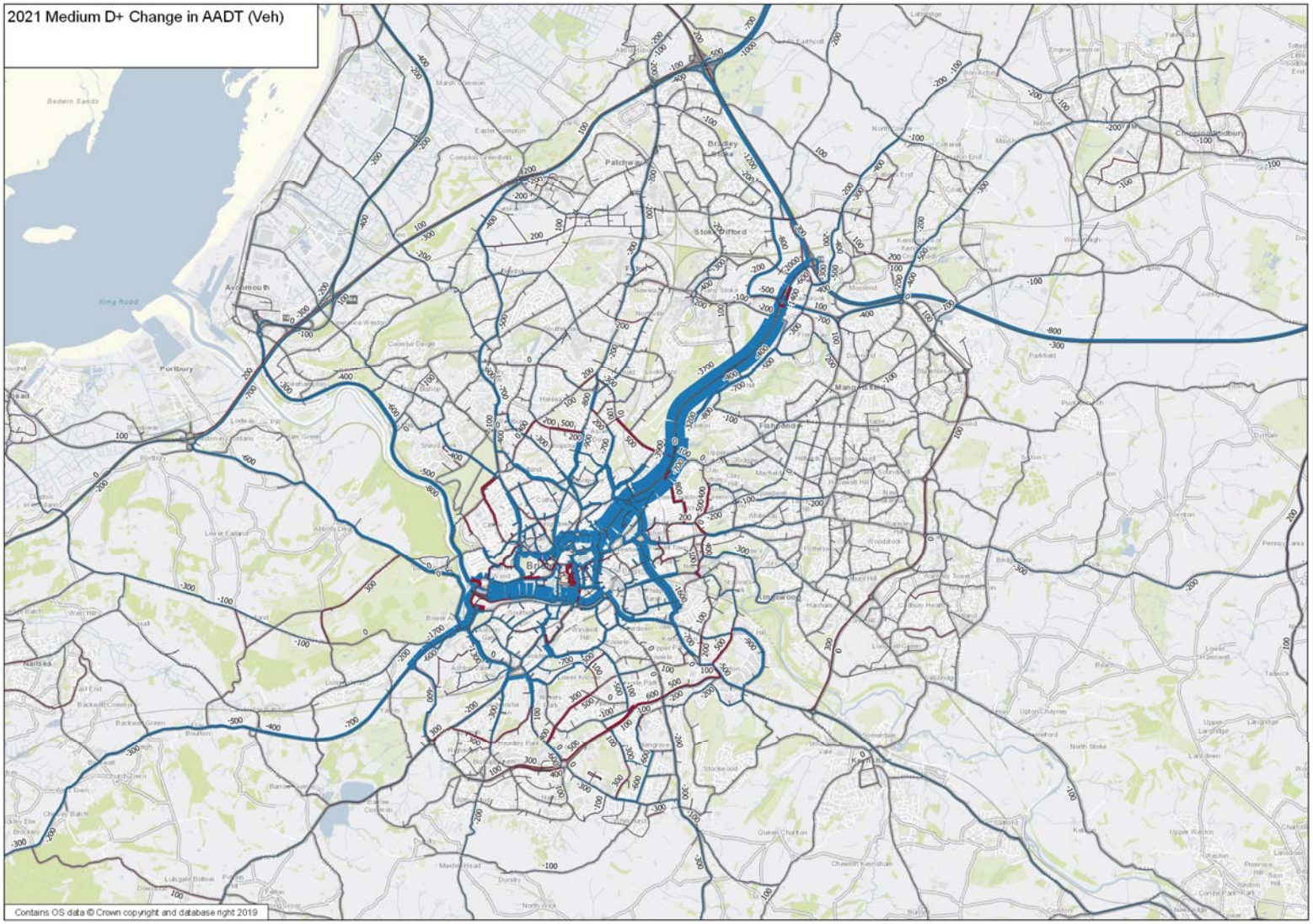
A.6 2021 Option 2 - Baseline: AADT – Greater Bristol Area



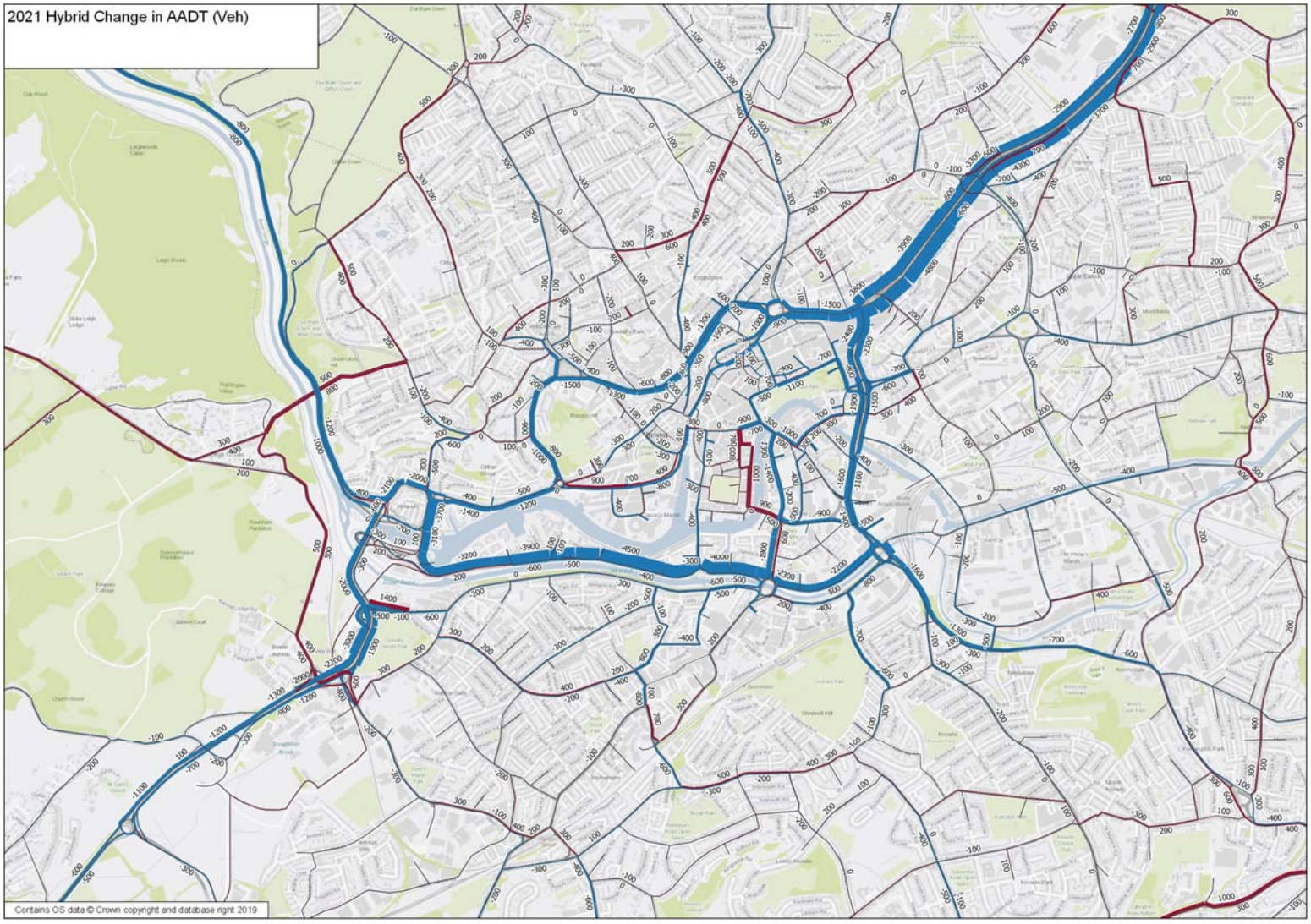
A.7 2021 Medium CAZ D + Option 1 - Baseline: AADT – Central Bristol Area



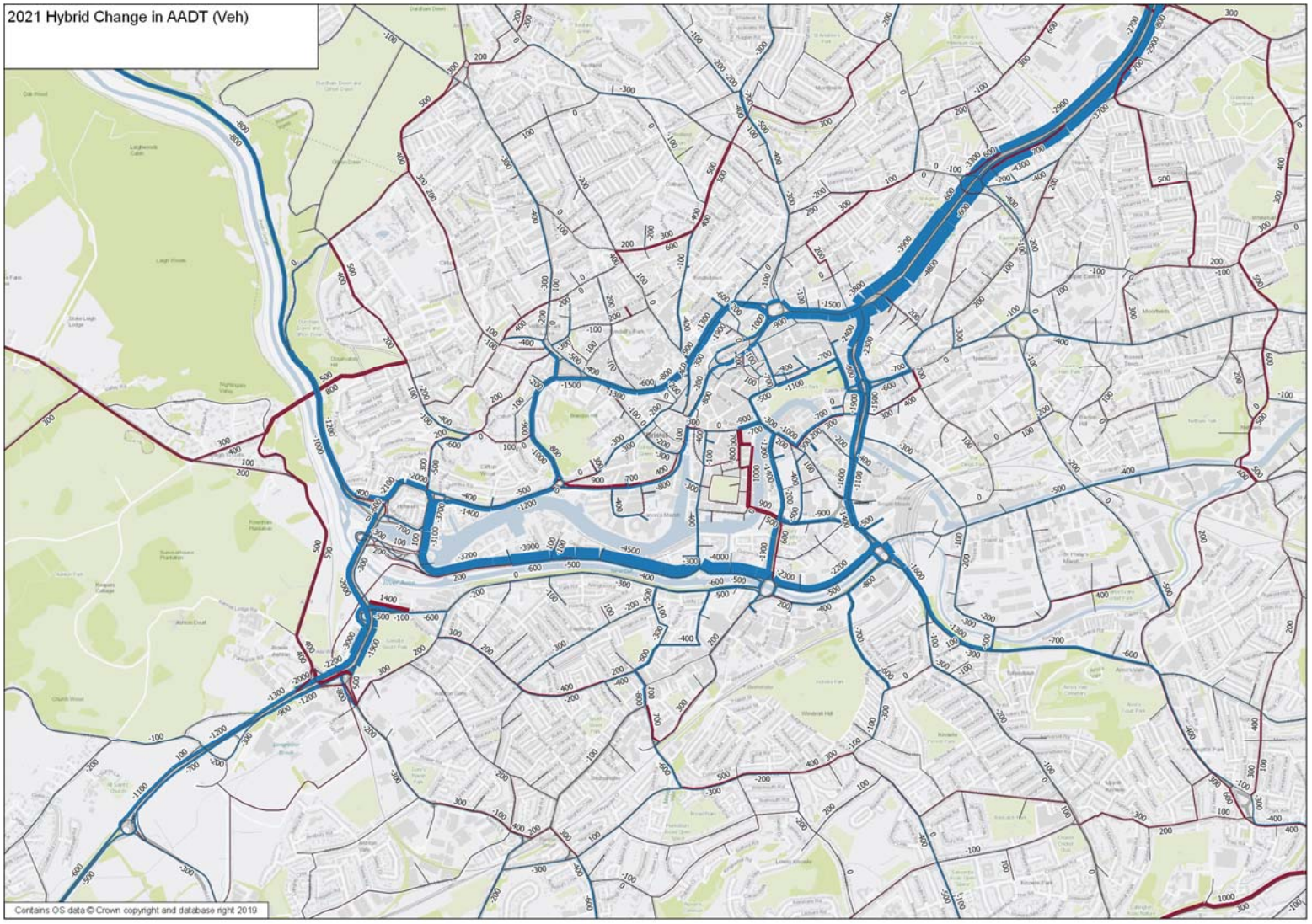
A.8 2021 Medium CAZ D + Option 1- Baseline: AADT – Greater Bristol Area



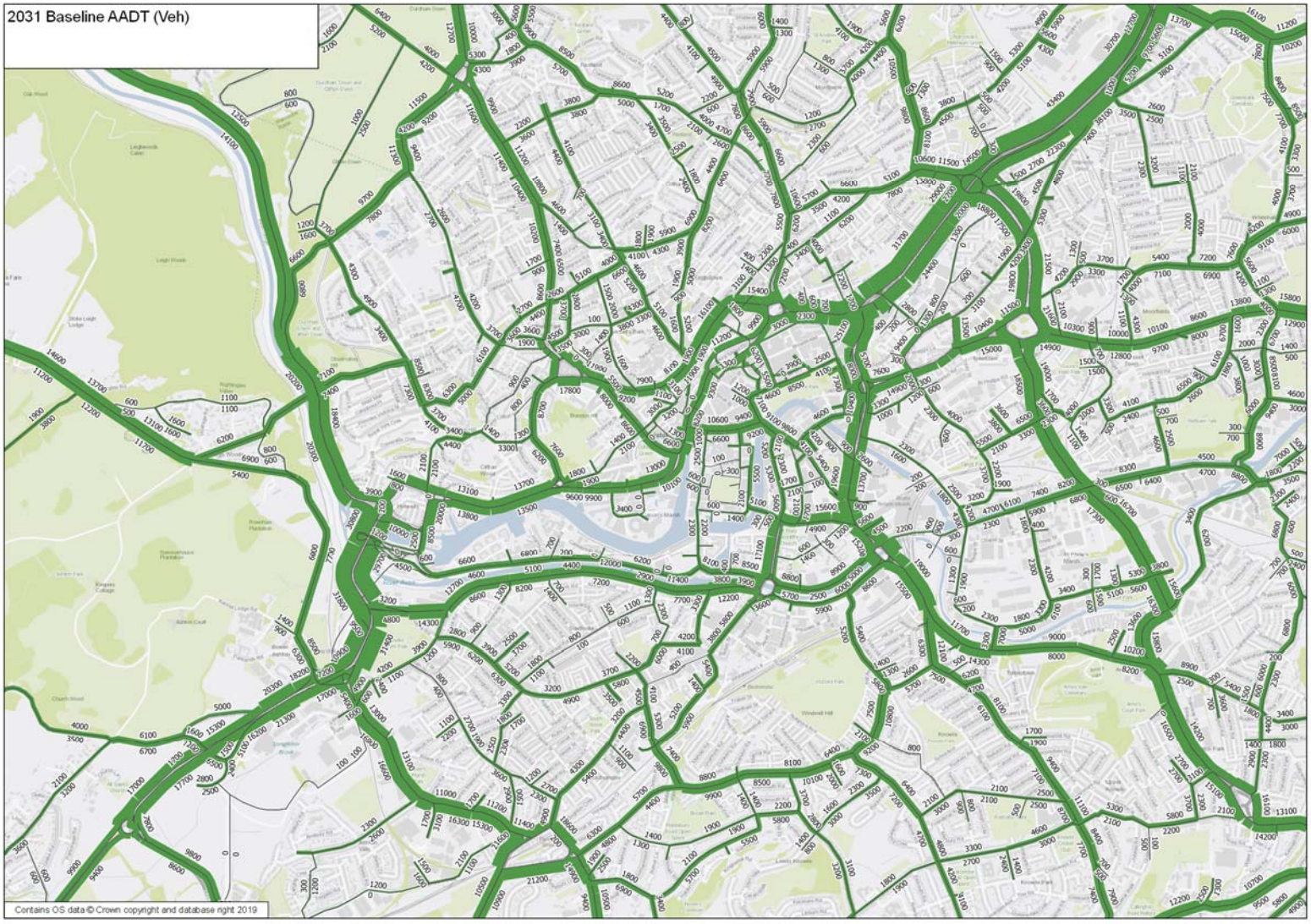
A.9 2021 Hybrid Option - Baseline: AADT – Central Bristol Area



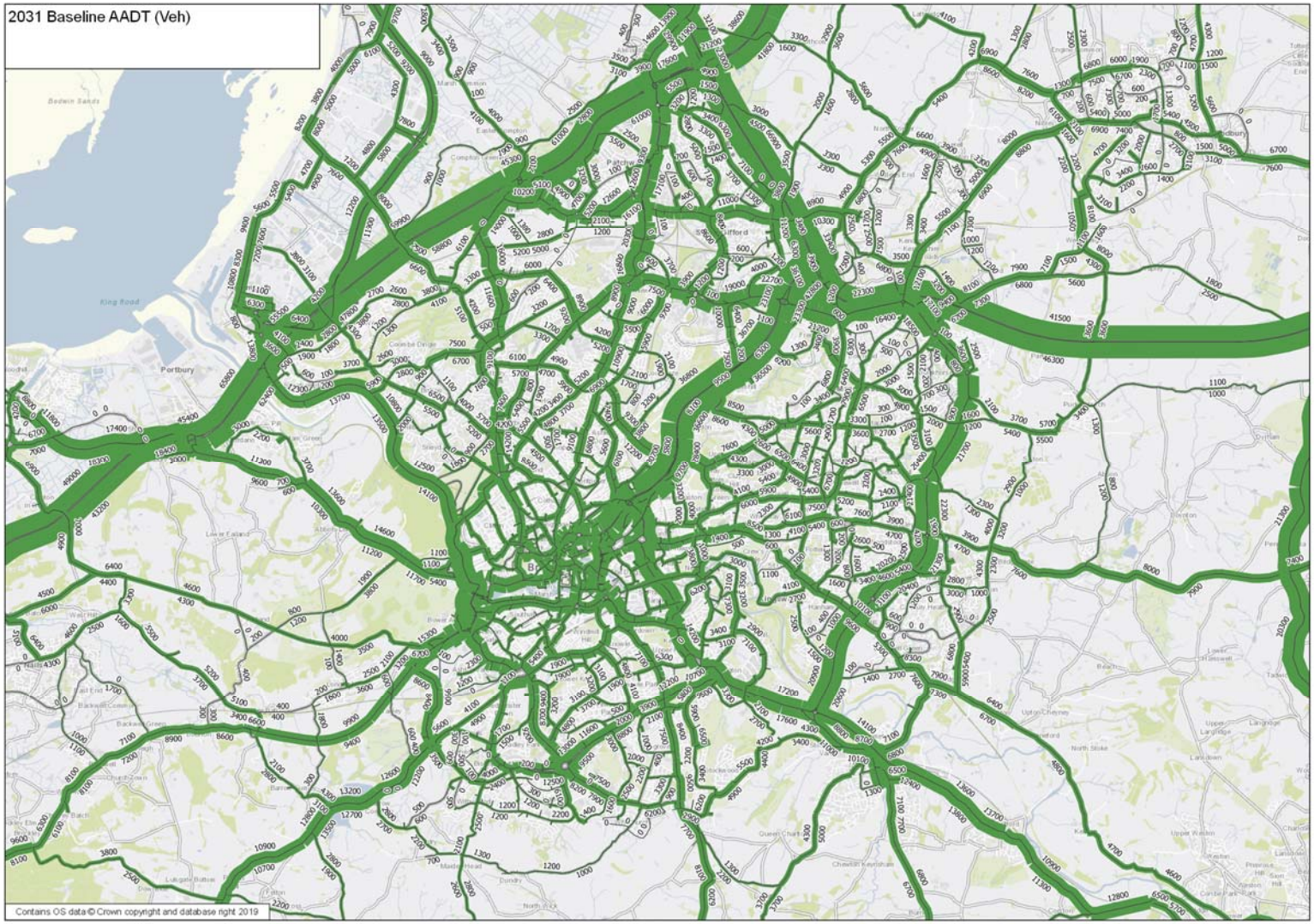
A.10 2021 Hybrid Option - Baseline: AADT – Greater Bristol Area



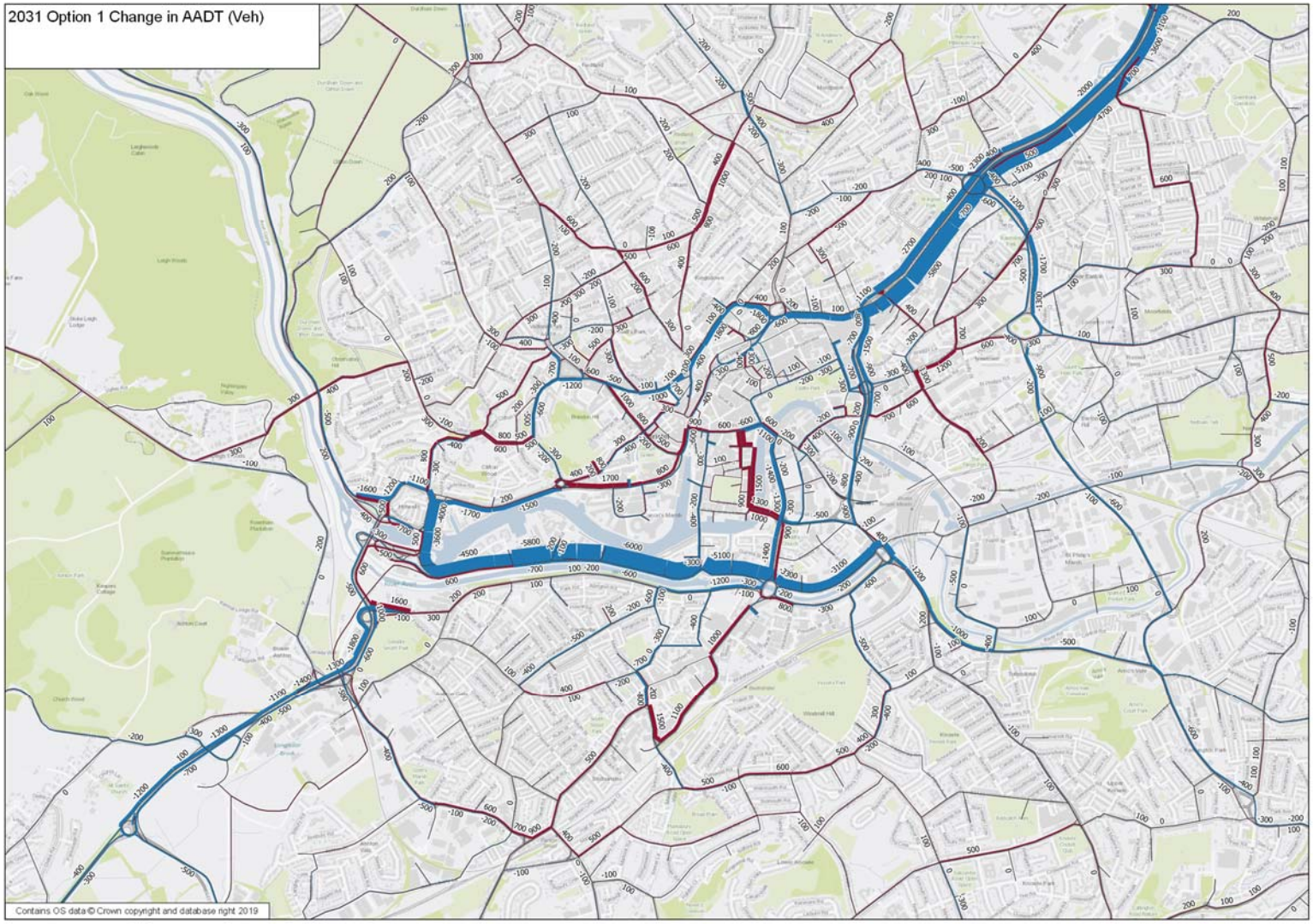
A.11 2031 Baseline: AADT – Central Bristol Area



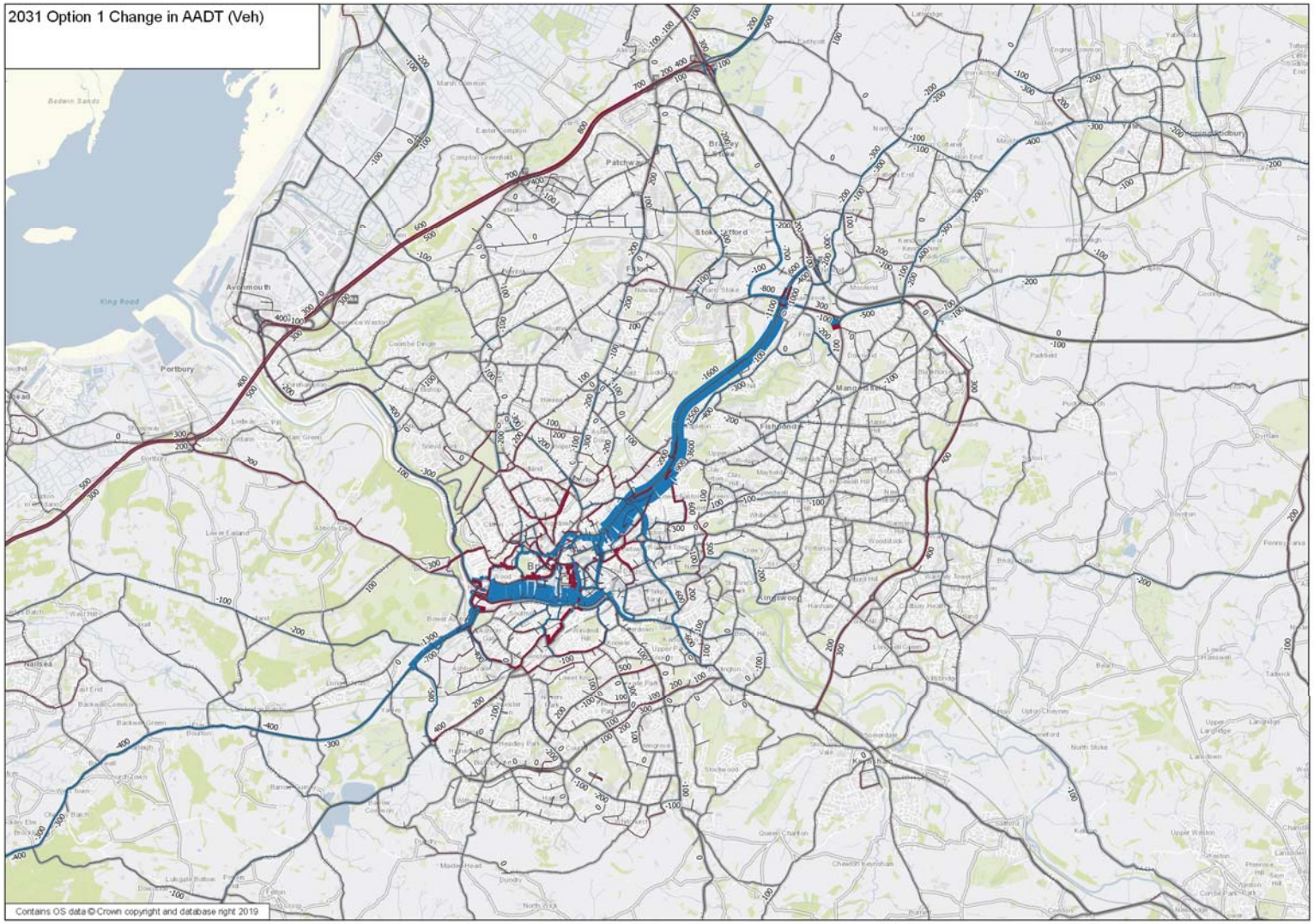
A.12 2031 Baseline: AADT – Greater Bristol Area



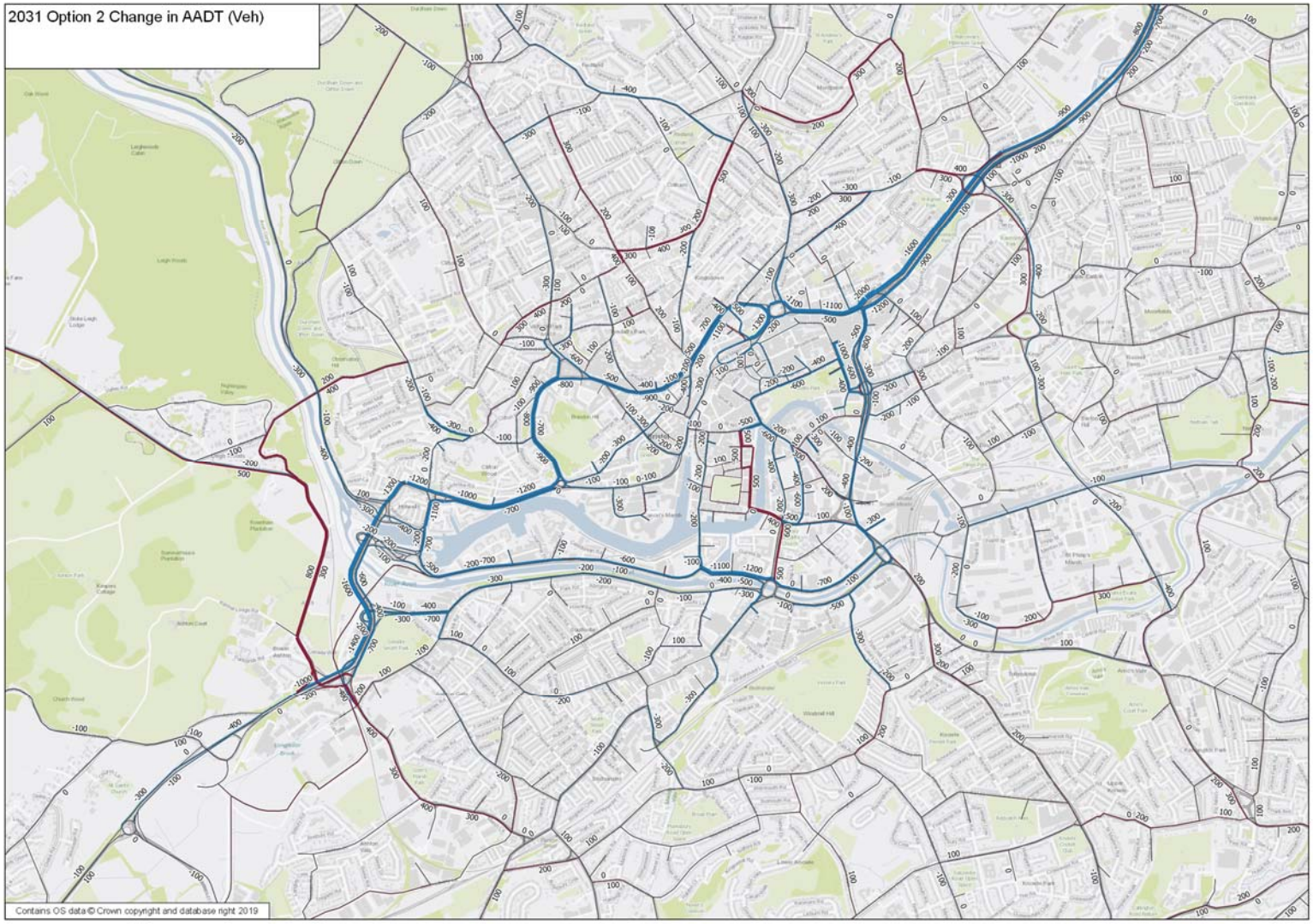
A.13 2031 Option 1 - Baseline: AADT – Central Bristol Area



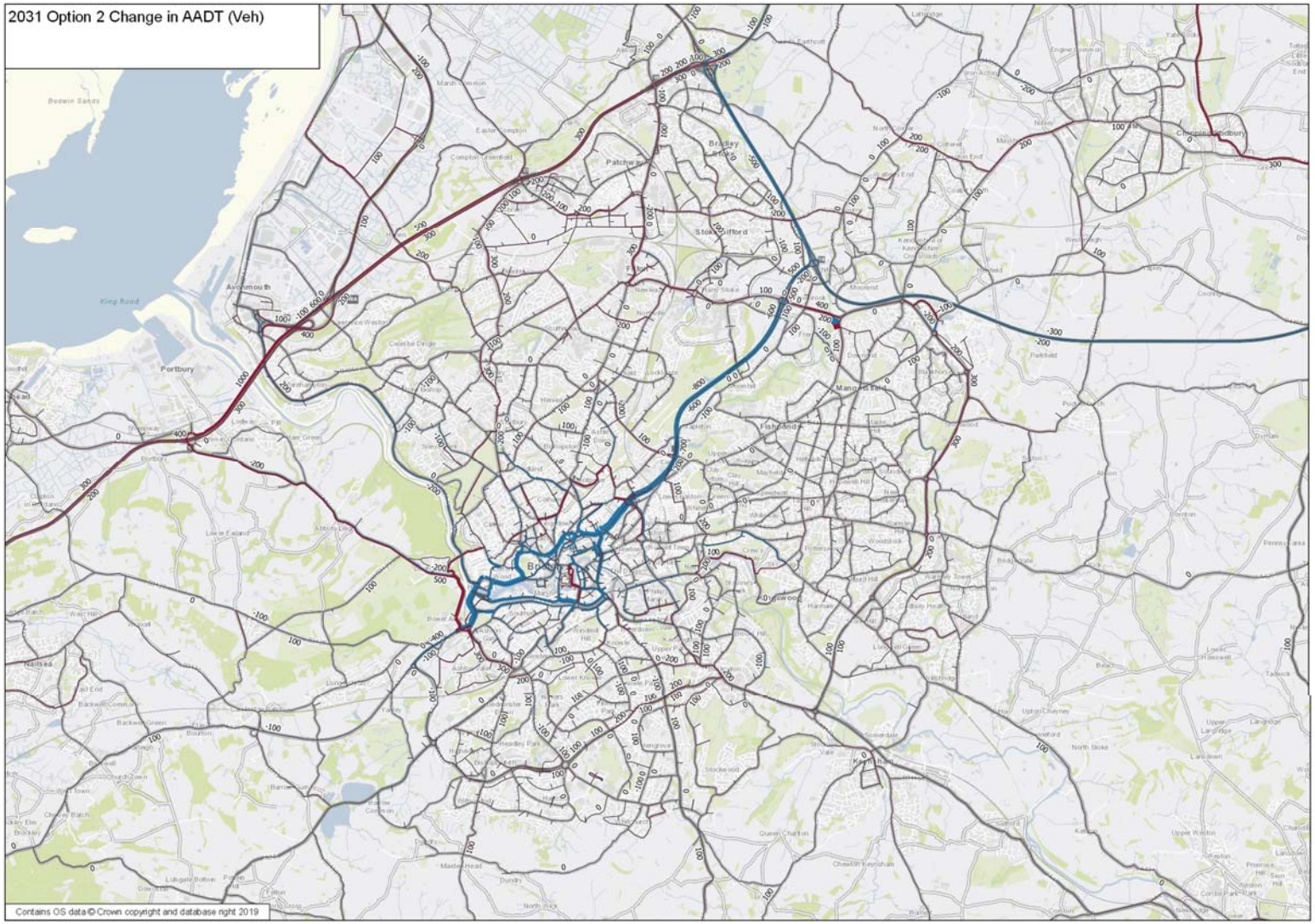
A.14 2031 Option 1 - Baseline: AADT – Greater Bristol Area



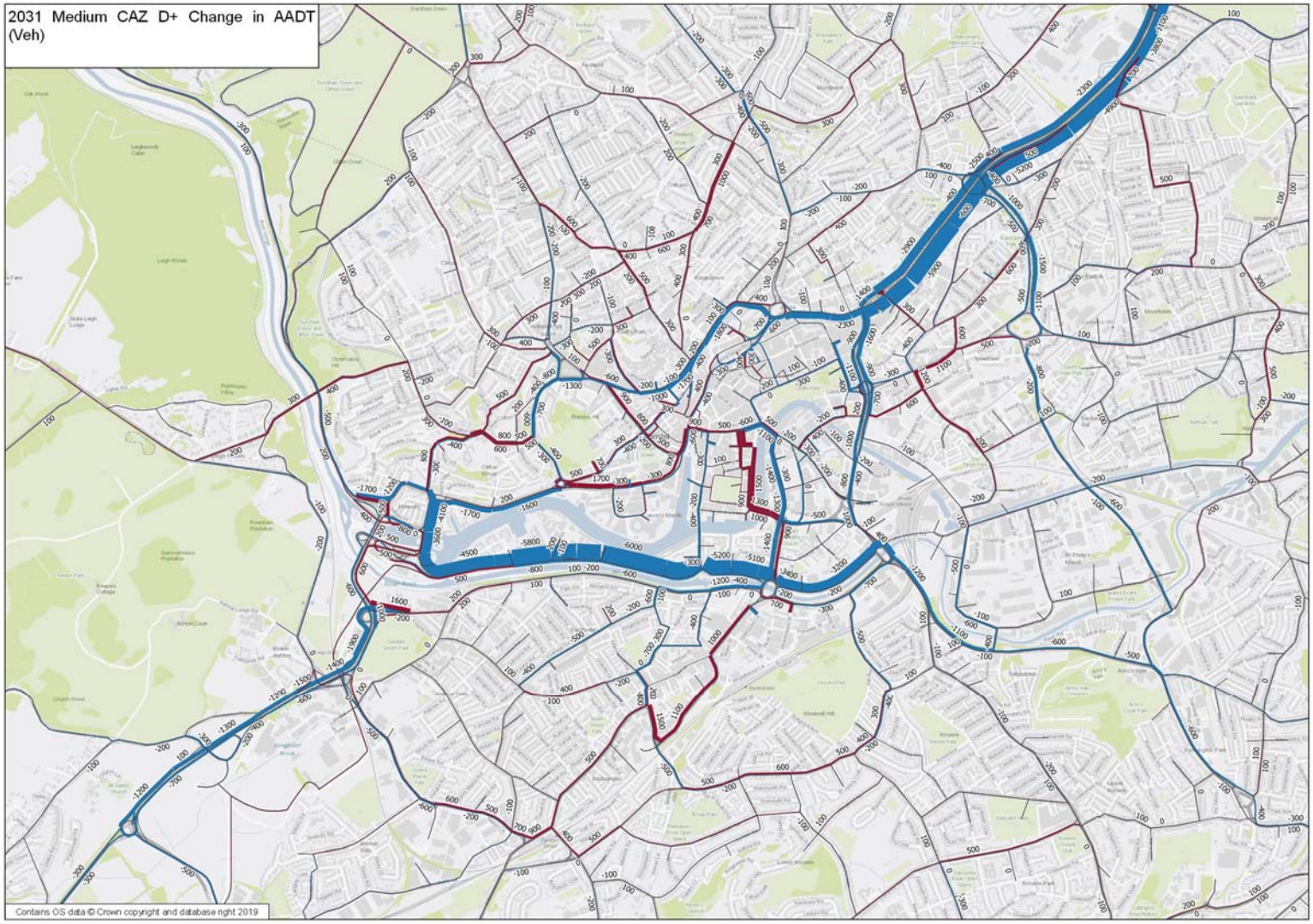
A.15 2031 Option 2 - Baseline: AADT – Central Bristol Area



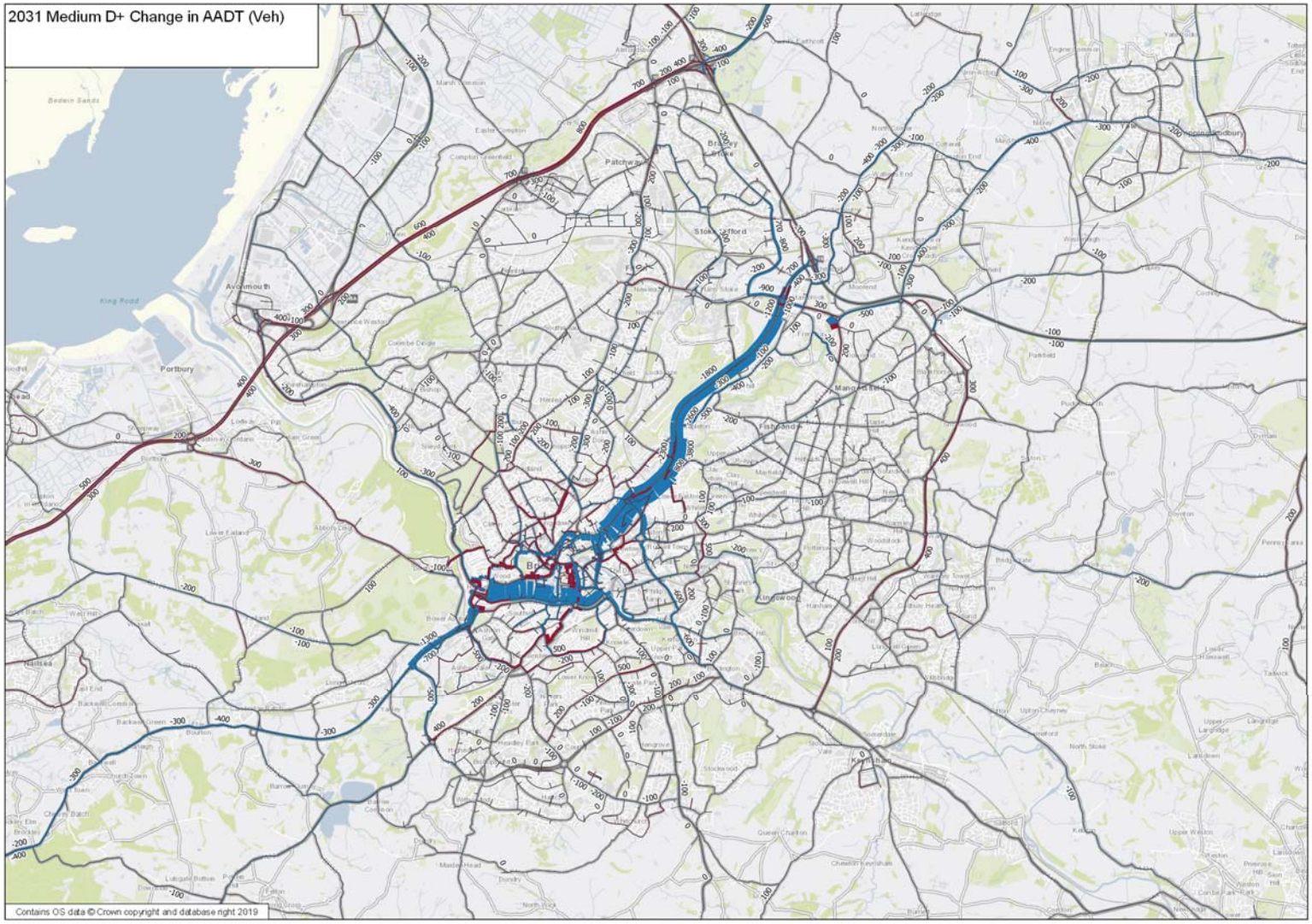
A.16 2031 Option 2 - Baseline: AADT – Greater Bristol Area



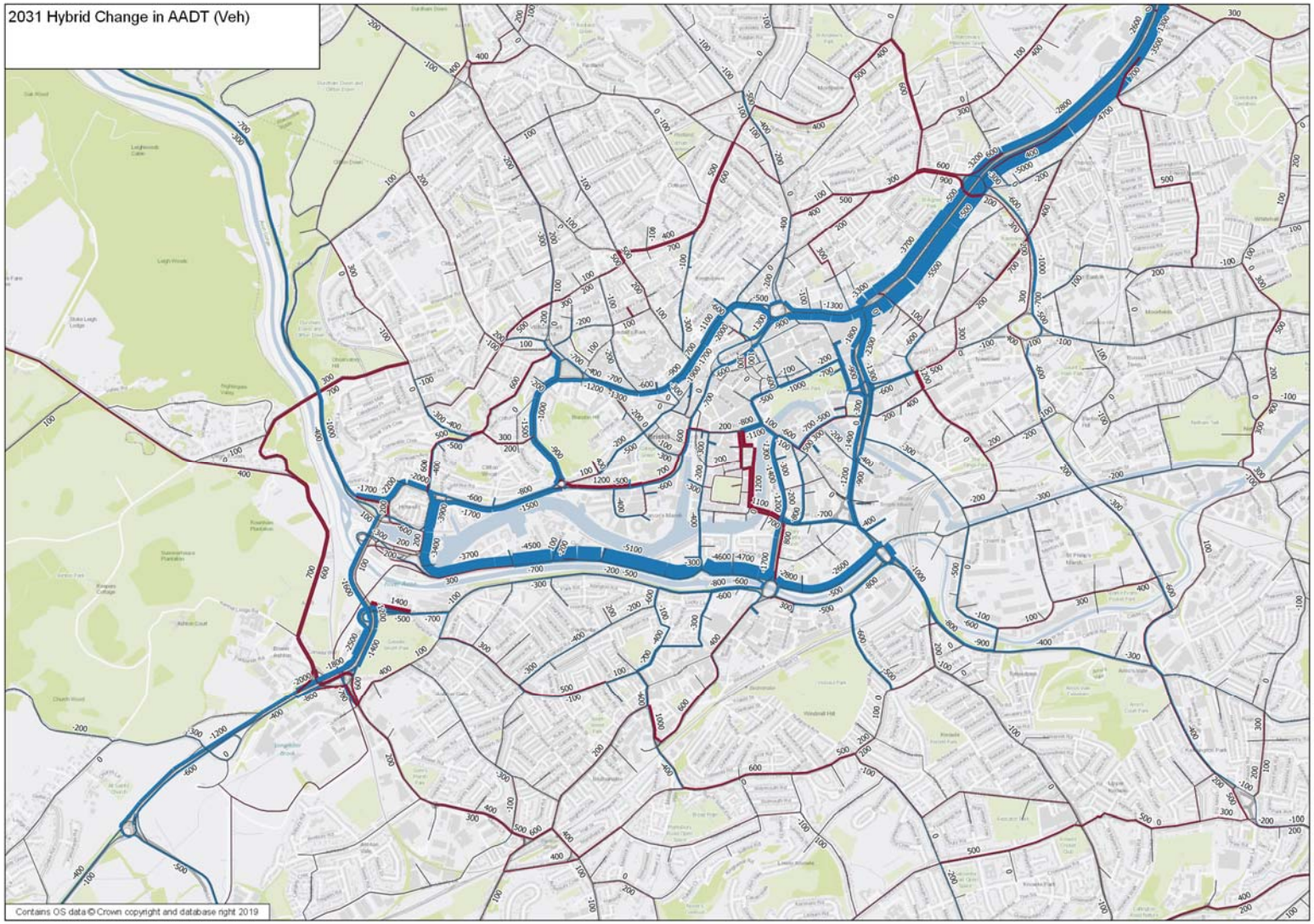
A.17 2031 Medium CAZ D + Option 1 - Baseline: AADT – Central Bristol Area



A.18 2031 Medium CAZ D + Option 1 - Baseline: AADT – Greater Bristol Area



A.19 2031 Hybrid Option - Baseline: AADT – Central Bristol Area



A.20 2031 Hybrid Option - Baseline: AADT – Greater Bristol Area