Dundee Low Emission Zone **19/05/2021**

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NATIONAL LOW EMISSION FRAMEWORK – INTERIM STAGE 2 ASSESSMENT

SYSTRA

DUNDEE LOW EMISSION ZONE

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1.1.1 In September 2017, the Scottish Government, in their Programme for Government, committed to the introduction of Low Emission Zones (LEZs) into Scotland's four biggest cities (Glasgow, Edinburgh, Aberdeen and Dundee) by 2020. Due to the impact of the COVID-19 pandemic in 2020 and 2021, plans to implement LEZs were temporarily paused with an indicative timeline for the introduction moved to between February 2022 and May 2022.

1.1.2 An LEZ is a scheme under which individuals will be prohibited from driving vehicles which fail to meet specified emissions standards within a designated geographical area in contravention of the terms of the scheme as proposed by a local authority.

1.1.3 Low Emission Zones are included in the Transport (Scotland) Act 2019 which received Royal Assent in November 2019. The Act provides the legislative framework for Scottish local authorities to design, establish and operate nationally consistent LEZs. It allows the Scottish Government to set consistent national standards for a number of key aspects including emissions, penalties, exemptions and parameters for grace periods. Local authorities now have the powers to create, enforce, operate or revoke a LEZ in their areas and to design the shape, size and vehicle scope of their low emission zone.

1.1.4 The accompanying LEZ Regulations were laid in Parliament in January 2021, thereby allowing Scottish Ministers to set nationally consistent standards (Regulations) on LEZ matters specified in the Act (e.g. emission standards, penalties and exemptions, statutory consultees). There are two sets of regulations for LEZs in Scotland. The Low Emission Zones (Emission Standards, Exemptions and Enforcement) (Scotland) Regulations 2021 cover the topics of emission standards, exemptions, penalty charge rates, and enforcement. The Low Emission Zones (Scotland) Regulations 2021 cover the topics of consultation, publication and representations, examinations, approved devices, accounts and amending or revoking LEZs.

1.1.5 An assessment and appraisal process to inform the size and scope of Dundee's LEZ follows the National Low Emission Framework (NLEF) guidance. The NLEF is "*an air quality-focused, evidence-based appraisal process developed to help local authorities consider transport related actions to improve local air quality, where transport is identified as the key contributor to air quality problems"* (NLEF, 2019).

1.1.6 NLEF is a two stage process consisting of the following elements:

- Stage 1 Screening
- Stage 2 Assessment

1.1.7 A NLEF Stage 1 Report (*Dundee Low Emission Zone, National Low Emission Framework Stage 1 Report, SYSTRA 2019*) detailed Dundee's Local Air Quality Management and built an evidence base to assist in the appraisal and implementation of Dundee's LEZ through the Stage 2 Assessment process.

1.1.8 An Interim NLEF Stage 2 Assessment Report (*Dundee Low Emission Zone, National Low Emission Framework Interim Stage 2 Report, SYSTRA 2019)* was published in September 2019. The report detailed the identification of the LEZ objectives and the LEZ options for stakeholder and public consultation and detailed testing through local traffic and air quality models.

1.1.9 This second Interim NLEF Stage 2 Assessment Report builds on the first interim report and incorporates findings from public and stakeholder engagement and detailed traffic modelling to identify a final LEZ option for Dundee.

1.1.10 The final Dundee LEZ option identified in this second Interim NLEF Stage 2 Report will then be subject to further stakeholder and public consultation, as set out in the LEZ Regulations. It will also be subject to detailed impact and environmental assessments (Strategic Environmental Assessment, Integrated Impact Assessment, Business and Regulatory Impact Assessment) and be assessed in the National Modelling Framework (NMF) Dundee City Air Quality Model before the NLEF process is finalised and a final NLEF Stage 2 Report is prepared. It is expected that these tasks will be complete by autumn 2021.

1.1.11 This Interim NLEF Stage 2 Assessment Report is structured as follows:

1. Introduction
2. Background of Dundee's LEZ
3. Air Quality in Dundee
4. Objectives of Dundee's LEZ
5. National Modelling Framework Scenario Modelling
6. LEZ Option generation
7. LEZ Option analysis and emerging options for consultation and detailed modelling
8. LEZ Public & Stakeholder Engagement
9. LEZ Traffic Modelling
10. Refinement of remaining LEZ Options
11. Final recommended LEZ Option for Dundee

2. DUNDEE LOW EMISSION ZONE

2.1 Background

2.1.1 The Environment Act 1995 requires all local authorities in the UK the statutory duty to undertake an air quality assessment within their area and determine whether they are likely to meet the air quality objectives for a number of pollutants. The process of review and assessment of air quality undertaken by local authorities is set out under the Local Air Quality Management (LAQM) regime.

2.1.2 Where the results of the review and assessment process highlight problems in meeting the objectives for air quality, the authority is required to declare an Air Quality Management Area (AQMA). Following the declaration of an AQMA, the local authority is then required to produce an Air Quality Action Plan (AQAP) which sets out measures that the local authority will implement to work towards to achieve air quality objectives.

2.1.3 In 2006 Dundee City Council (DCC) declared the whole of DCC local authority area as an AQMA for the NO_2 annual mean objective. In 2010, DCC amended the initial AQMA to include the annual mean objective for PM_{10}. Following the declaration of the AQMA, DCC published an Air Quality Action Plan (AQAP) in January 2011.

2.1.4 The AQAP provide the mechanism by which local authorities, in collaboration with national agencies and others, will state their intentions for working towards the air quality objectives using the powers they have available. DCC's AQAP includes a series of measures that they will introduce in pursuit of the Air Quality Standards (AQS). The principal aim of the AQAP is to minimise the effects of air pollution on human health within the local authority area using all reasonable measures, within reasonable time frames, and by working towards achieving the AQS.

2.1.5 Despite improvements in air quality since the introduction of the AQAP, there remain several locations in the AQMA where exceedances of emissions exist and where the AQS are not being met. The number of exceedances of the NO_2 annual mean objective has decreased from 16 in 2018 to 10 in 2019. The 2020 Air Quality Annual Progress Report (APR) for Dundee City Council, contains the latest (2019) information on air quality in Dundee and is summarised in Chapter 3.

2.1.6 A LEZ, and any associated measures are therefore being introduced in the city to accelerate Dundee's required compliance with the AQS.

2.2 Legislative Framework and operation of a LEZ

2.2.1 Low Emission Zones are included in the Transport (Scotland) Act 2019 which received Royal Assent in November 2019. The Act provides the legislative framework for Scottish local authorities to design, establish and operate nationally consistent LEZs. It allows the Scottish Government to set consistent national standards for a number of key aspects including emissions, penalties, exemptions and parameters for grace periods. Local authorities have the powers to create, enforce, operate or revoke a LEZ in their areas and to design the shape, size and vehicle scope of their low emission zone.

2.2.2 The accompanying LEZ Regulations were laid in Parliament in January 2021, thereby allowing Scottish Ministers to set nationally consistent standards (Regulations) on LEZ matters specified in the Act (e.g. emission standards, penalties and exemptions, statutory consultees). There are two sets of regulations for LEZs in Scotland. The Low Emission Zones (Emission Standards, Exemptions and Enforcement) (Scotland) Regulations 2021 cover the topics of emission standards, exemptions, penalty charge rates, and enforcement. The Low Emission Zones (Scotland) Regulations 2021 cover the topics of consultation, publication and representations, examinations, approved devices, accounts and amending or revoking LEZs.

2.2.3 The Transport (Scotland) Act 2019 section 6(4)(a) provides the powers to specify LEZ emission standards for vehicles in the Regulations and allows all Scottish LEZs operate to a consistent national level. A person may not drive a vehicle on a road within a LEZ unless that vehicle meets the specified emission standard. Vehicles that fail to comply with the LEZ emission standard will be subject to LEZ enforcement measures once any LEZ grace period has ended. The LEZ emission standards are:

- Euro VI emission standards for buses, coaches and heavy good vehicles with diesel engines, with retrofitted vehicles to this standard also being acceptable (Euro VI vehicle registrations from 2013)
- Minibuses, large vans, taxi's and cars are set at the Euro 6 for diesel and Euro 4 for petrol vehicles (Euro 6 diesel vehicle registrations in 2015, Euro 4 petrol vehicles in 2006).
- Euro 3 emission standards for motorcycles and mopeds

2.2.4 Section 6(4)(a) of the Transport (Scotland) Act 2019 enables exemptions to be set consistently across Scotland. DCC will have no ability to vary or choose from the national LEZ exemptions listed in Regulation 3 of the LEZ Regulations and outlined in Table 2.1. DCC are therefore required to operate their LEZ in compliance with the exemption list, so that there is national consistency in its application.

Table 2.1 : National LEZ Exemptions

Vehicle type of classification	Description
Emergency Vehicles	For or in connection with the exercise of any function of:
	the Scottish Ambulance Service,
	the Scottish Fire and Rescue Service,
	Her Majesty's Coastguard, and
	the National Crime Agency.
Military Vehicles	Vehicles belonging to any of Her Majesty's forces; or used for the purposes of any of those forces
Vehicles of Historic Interest	Vehicles which are 30 years old or older, are no longer in production and historically preserved or maintained
Vehicles for Disabled Persons	Vehicles registered with a 'disabled' or 'disabled passenger vehicles' tax class
	Vehicles being used for the purposes of the 'Blue Badge Scheme'.
Showman Vehicles	Highly specialised vehicles used for the purposes of travelling showmen, where the vehicle is used during the performance, used for the purpose of providing the performance or used for carrying performance equipment.

2.2.5 The Transport (Scotland) Act 2019 requires a LEZ to specify a grace period before penalty enforcement of the scheme. Section 15 details the scope and time-limits of the grace period. The grace period applicable to non-residents must expire:

- not less than 1 year after it (LEZ declaration) begins, and
- not more than 4 years after it begins.

2.2.6 The grace period applicable to residents (whose registered address is inside the zone) must expire not more than 2 years after the expiry of the grace period applicable to non-residents.

2.2.7 Section 6(4)(a) of the Transport (Scotland) Act 2019 enables penalty charges to be set, based on the vehicle class, and sets out the circumstances in which penalty charges can be subject to a discount or surcharges or to escalate the penalties over time. The LEZ Regulation 4 and Schedule 4 has set 'tiers' of penalties based on a pre-set number of Penalty Charge Notices (PCN's) being issued. The tier structure is outlined in Table 2.2

Table 2.2 : Proposed penalty charge structure for a non-compliant, non-exempt vehicles in a LEZ

Vehicle Category / Tier	Tier				
	1	2	3	4	5
Car, Taxi and Private Hire	£60	£120	£240	£480	£480
Minibus	£60	£120	£240	£480	£960
Light goods vehicles	£60	£120	£240	£480	£480
Bus or Coach	£60	£120	£240	£480	£960
Heavy goods vehicles	£60	£120	£240	£480	£960
Motorcycle or Mopeds	£60	£120	£240	£480	£480
Special purpose vehicles	£60	£120	£240	£480	£480

2.2.8 Section 8 of the Transport (Scotland) Act 2019 also enables the enforcement of LEZ schemes. The LEZ will be enforced through Automatic Number Plate Recognition (ANPR) cameras with the LEZ Regulations Schedule 6 detailing the approved devices.

2.3 Related Plans, Policy and Strategies

2.3.1 The NLEF Stage 1 Report (*Dundee Low Emission Zone, National Low Emission Framework Stage 1 Report, SYSTRA 2019*) includes a detailed review of the plans, policies and strategies (PPS) related to the introduction of a LEZ in Dundee.

2.3.2 The review found there are many related national, regional and local PPS that can influence and be influenced by, the delivery of Dundee's Low Emission Zone. Many of these PPS are focused on transportation issues, and may help contribute to overall improvements in air quality in the Dundee City AQMA. Similarly, it is crucial that local PPS are informed by the LEZ to ensure they continue to drive improvements in air quality. Consideration of local PPS is critical to the introduction of a LEZ in Dundee. A LEZ on its own may be limited in what it can achieve and other PPS, such as active travel and electric vehicles strategies, will have an important role in reducing traffic levels and emissions in the city.

2.3.3 The NLEF Stage 1 Report identified the following key PPS and summarises their influence on the development of a LEZ in Dundee:

- Air Quality
  - Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive (2008/50/EC) Clean Air Programme for Europe (COM(2013)918)
  - National Emissions Ceiling Directive (2016/2284/EU)
  - The Environment Act 1995: Part IV
  - The Air Quality Strategy for England, Scotland, Wales and Northern
  - Air Quality Standards (Scotland) Regulations 2010
  - Air Quality (Scotland) Regulations 2000
  - Air Quality (Scotland) Amendment Regulations 2002
  - Air Quality (Scotland) Amendment Regulations 2016
  - Cleaner Air for Scotland – The Road to a Healthier Future (CAFS)
  - National Low Emission Framework
  - National Modelling Framework
  - Transport (Scotland) Act 2019
- National Plans and Policies
  - National Planning Framework 3
  - National Transport Strategy
  - Strategic Transport Projects Review (STPR & STPR2)
- Regional Plans and Polices

- Strategic Development Plan for the City Region: The TAY Plan
- TACTRAN Regional Transport Strategy (2015-2036 Refresh)
- Tay Cities Regional Economic Strategy 2017 – 2037

- Local Plans and Policies and Projects

  - City Plan for Dundee 2017 – 2026
  - Dundee Local Development Plan
  - Dundee Cycle Strategy
  - Drive Dundee Electric (electric vehicle)
  - Dundee Core Paths Plan 2020
  - Tay Cities Regional Transport Model
  - Dundee City Microsimulation Model

2.4 National Low Emission Framework & National Modelling Framework

2.4.1 The National Low Emission Framework (NLEF) guidance, published in January 2019, states that NLEF *is an air quality-focused, evidence-based appraisal process developed to help local authorities consider transport related actions to improve local air quality, where transport is identified as the key contributor to air quality problems (*NLEF, 2019).

2.4.2 The guidance states that the aim of the NLEF is to improve local air quality in areas where Scottish Air Quality Objectives (AQOs) are exceeded, or likely to be exceeded, and transport is identified as the key contributor. Local authorities that have declared AQMAs should have regard to the NLEF when developing their air quality action plans and Low Emission Zones.

2.4.3 The NLEF appraisal process provides a consistent approach that can be applied across Scotland to inform decisions on transport-related actions to improve local air quality. It is designed to support local authorities in considering transport-related issues in the context of local air quality management and help develop evidence to support consideration of the introduction of an LEZ as an appropriate option to improve air quality.

2.4.4 It is intended to be a two stage process consisting of screening and assessment. The initial screening stage should be completed by local authorities that have identified air quality problems (where transport is the primary cause) and declared an AQMA.

2.4.5 As the Scottish Government is committed to delivering a LEZ in Scotland's four biggest cities (Glasgow, Edinburgh, Aberdeen and Dundee) through its Programme for Government, the NLEF Stage 1 screening was not utilised to determine if a LEZ is required in Dundee but used to review Dundee's Local Air Quality Management and build an evidence base to inform the appraisal and implementation of Dundee's LEZ through the Stage 2 Assessment process. The NLEF Stage 1 process is therefore be used as a tool to build a suitable evidence base to assess all potential LEZ options.

2.4.6 NLEF Guidance describes the following key steps that should be undertaken as part of the Stage 2 Assessment:

1. Define the objectives for the potential LEZ
2. Assess the impact of potential LEZ options with regard to air quality using the National Modelling Framework Dundee City Model
3. Identify the preferred option, including consideration of geographical extent and scope of vehicles to be included
4. Stakeholder input and consultation
5. Consider the wider impacts of the preferred option (e.g. traffic and air quality modelling, Strategic Environmental Assessment, Equality Impact Assessment

2.4.7 An Interim NLEF Stage 2 Assessment Report (*Dundee Low Emission Zone, National Low Emission Framework Interim Stage 2 Report, SYSTRA 2019)* was published in September

2019 and detailed the identification of the LEZ objectives and a set of LEZ options (steps 1-3) for stakeholder and public consultation, detailed testing through local traffic and air quality models and wider impact assessments of the preferred option (steps 4-6). The first Interim Stage 2 Report did not include results from the consultation period or the detailed testing.

2.4.8 At Stage 2, the National Modelling Framework (NMF) supports the identification of the scope and key contributors to air quality issues and provides the evidence to help assess potential benefits of transport-related actions to address those issues, with a focus on the introduction of an LEZ. The NMF Dundee City Air Quality Model has been utilised to provide high level impacts from the inclusion of particular vehicles types in a LEZ and to inform the appraisal process of the emerging LEZ options.

2.4.9 It should be noted that SEPA, who develop and run the National Modelling Framework (NMF) Dundee City Air Quality Model, were subject to a cyber-attack in late 2020 and detailed NMF analysis is delayed and cannot currently be utilised in the final LEZ option assessment at this stage. Any final LEZ option will however be assessed in the NMF prior to submission to Scottish Minsters, subject to the availability of the NMF Dundee City Model.

2.4.10 This second Interim NLEF Stage 2 Assessment Report builds on the first interim report and incorporates findings from public and stakeholder engagement and detailed traffic modelling to identify a final LEZ option for Dundee.

2.4.11 The final LEZ option identified in the second Interim NLEF Stage 2 Report will then be subject to further stakeholder and public consultation, as set out in the LEZ Regulations. It will also be subject to detailed impact and environmental assessments (SEA, IIA, BRIA) and be assessed in the NMF Dundee City Air Quality Model before the NLEF process is finalised and a final NLEF Stage 2 Report is prepared. It is expected that these tasks will be complete by autumn 2021.

2.5 Covid-19 pandemic

2.5.1 Due to the impact of the COVID-19 pandemic in 2020 and 2021, plans to implement LEZs were temporarily paused with an indicative timeline for the introduction moved to between February 2022 and May 2022. The LEZ Leadership Group, which includes Scottish Ministers and representatives from Glasgow City Council, The City of Edinburgh Council, Dundee City Council, Aberdeen City Council, Public Health Scotland and SEPA, agreed the indicative timeframe to introduce LEZs across Scotland's four largest cities.

2.5.2 It is recognised that the Covid-19 pandemic has had an unprecedented impact on society, including on the wider environment and the economy. Transport Scotland and DCC recognise that the Covid-19 pandemic may significantly influence future travel demand and in turn emissions attributed to road transport. Transport Scotland commissioned a study to consider the uncertainty over what travel will look like after the Covid-19 pandemic has ended. Outcomes from this study are summarised in Chapter 9 and used to inform the final LEZ Option.

2.5.3 In light of the difficulties faced by many throughout 2020 and 2021, particularly, in the context of a Dundee city centre LEZ, city businesses and bus operators, DCC were keen to understand the level of support for the introduction of a LEZ in the city post pandemic and gauge the impact the pandemic may have had on businesses and bus operators in preparing for its introduction. As a result, additional consultation on this issue was undertaken in March 2021, with the outcomes summarised in Chapter 8 and used to inform the final LEZ Option detail.

3. AIR QUALITY IN DUNDEE

3.1 Introduction

3.1.1 The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. As of 2016, a requirement of LAQM process is the delivery of Annual Progress Reports (APR) to summarise the work being undertaken by the local authority to improve air quality and report any progress that has been made.

3.1.2 The APRs provide extensive detail on existing air quality issues in Dundee City, the level of success from the LAQM measures and provide a key source of information for the NLEF process. DCC have produced APRs for 2016 to 2020. The results and findings of the 2018 APR (note, the 2018 APR reports on the 2017 air quality monitoring dataset) were summarised in the NLEF Stage 1 Report and subsequent LEZ option development and analysis was undertaken utilising the 2017 air quality dataset. The 2019 APR was published in June 2019, after the NLEF Stage 1 Screening had started. The 2018 air quality monitoring dataset was shown to be comparable to 2017 data and the NLEF Stage 1 Screening assessment was not required to be updated.

3.1.3 The 2020 APR was published in June 2020 and contains the 2019 air quality dataset (the most recent fully ratified air quality monitoring data). Given the two year gap between the 2017 dataset used in the NLEF Stage 1 Report and the current 2019 dataset, a full review is undertaken here to ensure the LEZ option appraisal process (NLEF Stage 2) is targeting the correct locations of air quality exceedances.

3.1.4 At the time of writing (April 2021), the 2020 air quality dataset is not available. However, due to the impact of the Covid-19 pandemic on traffic levels, the 2020 dataset is not likely to be representative of ongoing and future air quality exceedance locations. Transport Scotland have recognised that the Covid-19 pandemic may significantly influence future travel demand and in turn emissions attributed to road transport and commissioned a study to consider the uncertainty over what travel will look like after the Covid-19 pandemic has ended, and this is summarised in Chapter 9.

3.1.5 The summary provided in Section 3.2 below shows the area of focus for the LEZ in Dundee remains the same, when assessed using either 2017 or 2019 datasets. Detailed analysis of air quality in Dundee (in 2017) is reported in the NLEF Stage 1 Report (*Dundee Low Emission Zone, National Low Emission Framework Stage 1 Report, SYSTRA 2019*) and as this is shown to be comparable to 2019, this detailed analysis is utilised in the ongoing development and appraisal of Dundee's LEZ.

3.2 2019 Air Quality Monitoring Data

Nitrogen Dioxide (NO_2)

3.2.1 The 2020 APR provided the full ratified and adjusted 2019 dataset for monthly means for automatic monitoring sites and diffusion tubes. The locations where annual mean concentrations of NO_2 (biased adjusted) are recorded as greater than 36 µg/m^3 is detailed in Table 3.1 alongside the annual mean concentrations recorded from 2015 to 2018. Note concentrations greater than 36 µg/m^3 are presented as locations that may be at risk of future exceedance, in line with the 2020 APR. The cells highlighted in grey are the locations where the annual mean Air Quality Objective (AQO) of 40 µg/m^3 was exceeded.

Table 3.1 : Annual Mean Concentrations of NO_2 greater than 36 µg/m³

Site ID	Site Name/Location	Annual mean NO2 concentration (µg/m3)				
		2015	2016	2017	2018	2019
DT70	Victoria Rd/Hilltown	54.1	50.8	51.5	49.2	48.3
DT37	Logie St (114)	51.0	53.8	47.9	48.2	47.1
DT205	West Marketgait/Old Mill (23)	54.0	51.6	45.1	47.0	47.1
DT31	Lochee Rd (140) Traffic Lts	50.3	53.0	48.1	48.8	46.2
DT30	Lochee Rd (138)	49.6	48.9	47.3	48.4	45.8
CM5	Seagate	49.9	47.0	44.3	45.9	44.5
DT156	Dock St (57)	51.4	49.3	49.4	46.4	44.2
CM4	Lochee Road	47.8	44.6	43.6	43.4	43.0
DT158	Lochee Rd (Romon) Average	44.8	43.8	42.6	43.1	41.5
DT190	Seagate (97)	44.6	41.8	38.7	41.7	41.0
DT76	Whitehall St (1)	44.1	43.0	40.9	42.5	40.3
DT159	Seagate(Romon) Average	42.3	41.3	38.4	40.0	39.1
DT44	Nethergate (88)	42.7	41.9	39.1	41.3	39.0
DT227	Dudhope Crescent Road (40)	0.0	0.0	0.0	39.3	38.8
DT183	West Marketgait / Guthrie St	46.8	46.1	44.1	41.4	38.3
DT83	Forfar Rd (104)	45.1	46.3	40.6	41.0	38.1
DT217	Seagate (99)	0.0	0.0	42.5	41.3	37.9
DT149	Meadowside (Romon) Average	41.2	41.0	39.3	40.4	37.7
DT224	Seagate (112)	0.0	0.0	34.1	37.6	37.1
DT204	Broughty Ferry Rd (129)	38.3	36.0	38.2	40.1	37.0
DT49	Rankine St (2)	40.2	36.5	39.3	38.5	36.7
DT92	Abertay 2	36.3	38.5	35.9	37.9	36.5
DT11	Broughty Ferry Rd (141)	35.4	40.4	40.0	36.4	36.3
Total No. Sites > 40 µg/m3		**17**	**17**	**14**	**17**	**11**

source: 2020 Air Quality Annual Progress Report (APR) for Dundee City Council

3.2.2 In total, there are 11 locations where annual mean concentrations of NO_2 exceed the AQO of 40 µg/m³ and a further 12 sites where annual mean concentrations of NO_2 exceed 36 µg/m³. The primary exceedance locations of NO_2 are shown to be on or inside the inner ring road area of the city centre and on the Lochee Road corridor and these are shown in detail in Figure 11.1

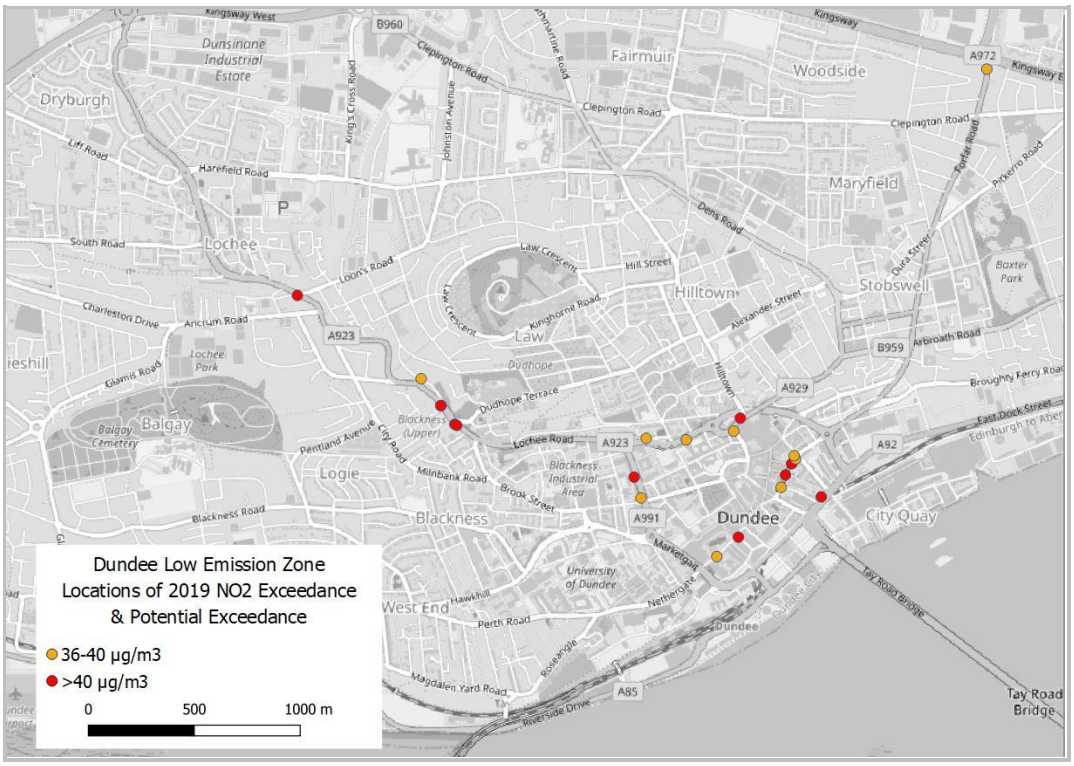


Figure 3.1 : 2019 Annual Mean Concentrations of NO_2 greater than 36 µg/m3 (City Centre & Lochee Rd)

3.2.3 At the 2019 monitoring locations listed in Table 3.1, there is a recorded reduction in annual mean concentrations of NO_2 at all sites with the exception of those on Seagate and West Marketgait, compared to 2017 the dataset used in the NLEF Stage 1 analysis. There are three additional sites listed in 2019 at Dudhope Crescent Road (new monitoring location in 2018), Seagate (112) and Abertay (2). All locations are within the area of focus for the LEZ option development and together with the overall reduction in annual mean concentrations of NO_2 it is considered that the current air quality dataset confirms the previous NLEF appraisal and analysis still holds true.

Particulate Matter (PM_{10} and $PM_{2.5}$)

3.2.4 The 2020 APR reports that no exceedances of the PM_{10} annual mean objective (18 µg/m^3) were predicted at any of the monitoring locations within the AQMA during 2019. This is comparable to 2017 where there were also no recorded exceedances.

3.2.5 The PM_{10} daily mean objective (*50µg/m^3, not to be exceeded more than 7 times per year*) was met at all monitoring locations in 2019, in line with 2017.

3.2.6 The 2020 APR reports that, using the methodology described in LAQM.TG (16) all estimated concentrations of $PM_{2.5}$ would be below the annual mean objective 10µg/m^3.

3.2.7 With no exceedances of the PM_{10}, $PM_{2.5}$ AQOs in both 2017 and 2019, NO_2 remains the key pollutant of interest for Dundee. However, although there are no recorded monitored exceedances of PM_{10} or $PM_{2.5}$ in the 2019 air quality data for Dundee, any reduction in NO_2 as a result of the LEZ will also result in a reduction in PM_{10} or $PM_{2.5}$ and continued compliance with the AQOs.

3.3 LEZ Vehicle Compliance in Dundee

3.3.1 Transport Scotland commissioned Automatic Number Plate Recognition (ANPR) surveys in 2017 to inform the characteristics of the vehicle fleet in Dundee for the development of the NMF. Each surveyed vehicle type was identified in the DVLA database to classify the following characteristics:

- Vehicle make and model
- Fuel type
- Euro class
- CO2 Band
- Actual CO2 emission value

3.3.2 This information allowed detailed modelling of the vehicle fleet in the Dundee NMF air quality model. The data also identifies the proportion of vehicles considered compliant or non-compliant with the LEZ regulations. This information is crucial in developing and appraising options for a LEZ as it informs the total number of vehicles required to find alternative routes to avoid the LEZ penalty and can help identify whether a particular option is feasible or not.

3.3.3 In line with the Transport (Scotland) Act 2019, the vehicle compliance for LEZ is:

- Euro 6 for diesel vehicles
- Euro 4/IV for petrol vehicles
- Euro VI for heavy-duty diesel engine vehicles including older retrofitter vehicles improved to Euro 6/VI standard
- Euro 3 for motorcycles and mopeds

3.3.4 The proportion of non-compliant vehicles in Dundee, based on 2019 survey data is shown in Table 3.2.

Table 3.2 : LEZ non-compliant vehicle proportions

Fuel Type	Car	LGV	HGV
Non-compliant diesel	31.9%	79.5%	73.0%
Non-compliant petrol	3.9%	0.2%	0.0%
Total non-complaint	35.8%	79.7%	73.0%

3.3.5 It should be noted that if and when a LEZ is enforced in Dundee, the total proportion of non-compliant vehicles is likely to have reduced, primarily due to normal fleet improvements as drivers replace their vehicles but also from potential behaviour changes such as a switch to more sustainable modes of transport and possibly increased working from home practices as a result if the Covid-19 pandemic.

4. OBJECTIVES OF DUNDEE LOW EMISSION ZONE

4.1 Introduction

4.1.1 NLEF Guidance states that "*the starting point for the stage two assessment process will be to define the objectives for the potential LEZ, taking account of the pollutant(s) of concern and with regard to any available information on source apportionment that identifies particular vehicle types that are a significant contributor to any air quality exceedances"* (NLEF, 2019).

4.1.2 The Dundee Low Emission Zone Delivery Group (DLEZDG) meeting on 12th March 2019 agreed the following principles to help devise the objectives of Dundee's Low Emission Zone:

- The principal aim of the LEZ is to improve air quality in Dundee and achieve air quality standards (as specified in the draft Transport (Scotland) Act 2019)
- An individual health objective should not be set, given the difficulty in obtaining baseline health information of the population and measuring any resultant health benefits directly as a result of the LEZ
- Protection of and improvements to health will be an outcome of improvements to air quality
- The introduction of a LEZ should not be to the detriment of the city's economic or social inclusion objectives
- The LEZ should aim to positively impact on the city economy, access to active travel options and changes in mode-share, city placemaking, social equality, tourism, and sustainable development, and the LEZ objectives should reflect this.

4.1.3 The themes agreed at the DLEZDG meeting closely mirrored the vision of the *City Plan for Dundee 2017–2026*. The City Plan is a Local Outcome Improvement Plan and replaces the Single Outcome Agreement for Dundee. The plan builds on a series of Dundee Outcomes which reflect and contribute to the national ambitions for Scotland including the Scottish Government's national priorities of creating inclusive growth and reducing inequalities.

4.1.4 The vision in The City Plan is for Dundee to:

- "*have a strong and sustainable city economy that will provide jobs for the people of Dundee, retain more graduates and make the city a magnet for new talent;*
- *offer real choice and opportunity in a city that has tackled the root causes of social and economic exclusion, creating a community which is healthy, safe, confident, educated and empowered;*
- *be a vibrant and attractive city with an excellent quality of life where people choose to live, learn, work and visit*".

4.1.5 The City Plan is the overarching policy document for Dundee City Council and it is therefore crucially important that cognisance is taken of its aims and objectives when developing the LEZ for Dundee.

4.1.6 Whilst Dundee City Council have set objectives for the LEZ in 2019, air quality issues will likely change in the coming years with the LEZ expected to impact positively on air quality in Dundee. It should be noted that while the objectives for the LEZ can be adjusted over time to better target emerging issues and policies it is important that the initial LEZ objectives have longevity and be futureproofed to any changes in the LEZ size, scope or location.

4.1.7 Dundee's LEZ will contribute to broader city objectives and the vision of The City Plan to create a healthy, vibrant and attractive city.

4.2 Objectives of Dundee's Low Emission Zone

4.2.1 Objectives for Dundee's Low Emission Zone were first accepted at the Community Safety & Public Protection Committee meeting on June 3 2019.

4.2.2 After publication of the Transport (Scotland) Act in November 2019, an amendment was made to the original LEZ objectives to address Section 14 of the Act that included a requirement for LEZ schemes to contribute towards the emission reduction targets set out in the Climate Change (Scotland) Act 2009. The final objectives for Dundee's Low Emission Zone were accepted at the Community Safety & Public Protection Committee meeting on February 24 2020.

4.2.3 They are that Dundee's Low Emission Zone will:

Protect public health through improving air quality in Dundee and achieving air quality compliance for NO_2, PM_{10} and $PM_{2.5}$

Develop an environment that helps promote more active and sustainable travel choices in Dundee and contributes to meeting emission reduction targets set out in Part 1 of the Climate Change (Scotland) Act 2009

Contribute to the ongoing transformational change in Dundee and help promote the city as an inclusive and desirable place to live, invest, visit and learn

4.3 Appraisal of Objectives against SMART Principles and Key Strategies

4.3.1 The objectives have been developed with SMART principles in mind, such that they are:

- **Specific:**
  They say in precise terms what is sought
- **Measurable:**
  There exists a means to establish whether or not the objective has been achieved
- **Attainable:**
  There is a general agreement that the objectives set can be reached
- **Relevant:**
  The objective is a sensible indicator or proxy for the change which is sought
- **Timed:**
  The objective will be associated with an agreed future point by which it will have been met.

4.3.2 Table 4.1 shows the how the objectives follow SMART principles.

Table 4.1 : Dundee's LEZ SMART Objectives

Specific Objective	Measurable	Attainable	Relevant	Timed
Protect public health through improving air quality in Dundee and achieving air quality compliance for NO_2, PM_{10} and $PM_{2.5}$	Changes in measured levels of NO_2, PM_{10} and $PM_{2.5}$ within the LEZ and outside it	Yes [current downward trend and LEZ designed to improve AQ]	Yes [in line with current AQ legislation]	Yes [Dependent on grace period after 2020]
Develop an environment that helps to promote more active and sustainable travel choices in Dundee and contributes to meeting emission reduction targets set out in Part 1 of the Climate Change (Scotland) Act 2009	Dundee City Council Performance Indicators	Yes	Yes [in line with The City Plan]	Yes
Contribute to the ongoing transformational change in Dundee and help promote the city as an inclusive and desirable place to live, invest, visit and learn	Dundee City Council Performance Indicators	Yes	Yes [in line with The City Plan]	Yes

4.3.3 The LEZ objectives support the key policies and strategies for Dundee and for air quality in Scotland, in particular The City Plan for Dundee (2017-2026) and Cleaner Air for Scotland (2015). Table 4.2 shows the alignment of the LEZ objectives to these strategies, confirming that the objective sets for Dundee's LEZ are SMART, are appropriate to local needs and to Government's aspirations for LEZs.

Table 4.2 : Alignment of Dundee's LEZ Objectives

Policy	Key Theme/Objective/Vision	LEZ Objective		
		1	2	3
Cleaner Air for Scotland	A Scotland that reduces transport emissions by supporting low and zero emission fuels & technologies, promoting a modal shift away from the car, through active travel and reducing the need to travel.		✓	
	A Scotland where all European and Scottish legal requirements relating to air quality are as a minimum complied with	✓		
	A Scotland where all citizens are well informed, engaged, and empowered to improve our air quality.	✓		
	A Scotland which protects its citizens from the harmful effects of air pollution, reducing health inequalities.	✓		
	A Scotland where air quality is not compromised by new or existing development and where places are designed to minimise air pollution and its effects.	Not directly addressed in the objectives but the LEZ may influence future developments in Dundee		
	A Scotland that reduces greenhouse gas emissions and achieves its renewable energy targets whilst delivering co-benefits for air quality		✓	
The City Plan for Dundee (2017 – 2026)	Have a strong and sustainable city economy that will provide jobs for the people of Dundee, retain more graduates and make the city a magnet for new talent			✓
	Offer real choice and opportunity in a city that has tackled the root causes of social and economic exclusion, creating a community which is healthy, safe, confident, educated and empowered	✓	✓	✓
	Be a vibrant and attractive city with an excellent quality of life where people choose to live, learn, work and visit	✓		✓

5. THE NATIONAL MODELLING FRAMEWORK

5.1 Introduction

5.1.1 The Cleaner Air for Scotland Strategy (CAFS) provided a commitment to develop a National Modelling Framework (NMF) to provide a standardised approach to modelling air quality to support the consideration of LEZs in Scotland. The NMF ensures that the analysis and generation of evidence to support decision-making in the LEZ development process is consistent across those local authorities undertaking a NLEF Stage 2 assessment.

5.1.2 The NMF air quality modelling is undertaken by SEPA who support local authorities throughout a Stage 2 assessment and the LEZ decision-making process. Modelling results presented in this report have therefore been provided by SEPA in line with the NMF. Full details of the development and applications of the NMF Dundee City Air Quality Model will be published in a NMF report, currently in preparation by SEPA.

5.1.3 It should be noted that the existing NMF Dundee City Model currently focuses on modelled NOx and NO_2 as the key pollutant of interest for Dundee. Other pollutants, such as PM_{10} or $PM_{2.5}$, will be modelled at a later date if required. As noted in the NLEF Stage 1 Screening Report and in Chapter 2.4.11 above, there are no recorded monitored exceedances of PM_{10} or $PM_{2.5}$ in the 2017 or 2019 air quality data for Dundee. Any reduction in NO_2 as a result of LEZ measures will also result in a reduction in PM_{10} or $PM_{2.5}$. Analysis of only NOx and NO_2 modelled outputs from the NMF are therefore considered suitable for this stage in the development of Dundee's LEZ.

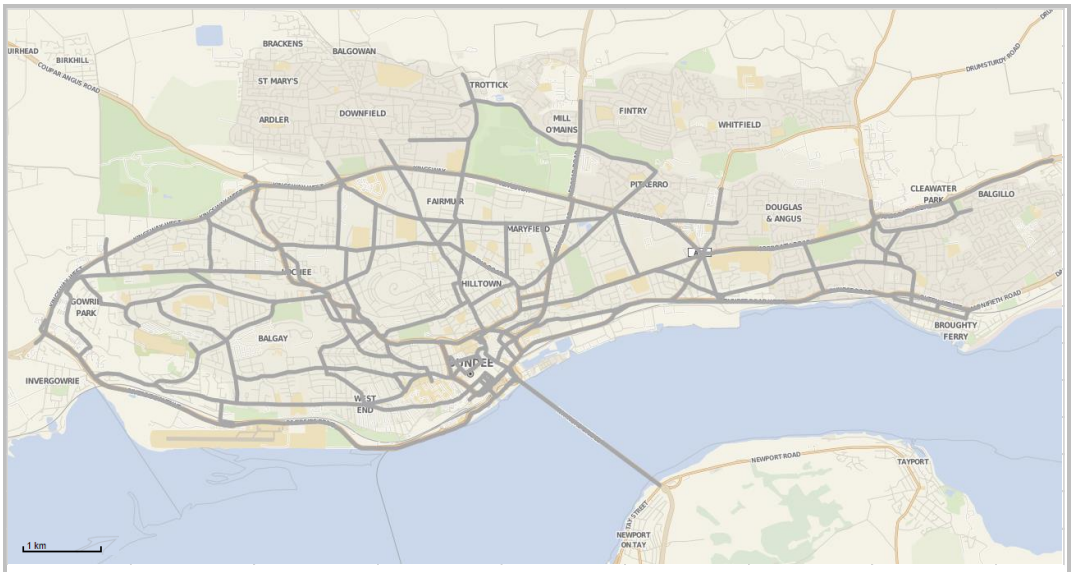
5.1.4 The Base year for the NMF for Dundee is 2017 and therefore all comparisons and calculations using observed data use the 2017 observed dataset, as published in the *2018 Annual Progress Report for Dundee City Council (DCC, June 2018)*. As noted in Chapter 3 above, the 2018 and 2019 air quality dataset is considered sufficiently comparable to the 2017 observed dataset that basing the initial LEZ option development on 2017 data is acceptable, as agreed with DCC and SEPA. To provide further evidence of this conclusion, analysis of the 2019 air quality dataset was undertaken against the 2017 NMF outputs and is summaries in Section 5.6 below.

5.1.5 The analysis presented in this Chapter informs the LEZ option development and sifting process detailed in Chapters 6 and 7 and does not include full model analysis of a final LEZ scheme. As noted in Chapter 2, SEPA were subject to a cyber-attack in late 2020 delaying any NMF analysis for final LEZ option assessment at this stage.

5.2 NMF High Level Scenarios

5.2.1 Dundee City Council and SYSTRA have worked with SEPA to produce a set of high level NMF scenarios to inform the LEZ option generation process. Three potential LEZ areas were identified as follows:

- Seagate – the full extent of Seagate in Dundee City Centre (Figure A.1, Appendix A)
- Inner Ring Road – covering the area inside the inner ring road (Figure A.2, Appendix A)
- All Roads – covering the full NMF AQ model extent (Figure 5.1 , below)



Source: National Modelling Framework Online (SpotFire) Application, 2019

Figure 5.1 :NMF Dundee Model Extents (All Roads Scenario)

5.2.2 The LEZ emission standards under The Transport (Scotland) Act are Euro VI/6 for all diesel vehicles and Euro 4 for petrol vehicles. Six sets of options for vehicle restrictions were identified and combined with the three option areas to create 18 high level scenario tests in total to be run in the Dundee NMF Model. The vehicle restriction groups all assume 100% compliance with LEZ emission standards for the particular vehicle in question with the Base Euro class mix for the other vehicle types remaining unchanged, and were as follows:

- Bus
- Bus and diesel car
- Bus and Heavy Goods Vehicle (HGV)
- Bus, diesel car and HGV
- Bus, diesel car HGV and Light Goods Vehicle (LGV)
- Bus, diesel car, HGV, LGV and petrol car

5.2.3 The vehicle restriction groups are structured such that the vehicle types are added incrementality based on their contribution to modelled emissions of NOx in the NMF. Figure 5.2 is taken from the NMF online model visualisation tool (Spotfire) and shows the modelled NOx by vehicle type at all corresponding on-street monitoring locations. The graphs show that buses and coaches contribute up to approximately 80% of modelled NOx at some sites with diesel cars the next highest contributor, accounting for over 50% of modelled NOx at some locations. LGVs and artic and rigid HGVS contribute lower levels of modelled NOx, up to a maximum of 25% at certain locations while petrol cars account for no more than 8% of modelled NOx at any individual site. Motorcycles are not included in the NMF scenario testing due to their low (<0.12%) contribution to modelled NOx.

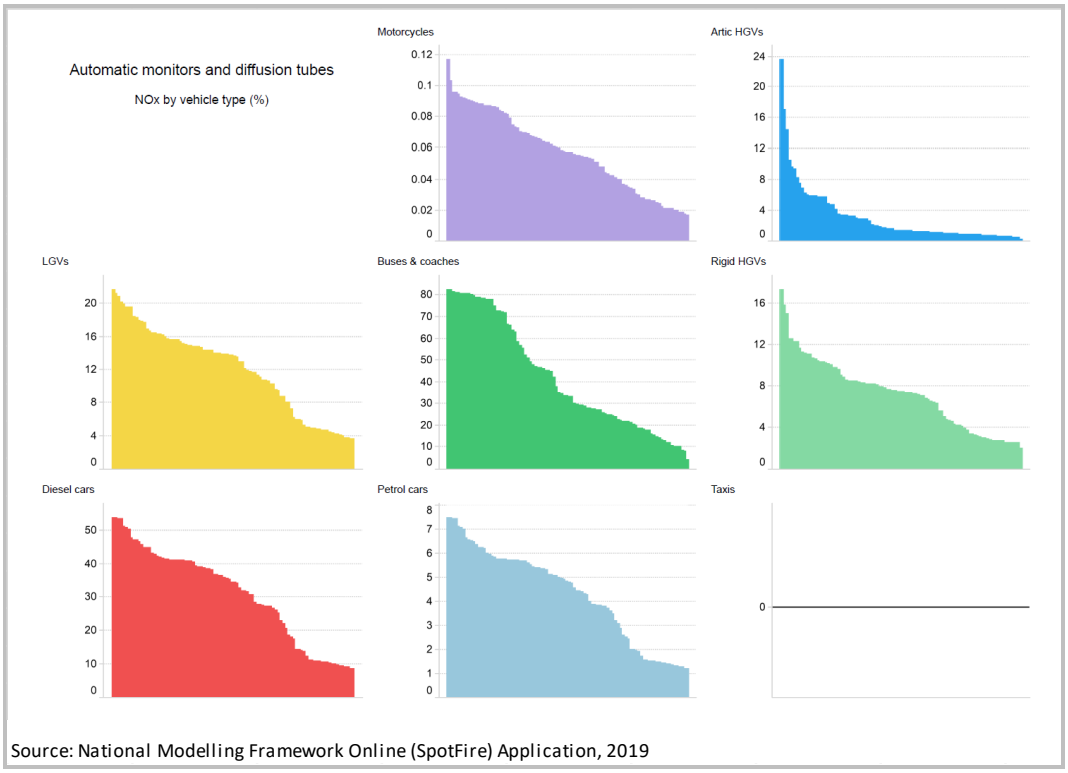


Figure 5.2 : NOx by Vehicle Type at all monitoring locations (NMF)

5.2.4 Each modelled scenario assumes that, within the area represented, 100% compliance is achieved for each of the six different vehicle type classifications detailed here (e.g. in the All Roads bus scenario, all modelled buses are assumed to be Euro VI standard). From the All Roads Scenarios, covering the full extent of the NMF for Dundee, the impact of any other smaller LEZ option area can be inferred for its likely impacts on air quality and this is critical in the LEZ option development and appraisal process. In theory, any number of potential LEZ options can be assessed using the All Roads scenario results and this is detailed in Section 6.

5.3 Modelled reduction in NO_2

5.3.1 18 high level scenarios were devised to inform the LEZ development, however not all scenario runs have been simulated, primarily due to the order in which the tests were undertaken, starting from largest area/highest NO_2 attribution (All Roads/Bus). It was noted that as the area reduced in size and the modelled vehicle type added reduced in pollution apportionment percentage, the reductions in modelled NO_2 were considered insignificant and continuing to produce results with smaller reductions in modelled NO_2 was not considered a suitable use of NMF resource at this stage.

5.3.2 Of the 18 high level scenarios identified, 9 were completed, as shown by the percentage reductions in total modelled NO_2 per modelled scenario in Table 5.1. Those cells where no value is recorded were not simulated. It is noted that the remaining 9 tests may be undertaken if required and that further NMF scenarios will be run as informed by the emerging LEZ option development and detailed option appraisal.

5.3.3 The total modelled NO_2 at all automatic monitoring and diffusion tubes sites for the full extent of the NMF modelled area (Figure 5.1) was calculated for the NMF 2017 Base and each modelled scenario. The percentage reduction in network wide modelled NO_2 between each scenario and the NMF 2017 Base was then calculated and is detailed in Table 5.1.

Table 5.1 : Total percentage reduction in modelled NO_2 in NMF Scenario

Vehicle Type Restriction	% reduction in modelled NO2 from 2017 Base NMF		
	All Roads	Inner Ring Rd	Seagate
Bus	-19.4%	-19.2%	-12.8%
Bus & diesel car	-23.3%	-19.7%	-
Bus & HGV	-22.8%	-	-
Bus, diesel car & HGV	-26.8%	-	-
Bus, diesel car, HGV & LGV	-27.7%	-	-
Bus, diesel car, HGV, LGV & petrol car	-27.9%	-	-

5.3.4 By building the vehicle restriction groups up incrementally, the impact of individual vehicle type restrictions can be calculated and a wide range of possible LEZ options and their potential impact on air quality can be built from the above LEZ scenarios. The percentage reduction in total network wide modelled NO_2 per vehicle type tested across all modelled links is shown in Table 5.2.

Table 5.2 : Percentage reduction in total modelled NO_2 per vehicle type

Vehicle Type	% reduction in modelled NO2 from 2017 Base NMF		
	All Roads	Inner Ring Rd	Seagate
Bus	-19.4%	-19.2%	-12.8%
Diesel Car	-4.0%	-0.5%	-
HGV	-3.5%	-	-
LGV	-0.9%	-	-
Petrol Car	-0.2%	-	-

5.3.5 Whilst Table 5.2 shows the difference in total modelled NO_2 per vehicle type and gives a clear picture of the likely impact of including each vehicle type in the NMF scenario, it should be noted that reductions in NO_2 vary by location and are dependent on factors such as total vehicle flow and proportions of vehicle types on specific modelled links. To illustrate this, the minimum, average and maximum percentage modelled reductions in NO_2 across all automatic monitoring and diffusion tube site locations has been calculated for the All Roads scenario and is presented in Table 5.3. The range of percentage reductions at all 2017 exceedance locations is also presented in Section 5.4 and Table 5.5.

Table 5.3 : Min, Ave and Max percentage reduction by vehicle type in All Road Scenario

Vehicle Type	% reduction in modelled NO2 from 2017 Base NMF		
	Minimum	Average	Maximum
Bus	-2.6%	-17.4%	-44.5%
Diesel Car	-1.2%	-4.6%	-8.5%
HGV	-1.7%	-4.2%	-15.5%
LGV	-0.9%	-4.8%	-8.8%
Petrol Car	0.0%	-1.2%	-2.5%

5.3.6 The high level NMF results show that if all buses in Dundee were of Euro VI standard there would be a 19.4% predicted reduction in total network wide NO_2 and that this reduction is significantly more than any other individual vehicle type. The impact of this reduction varies between a 2.6% and 44.5% reduction depending on model location.

5.3.7 The results also highlight that a city wide (All Roads) LEZ and a significantly smaller LEZ contained within the inner ring road both bring similar significant reductions in NO_2, with an inner ring road bus only LEZ predicted to lower network wide NO_2 by 19.2%. Analysis of all bus routes modelled in the NMF for Dundee show that all but one bus service that serves Dundee enters the inner ring road area and therefore the benefits from both these scenarios are comparable.

5.3.8 A Seagate bus only LEZ also brings more predicted benefit to air quality than any other vehicle type with a 12.8% reduction in modelled NO_2 predicted. Analysis of bus routes modelled in the NMF for Dundee show that of the 33 bus routes that serve Dundee, 25 route along Seagate, resulting in lower predicted NO_2 reductions for this scenario.

5.3.9 The restriction of diesel cars in a network wide All Roads scenario results in a 4% decrease in total network wide modelled NO_2 and this reduction varies between 1.2% and 8.5% depending on model location. Reducing the scenario area to inside the inner ring road, the addition of diesel cars brings a less than 1% reduction in total network wide modelled NO_2.

5.3.10 The addition of HGVs to a network wide All Roads scenario results in a 3.5% reduction in modelled NO_2 and the introduction of LGVs or petrol cars predicts reductions of less than 1%.

5.3.11 No further scenario results have been produced as it can be inferred from the results above that any vehicle type with a lower apportionment of emissions and/ or any smaller scenario area would produce modelled reductions in NO_2 of less than 0.5% and are therefore not likely to be considered effective LEZ options.

5.4 Modelled reduction in NO_2 applied to 2017 observed air quality data

5.4.1 Modelled NO_2 emissions at all of Dundee's automatic monitoring stations and diffusion tube sites were extracted for the six All Roads NMF scenarios and the percentage change from the 2017 Base NMF model was calculated. The percentage changes were applied to the corresponding observed on-street levels from the 2017 air quality dataset as reported by DCC in the 2018 Annual Progress Report (Dundee City Council, June 2018).

5.4.2 As noted, the results presented from the NMF All Roads scenarios assume 100% compliance with the particular LEZ vehicle restrictions for the entire Dundee NMF model area.

5.4.3 The observed 2017 locations of exceedance (greater than the 40 $\mu g/m^3$) in annual mean concentrations of NO_2 are detailed in Table 5.4 and shown in Figure 5.3. Note all locations with annual mean concentrations greater than 36 $\mu g/m^3$ are presented as they are considered to be within the accepted 10% margin of error range from on-street monitoring data therefore are potential locations that may be in exceedance of the legal limit.

Table 5.4 : 2017 Annual Mean Concentrations of NO_2 greater than 36 µg/m³

Site ID	Site Name/Location	2017 Annual mean NO2 concentration (µg/m3)
DT 70	Victoria Rd/Hilltown	51.5
DT 156	Dock St (57)	49.4
DT 31	Lochee Rd (140) Traffic Lts	48.1
DT 37	Logie St (114)	47.9
DT 30	Lochee Rd (138)	47.3
DT 205	West Marketgait/Old Mill (23)	45.1
CM 5	Seagate	44.3
DT 183	West Marketgait / Guthrie St	44.1
CM 4	Lochee Road (CM)	43.6
DT 158	Lochee Road (DT)	42.6
DT 217	Seagate (99)	42.5
DT 76	Whitehall St (1)	40.9
DT 83	Forfar Rd (104)	40.6
DT 11	Broughty Ferry Rd (141)	40.0
DT 75	Whitehall St (5)	39.5
DT 49	Rankine St (2)	39.3
DT 149	Meadowside Average	39.3
DT 44	Nethergate (88)	39.1
DT 190	Seagate (97)	38.7
DT 159	Seagate Average	38.4
DT 204	Broughty Ferry Rd (129)	38.2
DT 26	Kingsway East Roundabout	37.9
DT 85	Dock St (21)	36.7

source: 2018 Air Quality Annual Progress Report (APR) for Dundee City Council

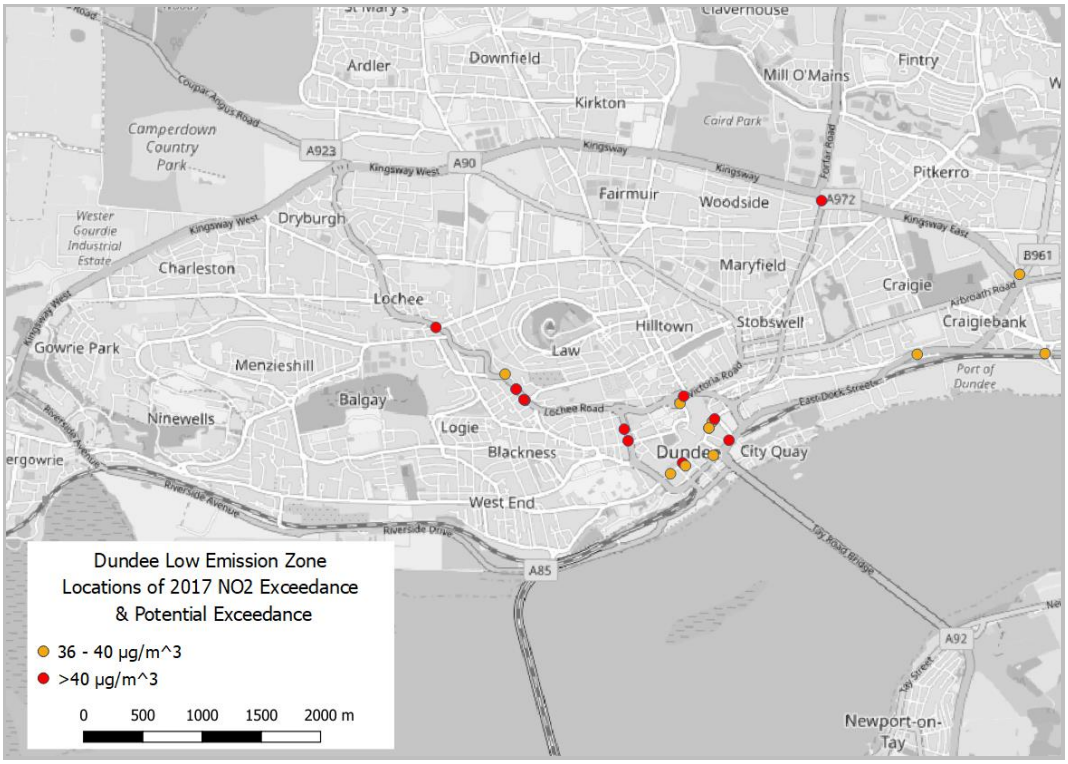


Figure 5.3 : Locations of 2017 Annual Mean Concentrations of NO_2 greater than 36 µg/m³

5.4.4 The percentage reduction in modelled NO_2 per scenario at these locations for the six All Roads scenarios are shown in Table 5.5.

Table 5.5 : Modelled % reduction in NO_2 (NMF All Roads Scenarios)

Site Name	Bus	Bus & Diesel Car	Bus & HGV	Bus, Diesel Car & HGV	Bus, Diesel Car, HGV & LGV	Bus, Diesel Car, HGV, LGV & Petrol Car
Victoria Rd/Hilltown	-27%	-34%	-30%	-36%	-38%	-38%
Dock St (57)	-13%	-20%	-20%	-27%	-28%	-28%
Lochee Rd (140) Traffic Lts	-13%	-20%	-17%	-24%	-25%	-25%
Logie St (114)	-12%	-18%	-15%	-22%	-23%	-24%
Lochee Rd (138)	-11%	-17%	-15%	-20%	-21%	-22%
West Marketgait/Old Mill (23)	-11%	-17%	-14%	-20%	-22%	-22%
Seagate	-37%	-39%	-39%	-41%	-42%	-42%
West Marketgait / Guthrie St	-9%	-16%	-13%	-19%	-20%	-21%
Lochee Road (CM)	-8%	-11%	-10%	-13%	-13%	-14%
Lochee Road (DT)	-15%	-22%	-18%	-26%	-27%	-28%
Seagate (99)	-10%	-11%	-12%	-14%	-14%	-14%
Whitehall St (1)	-41%	-43%	-43%	-44%	-45%	-45%
Forfar Rd (104)	-14%	-19%	-21%	-26%	-28%	-28%
Broughty Ferry Rd (141)	-4%	-9%	-7%	-12%	-13%	-13%
Whitehall St (5)	-38%	-40%	-40%	-42%	-43%	-43%
Rankine St (2)	-5%	-13%	-9%	-16%	-18%	-18%
Meadowside Average	-44%	-47%	-46%	-48%	-49%	-49%
Nethergate (88)	-29%	-31%	-31%	-33%	-34%	-34%
Seagate (97)	-37%	-39%	-39%	-41%	-42%	-42%
Seagate Average	-38%	-40%	-39%	-42%	-42%	-42%
Broughty Ferry Rd (129)	-8%	-14%	-13%	-19%	-20%	-21%
Kingsway East Roundabout	-7%	-12%	-13%	-18%	-20%	-20%
Dock St (21)	-33%	-35%	-35%	-38%	-39%	-39%

5.4.5 The percentage reductions in modelled NO_2 in the six NMF scenarios was then applied to the 2017 observed dataset to inform the likely impact of a LEZ on existing exceedance locations and assist the LEZ development process with the results shown in Table 5.6.

Table 5.6 : Modelled % reduction in NO_2 applied to 2017 observed data ($\mu g/m^3$)

Site Name	Bus	Bus & Diesel Car	Bus & HGV	Bus, Diesel Car & HGV	Bus, Diesel Car, HGV & LGV	Bus, Diesel Car, HGV, LGV & Petrol Car
Victoria Rd/Hilltown	37.4	34.2	36.0	32.9	32.1	32.0
Dock St (57)	42.9	39.8	39.4	36.3	35.5	35.4
Lochee Rd (140) Traffic Lts	41.7	38.3	40.0	36.6	35.9	35.9
Logie St (114)	42.2	39.2	40.5	37.3	36.7	36.5
Lochee Rd (138)	42.0	39.3	40.4	37.9	37.3	37.1
West Marketgait/Old Mill (23)	40.0	37.2	38.8	35.9	35.4	35.4
Seagate	27.8	26.8	26.9	26.0	25.7	25.7
West Marketgait / Guthrie St	40.2	37.2	38.6	35.8	35.2	35.0
Lochee Road (CM)	40.2	39.0	39.2	37.9	37.7	37.5
Lochee Road (DT)	36.3	33.3	34.7	31.7	31.1	30.8
Seagate (99)	38.4	37.8	37.3	36.7	36.5	36.5
Whitehall St (1)	24.3	23.5	23.4	22.8	22.5	22.5
Forfar Rd (104)	35.0	33.0	31.9	29.9	29.3	29.3
Broughty Ferry Rd (141)	38.5	36.6	37.1	35.2	34.9	34.7
Whitehall St (5)	24.4	23.7	23.6	22.9	22.6	22.6
Rankine St (2)	37.2	34.3	35.9	33.0	32.2	32.1
Meadowside Average	22.0	21.0	21.4	20.5	20.2	20.2
Nethergate (88)	27.6	26.8	26.8	26.0	25.9	25.9
Seagate (97)	24.3	23.5	23.6	22.8	22.6	22.5
Seagate Average	24.0	23.0	23.3	22.3	22.1	22.1
Broughty Ferry Rd (129)	35.3	32.9	33.2	30.8	30.4	30.3
Kingsway East Roundabout	35.3	33.4	32.8	30.9	30.5	30.5
Dock St (21)	24.7	23.8	23.7	22.7	22.4	22.4

5.4.6 Grey cells in Table 5.6 show locations where the modelled reductions do not predict a sufficient reduction in NO_2 for observed levels to fall below 40 $\mu g/m^3$. Yellow cells show locations where levels of NO_2 are predicted to be between 36 $\mu g/m^3$ and 40 $\mu g/m^3$.

5.4.7 The scenario predicts that levels of NO_2 will fall below 36 $\mu g/m^3$ at 11 of the 23 exceedance locations identified in the 2018 Annual Progress Report. The high level NMF results show that if all buses in Dundee were of Euro VI standard there would be a 19.4% predicted reduction in network wide NO_2 and that this reduction is significantly more than any other individual vehicle type. Table 5.6 shows however, that 6 sites do not have a sufficient reduction in NO_2 to fall below 40 $\mu g/m^3$ and a further 5 sites are calculated to have between 36 $\mu g/m^3$ and 40 $\mu g/m^3$. Of the locations where NO_2 is predicted to be above 40 $\mu g/m^3$, three are located on the inner ring road and three are located on the Lochee Road/Logie Street corridor, as shown in Figure 5.4.

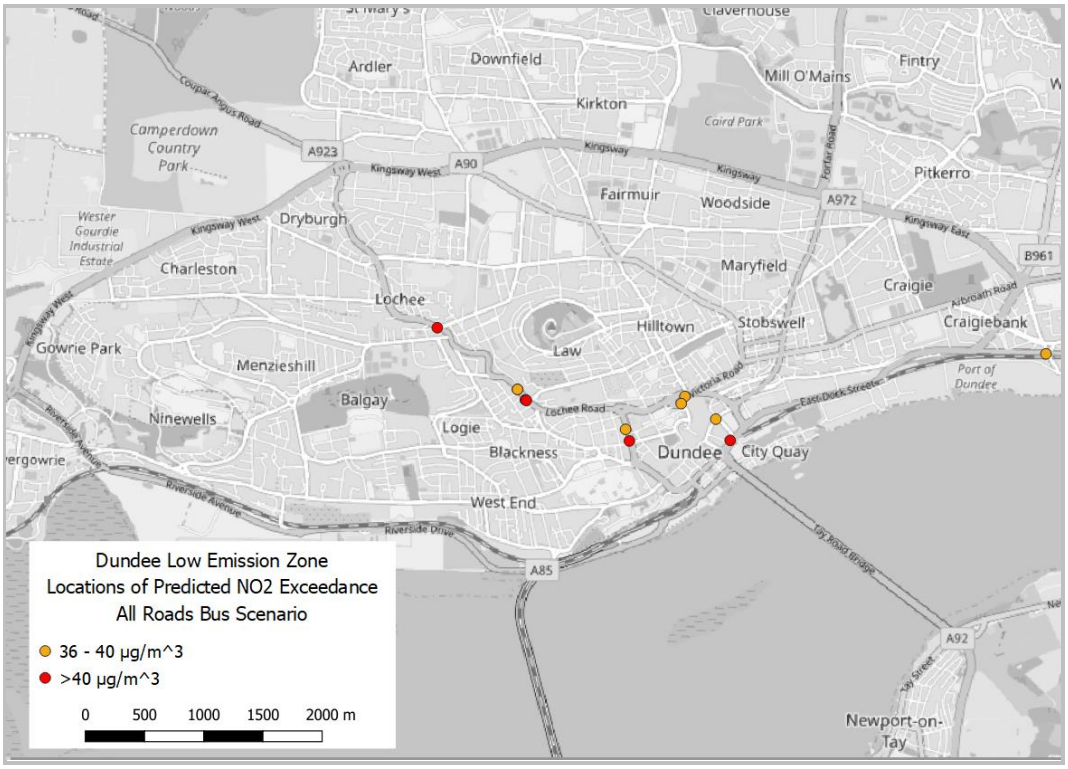


Figure 5.4 : Locations of predicted NO_2 greater than 36 µg/m³ – Bus only

5.4.8 Adding diesel cars to the NMF predicts levels of NO_2 will fall below 36 µg/m³ at 14 of the 23 sites identified in the 2018 Annual Progress Report, with all sites predicted to fall below 40 µg/m³ and of these, 9 sites predicted to have NO_2 levels between 36 µg/m³ and 40 µg/m³, as shown in Figure 5.5.

Figure 5.5 : Locations of predicted NO_2 greater than 36 µg/m³ – Bus & diesel car

5.4.9 A bus and HGV NMF scenario predicts levels of NO_2 will be above 40 µg/m³ at 3 sites, all on the Lochee Road/Logie Street corridor and between 36 µg/m³ and 40 µg/m³ at 7 sites, as shown in Figure 5.6.

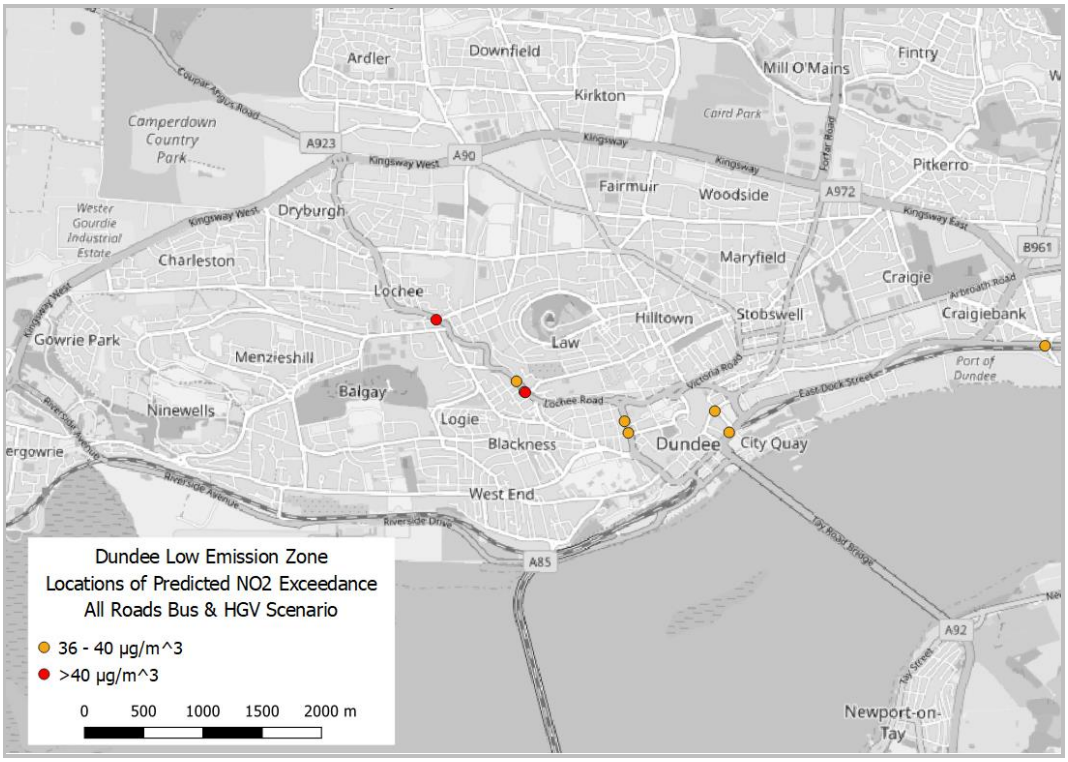


Figure 5.6 : Locations of predicted NO_2 greater than 36 µg/m³ – Bus & HGV

5.4.10 The combined bus, diesel car and HGV NMF scenario predicts levels of NO_2 will fall below 36 µg/m³ at 17 of the 23 sites identified in the 2018 Annual Progress Report, with all remaining sites predicted to fall below 40 µg/m³ and 6 sites predicted to have NO_2 levels between 36 µg/m³ and 40 µg/m³, as shown in Figure 5.7.

Figure 5.7 : Locations of predicted NO_2 greater than 36 µg/m³ – Bus, diesel car & HGV

5.4.11 Adding LGVs and then petrol cars to the NMF scenario results in further minor reductions in predicted levels of NO_2, with 19 of the 23 sites identified in the 2018 Annual Progress Report falling below 36 µg/m³ and 4 sites predicted to have NO_2 levels between 36 µg/m³ and 40 µg/m³. This is true in both scenarios with the LGV scenario shown in Figure 5.8.

Figure 5.8 : Locations of predicted NO_2 greater than 36 µg/m³ – Bus, diesel car, HGV & LGV

5.4.12 The NMF scenario results show that a network wide (All Roads) scenario, where all vehicles are compliant with emerging LEZ guidelines (Euro VI for diesel HGVs/buses, Euro 6 for diesel vehicles and Euro 4 for petrol vehicles), predicts there to be locations in Dundee where NO_2 levels are between 36 µg/m³ and 40 µg/m³ and are therefore considered possible locations of exceedance.

5.5 Comparisons of NMF Bus Only Scenarios

5.5.1 As noted in Table 5.1, the bus only scenario for the network wide All Roads scenario results in an overall reduction in modelled NO_2 of approximately 19.4% with a comparable reduction of 19.2% for the bus only the inner ring road scenario. The bus only Seagate scenario results in a reduction of modelled NO_2 of approximately 12.8%.

5.5.2 Applying the modelled percentage reductions at the corresponding on-street automatic monitor and diffusion tubes sites for each NMF bus scenario shows the predicted impact each is likely to have on existing locations of exceedance. The comparison in Table 5.7 shows that the inner ring road scenario and the All Roads scenario will have an almost identical impact on NO_2 at the exceedance locations.

5.5.3 Applying modelled percentage reductions from the Seagate scenario to the observed data shows that one additional site is predicted to have NO_2 levels over 40 µg/m³, at Victoria Road/Hilltown. The remaining locations in the Seagate scenario where there is predicted to be an exceedance in NO_2 is consistent with the All Roads and inner ring road scenarios however the NO_2 levels are predicted to be approximately 10% higher on average across all sites in the Seagate scenario.

Table 5.7 : Comparison of modelled % reduction in NO_2 for NMF Bus Scenarios

Site ID	Site Name	Bus Only Scenarios		
		All Roads	Inner Ring Road	Seagate
DT70	Victoria Rd/Hilltown	37.4	37.2	44.9
DT156	Dock St (57)	42.9	42.9	43.7
DT31	Lochee Rd (140) Traffic Lts	41.7	41.7	44.7
DT37	Logie St (114)	42.2	42.2	42.8
DT30	Lochee Rd (138)	42.0	42.0	44.4
DT205	West Marketgait/Old Mill (23)	40.0	40.0	42.5
CM5	Seagate	27.8	27.7	28.5
DT183	West Marketgait / Guthrie St	40.2	40.2	41.9
CM4	Lochee Road (CM)	40.2	40.4	41.8
DT158	Lochee Road (DT)	36.3	36.3	36.7
DT217	Seagate (99)	38.4	38.6	39.8
DT76	Whitehall St (1)	24.3	24.0	32.8
DT83	Forfar Rd (104)	35.0	35.2	35.5
DT11	Broughty Ferry Rd (141)	38.5	39.0	39.1
DT75	Whitehall St (5)	24.4	24.2	32.1
DT49	Rankine St (2)	37.2	37.2	38.3
DT149	Meadowside Average	22.0	21.8	31.2
DT44	Nethergate (88)	27.6	27.6	33.3
DT190	Seagate (97)	24.3	24.2	24.9
DT159	Seagate Average	24.0	23.8	24.5
DT204	Broughty Ferry Rd (129)	35.3	35.3	35.6
DT26	Kingsway East Roundabout	35.3	35.6	35.9
DT85	Dock St (21)	24.7	25.0	31.1

5.6 NMF Analysis using 2019 Air Quality Data

5.6.1 The first Interim Stage 2 NLEF Report utilised the 2017 air quality dataset as described in the sections above. As noted in Chapter 3, the 2019 air quality dataset is now available and analysis of the predicated modelled reduction in NO_2 from each All Roads scenario applied to the 2019 air quality dataset was undertaken. Although this exercise utilises information from different years (2017 modelled against 2019 observed) it is considered important to understand how possible LEZ options impact on the most recent observed dataset.

5.6.2 As with the 2017 data analysis, the percentage reductions in modelled NO_2 in the six NMF scenarios have been applied to the 2019 observed dataset as a comparison to 2017. This exercise will further inform the likely impact of a LEZ on existing exceedance locations and assist the LEZ development process. The results of the 2019 analysis is shown in Table 5.8.

Table 5.8 : Modelled % reduction in NO_2 applied to 2019 observed data ($\mu g/m^3$)

Site Name	Bus	Bus & Diesel Car	Bus & HGV	Bus, Diesel Car & HGV	Bus, Diesel Car, HGV & LGV	Bus, Diesel Car, HGV, LGV & Petrol Car
Victoria Rd/Hilltown	35.0	32.0	33.8	30.9	30.1	30.1
Dock St (57)	38.4	35.6	35.2	32.4	31.8	31.7
Lochee Rd (140) Traffic Lts	40.0	36.8	38.4	35.2	34.4	34.4
Logie St (114)	41.5	38.6	39.9	36.8	36.1	35.9
Lochee Rd (138)	40.7	38.1	39.1	36.7	36.1	35.9
West Marketgait/Old Mill (23)	41.8	38.9	40.5	37.5	36.9	36.9
Seagate	27.9	26.9	27.1	26.1	25.8	25.8
West Marketgait / Guthrie St	34.9	32.3	33.5	31.1	30.6	30.4
Lochee Road (CM)	39.6	38.4	38.6	37.4	37.2	37.0
Lochee Road (DT)	35.4	32.4	33.8	30.8	30.2	30.0
Seagate (99)	34.2	33.7	33.3	32.8	32.6	32.6
Whitehall St (1)	23.9	23.2	23.0	22.4	22.2	22.2
Forfar Rd (104)	32.9	31.0	30.0	28.1	27.5	27.5
Broughty Ferry Rd (141)	34.9	33.2	33.6	31.9	31.6	31.5
Whitehall St (5)	22.1	21.5	21.4	20.8	20.5	20.5
Rankine St (2)	34.8	32.0	33.5	30.8	30.1	30.0
Meadowside Average	21.1	20.2	20.5	19.6	19.4	19.4
Nethergate (88)	27.5	26.7	26.7	25.9	25.8	25.8
Seagate (97)	25.7	24.9	25.1	24.2	23.9	23.8
Seagate Average	24.4	23.5	23.7	22.7	22.5	22.5
Broughty Ferry Rd (129)	34.2	31.9	32.1	29.8	29.4	29.3
Kingsway East Roundabout	31.7	30.1	29.5	27.8	27.4	27.4
Dock St (21)	22.3	21.5	21.4	20.4	20.2	20.2

5.6.3 Grey cells in Table 5.8 show locations where the modelled reductions do not predict a sufficient reduction in NO_2 for observed levels to fall below 40 $\mu g/m^3$. Yellow cells show locations where levels of NO_2 are predicted to be between 36 $\mu g/m^3$ and 40 $\mu g/m^3$.

5.6.4 The analysis suggests that levels of NO_2 will fall below 36 $\mu g/m^3$ at 17 of the 23 monitoring locations based on 2019 observed levels/ This is in comparison to 11 predicted locations in 2017. The analysis shows however, that 4 sites will not have a sufficient reduction in NO_2 to fall below 40 $\mu g/m^3$ and 2 sites are calculated to have between 36 $\mu g/m^3$ and 40 $\mu g/m^3$. This is in comparison to 6 and 5 sites respectively seen in the 2017 analysis. Of the locations where NO_2 is predicted to be above 40 $\mu g/m^3$, one is located on the inner ring road and three are located on the Lochee Road/Logie Street corridor. As in the 2017 analysis, the 2019 analysis suggests that the inclusion of diesel cars in addition to buses would result in NO_2 falling below 40 $\mu g/m^3$ at all locations.

5.6.5 As noted in Chapter 2.4.11 and the 2020 APR, observed air quality data shows an improving picture in city wide NO_2 levels. As such, applying the same percentage reductions to lower observed levels results in a lower number of remaining exceedance site. What the analysis does confirm however it that even with improving levels of NO_2, the requirement for a LEZ to accelerate this improvement is required and that the area of focus for Dundee's LEZ remains the same.

5.7 Conclusions from the NMF High Level Scenario Testing

5.7.1 The high level NMF results show that should all buses in Dundee be of Euro VI standard there would be approximately a 19% reduction in NO_2 network-wide and that this reduction is significantly more than any other vehicle type would provide. This suggests that a LEZ for Dundee is likely to have to include buses in order for a LEZ to achieve its air quality objective.

5.7.2 When applying modelled NO_2 reductions from the All Roads/inner ring road bus only scenarios to 2017 observed exceedance locations, however, the NMF predicts there to be six locations still exceeding 40 $\mu g/m^3$ and a further five sites between 36 $\mu g/m^3$ and 40

µg/m^3. This result suggest that while a Euro VI bus fleet would bring the largest reduction in NO_2, this alone is not sufficient in addressing all exceedances in Dundee.

5.7.3 The introduction of diesel cars to a network wide All Roads scenario results in a 4% decrease in modelled NO_2. The addition of diesel cars to a city wide scenario (including buses at Euro VI) predicts all 2017 exceedance locations will drop below 40 µg/m^3 . A network wide bus and HGV scenario results in a 3.5% reduction in modelled NO_2. While this reduction is comparable to the bus and diesel car NMF scenario, the reduction in modelled NO_2 is not enough to result in all 2017 exceedance locations falling below 40 µg/m^3 .

5.7.4 The bus only NMF results also highlight that a city wide LEZ and a significantly smaller LEZ contained within the inner ring road both bring similar significant reductions in NO_2 of approximately 19%, suggesting a smaller bus only LEZ to be just as effective as a city wide LEZ. Including diesel cars in an inner ring road scenario brings significant reductions to NO_2 in the inner ring road area but the impact on exceedance locations outside an inner ring road options area is minimal. However, it should be noted that the high level NMF modelling does not, at this stage, account for any reduction in trips associated with changes in driver behaviour after the introduction of a LEZ therefore the impact outside any LEZ area could be greater.

5.7.5 It can be inferred from the NMF results that any LEZ option which simply targets a vehicle type responsible for a small proportion of emissions (e.g. LGVs or petrol cars) and/or any smaller boundary area would produce modelled reductions in NO_2 of less than 0.5%. They are therefore not likely to be effective LEZ options in their own right, albeit may be beneficial if added to a bus and/or diesel car and HGV LEZ.

6. LEZ OPTION GENERATION

6.1 Introduction

6.1.1 NLEF is objective-led and consistent with the principles of Scottish Transport Appraisal Guidance (STAG). The starting point for the Stage 2 assessment is to define the objectives for the potential LEZ to inform the LEZ option generation, sifting and development. STAG states:

"The purpose of Option Generation, Sifting and Development is to derive a range of options which should provide the solution/s to meet the Objectives and alleviate the problems identified. It is vital to derive options which fully reflect the range available and at this early phase in the process, this exercise should not be constrained."

6.1.2 The NLEF Stage 1 Screening Report identified the existing air quality problems and issues in Dundee, and the LEZ objectives have been derived such that any options that satisfy these objectives will address the current air quality issues in the city.

6.1.3 Following STAG principles, an unconstrained option generation exercise was undertaken to allow all possible options to be considered and open to appraisal. This led to a large number of potential options that required sifting, refinement and high level appraisal to ensure they were suitable to be progressed to detailed appraisal and testing.

6.1.4 STAG emphasises that option generation, sifting and development should be carried out in a logical, transparent and therefore auditable manner. As such, the steps undertaken for Dundee's LEZ options development are as follows:

- **Option Generation**
  - Define suitable LEZ areas
  - Combine with possible LEZ vehicle restrictions to create long list of LEZ options
- **Option Sifting**
  - Screen against LEZ objective 1 (air quality objective)
  - Screen against feasibility, affordability and public acceptability
  - Screen against all LEZ objectives
- **Option Development**
  - Undertake high level qualitative appraisal
  - Define emerging options for detailed appraisal

6.1.5 At suitable stages in the assessment process, options that fail the screening criteria were removed and not progressed in the appraisal process. The options remaining at the end of this process are taken forward for detailed appraisal.

6.1.6 In line with STAG guidance all options will be assessed for their feasibility, affordability and public acceptability as follows

- Feasibility – a preliminary assessment of the feasibility of implementation and operation of an option as well as any cost, timescale or deliverability risks associated with the operation of the option.
- Affordability – the scale of the financing burden on the promoting authority and the risks associated with these should be considered together with the level of risk associated with an option's ongoing operating or maintenance costs and its likely operating revenues
- Public Acceptability – the likely public response is of importance at the initial appraisal phase and reference to supporting evidence, for example results from a consultation exercise must be provided where appropriate.

6.1.7 Where required, the options are assessed using a seven-point assessment scale, in line with STAG, and as detailed in Figure 6.1. The STAG Technical Database suggests that qualitative information on impacts is all that is required at the option generation and

development stage, but where available, quantitative information can be provided, as informed by the NMF results in Section 5.

Major negative impacts	Moderate negative impacts	Minor negative impacts	No benefit or impact	Minor benefit	Moderate benefit	Major benefit
---	--	-	0	+	++	+++

Figure 6.1 : STAG Seven-point assessment scale

6.2 Areas for a Low Emission Zone

6.2.1 The NLEF guidance states that:

"The indicative boundary of potential options for consideration should be defined at the outset, taking account of local circumstances. Potentially, more than one boundary may be considered. For example, the AQMA boundary or one which covers just a few streets with the highest concentrations of air pollutants."

6.2.2 In accordance with NLEF guidelines, the area for consideration will be informed by:

1. the area of exceedance of air quality objectives and the main sources of pollutants
2. geographically discrete areas, such as a town centre, or other areas which are well defined (e.g. within an inner ring road)
3. features that may influence enforcement (e.g. an outer ring-road with junctions leading into exceedance areas, key access points such as bridges)
4. mapped emissions by vehicle type in order to identify areas where options are likely to be most effective. Mapping bus routes, taxi ranks and/or residential and commercial land-uses will be useful.
5. air quality along any such alternative routes to determine if they could be at risk of new exceedances as a result of displaced traffic
6. the potential need to allow vehicles to divert onto alternative routes to avoid the area of the LEZ

6.2.3 The initial option generation exercise will primarily consider points 1 to 4 in the NLEF guidance. Points 5 and 6 will inform the more detailed qualitative appraisal of emerging LEZ options, as described in Section 7.

6.2.4 The size and extent of areas should be designed to meet the objectives that have been set for the LEZ but there is likely to be a range of other issues that will require to be considered such as access and traffic management and the effect on surrounding roads.

6.2.5 Following this NLEF guidance, the LEZ option generation exercise was started where the potential area of the LEZ was the only consideration. By excluding vehicle restrictions from the exercise, a wide-ranging (and unconstrained) option list could be developed. For example, an all vehicle LEZ or a bus only LEZ will significantly influence the practicality or feasibility of an LEZ and in turn the areas that can be considered. Table 6.1 details all the areas considered and provides a link to a plan of each area.

Table 6.1 : Dundee LEZ areas for consideration

LEZ Area Option Name	Description	Drawing Reference
Seagate	Seagate, from East Marketgait to Commercial Street	Appendix B, B1
Inner ring road (Option 1)	Covering the entire area within the inner ring road but excluding the inner ring road	Appendix B, B2
Inner ring road (Option 2)	Covering the entire area within the inner ring road area and including sections of the inner ring road	Appendix B, B3
Lochee Road corridor	Covering pollution exceedance locations on Lochee Rd, from Dudhope roundabout to High Street/Rankine Street	Appendix B, B4
Inner ring road (Option 2) & Lochee Road	Combination of inner ring road (Option 2) and Lochee Road	Appendix B, B5
Inner ring road (Option 2) & Lochee Road to Forfar Road	Covering the area bounded by Lochee Road, A90 Kingsway and Forfar Road and including the area of inner ring road (Option 2)	Appendix B, B6
Kingsway (excluding trunk road network & Ninewells Hospital)	Covering the area bounded by A90 Kingsway, Riverside Drive, Greendykes Road but excluding area around Ninewells Hospital to allow access there for all vehicles	Appendix B, B7
Kingsway (excluding trunk road network)	Covering the area bounded by A90 Kingsway, Riverside Drive, Greendykes Road (and including Ninewells Hospital)	Appendix B, B8
AQMA	Covering the entire AQMA (the entire Dundee City Council area)	Appendix B, B9

6.2.7 At this stage, all areas considered are not fully defined in scope and are open to adjustment and variation as the appraisal process develops. The appraisal process may result in multiple variants of each option that include or exclude some areas or sections of road as details of the impacts of each option emerge.

6.2.8 A high level assessment was made on each of these areas to assess whether they would likely be feasible, affordable and publicly acceptable if adopted as a Low Emission Zone as shown in Table 6.2.

Table 6.2 : Dundee LEZ Area Screening

LEZ Area	Feasible	Affordable	Publicly Acceptable	Progress in appraisal
Seagate	Yes	Yes	Yes	**Yes**
Inner ring road (Option 1)	Yes	Yes	Yes	**Yes**
Inner ring road (Option 2)	Yes	Yes	Yes	**Yes**
Lochee Road corridor	Yes	Yes	Yes	**Yes**
Inner ring road (Option 2) & Lochee Road	Yes	Yes	Yes	**Yes**
Inner ring road (Option 2) & Lochee Road to Forfar Road	Yes	Yes	Yes	**Yes**
Kingsway (excluding trunk road network & Ninewells Hospital)	Yes	Yes	Yes	**Yes**
Kingsway (excluding strategic road network)	Yes	Yes	Yes	**Yes**
AQMA	No	No	Yes	No

6.2.9 Only the AQMA option was considered unfeasible and unaffordable. Primarily this was due to the lack of alternative routes available to drivers who did not want to enter the LEZ with significant additional trip distances required and due to the likely high costs of implementing and monitoring such a large area, including the trunk road network.

6.2.10 All other options were considered potentially feasible based on alternative route choice available. Although costs as this stage are unknown, all these "feasible" options were considered affordable due to the commitment from the Scottish Government to implement a LEZ in Dundee. All options were considered publicly acceptable at this early stage in the screening process (i.e. before a vehicle restriction is added).

6.2.11 All area options, excepting the AQMA option, were progressed in the appraisal process to include the addition of a vehicle restriction and the creation of a LEZ option.

6.3 Vehicle Restriction and Air Quality Objective

6.3.1 The eight areas considered potentially suitable as a Low Emission Zone were then combined with one vehicle type restriction and assessed against their likely impact on the LEZ air quality objective (objective 1): *Protect public health through improving air quality in Dundee and achieving air quality compliance for* NO_2, PM_{10} *and* $PM_{2.5}$. As noted, the NMF outputs changes in NO_2 and screening is therefore informed by changes in NO_2 only.

6.3.2 Although a LEZ can restrict multiple types of non-compliant vehicles from entry, this initial appraisal considered only one vehicle restriction at a time to reduce the complexity of impacts and allow a suitable appraisal to be undertaken on the impacts of each vehicle class on its own. Five possible non-compliant vehicles were defined, in line with the NMF results in Section 5, as follows:

- Bus (pre-Euro VI)
- Diesel Car (pre-Euro 6)
- HGV (pre-Euro VI)
- LGV (pre-Euro VI)
- Petrol Car (pre-Euro 4)

6.3.3 The combination of eight option areas and five vehicle type restrictions results in 40 LEZ options at the start of the appraisal process.

6.3.4 A high level appraisal of the 40 LEZ options (eight areas and five vehicle restrictions) was undertaken using a seven-point assessment scale against their likely impact on the air quality objective. This appraisal was informed by the NMF results, with a +3 score representing any option that meant full compliance with air quality standards Dundee-wide. By restricting non-compliant vehicles from an area of the city, all 40 potential LEZ options will at least bring a neutral impact on air quality and therefore all options score at least 0 on the seven-point scale. At this stage, the assessment does not include the re-routing of non-compliant vehicles and the potential to move air quality problems outside the LEZ. The assessment of the 40 LEZ options is shown in Table 6.3

Table 6.3 : Appraisal of area and 1 vehicle restriction

LEZ Area	LEZ Restriction	Objective 1
Seagate	Bus	+
Inner ring road (option 1)	Bus	++
Inner ring road (option 2)	Bus	++
Lochee Road corridor	Bus	0
Inner ring road (Option 2) & Lochee Road	Bus	++
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus	++
Kingsway (excluding trunk road network & Ninewells)	Bus	++
Kingsway (excluding trunk road network)	Bus	++
Seagate	Diesel Car	0
Inner ring road (option 1)	Diesel Car	0
Inner ring road (option 2)	Diesel Car	+
Lochee Road corridor	Diesel Car	0
Inner ring road (Option 2) & Lochee Road	Diesel Car	+
Inner ring road (Option 2) & Lochee Road to Forfar Road	Diesel Car	+
Kingsway (excluding trunk road network & Ninewells)	Diesel Car	+
Kingsway (excluding trunk road network)	Diesel Car	+
Seagate	HGV	0
Inner ring road (option 1)	HGV	0
Inner ring road (option 2)	HGV	0
Lochee Road corridor	HGV	0
Inner ring road (Option 2) & Lochee Road	HGV	0
Inner ring road (Option 2) & Lochee Road to Forfar Road	HGV	0
Kingsway (excluding trunk road network & Ninewells)	HGV	0
Kingsway (excluding trunk road network)	HGV	0
Seagate	LGV	0
Inner ring road (option 1)	LGV	0
Inner ring road (option 2)	LGV	0
Lochee Road corridor	LGV	0
Inner ring road (Option 2) & Lochee Road	LGV	0
Inner ring road (Option 2) & Lochee Road to Forfar Road	LGV	0
Kingsway (excluding trunk road network & Ninewells)	LGV	0
Kingsway (excluding trunk road network)	LGV	0
Seagate	Petrol Car	0
Inner ring road (option 1)	Petrol Car	0
Inner ring road (option 2)	Petrol Car	0
Lochee Road corridor	Petrol Car	0
Inner ring road (Option 2) & Lochee Road	Petrol Car	0
Inner ring road (Option 2) & Lochee Road to Forfar Road	Petrol Car	0
Kingsway (excluding trunk road network & Ninewells)	Petrol Car	0
Kingsway (excluding trunk road network)	Petrol Car	0

6.3.5 The NMF scenario results show that including buses in a LEZ would bring the largest benefit in NO_2 reduction, both in terms of level of reduction and area influence by improved air quality. Having a bus only LEZ does not however result in all 2017 NO_2

exceedance locations falling below 40 µg/m^3, and therefore each bus option scores +2 in the seven-point scale in all options, with the exception of the Seagate and Lochee Road corridor options that, with limited scope, score +1 and 0 respectively. The NMF results show that the inner ring road (option 1) has a significant impact on modelled NO_2 and therefore options of this size or larger will have at least a similar impact.

6.3.6 The NMF scenario results show that the next largest impact on modelled NO_2 is from diesel cars but that their inclusion in a LEZ will bring minor benefit city wide with moderate benefit at certain key locations where. A LEZ that only excludes non-compliant diesel cars will not, on its own, bring large enough benefit to be considered a viable stand-alone option but is considered to result in a score of +1 (minor benefit) for all options with the exception of Seagate, the Lochee Road corridor and the inner ring road (option 1), due to the NMF results showing there to be little impact of including non-compliant diesel cars in these areas.

6.3.7 The NMF results show a LEZ with only non-compliant HGVs, LGVS or petrol cars does not, own its own, bring enough benefit to be consider to have a positive score on the seven-point scale and is awarded a neutral score.

6.3.8 The NMF results and high level appraisal detailed in Table 6.3 can be summarised as follows:

- Buses bring the largest reduction in modelled NO_2 and should be included in any LEZ option for Dundee
- The inclusion of diesel cars (in addition to buses) would allow all key locations of exceedances to fall within air quality standards
- HGVs, LGVs and petrol cars do not bring sufficient benefit on their own to be included in any LEZ, but do bring some further pollution benefits to an LEZ which includes buses.

6.3.9 Based on these conclusions, the list of options containing only one vehicle restriction was adjusted so that each option contained a bus vehicle restriction to reflect a more realistic LEZ for Dundee. The options were then re-assessed using the same seven-point assessment against their likely impact on the air quality objective, as shown in Table 6.4.

Table 6.4 : Appraisal of area and bus focussed vehicle restriction

LEZ Area	LEZ Restriction	Objective 1
Seagate	Bus	+
Inner ring road (option 1)	Bus	++
Inner ring road (option 2)	Bus	++
Lochee Road corridor	Bus	0
Inner ring road (Option 2) & Lochee Road	Bus	++
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus	++
Kingsway (excluding trunk road network & Ninewells)	Bus	++
Kingsway (excluding trunk road network)	Bus	++
Seagate	Bus & Diesel Car	+
Inner ring road (option 1)	Bus & Diesel Car	++
Inner ring road (option 2)	Bus & Diesel Car	+++
Lochee Road corridor	Bus & Diesel Car	+
Inner ring road (Option 2) & Lochee Road	Bus & Diesel Car	+++
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus & Diesel Car	+++
Kingsway (excluding trunk road network & Ninewells)	Bus & Diesel Car	+++
Kingsway (excluding trunk road network)	Bus & Diesel Car	+++
Seagate	Bus & HGV	+
Inner ring road (option 1)	Bus & HGV	++
Inner ring road (option 2)	Bus & HGV	++
Lochee Road corridor	Bus & HGV	0
Inner ring road (Option 2) & Lochee Road	Bus & HGV	++
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus & HGV	++
Kingsway (excluding trunk road network & Ninewells)	Bus & HGV	++
Kingsway (excluding trunk road network)	Bus & HGV	++
Seagate	Bus & LGV	+
Inner ring road (option 1)	Bus & LGV	++
Inner ring road (option 2)	Bus & LGV	++
Lochee Road corridor	Bus & LGV	0
Inner ring road (Option 2) & Lochee Road	Bus & LGV	++
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus & LGV	++
Kingsway (excluding trunk road network & Ninewells)	Bus & LGV	++
Kingsway (excluding trunk road network)	Bus & LGV	++
Seagate	Bus & Petrol Car	+
Inner ring road (option 1)	Bus & Petrol Car	++
Inner ring road (option 2)	Bus & Petrol Car	++
Lochee Road corridor	Bus & Petrol Car	0
Inner ring road (Option 2) & Lochee Road	Bus & Petrol Car	++
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus & Petrol Car	++
Kingsway (excluding trunk road network & Ninewells)	Bus & Petrol Car	++
Kingsway (excluding trunk road network)	Bus & Petrol Car	++

6.3.10 Clearly all options now bring a higher benefit to air quality with the inclusion of buses within them, with the exception of the Lochee Road corridor option (area covering exceedance locations on Lochee Rd only, from Dudhope roundabout to High Street/Rankine Street, and excluding any other area in the city). The NMF scenario results infer that the Lochee Road corridor option will bring limited benefit as a LEZ on its own, and this is also the case when multiple vehicles restrictions are applied. For this reason, the Lochee Road corridor option is removed from the option list. All other options (35 in total) progress to the next step of appraisal. It should be noted that Lochee Road itself is not ignored from an air quality perspective and is included in a number of the remaining options.

6.4 Feasibility, Affordability & Public Acceptability

6.4.1 A further high level assessment was made on each of the 35 options to assess whether they would likely be feasible, affordable and publicly acceptable if adopted as a Low

Emission Zone, with the results shown in Table 6.5 and Table 6.6. The assessment is made using the seven-point scale, where a value of 0 is used where the impact is not known at this stage. If any one of these criteria scores negatively the option is not considered suitable to progress in the appraisal process.

6.4.2 Table 6.5 shows the appraisal against the bus only and bus and diesel car options.

Table 6.5 : Appraisal against feasibility, affordability and public acceptability (table 1)

LEZ Area	LEZ Restriction	Feasible	Affordable	Publicly Acceptable	Progress in appraisal
Seagate	Bus	++	++	++	**Yes**
Inner ring road (option 1)	Bus	++	++	++	**Yes**
Inner ring road (option 2)	Bus	++	++	++	**Yes**
Inner ring road (Option 2) & Lochee Road	Bus	++	++	++	**Yes**
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus	-	+	++	**No**
Kingsway (excluding trunk road network & Ninewells)	Bus	-	+	++	**No**
Kingsway (excluding trunk road network)	Bus	+	+	++	**Yes**
Seagate	Bus & Diesel Car	++	++	++	**Yes**
Inner ring road (option 1)	Bus & Diesel Car	++	++	+	**Yes**
Inner ring road (option 2)	Bus & Diesel Car	0	++	0	**Yes**
Inner ring road (Option 2) & Lochee Road	Bus & Diesel Car	0	++	0	**Yes**
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus & Diesel Car	--	0	-	**No**
Kingsway (excluding trunk road network & Ninewells)	Bus & Diesel Car	--	0	-	**No**
Kingsway (excluding trunk road network)	Bus & Diesel Car	---	0	-	**No**

6.4.3 Two of the bus only options are considered unfeasible, the inner ring road (option 2) with Lochee Road to Forfar Road and the Kingsway excluding Ninewells hospital. Primarily this is due to the feasibility of enforcing a non-simplistic boundary where there are a number of possible entry and exit points and where bus services may route in and out of the area on multiple occasions. This, together with the more "natural" boundary of the larger Kingsway option that is likely to be more feasible to sign, inform and enforce results in these two options being removed from the appraisal process. All other bus options are considered to be broadly feasible, affordable and publicly acceptable and therefore progress in the appraisal process.

6.4.4 Three bus and diesel car options are considered to be neither feasible, affordable or publicly acceptable and are removed from the appraisal process. These options cover Lochee Road to Forfar Road and extend to the boundary of the Kingsway and as the options encompass large geographical areas and are likely to be difficult to enforce for private car use. Outside the inner ring road area, the land use is predominately residential and therefore a large proportion of non-compliant vehicles will be residents in the proposed areas. A large proportion of daily non-compliant trips would be contained inside the option areas and therefore capturing such trips is likely to be difficult and require a large network of ANPR cameras. For these reasons, wide area options targeting private cars are not considered to be feasible, affordable or publicly acceptable.

6.4.5 Table 6.6 shows the appraisal against the bus options with HGVs, LGVs and Petrol Cars

Table 6.6 : Appraisal against feasibility, affordability and public acceptability (table 2)

LEZ Area	LEZ Restriction	Feasible	Affordable	Publicly Acceptable	Progress in appraisal
Seagate	Bus & HGV	++	++	++	**Yes**
Inner ring road (option 1)	Bus & HGV	+	++	++	**Yes**
Inner ring road (option 2)	Bus & HGV	0	++	-	**No**
Inner ring road (Option 2) & Lochee Road	Bus & HGV	-	++	-	**No**
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus & HGV	--	0	--	**No**
Kingsway (excluding trunk road network & Ninewells)	Bus & HGV	--	0	--	**No**
Kingsway (excluding trunk road network)	Bus & HGV	---	0	--	**No**
Seagate	Bus & LGV	++	++	++	**Yes**
Inner ring road (option 1)	Bus & LGV	+	++	++	**Yes**
Inner ring road (option 2)	Bus & LGV	0	++	-	**No**
Inner ring road (Option 2) & Lochee Road	Bus & LGV	-	++	-	**No**
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus & LGV	--	0	--	**No**
Kingsway (excluding trunk road network & Ninewells)	Bus & LGV	--	0	--	**No**
Kingsway (excluding trunk road network)	Bus & LGV	---	0	--	**No**
Seagate	Bus & Petrol Car	++	++	++	**Yes**
Inner ring road (option 1)	Bus & Petrol Car	++	++	+	**Yes**
Inner ring road (option 2)	Bus & Petrol Car	0	++	0	**Yes**
Inner ring road (Option 2) & Lochee Road	Bus & Petrol Car	0	++	0	**Yes**
Inner ring road (Option 2) & Lochee Road to Forfar Road	Bus & Petrol Car	--	0	-	**No**
Kingsway (excluding trunk road network & Ninewells)	Bus & Petrol Car	--	0	-	**No**
Kingsway (excluding trunk road network)	Bus & Petrol Car	---	0	-	**No**

6.4.6 As noted in the bus and diesel car options, the larger area options are not feasible, affordable or likely to be accepted by the public if they include any vehicle type other than buses and therefore the wide area options for HGV, LGV and petrol car options are removed from the appraisal process at this stage.

6.4.7 Two further options for bus and HGV and bus and LGV are also removed at this stage. These are the options that include part of the strategic inner ring road, namely inner ring road (option 2) and inner ring road (option 2) plus Lochee Road. These options are considered not to be feasible or publicly acceptable due to their likely impact of re-routing heavy goods vehicles or commercial vehicles away from the strategic network and on to unusable local roads that may have insufficient capacity or are of a residential nature.

6.4.8 In total, 18 of the 35 options are removed at this stage on consideration of their feasibility, affordability and/or public acceptability. 17 options progress to the next stage of the options development process.

6.5 Rationalisation of LEZ Option Long-List

6.5.1 The high level appraisal against the LEZ air quality objective and the assessment of their likely feasibility, affordability and public acceptability has reduced the number of options from 40 to 17.

6.5.2 Prior to further appraisal, and in line with STAG, the options can be further rationalised to give a more succinct set of options by making the following observations from the above appraisal:

- The bus only LEZ options provide sufficient benefit to air quality to be considered a viable option but do not result in full compliance with the air quality objective
- Other vehicle classes need to be combined with buses to bring about a suitable reduction in emission to allow the air quality objective to be met
- The bus and diesel car LEZ options provide the most benefit to air quality (discounting possible re-routeing impacts not quantified at this stage) and are suitable as individual options
- HGVS, LGVs and petrol cars bring minimal benefit to a LEZ unless combined with a bus and diesel car LEZ option

6.5.3 The remaining 17 options can therefore be further rationalised to 13 options, as detailed in Table 6.7

Table 6.7 : Rationalised LEZ options

LEZ Area	LEZ Vehicle Restriction
Seagate	Bus
Inner ring road (option 1)	Bus
Inner ring road (option 2)	Bus
Inner ring road (Option 2) & Lochee Road	Bus
Kingsway (excluding trunk road network)	Bus
Seagate	Bus & Diesel Car
Inner ring road (option 1)	Bus & Diesel Car
Inner ring road (option 2)	Bus & Diesel Car
Inner ring road (Option 2) & Lochee Road	Bus & Diesel Car
Seagate	Bus & Diesel Car plus HGV, LGV and/or petrol car
Inner ring road (option 1)	Bus & Diesel Car plus HGV, LGV and/or petrol car
Inner ring road (option 2)	Bus & Diesel Car plus HGV, LGV and/or petrol car
Inner ring road (Option 2) & Lochee Road	Bus & Diesel Car plus HGV, LGV and/or petrol car

6.6 Appraisal Against Low Emission Zone Objectives

6.6.1 As noted, NLEF is objective-led and consistent with the principles of STAG and therefore a qualitative appraisal of the remaining options against the LEZ objectives was undertaken using the seven-point assessment scale. The results of this assessment are shown in Table 6.8; a description of each assessment is then provided.

Table 6.8 : Option appraisal against all LEZ objectives

LEZ Area	LEZ Vehicle Restriction	Objective 1	Objective 2	Objective 3
Seagate	Bus	+	+	+
Inner ring road (option 1)	Bus	++	+	+
Inner ring road (option 2)	Bus	++	+	+
Inner ring road (Option 2) & Lochee Road	Bus	++	+	+
Kingsway (excluding trunk road network)	Bus	++	+	+
Seagate	Bus & Diesel Car	+	+	+
Inner ring road (option 1)	Bus & Diesel Car	++	++	0
Inner ring road (option 2)	Bus & Diesel Car	+++	++	0
Inner ring road (Option 2) & Lochee Road	Bus & Diesel Car	+++	++	0
Seagate	Bus & Diesel Car plus HGV, LGV and/or petrol car	+	+	+
Inner ring road (option 1)	Bus & Diesel Car plus HGV, LGV and/or petrol car	++	++	0
Inner ring road (option 2)	Bus & Diesel Car plus HGV, LGV and/or petrol car	+++	++	0
Inner ring road (Option 2) & Lochee Road	Bus & Diesel Car plus HGV, LGV and/or petrol car	+++	++	0

Objective 1: Protect public health through improving air quality in Dundee and achieving air quality compliance for NO_2, PM_{10} and $PM_{2.5}$

6.6.2 As noted, the NMF produces results on modelled NO_2 and not PM_{10} or $PM_{2.5}$ and therefore all analysis is on changes to NO_2.

6.6.3 All bus options score the same rating on the seven-point assessment scale with the exception of the Seagate option. There are 33 individual commercial bus routes in Dundee and all but one of these enters the inner ring road area and the benefits to air quality within the inner ring road area are extrapolated along Dundee's bus network. The NMF results show that a bus only LEZ for the inner ring road would bring a 19% reduction in NO_2 and for the Kingsway would also bring a 19% reduction. As such, the benefits of a bus only LEZ for the inner ring road is essentially the same for all larger options and all options return a score of +2 with the exception of the Seagate option. Of the 33 commercial bus routes in Dundee, 25 route through Seagate and therefore the city wide benefits to air quality are lower than the larger area options (with the NMF results showing a 12.8% reduction in modelled NO_2) and the option returns a score of +1. The NMF scenario results show there to be still locations of exceedance with a bus only LEZ option (Figure 5.4) and therefore no bus only option scores +3.

6.6.4 The NMF scenario results infer that the addition of diesel cars to the bus only options of Seagate and the inner ring road (option 1) do not bring a substantial increase in benefit to air quality within these in these option areas, with a 1% reduction in modelled NO_2 predicted from the inner ring road diesel car NMF scenario. However, the inner ring road (option 1) contains a number of trip attractors and generators (e.g. city centre shopping centres and car parks) and a LEZ for diesel cars covering this area may impact on trip generation and trip choice and therefore have a wider impact than shown in the NMF results. Detailed traffic modelling and assumptions on the impact to trip choice may be able to quantify the wider impacts but at this stage of the appraisal it is concluded that there is no significant additional benefit to air quality from this option and the scores are consistent with the bus only options.

6.6.5 The NMF scenario results imply that the addition of diesel cars to the inner ring road (option 2) and inner ring road (option 2) plus Lochee Road brings additional benefit to air quality, with all locations of 2017 NO_2 exceedance predicted to fall below 40 µg/m^3 (Figure 5.5), and the score of +3 reflects this.

6.6.6 As discussed above, the addition of HGVs, LGVs and/or petrol cars brings minimal benefit to air quality and the scoring for these options are consistent with the corresponding bus and diesel car options.

Objective 2: Develop an environment that helps to promote more active and sustainable travel choices in Dundee [note, appraisal against original LEZ objective and note the final adopted objective incorporating climate change as described in Chapter 4]

6.6.7 All bus only LEZ options score +1 when appraised against Objective 2. These LEZ options will bring about bus fleet of lower emitting vehicles and contribute to a positive change to Dundee's environment. This is particularly true of the city centre where there is high pedestrian activity and where buses may dwell at bus stops for longer or wait at signal controlled junctions with their engines running. Similarly, the environment on key routes in and out of the city, where there is a high proportion of buses, will benefit from this improved fleet. These factors may contribute to a city where walking and cycling is considered a more attractive mode of transport and an increase in active travel choices may result from these options. Additionally, a bus fleet that contains more modern vehicles that are likely to be more comfortable to travel on and have better facilities may promote a shift to this more sustainable travel mode, reducing the number of private vehicles on the road network and contributing to an overall improved environment that may in turn incentivise more active and sustainable travel choices.

6.6.8 Increasing the scope of the LEZ options to include diesel cars and HGV, LGV and/or petrol cars will further develop an environment that promotes more active and sustainable travel choices by removing more polluting vehicles from key routes. Furthermore, any option affecting car use may encourage some people to walk, cycle or use public transport instead of car for their journeys. Therefore all such options score +2 against Objective 2. The exception to this is the Seagate option where the limited size and predicted impact is likely to be less than other options and this scores +1, consistent with the bus only option.

Objective 3: Contribute to the ongoing transformational change in Dundee and help promote the city as an inclusive and desirable place to live, invest, visit and learn

6.6.9 Dundee has undergone many positive changes in recent years with high profile projects transforming the image of the city. It is considered that the introduction of a LEZ in Dundee will continue this trend however it is anticipated that any impact on accessibility of non-compliant private and commercial vehicles may be considered to have a negative impact on the city.

6.6.10 For similar reasons stated in the Objective 2 appraisal, improvements to the wider Dundee environment will contribute to making Dundee a more attractive place to live, study and visit and in the longer term, this may lead to the creation of jobs, services and investment that will drive an improved city economy for all. The improved environment and the "green tourist" may increase visitors to the city and continue its transformational change.

6.6.11 In the short term however, the options that may change the trip choice of non-compliant private and commercial vehicles to Dundee, particularly the city centre, may initially be viewed as detrimental to the city economy and may impact on overall person trips to the city centre. While a reduction in non-compliant vehicles impacts positively on the environment and the attractiveness of the city, there may be a negative impact on the city economy and therefore creation of jobs and services.

6.6.12 Based on these observations, all bus only options score +1 on the seven-point assessment scale as does the Seagate option for bus and diesel car plus HGV, LGV and/or petrol car

due to its limited size. All other options score neutral for their possible positive and negative contributions to the objective.

6.7 Refinement of LEZ Option List

6.7.1 Table 6.8 detailed 13 options appraised against the LEZ objectives and a clear outcome from this is appraisal is the similarity in scoring of each option. Following STAG principles, these options are again subject to further refinement and grouping to ensure that all options presented for detailed appraisal adequately address the LEZ objectives and that options that deliver the same benefits are grouped or rationalised.

6.7.2 The Seagate options score lowest in the seven-point scale assessment against LEZ objectives. As noted, not all bus services will be impacted by such a LEZ and the NMF results suggest the addition of further vehicle types to the Seagate LEZ options does not bring significant additional reductions in emission. As such, all Seagate options are not progressed in the appraisal process.

6.7.3 It can be inferred from the NMF results that the inner ring road (option 2) and inner ring road (option 2) plus Lochee Road options bring the similar reductions in modelled NO_2 as the inner ring road (option 1) for a bus only LEZ. Additionally all options score the same in the LEZ objective appraisal. This, together with the lack of easily defined boundary for a bus only LEZ for the inner ring road (option 2) and inner ring road (option 2) plus Lochee Road, results in these options not being progressed in the appraisal process.

6.7.4 The inner ring road options that include HGVs, LGVs and/petrol cars are shown to bring limited additional benefit to air quality compared to the bus and diesel car option and score similarly to those options in the LEZ objective appraisal. However, they may bring additional benefit in terms of public perception, indicating a more ambitious option for the LEZ and their inclusion may be desirable, either from a political view point or to align with DCC plans or strategies. For this reason, these options remain but can be grouped together and will be subject to detailed appraisal in order to assess their likely wider impacts.

6.7.5 These observations results in the 13 options reducing to 5 options. However, as described in the emerging Transport (Scotland) Act 2019, it is possible to have multiple LEZ areas for Dundee and these emerging options make this possible. From the 5 remaining LEZ options, the wide area Kingsway bus only LEZ option could be combined with the smaller area inner ring road LEZ for diesel cars (plus HGVs, LGVs and/or petrol cars). This possible combination of LEZ areas results in an additional 3 LEZ option permutations.

6.7.6 The final set of LEZ options to be taken forward to detailed appraisal are shown in Table 6.9.

Table 6.9 : LEZ Options progressed to detailed appraisal

LEZ Area	LEZ Restriction
Bus only LEZ	
Inner ring road (Option 1)	Bus
Kingsway (excluding trunk road network)	Bus
Single area and multiple vehicle LEZ	
Inner ring road (Option 1)	Bus & Diesel Car (&HGV, LGV, petrol car)
Inner ring road (Option 2)	Bus & Diesel Car (&HGV, LGV, petrol car)
Inner ring road (Option 2) & Lochee Road	Bus & Diesel Car (&HGV, LGV, petrol car)
Two areas and multiple vehicle LEZ	
Kingsway (excluding trunk road network)	Bus
Inner ring road (Option 1)	Diesel Car (&LGV, HGV, petrol car)
Kingsway (excluding trunk road network)	Bus
Inner ring road (Option 2)	Diesel Car (&LGV, HGV, petrol car)
Kingsway (excluding trunk road network)	Bus
Inner ring road (Option 2) & Lochee Road	Diesel Car (&LGV, HGV, petrol car)

7. LEZ OPTION ANALYSIS

7.1 Introduction

7.1.1 The high level appraisal process identified eight options that satisfied the LEZ Objectives and were considered feasible, affordable and publicly acceptable.

7.1.2 The NLEF guidance indicates that the LEZ area for consideration will be informed by:

1. the area of exceedance of air quality objectives and the main sources of pollutants
2. geographically discrete areas, such as a town centre, or other areas which are well defined (e.g. within an inner ring road)
3. features that may influence enforcement (e.g. an outer ring-road with junctions leading into exceedance areas, key access points such as bridges)
4. mapped emissions by vehicle type in order to identify areas where options are likely to be most effective. Mapping bus routes, taxi ranks and/or residential and commercial land-uses will be useful
5. air quality along any such alternative routes to determine if they could be at risk of new exceedances as a result of displaced traffic
6. the potential need to allow vehicles to divert onto alternative routes to avoid the area of the LEZ.

7.1.3 The initial option generation exercise (Section 6) broadly considered these points, in particular points 1-4. The next stage in the LEZ option development is to consider these in more detail and clearly define the boundary and predicted impacts of each emerging option in order to recommend detailed LEZ Options for stakeholder input and consultation.

7.1.4 In defining the detail of each emerging option, it is likely that a number of option variants will result from the process. The eight emerging options as described in Section 6.7 have been numbered to allow for ease of description throughout this analysis, as shown in Table 7.1.

Table 7.1 : Emerging LEZ Options

Option Number	LEZ Area	LEZ Restriction
Option 1	Inside Inner Ring Road	Bus
Option 2	Kingsway (excluding trunk road network)	Bus
Option 3	Inside Inner Ring Road	Bus & Diesel Car (&HGV, LGV, petrol car)
Option 4	Including Inner Ring Road	Bus & Diesel Car (&HGV, LGV, petrol car)
Option 5	Including Inner Ring Road & Lochee Road	Bus & Diesel Car (&HGV, LGV, petrol car)
Option 6	Kingsway (excluding trunk road network)	Bus
	Inside Inner Ring Road	Diesel Car (&LGV, HGV, petrol car)
Option 7	Kingsway (excluding trunk road network)	Bus
	Including Inner Ring Road	Diesel Car (&LGV, HGV, petrol car)
Option 8	Kingsway (excluding trunk road network)	Bus
	Including Inner Ring Road & Lochee Road	Diesel Car (&LGV, HGV, petrol car)

7.1.5 Each option and its variant will be assessed for its likely impact on the local transport network and its likely operational needs. This analysis may result in some of the eight emerging options being considered unsuitable and they will be removed from further appraisal or consultation. The outcome of this chapter will be a set LEZ options to be recommended for consultation and detailed traffic air quality modelling

7.1.6 The analysis in this chapter was undertaken in 2019 and reported in the Interim NLEF Stage 2 Assessment Report (*Dundee Low Emission Zone, National Low Emission Framework Interim Stage 2 Report, SYSTRA 2019)*. It utilises datasets from 2017 and these are still considered appropriate in the current timeline of the NLEF appraisal (April 2021)

and suitable for the needs at the time for defining LEZ options to be presented for future consultation and modelling.

7.2 LEZ Option 1: Inner Ring Road Bus LEZ

7.2.1 The option generation exercise identified the inner ring road (option 1) as a suitable area for a bus only LEZ and this is shown in Figure 7.1.

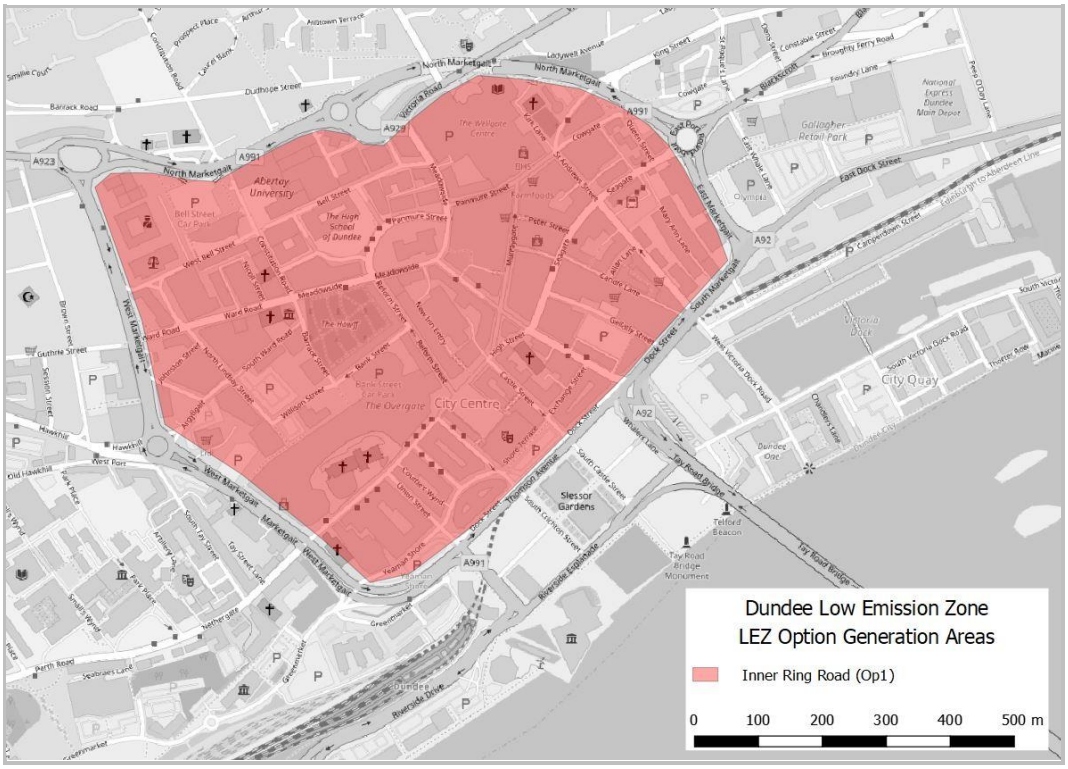


Figure 7.1 : Option 1A – Inner Ring Road Bus LEZ

7.2.2 As a bus only LEZ, it is important to understand the key bus movements and routes that will be impacted by this LEZ Option 1A. There are 10 key entry and exit points on the inner ring road for local bus service routes, as shown in Figure 7.2, on West Bell Street, Ward Road, Nethergate, Union Street Commercial Street, Trades Lane, Seagate, King Street, Meadowside and Victoria Road/Meadow Place.

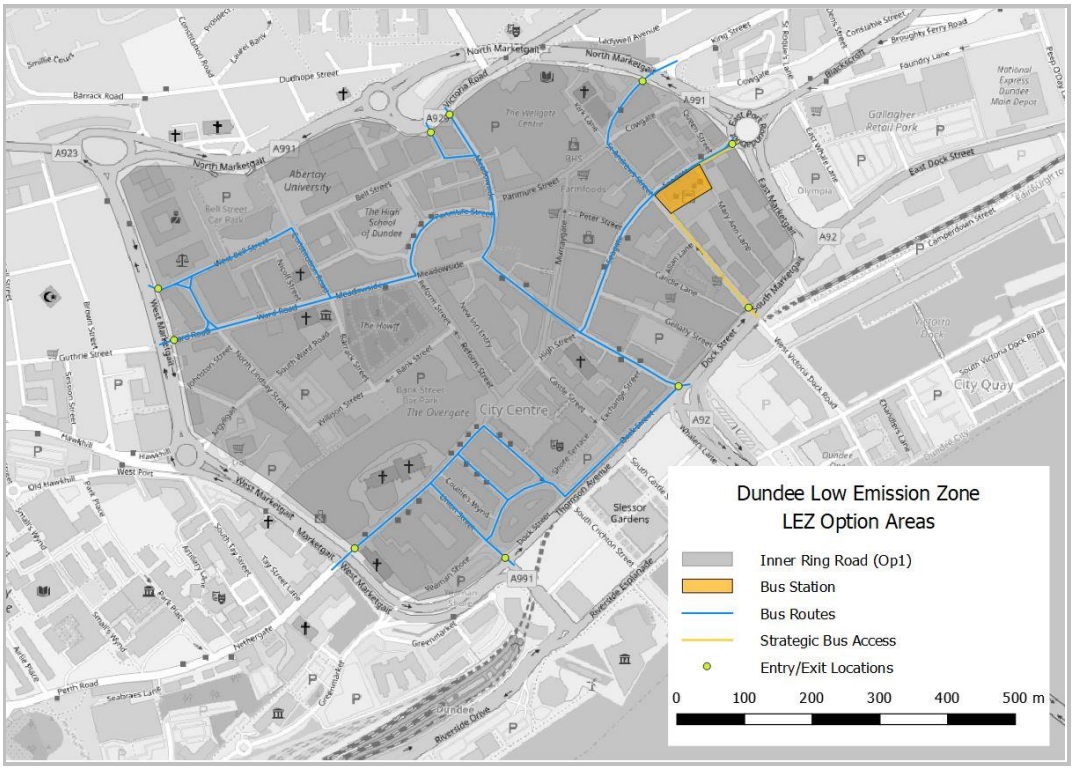


Figure 7.2 : Inner Ring Road Bus Routes with entry/exit locations

7.2.3 There is a key access point at Trades Lane/A911/A92 junction allowing strategic access to Dundee bus station that is located at the junction of Seagate and Trades Lane. The bus station is accessed from Trades Lane or Seagate, depending on the route of each service. It may therefore be desirable to alter the LEZ option area to exclude Seagate, between East Port roundabout and the bus station exit and Trades Lane. This would allow strategic bus services that connect Dundee with other regions and Scotland's cities to serve Dundee without being impacted LEZ restrictions. Consultation with bus operators will be crucial to provide further information on the acceptability of such options. It should also be noted that the north end of Trades Lane is currently closed due to a construction development at Trades Lane/Seagate junction and this has altered access to the bus station and will continue to do so for some time. Cognisance of the access arrangements to the bus station must be considered if this option is brought forward as a LEZ for Dundee.

7.2.4 A possible bus only LEZ option variant (Option 1B) that allows access to the bus station is shown in Figure 7.3.

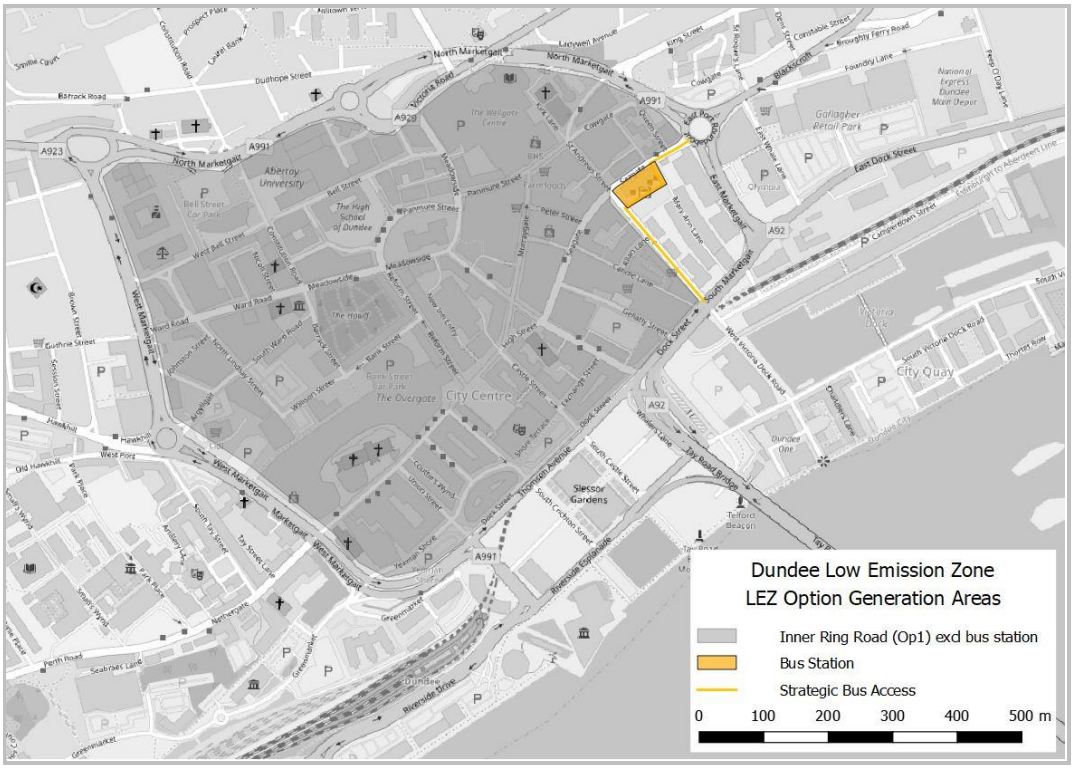


Figure 7.3 : Option 1B – Inner Ring Road Bus LEZ excluding bus station

7.2.5 The entry/exit locations shown in Figure 7.2 could possibly serve as locations for LEZ camera enforcement and signage however it is likely that there will also be a requirement to have camera coverage on all entry and exit points to the proposed LEZ area to capture non-timetabled services buses such as tour buses, community buses or school buses. There is one school (The High School of Dundee) located within the Option 1 boundary (on Euclid Crescent) with six dedicated bus services that use the above entry/exit points that would therefore be captured by either of bus only LEZ option variants.

7.2.6 Based on the above bus route analysis and consideration of Dundee bus station, two options are considered as viable LEZ options to be progressed to wider consultation:

- Option 1A – Inner Ring Road Bus Only
- Option 1B – Inner Ring Road Bus Only, excluding Dundee Bus Station

7.2.7 It is recommended that these LEZ options are taken to wider consultation and if required detailed testing is undertaken using the NMF and the Paramics microsimulation traffic model.

7.3 LEZ Option 2: Kingsway Bus LEZ

7.3.1 The option generation exercise identified the Kingsway option (excluding the trunk road network) as a possible suitable area for a bus only LEZ as shown in Figure 7.4. The proposed LEZ area is bound by the A90 (T) Kingsway to the north, the A85 Riverside Drive to the south and the A92 (T) East Dock Street/Greendykes Road to the East.

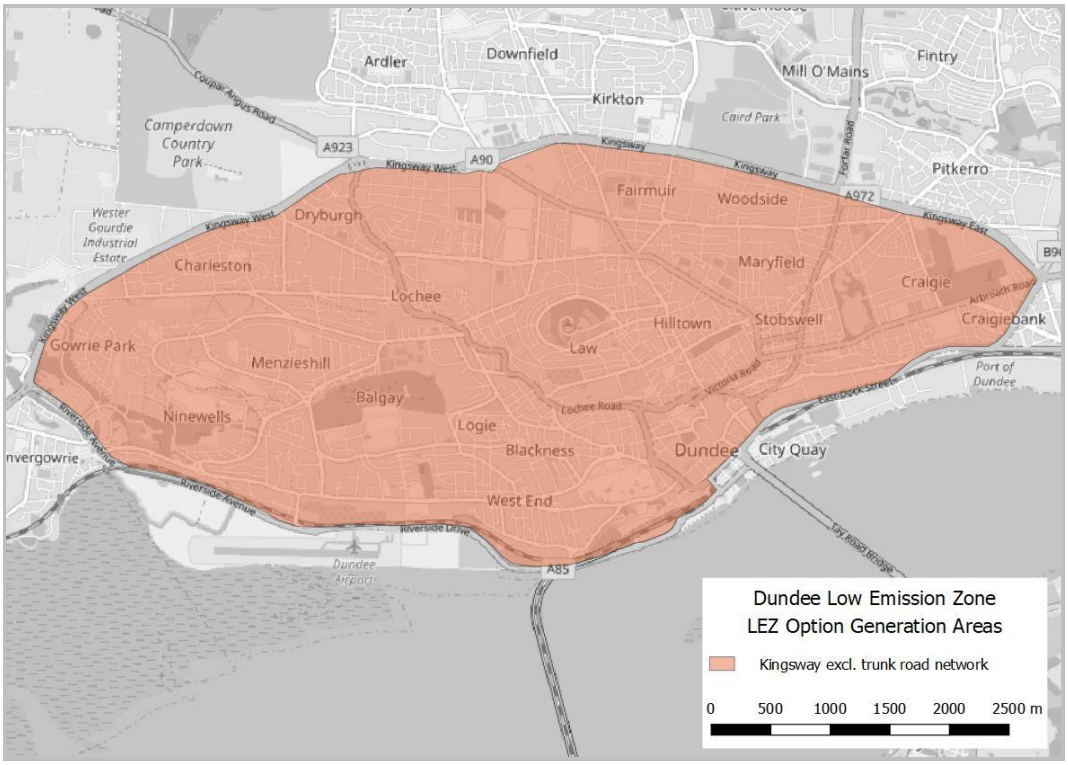


Figure 7.4 : Option 2 – Kingsway Bus LEZ

7.3.2 This option allows for strategic bus services that not do not enter Dundee to remain on the trunk road network with their journey not influenced by the LEZ. However, as noted above, a number of strategic bus services stop at Dundee bus station and these services would be required to comply with LEZ restrictions. As such, an option variant in line with the Option 1B excluding Dundee bus station could be considered a possible variant.

7.3.3 The NMF modelling has shown that a Kingsway wide LEZ for buses would have a similar impact on emissions as an inner ring road option. Both options emerged from the high level option development and screening process by meeting all necessary screening criteria. Investigating the Kingsway option in more detail highlights the greater difficulty in implementing and monitoring a wide area option for buses.

7.3.4 As well as capturing fixed bus route services operated in the city, a Kingsway option would be required to capture any bus that entered the area. Schools are one of the main generators of bus trips in the city per day and there are 48 schools in the Dundee Council area. Many are inside the Kingsway area and offer a bus service for eligible school pupils. These bus services would be required to be of LEZ standard (Euro VI) or they would incur the LEZ penalty fare. DCC runs 46 of the 48 schools and the cost associated with ensuring the school bus fleet was of LEZ standard or paying the LEZ penalty may fall to the council or the council may find it difficult to contract an operator to serve the schools. This may be considered impractical or not cost effective for the council.

7.3.5 There are two professional football teams in Dundee, with their stadiums located inside the Kingsway area. Each site will generate a regular number of bus trips taking fans to and from the stadium. All trips would be captured by a Kingsway LEZ and all buses would need to be of Euro VI standard to avoid penalty. This is considered unlikely and there would likely be strong opposition from each club if access to the stadiums is limited for non-compliant vehicles. An option variant could allow access to the stadiums, which are located less than 1 mile from the A90(T) Kingsway, although this would require increased signage, camera placement and public information events.

7.3.6 Other generators of bus trips may be community groups or local organisations that may utilise private bus services. There are currently 933 organisations listed in the Dundee

Directory of Local Organisations and it would be vital that these groups are consulted if this options was to be progressed.

7.3.7 The Kingsway bus LEZ would require a substantially higher number of cameras to enforce the LEZ than an inner ring road option and there would be a need for a wider signing strategy. Although not costed at this stage, it can be assumed that the cost of implementing and undertaking ongoing monitoring and enforcement of a Kingsway LEZ would be much greater than that of the smaller inner ring road options. Given the NMF results show there to be a similar benefit to air quality, the Kingsway bus option is not considered suitable to be progressed further in the appraisal process and is not recommended for consultation.

7.4 LEZ Option 3: Inside Inner Ring Road All Vehicle LEZ

7.4.1 The option generation exercise identified the area inside the inner ring road as a potentially suitable area for a bus and diesel car (plus HGV, LGV and/or petrol cars) LEZ and this is emerging option shown in Figure 7.1 above. The option generation exercise was informed by the NMF results where it was shown buses and diesel cars are the highest contributors to NO_2 and that these vehicle types should be included in this LEZ option. It was also identified that, although HGVs, LGVs and petrol cars do not make substantial contributions to NO_2, their inclusion may be desirable to align with DCC plans and strategies. As such, the LEZ detailed here is an all vehicle LEZ and, should the option be considered suitable for wider stakeholder consultation, the choice of vehicle types included will be consulted on by those likely to be impacted by any LEZ.

7.4.2 A key consideration for a LEZ is the impact on non-compliant vehicles resulting from restrictions in entering the LEZ area. Dundee's road network is such that no strategic trips should route through Dundee city centre but stay on the inner ring road. Dundee city centre however is a major trip attractor and generator with multiple land uses. City centre car parks are a key start and end point for vehicle trips to and from the city centre with the primary car park locations and LEZ Option 3A shown in Figure 7.5.

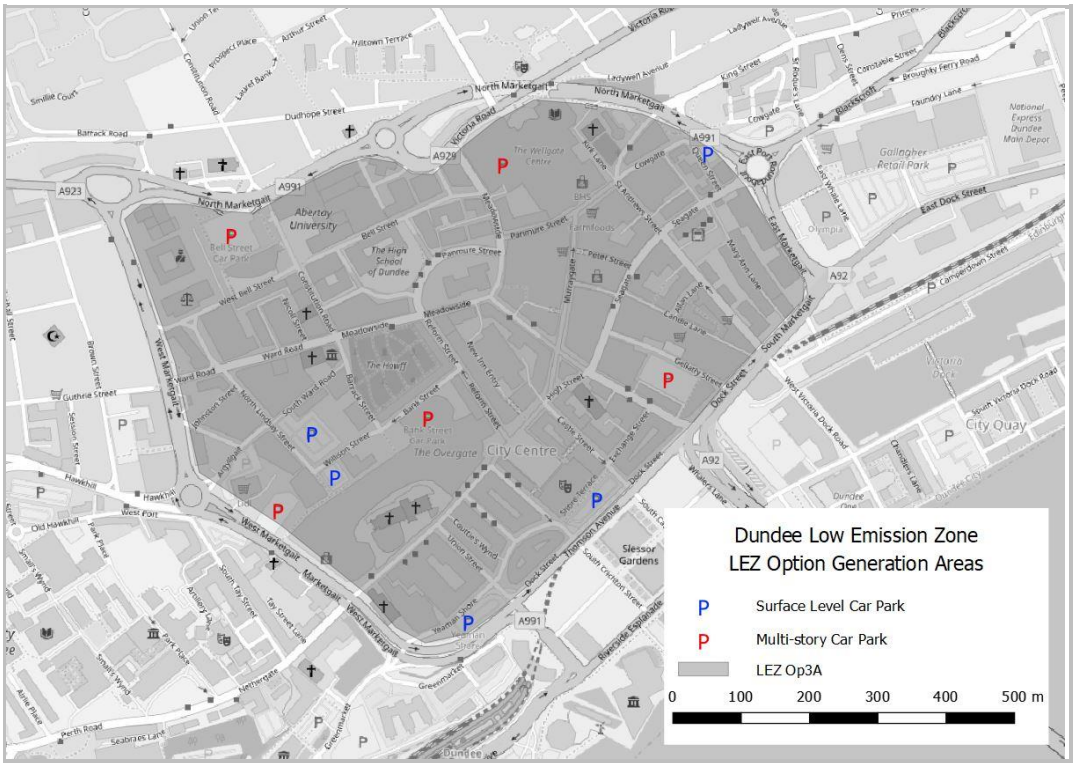


Figure 7.5 : Inside Inner Ring Road All Vehicle LEZ (Option 3A) and city centre car park locations

7.4.3 Car park occupancy surveys were undertaken in April 2019 at all multi-story car parks in Dundee and the data can be used to estimate the total number of non-compliant vehicles

at each site and their possible capacity to accommodate non-compliant vehicles should they be excluded from an LEZ, as detailed below.

7.4.4 A number of multi-story car parks are located on the periphery of the proposed inner ring road LEZ area. The car park occupancy data allows analysis of possible option variants to assess options where continued access to certain multi-story car parks is viable and whether these car parks would have sufficient capacity to accommodate all non-compliant vehicles from those car parks remaining inside the LEZ.

7.4.5 There are five multi-story car parks in the inner ring road area and two are accessed directly from the inner ring road, namely DCC Bell Street and NCP West Marketgait, as shown in Figure 7.6. A variant of an all vehicle inner ring road LEZ that excludes these car parks to allow for continued access for non-compliant vehicles is possible and creates LEZ Option 3B.

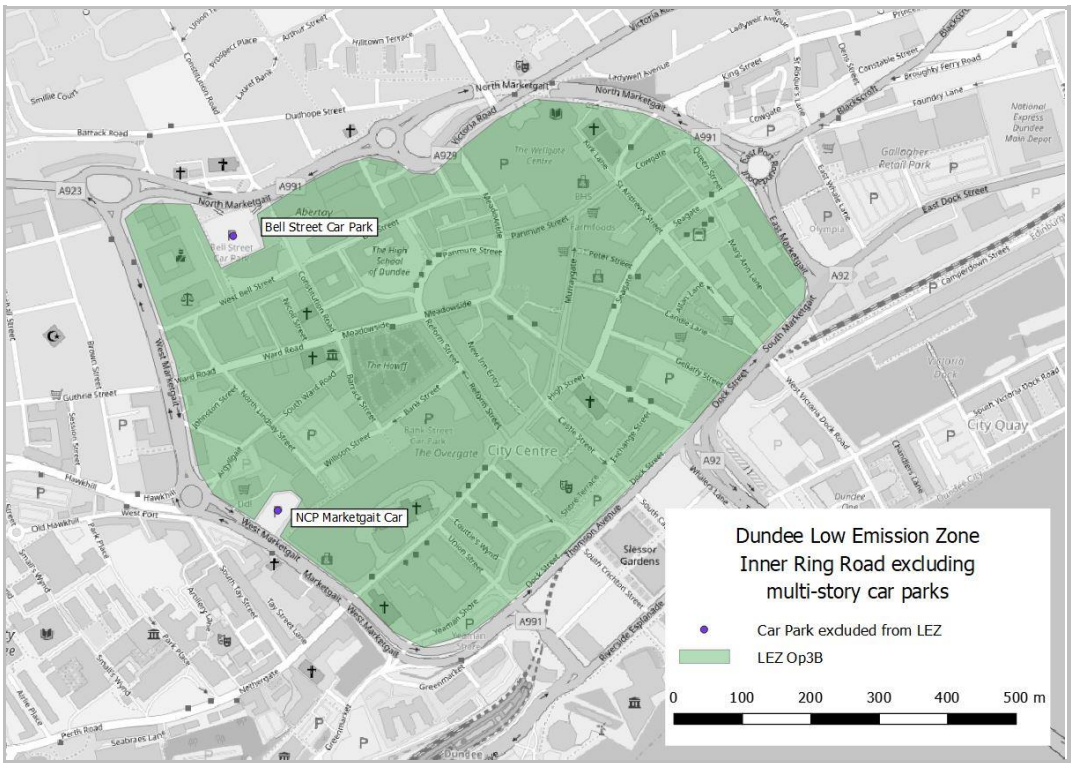


Figure 7.6 : Inner Ring Road LEZ excluding multi-story car parks (LEZ Option 3B)

7.4.6 The multi-story car park for the Wellgate Centre is accessed from the East Marketgait (inner ring road) with the exit on to Meadowside. Again an all vehicle inner ring road LEZ could be adjusted to allow the Wellgate Centre to be accessible to non-compliant vehicles to create LEZ Option 3C, as shown in Figure 7.7.

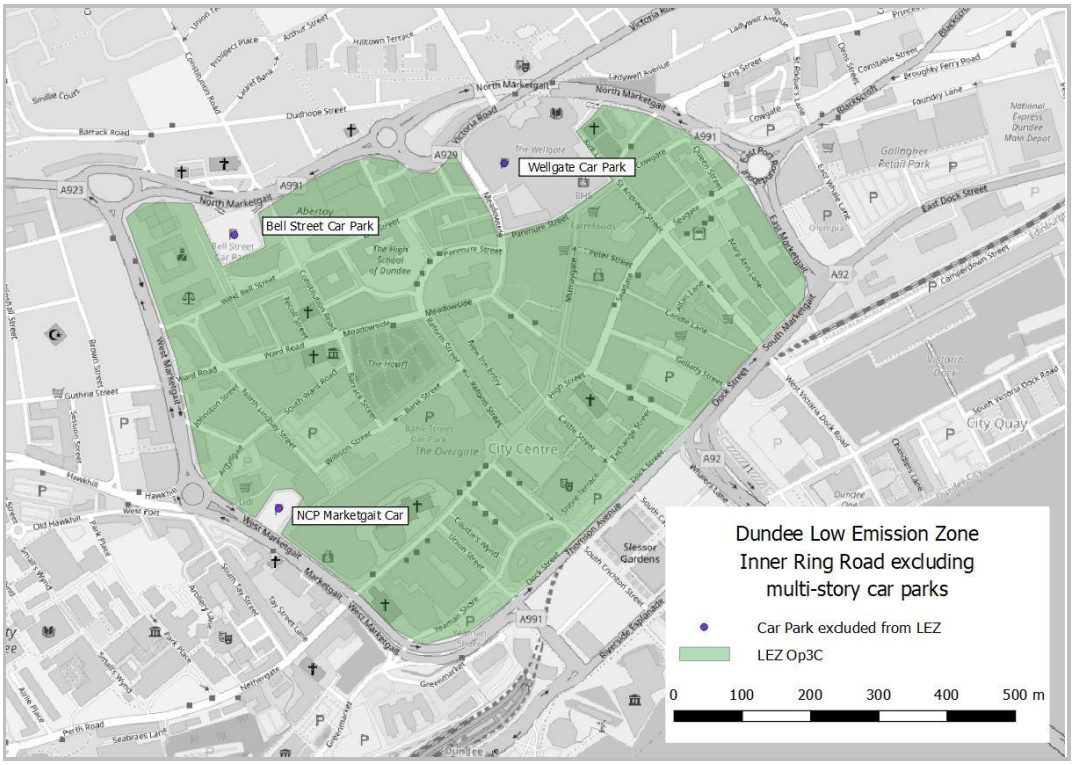


Figure 7.7 : Inner Ring Road LEZ excluding multi-story car parks (LEZ Option 3C)

7.4.7 Analysis of car park occupancy data (Table 7.2) shows that if all multi-story car parks are included in an all vehicle LEZ (Option 3A), there is sufficient capacity in Greenmarket car park and Olympia car park to accommodate non-compliant vehicles that are required to park outside the LEZ area. The total number of non-compliant vehicles at each car park was calculated (approximately 530 non-compliant vehicles) and this total was then split between Greenmarket and Olympia. Greenmarket reached full capacity and Olympia operates at 94% capacity. This is based on the assumption that the total volume of trips to each car park remains constant before and after any LEZ is in place and users do not switch modes to access the city centre.

7.4.8 If Bell Street and NCP West Marketgait car parks were excluded from a possible LEZ (Option 3B), the car park occupancy data shows there to be sufficient capacity in these two car parks to accommodate those non-compliant vehicles types that can no longer access other city centre car park without penalty. As in Option 3A, the total number of non-compliant vehicles at each car park was calculated (approximately 330 non-compliant vehicles) and this total was then split between Bell Street and NCP West Marketgait. This is based on the assumption that all trips that currently park inside the inner ring road continue to do so and use Bell Street and NCP West Marketgait car parks and do not utilise Greenmarket or Olympia (which they would still be able to do).

7.4.9 It is important to note that Shopmobility Dundee, a registered charity that provides mobility scooters and wheelchairs for access to Dundee city centre, is located at the NCP West Marketgait car park and the continued access to this service which this option provides ensures the LEZ does not discriminate against those who may require such provision.

7.4.10 Allowing access to Wellgate car park opens up additional parking for non-compliant vehicles and it therefore be inferred that this LEZ option variant (Option 3C) has sufficient capacity to accommodate all non-compliant vehicles.

Table 7.2 : Car Park Occupancy Analysis

Location	Number of spaces	Maximum observed occupancy[1]	Option 3A	Option 3B
Greenmarket	550	63%	100%	63%
Olympia	504	29%	94%	29%
West Bell St	930	46%	32%	78%
Overgate	718	72%	51%	51%
Wellgate	460	85%	60%	60%
Gellatly Street	430	52%	37%	37%
West Marketgait	280	88%	62%	100%
Total spaces	*3,872*	*2,298*	*2,298*	*2,298*

[1] Highest proportion of spaces filled at any point during the week 15-22 April 2019

7.4.11 There are nearly 1,700 further off-street spaces available for public use in surface level car parks in or on the periphery of the inner ring. These are in 18 different locations, 14 of which (comprising 791 spaces) are managed by the Council. Charges apply in all these except for the Gallagher retail park (630 spaces) and Lidl (90 spaces), which are available on a time-limited basis for customers only.

7.4.12 Dundee City Council provides approximately 530 charged on-street spaces for public use in the city centre, seeking in particular to meet short-stay demand and enable easy access for disabled people. There are estimated to be approximately 1,700 private residential or business car parking spaces in the city centre. These are not available for members of the public to use, but do influence total traffic volumes.

7.4.13 It is not considered possible to exclude any other car park than those identified (Bell Street, NCP West Marketgait or Wellgate) as no other sites have direct access from the inner ring road. Clearly if private and commercial car parking spaces are included in an inner ring road LEZ there would be an impact on traffic volumes inside and around the LEZ and full analysis of parking provision would need to be considered.

7.4.14 Dundee is a relatively compact city and it may be considered a viable alternative for many drivers of non-compliant vehicles to park outside an inner ring road LEZ. There are a number of surface level car parks outside the inner ring road and short-stay on-street parking spaces. A walking isochrone has been produced to understand the current parking provision inside a 5, 10 and 15 minute walk time from Dundee city centre, as shown in Figure 11.1 (estimate from Google Maps Direction Calculator). This shows that the majority of car parks outside the proposed inner ring road LEZ area are within a 10 minute walk of a central point in Dundee city centre (Caird Hall) and that parking provision outside the inner ring road area may be a suitable alternative for some. Clearly, not all existing car park users that park in the inner ring road area will be able to walk 10 or 15 minutes and any future parking strategy must take cognisance of emerging LEZ proposals that may alter the parking provision in the city.

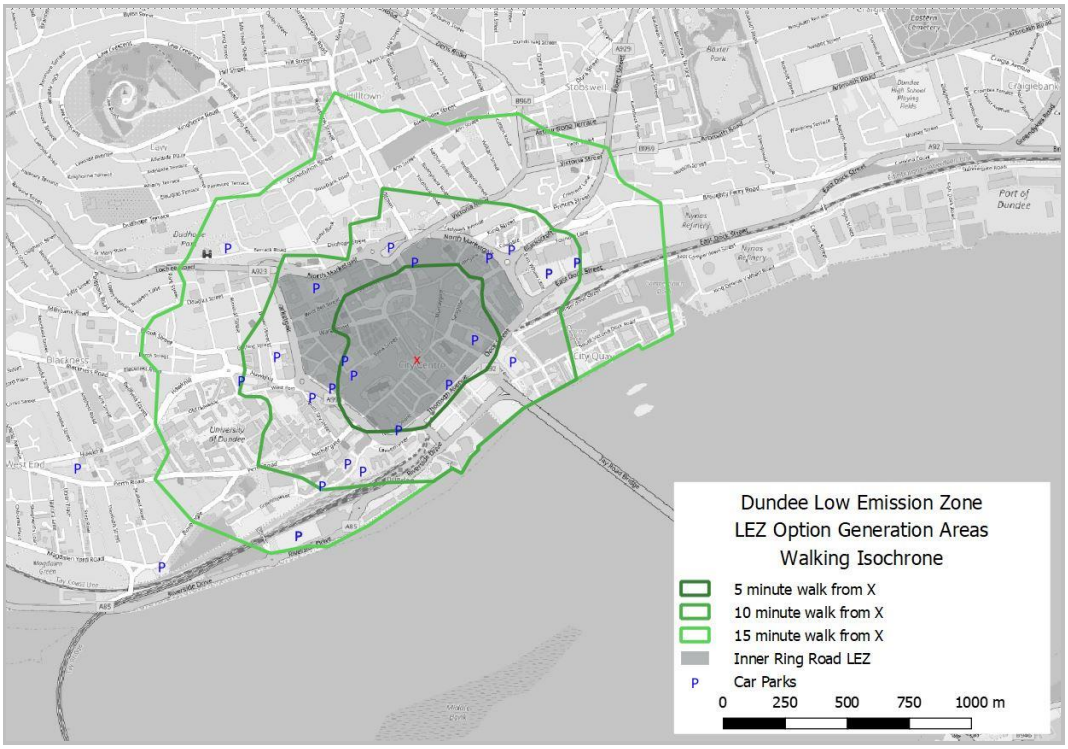


Figure 7.8 : Dundee City Centre Walking Isochrone

7.4.15 Based on the above analysis and consideration of Dundee city centre trip attractors and parking provision, three options are considered as viable LEZ options to be progressed to wider consultation:

- Option 3A – Inner Ring Road All Vehicles
- Option 3B – Inner Ring Road All Vehicles, excluding Bell Street and NCP West Marketgait car parks
- Option 3C – Inner Ring Road All Vehicles, excluding Bell Street, NCP West Marketgait and Wellgate car parks.

7.4.16 It is recommended that these LEZ options are taken to wider consultation and, if required, detailed testing using the NMF and the Paramics microsimulation traffic model. As noted, the precise vehicle types included in these options has yet to be determined and the vehicles restrictions should be informed through wider consultation with relevant stakeholders and model testing.

7.5 LEZ Option 4: Including Inner Ring Road All Vehicle LEZ

7.5.1 The option generation exercise identified the inner ring road area, including sections of the inner ring road itself, as a potentially suitable area for a bus and diesel car (plus HGV, LGV and/or petrol cars) LEZ and this emerging option shown in Figure 7.9. As in Option 3 above, the option generation exercise was informed by the NMF results where it was shown buses and diesel cars are the highest contributors to NO_2 and that these vehicle types should be included in this LEZ option. It was also identified that, although HGVs, LGVs and petrol cars do not make substantial contributions to NO_2, their inclusion may be desirable, either from a political view point or to align with DCC plans or strategies. As such, the LEZ detailed here is an all vehicle LEZ and should the option be considered suitable for wider stakeholder consultation and model testing, the choice of vehicle types included will be consulted on by those likely to be impacted by any LEZ.

7.5.2 The area represented in Figure 7.9 was purely indicative for the option generation and sifting stage and this option is now considered in more detail.

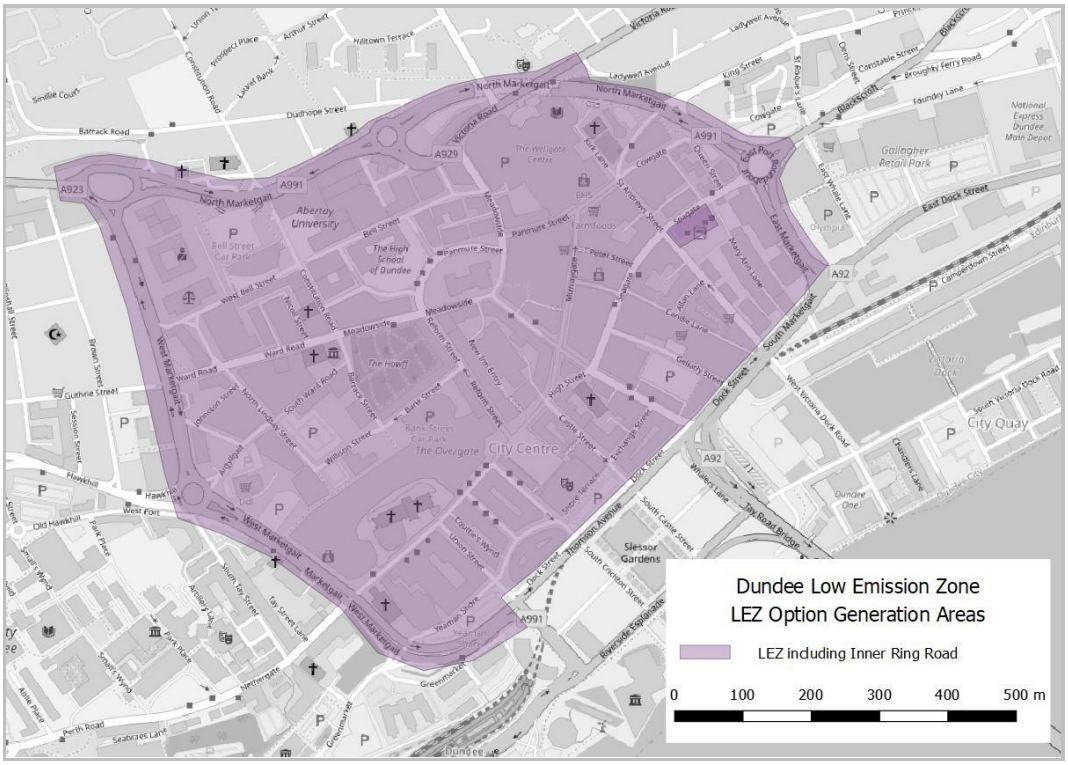


Figure 7.9 : Emerging LEZ Area – Including Inner Ring Road

7.5.3 Including sections of the inner ring road (defined as the A911 West Marketgait, North Marketgait, East Marketgait and Dock Street) in a LEZ will impact on the strategic routes in the city with non-compliant vehicles required to find alternative routes to avoid the LEZ. To assess the impact of such rerouting, the option is developed by incrementally adding sections of the inner ring road, particularly targeting locations of exceedance observed in 2017 (Section 5).

7.5.4 The proposed option includes buses and the impact on timetabled bus services in the city will not differ from that shown in the inner ring road bus only LEZ as described in Section 7.2. Non-timetabled buses however may be impacted by any option that includes sections of the inner ring road and this impact can be quantified through analysis of traffic survey data and detailed traffic modelling if the option is progressed to detailed assessment.

7.5.5 The first stage in developing this option incorporating key strategic routes, is to understand the total number of non-compliant vehicles that may be impacted by a LEZ including some of the inner ring road. Figure 7.10 shows the total 12 hour flow for non-compliant vehicles (diesel cars, HGVs, LGVs and petrol cars combined). Non-compliant vehicles have been calculated using traffic survey data collected by SEPA in 2017 for the NMF Dundee model development where Automatic Number Plate Recognition surveys identified the proportion of vehicle emission classes. Non-compliant vehicles are considered to be those below Euro VI for diesel HGVs/buses, Euro 6 for diesel cars and Euro 4 for petrol cars, in line with the Transport (Scotland) Act.

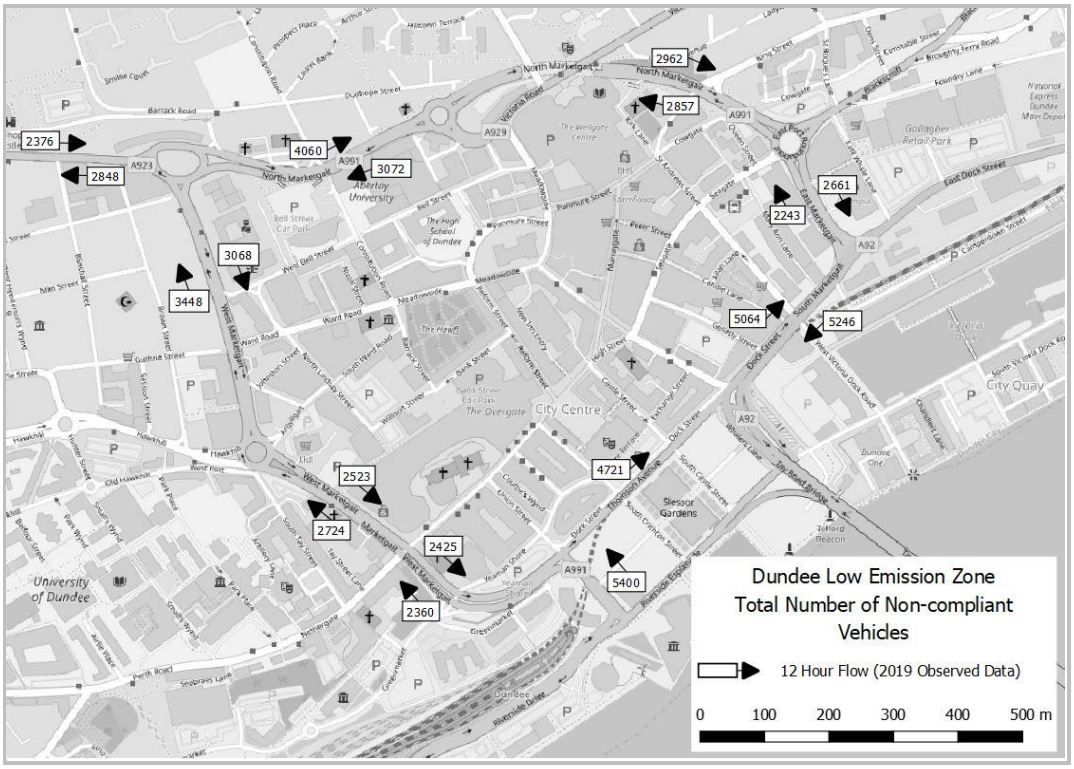


Figure 7.10 : Total non-compliant vehicles (12 hour flow) – Inner Ring Road

7.5.6 To develop the option, locations where there are existing exceedances of pollution standards are the first targets for investigation. On the inner ring road, there are recorded exceedances in 2017 annual mean concentrations of NO_2 in West Marketgait, Victoria Road and Dock Street. The NMF scenario results show that the inclusion of buses in a LEZ reduces NO_2 at these locations but that there are still exceedances on West Marketgait and Dock Street, as shown in Figure 7.11. It was also inferred from the NMF scenario results that the exclusion of non-compliant diesel cars from the inner ring road resulted in these remaining exceedance locations being removed.

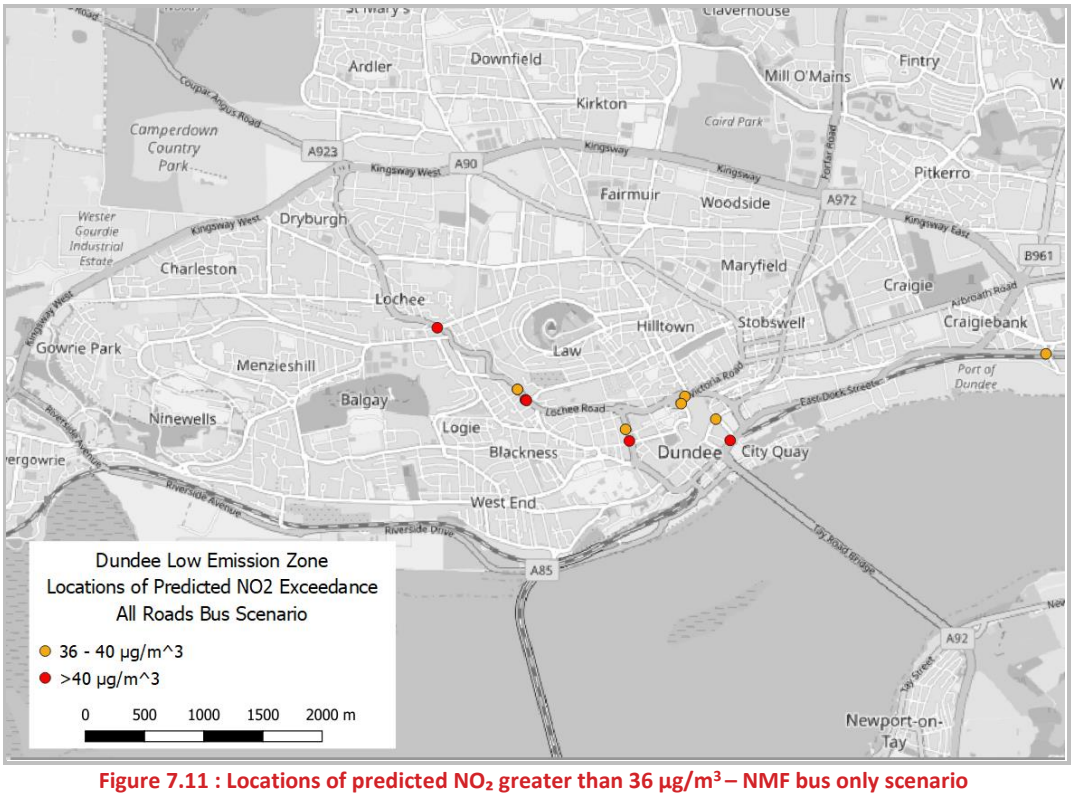


Figure 7.11 : Locations of predicted NO_2 greater than 36 µg/m³ – NMF bus only scenario

7.5.7 A first option (LEZ Option 4A), considers extending the inner ring road LEZ to include West Marketgait, where it can be inferred from the NMF scenario testing that the inclusion of

diesel cars will reduce NO_2 levels below 40 µg/m^3 on West Marketgait, with this option shown in Figure 7.12.

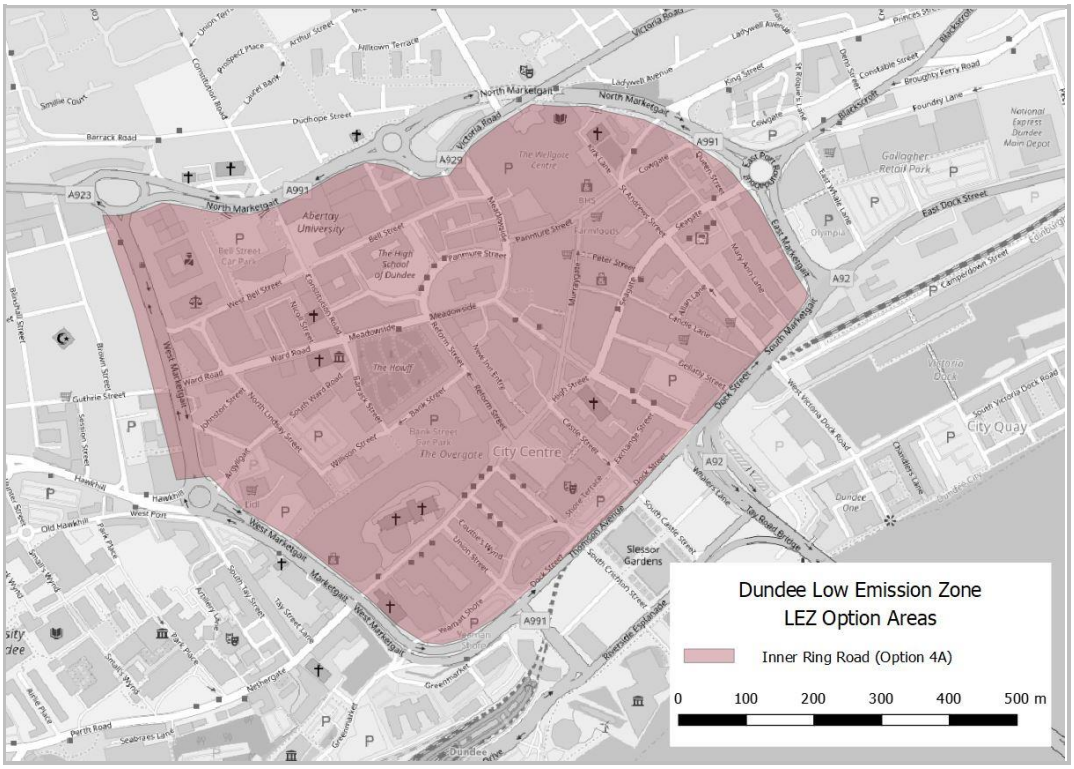


Figure 7.12 : Inner Ring Road (LEZ Option 4A) West Marketgait

7.5.8 This option is devised with roundabout junctions at the north and south of the West Marketgait section, allowing for vehicles to divert from the LEZ should they be non-compliant or not wish to enter the LEZ.

7.5.9 The 2017 traffic survey data (Figure 7.10) shows there to be a maximum of approximately 6500 non-compliant vehicles during a 12-hour weekday daytime period on West Marketgait that may be impacted by this LEZ. This non-compliant traffic will find alternative routes in the road network and detailed traffic modelling can inform the rerouting impacts of this option, should it be progressed to detailed testing. Modelled outputs can also be input to the NMF where the impact on modelled NO_2 will be calculated to inform of any additional exceedances resulting from the option. Traffic modelling can test the full extent that this option will have on local rerouting, should it be progressed, but it can be assumed during this qualitative appraisal that parallel routes may be used as alternatives.

7.5.10 The inclusion of West Marketgait in a LEZ restricting non-compliant vehicles will change the strategic routeing on the inner ring road. There may be an increase in non-compliant vehicles travelling on Hawkhill and Polepark Road and it may be assumed that many of these vehicles are likely to be those familiar to the local area and know this to be a viable alternative route. Hawkhill and Polepark Road are predominately narrow residential streets with frequent instances of on-street parking that require courtesy give way behaviour. Any increases in traffic flow on these routes is likely to lead to congestion with a higher volume of traffic than suitable for the standard of road which in turn may impact on the safety of pedestrians and other road users. The additional vehicle flow will comprise of the most polluting vehicle types and the option may result in negative impacts on the health of local residents, particularly children and the elderly.

7.5.11 It is assumed that the likely signed route to avoid this LEZ option would advise vehicles to remain on the inner ring road and this may see an increase in traffic on Dock Street, East Marketgait and North Marketgait. As shown in Figure 7.11, there is an exceedance location (for annual mean concentrations of NO_2) on Dock Street and there are additional

locations on the inner ring road that may experience exceedance if there is an increase in non-compliant vehicles.

7.5.12 The West Marketgait option will not directly impact the exceedance locations on Lochee Road (Figure 7.11) with non-compliant vehicles still able to route along Lochee Road. A second variant of the option can be defined to alter access to Lochee Road by the inclusion of North Marketgait. This option (LEZ Option 4B) is shown in Figure 7.13 and has been defined to exclude Dudhope roundabout allowing for vehicles to divert from the LEZ should they be non-compliant or not wish to enter the LEZ.

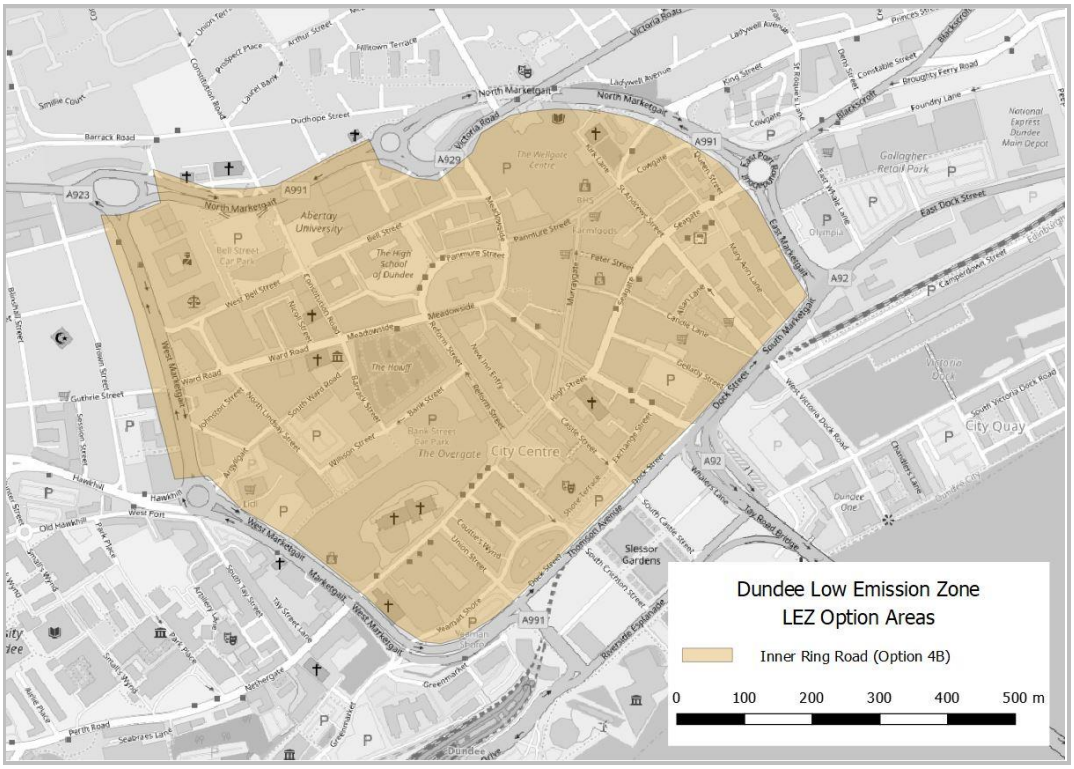


Figure 7.13 : Inner Ring Road (LEZ Option 4B) West Marketgait and North Marketgait

7.5.13 The 2017 traffic survey data (Figure 7.10) shows there to be approximately 8300 non-compliant vehicles on North Marketgait that may be impacted by this LEZ option. Again, detailed traffic modelling can test the full extent that this option will have on local rerouting should it be progressed to detailed testing but it can be assumed parallel routes may be used as alternatives for non-compliant vehicles.

7.5.14 The inclusion of North Marketgait in a LEZ restricting non-compliant vehicles will change the strategic routeing on the inner ring road and also impact traffic volumes on Lochee Road, between Dudhope roundabout and Polepark Road. However, this option does not prevent non-compliant vehicles from routeing via Hawkhill and Polepark Road to link Lochee Road and the inner ring road and, as noted above, this route is predominately residential in nature. It is also anticipated that this option may increase vehicle flow on Hilltown, Constitution Street and Dudhope Terrace and these streets are again predominately residential and any increase in vehicle flows will have the same associated negative impacts on congestion, safety and health. Again, the detailed traffic model can inform the rerouting impacts of this option, should it be progressed to detailed testing. Modelled outputs will be input to the NMF where the impact on modelled NO_2 will be calculated to inform of any additional exceedances resulting from the option.

7.5.15 A third option variant could be considered that extends the LEZ to include Dock Street only (and not include West Marketgait or North Marketgait), where there is a current exceedance location. However as the 2017 traffic survey data shows there to be 10500 non-compliant vehicles on Dock Street. As this is part of the Trunk Road network and there is no appropriate alternative route available for traffic moving between, a further appraisal of such an option is not progressed.

7.5.16 Defining the LEZ for Dundee to include the inner ring road network is shown to impact a high number of vehicles that would be required to find alternative routes to travel in the city. As the inner ring road is the only signed strategic route in the city centre, any other route utilised by non-compliant vehicles will not be fit for purpose. All option variants will move non-compliant traffic from existing routes with sufficient road capacity on to routes of a lesser standard. For this reason, it is considered that the existing Dundee road network is not suitable to allow a LEZ to include parts of the inner ring road and therefore all LEZ Option 4 variants are not recommended to be progressed to consultation.

7.6 LEZ Option 5: Inner Ring Road and Lochee Road All Vehicle LEZ

7.6.1 The option generation exercise identified the inner ring road and Lochee Road option as a potentially suitable area for a bus and diesel car (plus HGV, LGV and/or petrol cars) LEZ and this emerging option is shown in Figure 7.14. As in Option 4 above, the option generation exercise was informed by the NMF results where it was shown buses and diesel cars are the highest contributors to NO_2 and that these vehicle types should be included in this LEZ option. It was also identified that although HGVs, LGVs and petrol cars do not make substantial contributions to NO_2, their inclusion may be desirable, either from a political view point or to align with DCC plans or strategies. As such, the LEZ detailed here is an all vehicle LEZ and should the option be considered suitable for wider stakeholder consultation and model testing, the choice of vehicle types included will be consulted on by those likely to be impacted by any LEZ.

7.6.2 The areas represented in Figure 7.14 was purely indicative for the option generation and sifting stage and this option is now considered in more detail.

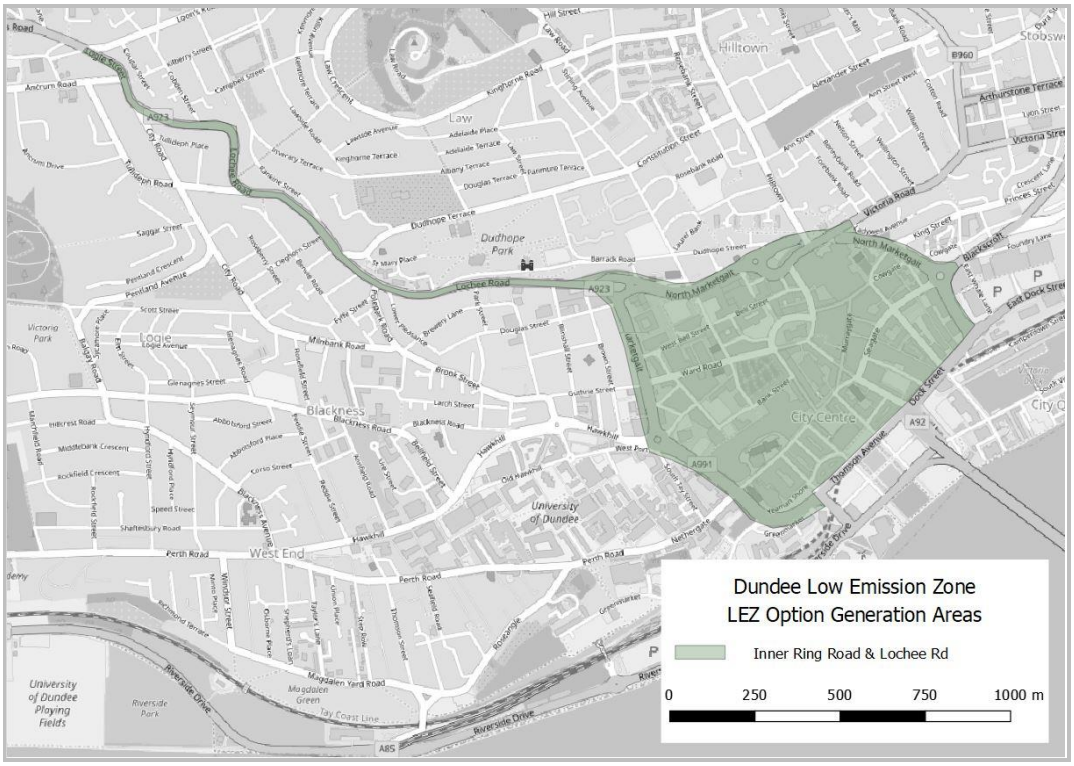


Figure 7.14 : Emerging LEZ Area – Inner Ring Road (Option 2) and Lochee Road

7.6.3 To assess the likely impact of this option, it is important to understand the total number of non-compliant vehicles that may be impacted by a LEZ. Figure 7.15 shows the total 12 hour flow for non-compliant vehicles (diesel cars, HGVS, LGVs and petrol cars) on the Lochee Road corridor with Figure 7.15 detailing the total non-compliant vehicles by individual vehicle type. Non-compliant vehicles have been estimated using traffic survey data collected in by SEPA in 2017 for the NMF Dundee model development where Automatic Number Plate Recognition surveys identified the proportion of vehicle emission classes. Non-compliant vehicles are considered to be those below Euro VI for

diesel HGVs/buses, Euro 6 for diesel cars and Euro 4 for petrol cars, in line with the Transport (Scotland) Act 2019.

7.6.4 Two-way 12-hour non-compliant vehicle flow along the Lochee Road corridor ranges from approximately 2000 to approximately 5500 vehicles between Dudhope roundabout and Logie Street/High Street. Any LEZ option that extends along Lochee Road will have to accommodate this non-compliant vehicle flow on alternative routes.

Figure 7.15 : Total non-compliant vehicles (12 hour flow) – Lochee Road

7.6.5 The option variant of the inner ring road (LEZ Option 4A) with West Marketgait (Figure 7.12) is considered the most viable inner ring road option to be combined with sections of Lochee Road. This option would exclude Dudhope roundabout from the LEZ allowing non-compliant vehicles the opportunity route away from the LEZ at Dudhope roundabout. The inclusion of North Marketgait is not required as the subsequent inclusion of Lochee Road performs a similar function in restricting non-compliant vehicles from Lochee Road.

7.6.6 The Lochee Road extension is added incrementally to ensure all permutations and associated impacts are considered. In the first variant, LEZ Option 5A, the LEZ is extended to Dudhope Terrace, as shown in Figure 7.16. The area is starts/ends immediately south of the signalised junction to allow use of Dudhope Terrace as a possible route to avoid the LEZ.

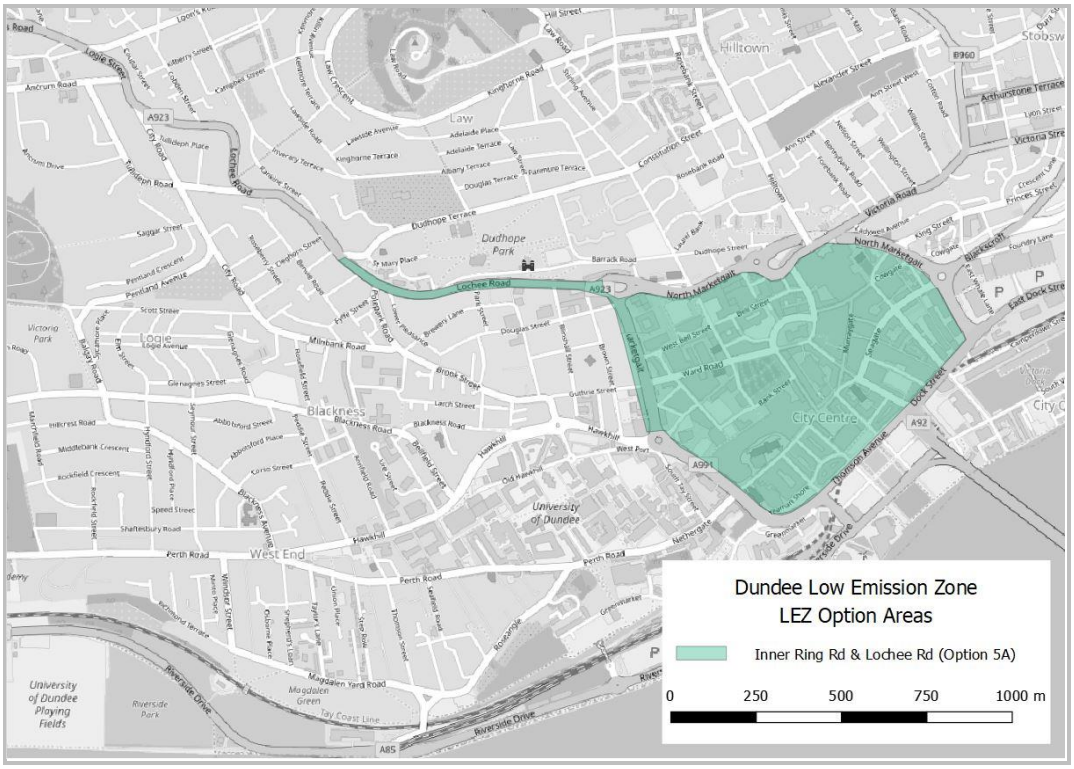


Figure 7.16 : Inner Ring Road and Lochee Road (LEZ Option 5A)

7.6.7 This option does not extend to any observed exceedance locations for NO_2 but will significantly alter the strategic routeing along Lochee Road and may result in reductions in NO_2 levels at remaining exceedance locations. Traffic data shows that up to 5500 non-compliant vehicles would be impacted by this option. As noted above, detailed traffic modelling can test the full extent that this option will have on local rerouting, should it be progressed, but it can be assumed during this qualitative appraisal that parallel routes may be used as alternatives.

7.6.8 It is assumed that drivers who wish to route to or from Lochee Road would do so using routes linking Lochee Road to the inner ring road such as Hawkhill, Brook Street and City Road or Hilltown/Constitution Street/Dudhope Terrace to avoid the LEZ area. If this were to be the case, non-compliant vehicles would continue to contribute to NO_2 levels at existing exceedance locations on Lochee Road and therefore this option variant is not considered a viable option. In addition, these alternative routes are predominately residential streets and as noted previously, any increases in traffic flow on these routes is likely to lead to congestion with a high volume of traffic for the standard of road which in turn may result in safety impacts of pedestrians and other road users. The additional vehicle flow will comprise the most polluting non-compliant vehicle types and the option may result in negative impacts on the health of local residents, particularly children and the elderly.

7.6.9 A second option variant, LEZ Option 5B, extends the LEZ area to the Logie Street/Loons Road junction as shown in Figure 7.17. This option covers all exceedance locations on the Lochee Road corridor and NMF results have shown the option would reduce all exceedance in annual mean concentrations of NO_2 to below 40 µg/m^3. As in LEZ Option 5A, this option would significantly alter strategic routeing along Lochee Road and would likely create alternative routes parallel route for non-compliant vehicles. The 2017 survey data shows the number of non-compliant vehicles impacted by such an option would range from 2000 to 5500. With the extended Lochee Road corridor included it is difficult to make assumptions on what alternative routes vehicles may choose and the longer the LEZ extends the less likely it is that vehicles will try to route back to the Lochee Road corridor. However as previous options, it is likely that alternatives are predominately of a residential nature.

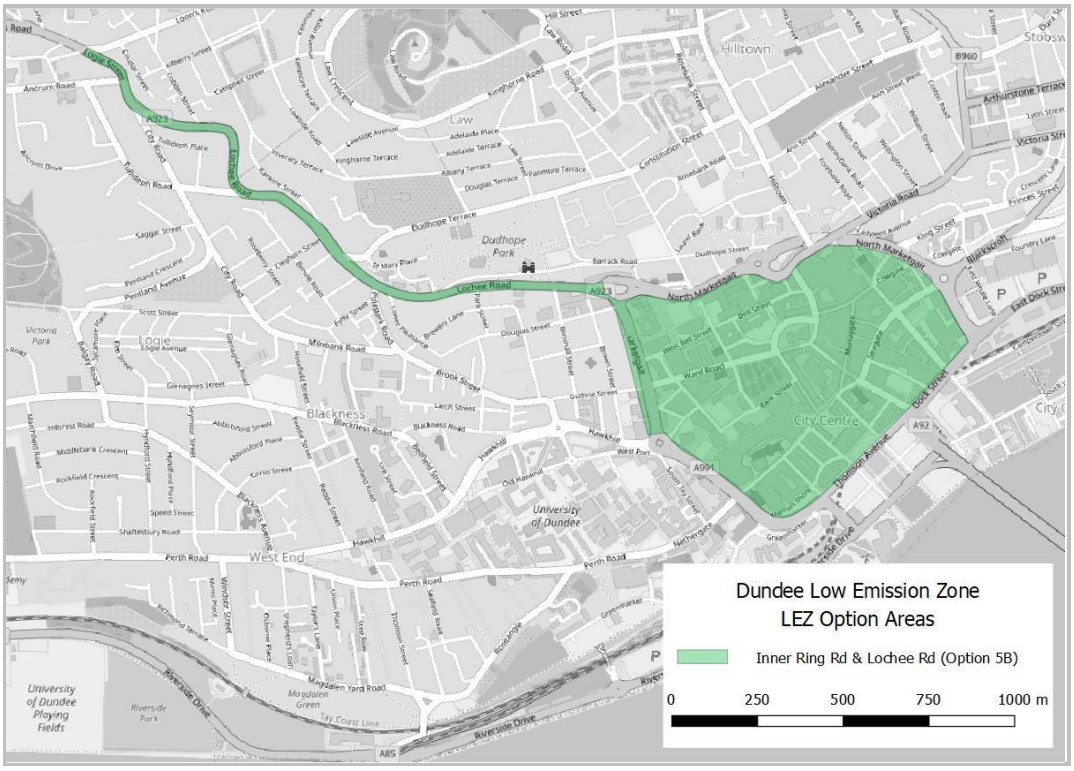


Figure 7.17 : Inner Ring Road and Lochee Road (Option 5B)

7.6.10 Defining the LEZ for Dundee to include the inner ring road and Lochee Road corridor is shown to impact a high number of vehicles that would be required to find alternative routes to travel in the city. As discussed with the inner ring road (LEZ Option 4), the Lochee Road corridor is a key signed north/south strategic route in the city, and any other route utilised by non-compliant vehicles is not considered to be fit for purpose. All option variants will move non-compliant traffic from existing routes with sufficient road capacity on to routes of a lesser standard. For this reason, it is considered that the existing Dundee road network is not suitable to allow a LEZ to include parts of the inner ring road and Lochee Road corridor and therefore all LEZ Option 5 variants are not recommended to be progressed to consultation.

7.6.11 The removal of LEZ Option 5 variants from further consideration will likely result in some exceedance locations remaining on the Lochee Road corridor. It is therefore recommend that Dundee City Council considers other non-LEZ options which could help to reduce pollution levels from traffic in these locations (as detailed in 7.10).

7.7 LEZ Options 6 – 8: Kingsway Bus Only Plus Inner Ring Road/Lochee Road

7.7.1 The emerging LEZ options resulting from the high level option generation and sifting exercise concluded that it may be possible to deliver the wide area Kingsway bus only LEZ together with a smaller area LEZ for diesel cars plus HGVs, LGVs and/or petrol cars and this led to three additional LEZ options:

- LEZ Option 6 – Kingsway Bus Only plus Inside Inner Ring Road All Vehicles
- LEZ Option 7 – Kingsway Bus Only plus Including Inner Ring Road All Vehicles
- LEZ Option 8 – Kingsway Bus Only plus Including Inner Ring Road and Lochee Road All Vehicles.

7.7.2 The detailed analysis of the individual options making up these combined options has concluded that all such combined options contain a LEZ option variant not suitable to be taken forward for wider consultation. As such, LEZ Options 6, 7, and 8 are also not recommended to be taken forward for consultation.

7.8 Summary of LEZ Option Analysis

7.8.1 The eight emerging options resulting from the high level appraisal have been further defined and analysed and in most cases the emerging option has been shown to have a number of possible variants.

7.8.2 The analysis of the inner ring road bus only option concludes two possible variants are viable LEZ options that should be progressed to consultation:

- Inner Ring Road Bus Only LEZ Option 1A – including bus station
- Inner Ring Road Bus Only LEZ Option 1B – excluding bus station

7.8.3 The option generation exercise identified the area inside the inner ring road as a suitable area for a bus and diesel car (plus HGV, LGV and/or petrol cars) LEZ. The detailed analysis has shown there to be three possible variants of this option that should be progressed to consultation:

- Inner Ring Road All Vehicles Option 3A – including all car parks
- Inner Ring Road All Vehicles Option 3B – excluding Bell Street and West Marketgait NCP car parks
- Inner Ring Road All Vehicles Option 3C – excluding Bell Street, West Marketgait NCP and Wellgate car parks.

7.8.4 The analysis of the Kingsway bus only LEZ concluded that that the cost of implementing and undertaking ongoing monitoring and enforcement of a Kingsway LEZ would be significantly greater than that of the smaller inner ring road options that, as NMF results show, have a similar benefit to air quality. The Kingsway option therefore is not considered suitable to be progressed further in the appraisal process and is not recommended for consultation.

7.8.5 A LEZ that included parts of the inner ring road network or the Lochee Road corridor is shown to impact a high number of vehicles that would be required to find alternative routes to travel in the city. As the inner ring road is the only signed strategic route around the city centre and Lochee Road is a key north/south strategic route, any other route utilised by non-compliant vehicles will not necessarily be appropriate. All option variants will move non-compliant traffic from existing routes with sufficient road capacity on to routes of a lesser standard. For this reason, it is considered that the existing Dundee road network is not suitable to adopt a LEZ that includes parts of the inner ring road or the Lochee Road corridor and such option variants are not recommended to be progressed to consultation.

7.8.6 It follows that the possible LEZ options combining the wide area Kingsway bus only LEZ and the smaller inner ring road options for all vehicles are not considered viable options and are not recommended to be progressed to consultation.

7.8.7 Table 7.3 summarises the results of the LEZ Option Analysis with LEZ Options 1 and 3, and their associated variants, recommended to be taken to consultation and model testing.

Table 7.3 : LEZ Option Analysis Results

Option Number	LEZ Area	LEZ Restriction	Progress to Consultation
Option 1	Inner ring road (Option 1)	Bus	Yes
Option 2	Kingsway (excluding trunk road network)	Bus	No
Option 3	Inner ring road (Option 1)	Bus & Diesel Car (&HGV, LGV, petrol car)	Yes
Option 4	Inner ring road (Option 2)	Bus & Diesel Car (&HGV, LGV, petrol car)	No
Option 5	Inner ring road (Option 2) & Lochee Road	Bus & Diesel Car (&HGV, LGV, petrol car)	No
Option 6	Kingsway (excluding trunk road network)	Bus	No
	Inner ring road (Option 1)	Diesel Car (&LGV, HGV, petrol car)	
Option 7	Kingsway (excluding trunk road network)	Bus	No
	Inner ring road (Option 2)	Diesel Car (&LGV, HGV, petrol car)	
Option 8	Kingsway (excluding trunk road network)	Bus	No
	Inner ring road (Option 2) & Lochee Road	Diesel Car (&LGV, HGV, petrol car)	

7.9 LEZ Options for Consultation and detailed model testing

7.9.1 The LEZ Option Analysis recommends that two emerging LEZ options be taken to wider consultation. The analysis has demonstrated that from these two emerging options there are five possible option variants. To provide a concise and understandable list for consultation and traffic and air quality modelling, the LEZ option numbering is reset and the LEZ Options are as follows:

- LEZ Option 1A - Inner Ring Road Bus Only, including bus station (Figure 7.18)
- LEZ Option 1B - Inner Ring Road Bus Only, excluding bus station (Figure 7.19)
- LEZ Option 2A - Inner Ring Road All Vehicles, including all car parks (Figure 7.20)
- LEZ Option 2B - Inner Ring Road All Vehicles, excluding Bell Street and West Marketgait NCP car parks (Figure 7.21)
- LEZ Option 2C - Inner Ring Road All Vehicles, excluding Bell Street, West Marketgait NCP and Wellgate car parks (Figure 7.22)

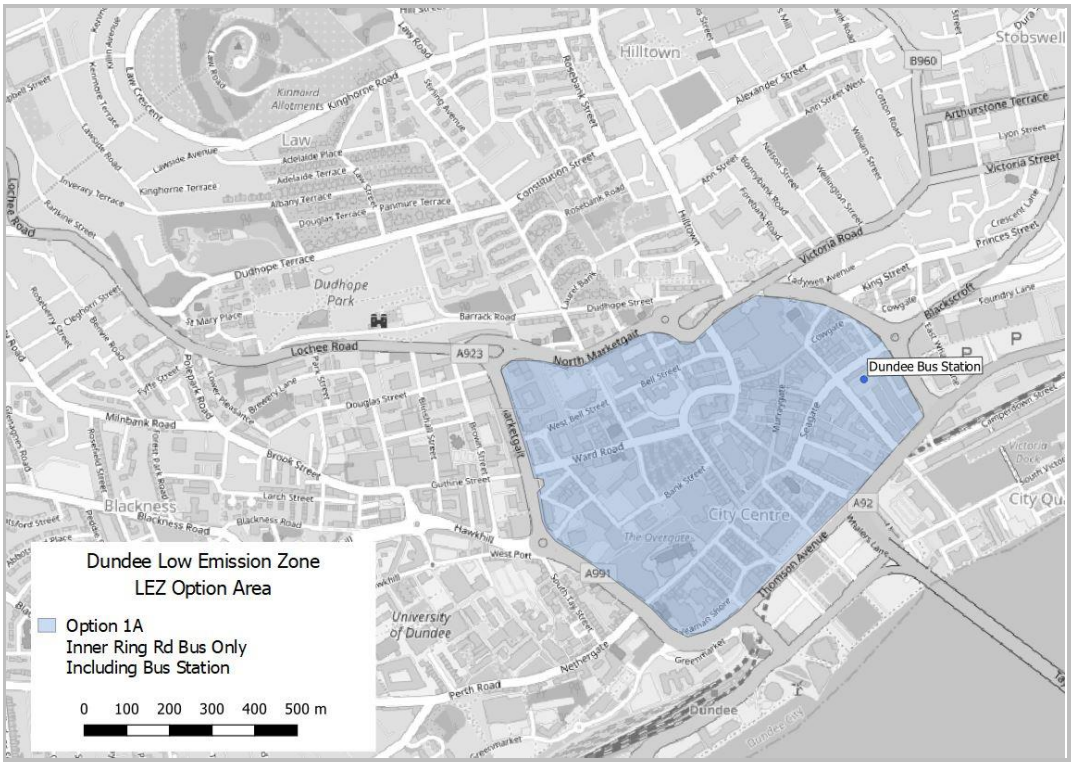


Figure 7.18 : LEZ Option 1A

Figure 7.19 : LEZ Option 1B

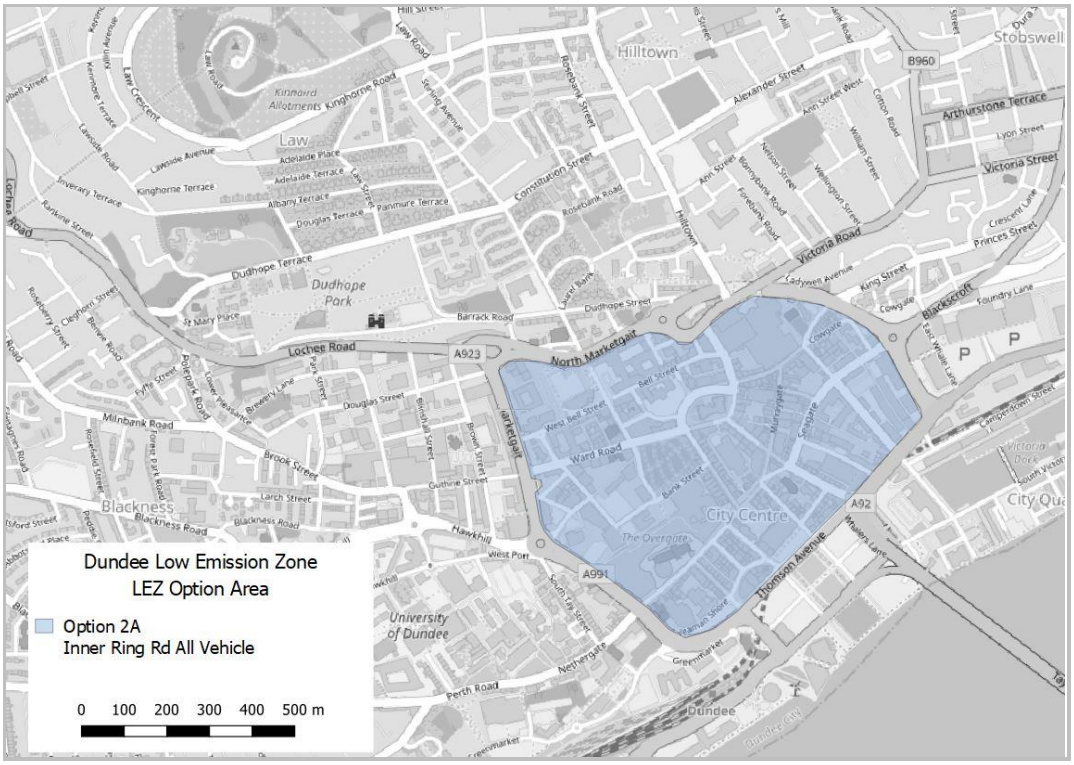


Figure 7.20 : LEZ Option 2A

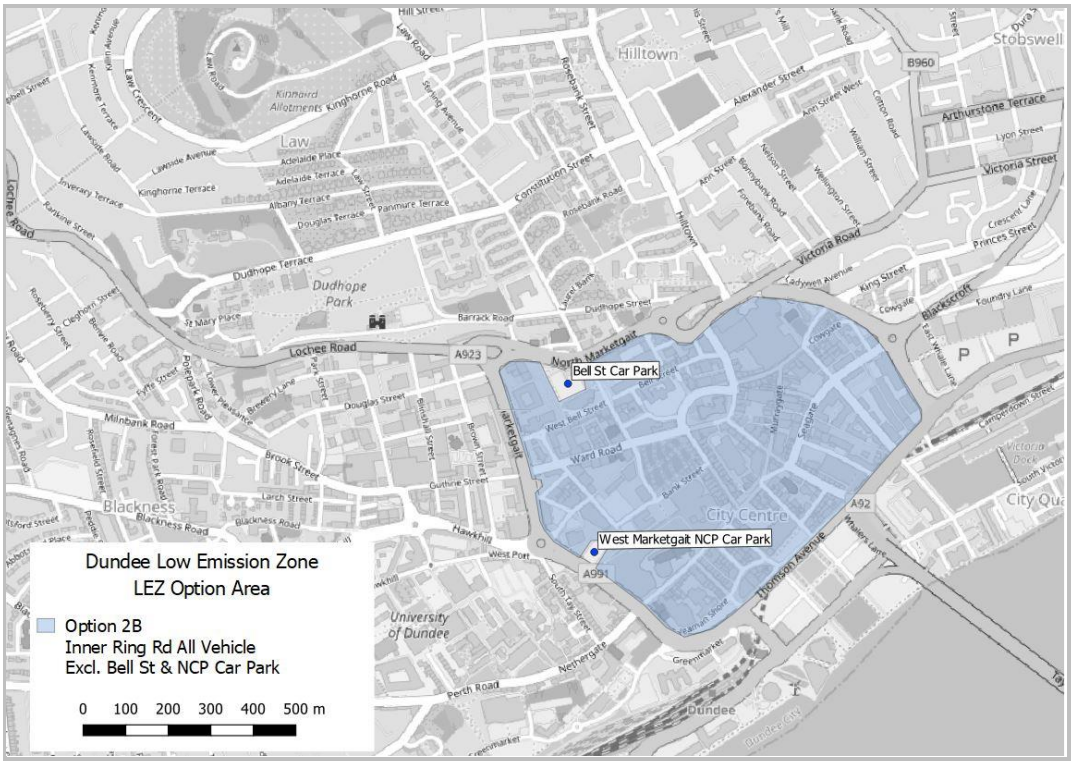


Figure 7.21 : LEZ Option 2B

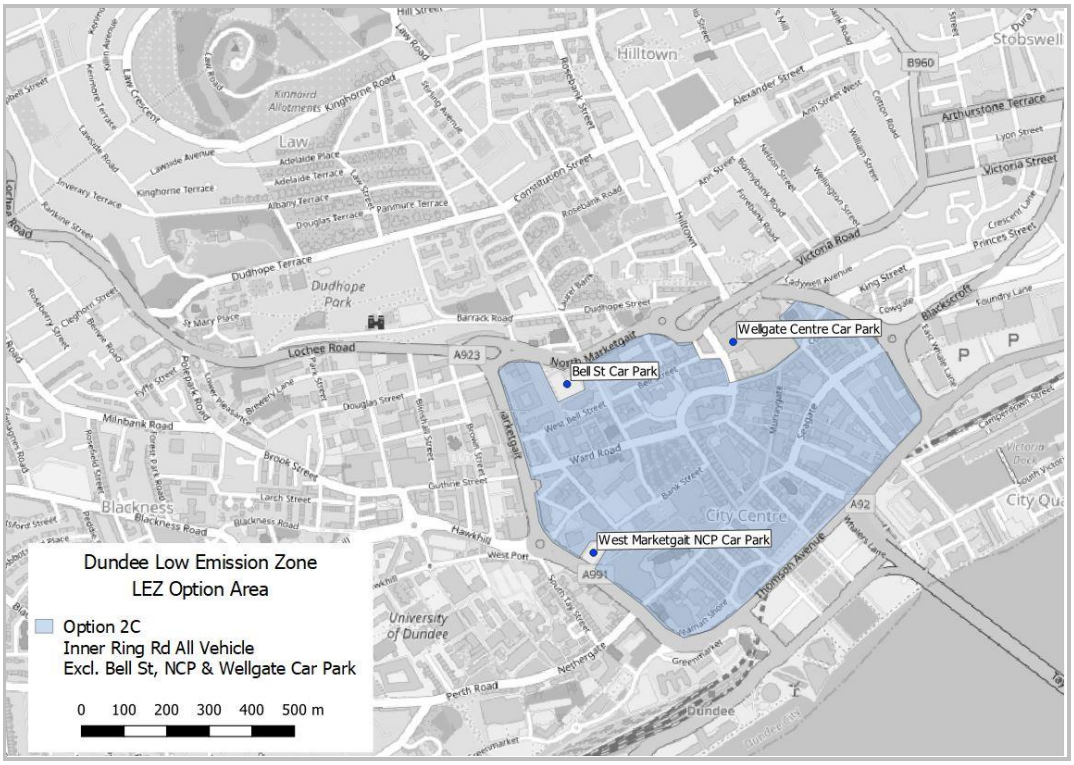


Figure 7.22 : LEZ Option 2C

7.9.2 Note, LEZ Options 2A, 2B and 2C are defined as all vehicle LEZs for the purposes of consultation and model testing. The final vehicle types included will be informed from the consultation and modelling exercises.

7.10 LEZ Options and Impact on Air Quality

7.10.1 It can be inferred from the NMF scenario testing that all five LEZ Options for consultation will not tackle all air quality exceedance locations, with exceedances in annual mean concentrations of NO_2 predicted to remain on Lochee Road, West Marketgait and Dock Street. The LEZ Option Analysis demonstrated that LEZ options which targeted these locations were not viable due to the expected rerouting of non-compliant vehicles. It

should be remembered however that at these locations, the introduction of any of the five remaining LEZ options does still improve concentrations of NO_2, bringing levels closer to the legal standards.

7.10.2 The predicted levels of NO_2, inferred from the NMF scenario outputs, at each 2017 exceedance location are shown in Table 7.4. As noted, a bus only LEZ predicts significant reduction to levels of NO_2 and at those locations where NO_2 is still exceeding the AQOs the overall level of NO_2 is still significantly falling (to within 10% of the limit of 40 µg/m^3). The introduction of all vehicle types to an inner ring road LEZ further reduces NO_2 levels at monitoring locations located inside the LEZ area. There may be additional reductions outside the LEZ area as drivers adjust their trip choice or mode as a result of the LEZ introduction but these impacts cannot be quantified from the NMF high level scenarios alone.

7.10.3 Grey cells in Table 7.4 show locations where the modelled reductions do not predict a sufficient reduction in NO_2 for observed levels to fall below 40 µg/m^3. Yellow cells show locations where levels of NO_2 are predicted to be between 36 µg/m^3 and 40 µg/m^3.

Table 7.4 : Predicted NO_2 for core LEZ options for consultation

Site Name	2017 Observed NO2	Predicted NO2 per Option	
		Inner Ring Road Bus Only (Op1)	Inner Ring Road All Vehicle (Op2)
Victoria Rd/Hilltown	51.5	37.4	32.0
Dock St (57)	49.4	42.9	42.9
Lochee Rd (140) Traffic Lts	48.1	41.7	41.7
Logie St (114)	47.9	42.2	42.2
Lochee Rd (138)	47.3	42.0	42.0
West Marketgait/Old Mill (23)	45.1	40.0	40.0
Seagate	44.3	27.8	25.7
West Marketgait / Guthrie St	44.1	40.2	40.2
Lochee Road (CM)	43.6	40.2	40.2
Lochee Road (DT)	42.6	36.3	36.3
Seagate (99)	42.5	38.4	36.5
Whitehall St (1)	40.9	24.3	22.5
Forfar Rd (104)	40.6	35.0	35.0
Broughty Ferry Rd (141)	40.0	38.5	34.7
Whitehall St (5)	39.5	24.4	24.4
Rankine St (2)	39.3	37.2	32.1
Meadowside Average	39.3	22.0	20.2
Nethergate (88)	39.1	27.6	25.9
Seagate (97)	38.7	24.3	22.5
Seagate Average	38.4	24.0	22.1
Broughty Ferry Rd (129)	38.2	35.3	35.3
Kingsway East Roundabout	37.9	35.3	35.3
Dock St (21)	36.7	24.7	24.7

7.10.4 NLEF Guidance states that "*it may be more appropriate to address the issue (air quality exceedance) by identifying additional location specific measures to be implemented through the AQAP, potentially through consideration of local transport measures. In this situation, the additional measures should be identified…along with a description of the likely contribution to removing exceedances" (NLEF, 2019).*

7.10.5 It is therefore important to note that the introduction of a LEZ is not the only tool which local authorities have to address air quality exceedance and it is recommended that the LEZ Options are delivered with targeted transport interventions at remaining exceedance

locations. The Paramics microsimulation traffic model of Dundee City Centre should be used to test the impact of any transport measures and outputs from the traffic model testing should be input to the NMF Dundee City Model to assess their impacts on removing the remaining exceedance locations.

7.10.6 DCC have identified traffic management measures to improve Lochee Road, with current progress provided in Chapter 10.2.3.

8. LEZ PUBLIC AND STAKEHOLDER CONSULTATION

8.1 Introduction

8.1.1 Section 11 of the Transport (Scotland) Act 2019 provides a list of statutory consultees, as follows:

- the Scottish Environment Protection Agency (SEPA)
- NatureScot (Scottish Natural Heritage)
- Historic Environment Scotland
- such persons as the local authority proposing the LEZ considers represent the interests of the road haulage industry, the bus and coach industry, the taxi and private hire car industry, local businesses, and drivers who are likely to be affected by the proposal.
- such other persons as the local authority considers appropriate.

8.1.2 Regulation 2 of the Low Emission Zones (Scotland) Regulations 2021 expands upon the 'other persons' list by including the following:

- Local authorities neighbouring the local authority responsible for the scheme,
- Regional Transport Partnerships in the area that the scheme will operate,
- NHS Health Boards in the area that the scheme will operate.

8.1.3 Upon completion of the Interim NLEF Stage 2 Assessment Report (*Dundee Low Emission Zone, National Low Emission Framework Interim Stage 2 Report, SYSTRA 2019)* DCC's Community Safety and Public Protection Committee gave approval on 30 September 2019 to undertake a consultation exercise on the five identified LEZ Options for consultation, as detailed in Chapter 7. The consultation took the form of an online public survey and face to face workshops with key (and statutory) stakeholders. The outcomes from the consultation period were reported to the Community Safety and Public Protection Committee in February 2020 and summarised here.

8.1.4 The LEZ Options presented for consultation were:

- LEZ Option 1A - Inner Ring Road Bus Only, including bus station (Figure 7.18)
- LEZ Option 1B - Inner Ring Road Bus Only, excluding bus station (Figure 7.19)
- LEZ Option 2A - Inner Ring Road All Vehicles, including all car parks (Figure 7.20)
- LEZ Option 2B - Inner Ring Road All Vehicles, excluding Bell Street and West Marketgait NCP car parks (Figure 7.21)
- LEZ Option 2C - Inner Ring Road All Vehicles, excluding Bell Street, West Marketgait NCP and Wellgate car parks (Figure 7.22Figure 11.1)

8.2 Public Consultation

8.2.1 An online public survey ran for six weeks from 4 October to 19 November 2019 and was administered by DCC. The survey was viewed 1902 times and was completed a total of 1336 times.

8.2.2 Most completions (96%) were by individuals and the greatest number of respondents (42%) live and work in Dundee. The largest single age group of respondents was those between 35 and 49 years old (29%). 44% of respondents visited the city centre most days or every day and 61% of total visitors used the car to make the journey. The largest group of respondents (41%) visited the city centre for work.

8.2.3 The survey included questions seeking to discover respondents' views on LEZs in general and specifically the potential options for Dundee that emerged from the Interim NLEF Stage 2 Report with:

- 65% of respondents supported the general principle of LEZs and;

- 60% supported the principle of a LEZ for Dundee.

8.2.4 Regarding the five LEZ options consulted on, the survey produced the following results:

- 30% considered that the LEZ should apply to buses only (options 1A & 1B combined)
- 64% considered that it should apply to all vehicle types
- 33% (the greatest percentage of respondents) thought option 2C would have the greatest impact on air quality.
- 32% (the greatest percentage of respondents) thought option 2C would do most to promote sustainable transport
- 37% (the greatest percentage of respondents) thought option 2C would do most to promote Dundee as an inclusive and desirable place to live, invest , visit , and learn
- 35% (the greatest percentage of respondents) preferred option 2C for the design of the Dundee LEZ. Option 2A was the next most popular preference at 24%.
- With regard to the length of grace period before LEZ enforcement begins, 31% of respondents wished for this to be as short a period as possible, 36% wished for this this to be as long as possible and 29% wanted an intermediate grace period preference.

8.2.5 The consultation also allowed for comment on other possible LEZ design options and a wide range of views were expressed. Out of the 1336 respondents, 641 provided some comments at this question, however not all were in respect to possible design options and included comments on LEZs in general.

8.2.6 Of the 641 comments, 148 respondents (11% of overall 1336 surveys) indicated that they believed that Lochee Rd should be included within the design of the LEZ. 43 of these respondents utilised the prescribed text provided for respondents by Friends of the Earth Scotland. In addition to including Lochee Road, many other streets/roads/areas were specified for inclusion in the LEZ by respondents, such as Albert Street (8), Perth Road (7), the area within the Kingsway (7), the entire Dundee Air Quality Management Area/as large as possible (6). 161 respondents (12% of overall 1336 surveys) wrote that there should not be a LEZ for Dundee at all, giving various reasons for this.

8.2.7 The information captured in the public consultation points towards a strong preference for all vehicles to be included in a LEZ in Dundee. Option 2C, the area inside the inner Ring Road for all vehicles but excluding Bell Street, West Marketgait NCP and Wellgate car parks, as shown in Figure 11.1, was identified as the preferred LEZ option. It should be noted however that Option 2C was the last option shown in sequence and this may have weighted the preference for this option.

8.3 Stakeholder Consultation

8.3.1 A range of workshops with key stakeholders were held concurrently with the live public survey dates during October and November 2019. 10 workshops were held in total and the format involved a presentation by a member of the Dundee LEZ Delivery Group on the Interim NLEF Stage 2 Report findings and the recommended LEZ options, followed by a questions and answer session. Key stakeholders were also invited to submit a formal written response on their views on the LEZ proposals. The stakeholders represented at the workshops were as follows:

- Bus industry representatives:
  - Stagecoach East Scotland, Xplore Dundee, Moffat & Williamson and the Confederation of Passenger Transport (CPT)
- Freight industry representatives:
  - Logistics UK (Freight Transport Association), Road Haulage Association, United Parcel Service (UPS), local freight operators
- The Tayside and Central Regional Transport Partnership (Tactran)
- Business community:

- DDOne, Federation of Small Businesses (FSB) and Dundee & Angus Chamber of Commerce, local businesses
- Community Councils:
  - Stobswell Forum, City Centre & Harbour, West End
- Environmental/interest groups
  - British Lung Foundation, Friends of the Earth Tayside (FoET), Friends of Riverside Nature Park, Scottish Wildlife Trust and Extension Rebellion, Dundee Civic Trust, Dundee Resource & Re-Use Centre
- Taxi representatives
- Car park operators (no response)

8.3.2 In addition to representation from the bus operators during the consultation period, Stagecoach East Scotland, Xplore Dundee and Moffat & Williamson have been engaged in the development of proposals since spring 2019, given their importance to the implementation of any LEZ in the city. Two joint face-to-face meetings were held with them. An initial meeting in April 2019 gave an overview of the process, and a further meeting in August 2019 (also attended by CPT) presented the emerging options.

8.3.3 A detailed summary of the outcomes from the workshops and the written submissions from the key stakeholders is provided in Appendix 2 of the Community Safety and Public Protection Committee Report (February, 2020). The key themes that emerged from the stakeholder engagement were:

- Of those that stated a preferred scheme option, Option 2A (all vehicles and no car parks excluded) was the preferred option.
- The bus station does not serve all bus operators and should not be excluded from any LEZ option
- Business representatives were concerned that restricting private vehicles may be negative to local businesses in the LEZ area with a wider belief that a LEZ may negatively impact on city centre businesses
- Concerns expressed that parking will be displaced into residential areas neighbouring the city centre
- Concerns expressed that Lochee Road, including some of the highest air quality exceedances, was not included in any LEZ option and this should be examined further
- A general theme across all groups that a maximum grace period is needed
- Financial support for individuals/businesses is needed to enable them to switch to compliant vehicles
- Exemptions should be provided for certain vehicles (disabled drivers, vintage vehicles)

8.3.4 Many of the discussions held and submissions received highlighted the need for complementary measures to improve traffic flow, reduce traffic volumes and encourage the use of sustainable modes. Those most commonly stated were:

- The LEZ should not be implemented in isolation and needs to be part of a wider delivery programme for the city
- Park and ride sites for Dundee were commonly requested. The south Tay Bridge site is considered “ready” by many stakeholders for a park and ride to be delivered and sites on the eastern and western edges of the city should also be considered.
- Traffic management measures are required in the city to improve congestion and provide more journey time reliability. These should be provided as part of the LEZ package.
- Investment in public transport, walking and cycling is required. This includes improved pedestrian access to the city centre and LEZ, additional cycle lane facilities, cycle parking and electric cycle provisions. The bus network would benefit from additional bus lanes and priority (and improved vehicles) to encourage drivers to switch to public transport.

8.4 Focussed Covid-19 Consultation

8.4.1 In response to the Covid-19 pandemic the national LEZ Leadership Group announced in May 2020, a temporary pause in plans to implement LEZs across Scotland. Plans were formally resumed in August 2020 and a new indicative timescale for the introduction of LEZs was published, that aims to see their introduction between February and May 2022.

8.4.2 It is recognised that the Covid-19 pandemic has had an unprecedented impact on society, including on the wider environment and the economy. Transport Scotland and DCC recognise that the Covid-19 pandemic may significantly influence future travel demand and in turn emissions attributed to road transport. Transport Scotland commissioned a study to consider the uncertainty over what travel will look like after the Covid-19 pandemic has ended, and this is summarised in Chapter 9.

8.4.3 In light of the difficulties faced by many throughout 2020 and 2021, particularly, in the context of a Dundee city centre LEZ, city businesses and bus operators, DCC were keen to understand the level of support for the introduction of a LEZ in the city post pandemic and gauge the impact the pandemic may have had on businesses and bus operators in preparing for its introduction.

8.4.4 As noted above, bus operators in the city have been consulted regularly and kept up to date with ongoing proposals for the city's LEZ. Given the importance of bus compliance to the success of any LEZ, the operators were approached in March 2021 and asked to complete a short questionnaire, comprising the following questions:

- What would LEZ enforcement in 2023 mean for your organisation and operations in Dundee?
- What will your level of fleet compliance to Euro VI standards be in 2023?
- Will you have to reduce services to meet a 2023 LEZ enforcement date?
- Would applying an additional year grace period before enforcement (to 2024) provide the opportunity for your full Dundee fleet to meet the required LEZ standards?
- What are your views on other vehicles being included in the LEZ and if they are included what length should the grace period be?

8.4.5 Key findings from the bus operator questionnaire were:

- All operators confirmed it difficult to ensure or commit to their full bus fleet Euro VI being compliant by the end of the 2023 grace period
- The impacts from the pandemic on passenger numbers is significantly hampering the ability to invest in new vehicles (and therefore meet compliance levels by 2023)
- The early enforcement of a LEZ may result in a reduction in services or a rerouting of services away from the LEZ area
- Any additional grace period (from the minimum of 2023) would allow time to plan fleet investment to meet LEZ requirements
- Private cars must be included to ensure the bus is not unfairly penalised
- Any grace period should be the same for all vehicles

8.4.6 If bus operators need to reduce or reroute services as a direct result of the LEZ, the city centre may become inaccessible to some city residents that depend on bus services to access the city. For those accessing the city who have a choice between bus or car access, service changes may push more to using private cars.

8.4.7 The business community has been significantly impacted by the Covid-19 pandemic, with many shops and services required to close or provide reduced service due to Government restrictions. Members of the Dundee LEZ Delivery Group attended the Dundee Business Recovery meeting in February 2021 to present the current LEZ proposals and to seek view from the broad range of city businesses in attendance. To further understand the impact on the Dundee business community from the pandemic and the introduction of a LEZ, a

short online survey was then circulated to approximately 300 city centre businesses and Dundee Chamber of Commerce members in March 2021. While the response rate and sample size was low (18 responses) and did not allow for any statistical conclusions to be drawn, the survey did draw further attention to the LEZ proposals planned for the city.

8.5 Scotland Wide Consultation

8.5.1 In 2017, Transport Scotland facilitated a public consultation, *Building Scotland's Low Emission Zones*, to inform development of the Transport (Scotland) Act 2019 and the draft National Low Emissions Framework (NLEF). In total, 967 responses were received (Consult.gov.scot) and key findings are published on the Low Emission Zone Scotland website as follows:

- 95.5% supported the principle of low emission zones to help protect public health by improving air quality in Scotland
- 62.3% of respondents agreed with the proposed minimum mandatory Euro class specification for vehicle compliance
- 86.3% of respondents agreed that low emission zone exemptions should be consistent across all Scottish local authorities

8.5.2 Transport Scotland also facilitated the Scotland Low Emission Zone Consultation on Regulations and Guidance 2019-2020. It sought responses about key aspects of LEZ regulations and guidance, particularly emission standards, exemptions and penalty charges.

8.6 Statutory Consultation

8.6.1 As noted above, the statutory consultees include SEPA, NatureScot and Historic Environment Scotland. As part of the overarching NLEF process, a Strategic Environmental Assessment (SEA) is being undertaken in parallel to the NLEF option appraisal process (this Interim NLEF Stage 2 Report). Through the SEA, DCC are required to seek the views from these statutory consultees. Full details of this consultation will be included in the final SEA Environmental Report which will be summarised in the final NLEF Stage 2 Report.

8.7 Key Outcomes from Consultation of LEZ Options

8.7.1 The consultation showed that the introduction of a LEZ in Dundee is generally favoured, with 65% of public responses supporting its introduction. Similarly, 64% support the introduction of a LEZ applying to all vehicle types. Support for an all vehicle LEZ is strongly favoured by bus operators who feel not including all vehicles would unfairly penalise the bus industry, a key sustainable mode of transport for the city.

8.7.2 Bus operators have been significantly impacted by the Covid-19 pandemic and are not likely to be able to suitably invest in their fleets to meet a 2023 enforcement date. A 2024 enforcement date or later would provide a more realistic timeline to meet LEZ compliance.

8.7.3 Although the consultation did not conclude that any of the five LEZ options can be ruled out at this stage, feedback from one bus operator (of three) highlighted that the bus station is not utilised by their services but is the hub for other operators in the city. The operator therefore considers the exclusion of the bus station would result in unequal impacts of the LEZ on all bus companies. The resultant impact of including or excluding the bus station from a LEZ is explored further in the accompanying Integrated Impact Assessment and Business & Regulatory Impact Assessment.

8.7.4 The stakeholder feedback suggested that further evidence is required to conclude whether Lochee Road is excluded from a LEZ. This was reflected in the public responses

that favoured the view that Lochee Road should be included in a LEZ. It is well known that the corridor is subject to some of the highest levels of pollutants in the city.

8.7.5 As such, it was stated at the Community Safety and Public Protection Committee in February 2020 that detailed traffic modelling of a LEZ option including Lochee Road would be undertaken. This will provide further evidence over and above the desktop exercise conducted in the option appraisal exercise in Chapter 7, to assess the impact of including Lochee Road in a LEZ for the city. Details of the outcome from this traffic modelling are provided in the next chapter.

9. LEZ TRAFFIC MODELLING

9.1 Introduction

9.1.1 Dundee City Council commissioned the development of a traffic microsimulation model of the Dundee Greater City Centre area for the purpose of assessing the LEZ options identified through the NLEF appraisal process.

9.1.2 An initial 2019 Base Model was developed (as detailed in the report *Dundee Greater City Centre Base Paramics Model Development Report (SYSTRA, November 2019)* and from this a future year 2023 Reference Case Model was created (as detailed in the technical note *Dundee Greater City Centre Reference Case Note (SYSTRA, February 2020))*. The 2023 Reference Case, as defined by DCC, reflects infrastructure changes and committed Local Development Plan forecasts to 2023.

9.1.3 The 2023 Reference Case Model was used as a basis to develop three LEZ option tests, namely the three all vehicle LEZ options identified through the NLEF high level appraisal (Chapter 7):

- LEZ Option 2A - Inner Ring Road All Vehicles, including all car parks (Figure 7.20)
- LEZ Option 2B - Inner Ring Road All Vehicles, excluding Bell Street and West Marketgait NCP car parks (Figure 7.21)
- LEZ Option 2C - Inner Ring Road All Vehicles, excluding Bell Street, West Marketgait NCP and Wellgate car parks (Figure 7.22)

9.1.4 In addition to these three core inner ring road options, two further variants were tested where the LEZ was extended along the Lochee Road corridor, as identified through the public and stakeholder consultation. The Lochee Road options tests were:

- LEZ Option 2A/B/C plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- LEZ Option 2A/B/C plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road

9.1.5 During the LEZ model testing, it was identified that the assessment of the Lochee Road corridor options was hindered by network congestion primarily resulting from the inclusion of West Marketgait between West Port Roundabout and Dudhope Roundabout in the LEZ area. To ensure a robust LEZ option testing programme, it was agreed with DCC to model further variants of the Lochee Road options, excluding West Marketgait, as follows:

- LEZ Option 2A/B/C plus Lochee Road to Tullideph Road (*excluding* West Marketgait between West Port Roundabout and Dudhope Roundabout)
- LEZ Option 2A/B/C plus Lochee Road to Loon's Road (*excluding* West Marketgait between West Port Roundabout and Dudhope Roundabout)

9.1.6 In total, 15 LEZ options were tested in the traffic model, representing a comprehensive testing programme that was widened in scope as a direct result of the public and stakeholder consultation outcomes. A technical modelling note (*Dundee Greater City Centre Paramics Model LEZ Option Testing Note (SYSTRA, April 2020)*) outlines the development of each of the LEZ option models and assesses the impact the introduction of each LEZ has on the Dundee road network, where modelled trips by non-compliant vehicle are displaced to a location outside the LEZ. The technical note is provided in Appendix C and the results and conclusions summarised in this chapter.

9.2 Modelling Results – Inner Ring Road All Vehicle LEZ

9.2.1 The Technical Note concludes the inner ring road option models operate without noticeable difference from the operation of the Reference Case model, suggesting the introduction of the LEZ options does not significantly impact on network conditions. The exception to this is the East Dock Street/East Marketgait junction which sees some increases in congestion in Option 2A, particularly in the AM, as a result of non-compliant vehicles being reassigned to car parks on the periphery of the LEZ inner ring road area. In Option 2B and 2C, where fewer vehicles are displaced due to greater car park availability in these options, this congestion is not noted in the option models.

9.2.2 Modelled journey times were analysed for each option, representing key routes that may be impacted by the LEZ proposals, and compared to the 2023 Reference Case. The modelling shows that journey times on key routes in the city are not significantly impacted as a result of the introduction of the three LEZ options. The most notable increases to journey times occurs in Option 2A with a maximum average journey time increase of approximately 1 minute recorded on East Dock Street (westbound between Greendykes Road and East Marketgait). In Options 2B and 2C this impact is not recorded with little change in journey times compared to the 2023 Reference Case.

9.2.3 Modelled link flow were compared for selected locations on the inner ring road for each LEZ option. This was undertaken to understand the localised impact of each option in restricting non-compliant vehicles from accessing the area inside the inner ring road and redistributing trips to car parks on the periphery of the proposed option area.

9.2.4 Table 9.1 shows 12 hour two-way modelled flows at 10 locations on the inner ring road for the Reference Case and each LEZ Option. The flow comparisons show there to be some redistribution of traffic on the inner ring road as a result of each LEZ option. In all options there is a decrease in traffic flow on West Marketgait north of West Port roundabout due to a reduction in non-compliant vehicles accessing the city centre using West Bell Street and Ward Road. Conversely there is an increase in traffic flow on West Marketgait south of West Port roundabout primarily due to an increase in non-compliant vehicles, displaced from the city centre to car parks on the periphery of the LEZ area (e.g. Greenmarket or West Marketgait NCP).

9.2.5 At all locations shown, the changes in traffic flows are not considered significant for the class of road (dual carriageway) for the two-way 12 hour time period represented and the operation of the option models suggest these changes do not result in noticeable increases in network congestion. The outputs from the traffic model will be input to the NMF air quality model when available (delayed due to cyber-attack on SEPA) and will quantify the impact these flow changes have on air quality exceedances. As a proxy, until the NMF is available, emissions analysis using EMIT software has been undertaken and detailed in Chapter 12, and this will identify any significant changes to emission levels resulting from the introduction of the LEZ options.

Table 9.1 : 12 Hour Two-Way Flow Comparisons on Inner Ring Road (All Vehicles)

Site	Location	Ref Case	Op2A	Difference (Op2A-Ref)	% Diff
West Marketgait	North of West Bell St	17386	16269	-1118	-6.4%
North Marketgait	West of Ladywell Rbt	23535	22158	-1377	-5.9%
Victoria Road	South of Ladywell Rbt	13344	13014	-330	-2.5%
North Marketgait	North of East Port Rbt	17470	16549	-920	-5.3%
East Marketgait	North of East Dock St	13950	14236	286	2.1%
Dock Street	West of Trades Lane	30051	30804	753	2.5%
Thomson Ave	At Slessor Grdns (1-way)	13609	13989	379	2.8%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	15679	470	3.1%
West Marketgait	South of Nethergate	11901	13815	1915	16.1%
West Marketgait	South of West Port Rbt	12779	13931	1152	9.0%

Site	Location	Ref Case	Op2B	Difference (Op2B-Ref)	% Diff
West Marketgait	North of West Bell St	17386	16014	-1372	-7.9%
North Marketgait	West of Ladywell Rbt	23535	22972	-562	-2.4%
Victoria Road	South of Ladywell Rbt	13344	12840	-504	-3.8%
North Marketgait	North of East Port Rbt	17470	16977	-493	-2.8%
East Marketgait	North of East Dock St	13950	14308	358	2.6%
Dock Street	West of Trades Lane	30051	30558	507	1.7%
Thomson Ave	At Slessor Grdns (1-way)	13609	14201	592	4.3%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	15395	186	1.2%
West Marketgait	South of Nethergate	11901	13694	1793	15.1%
West Marketgait	South of West Port Rbt	12779	14289	1510	11.8%

Site	Location	Ref Case	Op2C	Difference (Op2C-Ref)	% Diff
West Marketgait	North of West Bell St	17386	15894	-1492	-8.6%
North Marketgait	West of Ladywell Rbt	23535	22498	-1037	-4.4%
Victoria Road	South of Ladywell Rbt	13344	12977	-367	-2.8%
North Marketgait	North of East Port Rbt	17470	17556	86	0.5%
East Marketgait	North of East Dock St	13950	14313	363	2.6%
Dock Street	West of Trades Lane	30051	30642	591	2.0%
Thomson Ave	At Slessor Grdns (1-way)	13609	14254	645	4.7%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	15402	192	1.3%
West Marketgait	South of Nethergate	11901	13717	1816	15.3%
West Marketgait	South of West Port Rbt	12779	14222	1443	11.3%

9.3 Modelling Results – Inner Ring Road plus Lochee Road All Vehicle LEZ

9.3.1 The Technical Note shows the Lochee Road option models result in increased congestion at key city centre locations compared to the Reference Case model, suggesting the introduction of a LEZ incorporating the Lochee Road corridor significantly impacts on network conditions. The increase in network congestion is evident in all inner ring road option variants (Option 2A, 2B & 2C) tested with both Lochee Road variants (i.e. all 6 options models).

9.3.2 The LEZ option incorporating Lochee Road to Tullideph Road generally has a more localised impact on the road network, due to the shorter extent of the Lochee Road corridor influenced by the LEZ. Extending the LEZ option to incorporate Lochee Road to Loon's Road results in a more significant strategic shift of non-compliant traffic away from the Lochee Road corridor to other key routes in and out of the city such as Riverside Drive, Perth Road/Hawkhill and Strathmartine Road/Hilltown. Both options result in increased network congestion and this is particularly evident in the Loon's Road variants.

9.3.3 In both variants the congestion around the East Dock Street/East Marketgait junction is increased and in the PM period the queueing can extend past the East Dock Street/Tay Bridge junction and on to the bridge itself and through the waterfront development areas, with the reasons for this congestion discussed in the flow comparisons below. There is an also an increase in queueing at the High Street/Loon's Road junction in the Tullideph Road options, where queueing can extend back on to Ancrum Road and on Gardner Street northbound on approach to Loon's Road.

9.3.4 Again, modelled journey times were analysed for each Lochee Road model option, representing key routes that may be impacted by the LEZ proposals, and compared to the 2023 Reference Case. The modelling shows that journey times on key routes in the city are significantly impacted as a result of any LEZ option that incorporates the Lochee Road corridor. The most notable increases in journey times are seen southbound on Forfar Road and westbound on East Dock Street and this is noted in both the Tullideph Road and Loon's Road option models. In the Tullideph Road options, journey time increases of approximately 4 minutes are seen on both these routes. In the Loon's Road options, journey times increase by over 5 minutes on East Dock Street and almost 10 minutes southbound on Forfar Road. It is noticeable that these increases are on routes separate from the Lochee Road corridor and show that the inclusion of Lochee Road in any LEZ has wide ranging implications on the Dundee road network. The journey times on Lochee Road itself are shown to be comparable between all options as non-compliant vehicles are removed from this route.

9.3.5 Modelled link flows were compared for selected locations on the inner ring road, Lochee Road and selected adjacent routes outside the LEZ areas for each LEZ option. This was undertaken to understand the impact of each option in restricting non-compliant vehicles from accessing the area inside the inner ring road and the Lochee Road corridor.

9.3.6 The Technical Note provides modelled link flows for all model option variants where general changes in flow patterns are observed consistently in all Lochee Road option variants. As such Table 9.2 and Table 9.3 show 12 hour two-way modelled flows for the Reference Case and LEZ Option 2C with both Lochee Road variants only, with all other variant outputs provided in the Technical Note.

9.3.7 Table 9.2 shows 12 hour two-way modelled flows at 10 locations on the inner ring road for the Reference Case and LEZ Option 2C for both Lochee Road variants. The flow comparisons show there to be significant changes in traffic flows on the inner ring road as a result of incorporating Lochee Road in any LEZ option. The largest increase in vehicle flows are on East Marketgait, Dock Street, West Marketgait (south of West Port roundabout) and the waterfront area of between approximately 3000 vehicles and 5300 vehicles over 12 hours. This increase is a result of non-compliant vehicles no longer routeing to and from Lochee Road and choosing alternative routes to complete their journeys, such as Perth Road, Hawkhill and Riverside Drive. Conversely there is a significant reduction in traffic on West Marketgait (north of West Port roundabout) and North Marketgait as a result of a significant drop in vehicles on the adjacent Lochee Road. While such a reduction here may be welcome, the opposing increase on the southern and eastern inner ring road results in significant congestion, as noted above, with queues extending along the waterfront area, East Dock Street and the Tay Road Bridge and journey times significantly increasing on the routes approaching these locations (Forfar Road and East Dock Street).

Table 9.2 : 12 Hour Two-Way Flow Comparisons on Inner Ring Road for Lochee Road Options (All Vehicles)

Site	Location	Ref Case	Op2C & Lochee Rd to Tullideph Rd	Difference (Op-Ref)	% Diff
West Marketgait	North of West Bell St	17386	12558	-4829	-27.8%
North Marketgait	West of Ladywell Rbt	23535	19372	-4163	-17.7%
Victoria Road	South of Ladywell Rbt	13344	12900	-443	-3.3%
North Marketgait	North of East Port Rbt	17470	18270	801	4.6%
East Marketgait	North of East Dock St	13950	17276	3326	23.8%
Dock Street	West of Trades Lane	30051	35336	5285	17.6%
Thomson Ave	At Slessor Grdns (1-way)	13609	16553	2944	21.6%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	18416	3207	21.1%
West Marketgait	South of Nethergate	11901	16106	4206	35.3%
West Marketgait	South of West Port Rbt	12779	16098	3319	26.0%

Site	Location	Ref Case	Op2C & Lochee Rd to Loon's Rd	Difference (Op-Ref)	% Diff
West Marketgait	North of West Bell St	17386	12627	-4759	-27.4%
North Marketgait	West of Ladywell Rbt	23535	19369	-4165	-17.7%
Victoria Road	South of Ladywell Rbt	13344	13450	107	0.8%
North Marketgait	North of East Port Rbt	17470	18930	1461	8.4%
East Marketgait	North of East Dock St	13950	18111	4161	29.8%
Dock Street	West of Trades Lane	30051	36160	6109	20.3%
Thomson Ave	At Slessor Grdns (1-way)	13609	16811	3202	23.5%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	18851	3642	23.9%
West Marketgait	South of Nethergate	11901	16785	4885	41.0%
West Marketgait	South of West Port Rbt	12779	16909	4130	32.3%

9.3.8 Table 9.3 shows 12 hour two-way modelled flows at 18 locations on Lochee Road and adjacent local routes for the Reference Case and LEZ Option 2C with both Lochee Road variants. The flow comparisons show there to be significant reductions in vehicle flow on Lochee Road, as expected, with non-compliant vehicles restricted from utilising the corridor. The results show however, that non-compliant vehicles shift from Lochee Road to a number of other adjacent routes. When the LEZ is extended along Lochee Road to Tullideph Road, the largest increases in vehicles are seen on City Road and Loon's Road, of over 2000 vehicles over 12 hours. When the LEZ is extended to Loon's Road, the impact on local routes is dampened somewhat as the larger LEZ results in a more strategic shift of trips to routes such as Perth Road/Hawkhill, where flows increase by over 1000 vehicles over 12 hours. Analysis of the vehicles switching routes from Lochee Road confirm these to be non-compliant vehicles meaning the local adjacent routes are seeing a significant increase in the most polluting vehicles.

9.3.9 In addition to the increase in congestion and journey times and changes to vehicle flow in the city, the modelling results show that average trip distance increases as a result of introducing a LEZ with Lochee Road. This reflects the more strategic shift in non-compliant trips seeking alternative, often longer, routes in the city. From an increase in trip distance, it can be inferred that carbon emitted by road transport will also increase as a result of any LEZ that includes the Lochee Road corridor.

Table 9.3 : 12 Hour Two-Way Flow Comparisons on Lochee Rd and adjacent routes (All Vehicles)

Site	Location	Ref Case	Op2C & Lochee Rd to Tullideph Rd	Difference (Op-Ref)	% Diff
Lochee Road	North of Loon's Road	10171	9834	-337	-3.3%
Lochee Road	South of City Road	8223	5700	-2523	-30.7%
Lochee Road	North of Dudhope Terr	15905	11324	-4580	-28.8%
Lochee Road	West of Dudhope Rbt	13764	9875	-3889	-28.3%
Dudhope Terrace	At Lochee Road	3120	2143	-977	-31.3%
Inverary Terrace	South of Rankine Street	2631	3640	1008	38.3%
Rankine Street	South of Inverary Terr	4420	3036	-1384	-31.3%
Tullideph Road	At Lochee Road	3535	2542	-992	-28.1%
City Road	South of Tullideph Road	5756	8289	2533	44.0%
Milnbank Road	At Polepark Road	3627	4830	1202	33.2%
Gardner Street	South of Loon's Road	6284	6221	-62	-1.0%
Loon's Road	At Lochee Road	7358	9623	2265	30.8%
Brook Street	East of Edward Street	4437	5409	972	21.9%
Ancrum Road	At Lochee Road	5920	5869	-51	-0.9%
Hawkhill	East of Hunter Street Rbt	11847	12651	805	6.8%
Blackness Road	East of Forest Park Road	3273	3354	81	2.5%
Bellfield Street	At Hawkhill	2391	2501	111	4.6%
Balfield Road	North of Loon's Road	6500	6083	-418	-6.4%

Site	Location	Ref Case	Op2C & Lochee Rd to Loon's Rd	Difference (Op-Ref)	% Diff
Lochee Road	North of Loon's Road	10171	9335	-836	-8.2%
Lochee Road	South of City Road	8223	5671	-2552	-31.0%
Lochee Road	North of Dudhope Terr	15905	11286	-4618	-29.0%
Lochee Road	West of Dudhope Rbt	13764	9830	-3934	-28.6%
Dudhope Terrace	At Lochee Road	3120	2139	-981	-31.4%
Inverary Terrace	South of Rankine Street	2631	3504	872	33.1%
Rankine Street	South of Inverary Terr	4420	3215	-1205	-27.3%
Tullideph Road	At Lochee Road	3535	2400	-1134	-32.1%
City Road	South of Tullideph Road	5756	6731	975	16.9%
Milnbank Road	At Polepark Road	3627	4420	793	21.9%
Gardner Street	South of Loon's Road	6284	6253	-31	-0.5%
Loon's Road	At Lochee Road	7358	7615	257	3.5%
Brook Street	East of Edward Street	4437	5128	690	15.6%
Ancrum Road	At Lochee Road	5920	4688	-1231	-20.8%
Hawkhill	East of Hunter Street Rbt	11847	12931	1084	9.2%
Blackness Road	East of Forest Park Road	3273	3447	174	5.3%
Bellfield Street	At Hawkhill	2391	2588	197	8.2%
Balfield Road	North of Loon's Road	6500	5842	-659	-10.1%

9.4 Modelling Results – Inner Ring Road plus Lochee Road (excluding West Marketgait) All Vehicle LEZ

9.4.1 During the LEZ model testing, it was identified that the assessment of the Lochee Road corridor options was hindered by network congestion primarily resulting from the inclusion of West Marketgait between West Port Roundabout and Dudhope Roundabout in the LEZ area. With West Marketgait included in the LEZ area, non-compliant vehicles using the inner ring road are forced either clockwise or anti-clockwise around the ring road, away from West Marketgait, resulting in over capacity at the junctions on the eastern side of the inner ring road, primarily East Marketgait/Dock Street. With West Marketgait excluded from the LEZ area, the full inner ring road is available to non-

compliant vehicles and there is less conflicting traffic volumes at key junctions on the eastern side of the inner ring road, and therefore less network congestion stemming from this location. To ensure a robust LEZ option testing programme, it was agreed with DCC to model further variants of the Lochee Road options, excluding West Marketgait from the LEZ area.

9.4.2 The Technical Note in Appendix C details the outcomes from these model option tests and concludes that while the options operate with less congestion around the inner ring road area due to the full inner ring road route being available to non-compliant vehicles, the continued inclusion of the Lochee Road corridor still results in a shift of non-compliant vehicles from Lochee Road to adjacent local routes. The largest increases in traffic flow are recorded on Perth Road/Hawkhill of over 2000 vehicles over 12 hours.

9.5 LEZ Post Covid-19 Uncertainty

9.5.1 The Covid-19 pandemic has had a dramatic impact on travel across all modes and specifically travel in Scotland's city centres. To assist in the development of the LEZs across Scotland, Transport Scotland commissioned a study to apply the principals of modelling in considering the uncertainty over what travel will look like after the pandemic has ended.

9.5.2 The study set out a framework for embracing uncertainty by consulting with stakeholders on 'what will travel look like post Covid-19'. This framework set out the rationale for any additional modelling required to provide evidence to support the introduction of any LEZ. To assist this process, workshops were held with the local authorities, including DCC, to agree the key metrics to measure against the current LEZ objectives and identify the key disruptors which are likely to have the greatest impact on travel activities within each city centre.

9.5.3 A Scenario Planning Process was developed to allow a range of plausible future scenarios to be defined using important and likely disruptors. These scenarios were used as a reference case against which the anticipated LEZ impacts were applied to understand how an LEZ performs in the context of plausible future scenarios.

9.5.4 The outcomes from the study are detailed in the *LEZ Post-Covid Uncertainty Summary Note (SYSTRA Ref. GB01T20E86/11024112/005, January 2021*). The study concluded that the impact of the LEZs will vary between each city depending on their specific traffic levels and fleet composition. But importantly, the LEZ will protect the city centres by preventing non-compliant vehicles from entering them. Whilst the impact of the LEZ may vary across each city in terms of emissions, the outcome is likely to be very similar with the level of emissions limited to a reduced value compared to pre-LEZ levels.

9.5.5 For Dundee, plausible futures were considered against the model assessments undertaken to date and further sensitivity testing of the proposed LEZ schemes was proposed. The reasons for undertaking the sensitivity tests are to provide evidence that the LEZ schemes are robust to variations in network conditions that may occur in a post-pandemic world.

9.5.6 The traffic modelling results presented in the above sections were undertaken on one plausible future scenario, as defined as the 2023 Reference Case (committed infrastructure changes and committed Local Development Plan forecasts to 2023). The study recommended that a sensitivity test was undertaken on one other further plausible future, to ensure a robust set of modelling results to inform Dundee's LEZ.

9.5.7 The sensitivity scenario was defined as "Coping as Best We Can" where, following an economic downturn, the projected rate of change towards a cleaner fleet is lower than pre-Covid-19 forecasts (as provided by SEPA) and traffic shrinkage is experienced, similar to the 2010 economic downturn. The results from this sensitivity tests are detailed in the traffic modelling Technical Note in Appendix C.

9.5.8 It was agreed with DDC that Covid-19 sensitivity tests were undertaken on the following models:

- Reference Case
- LEZ Option 3 - Inner Ring Road area, excluding Bell Street, West Marketgait NCP and Wellgate car parks
- LEZ Option 3 Lochee Road Variant 1 – Op3 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- LEZ Option 3 Lochee Road Variant 2 – Op3 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road

9.5.9 To inform the required reduction in traffic, DCC's Road Traffic Reduction Act monitoring data was utilised. The data provides surveyed AM and PM peak and Annual Average Daily Traffic (AADT) flows from the city from 1996 to 2020. The data shows a reduction in traffic from pre financial crisis in 2006 to a lowest point in 2012 of around 9% in the AM peak hour and 7.5% in the PM Peak Hour. It was agreed with DCC that a 10% reduction would be applied to the traffic model demands for the 2023 Reference Case and appropriate LEZ Option models.

9.5.10 The results showed general network conditions between the Covid-19 sensitivity Reference Case and option models were relatively similar with no significant increase to network congestion or journey times on key routes. However flow comparisons highlighted that there remains significant changes to localised traffic flows as a result of the Lochee Road corridor being included in any LEZ. In a similar manner to the "full" forecast scenarios summarised above, significant increases in traffic flow is recorded on routes such as City Road (up to approximately 60% increase), Loon's Road (up to approximately 50% increase) and Brook Street (up to approximately 80% increase). The sensitivity testing therefore concludes that even under a future where traffic demand is at the lower end of forecast predictions, the inclusion of Lochee Road in any LEZ will still result in localised rerouting of non-compliant vehicles.

9.6 Conclusions from Traffic Modelling

9.6.1 15 LEZ options were tested in the Dundee City Paramics traffic model and the model results clearly show there to be considerable impacts on the Dundee Road network if Lochee Road is included in any LEZ option. For this this reason, all Lochee Road options are at this stage removed from the appraisal process and not are considered viable LEZ options.

9.6.2 The three core inner ring road options are shown to operate with less impact on the road network however it is noted that Option 2A shows increased congestion on the inner ring road, particularly the eastern side around East Marketgait and Dock Street. This is a result of non-compliant vehicles being reassigned to car parks on the periphery of the LEZ inner ring road area. In Option 2B and 2C, where fewer vehicles are displaced due to greater car park availability in these options, this congestion is not recorded through the modelling results.

9.6.3 At this stage in the appraisal process, Option 2A, 2B and 2C are progressed to further option refinement in the next chapter.

9.6.4 With the removal of the Lochee Road options it is important that additional traffic and demand management measures are explored on the Lochee Road corridor to address the remaining exceedance locations on the corridor, and these are noted in Chapter 10.2.3.

10. LEZ OPTION REFINEMENT

10.1 Introduction

10.1.1 The Interim Stage 2 Report identified five possible LEZ options for Dundee and these were progressed to public and stakeholder consultation and detailed testing with the results from these presented above. This chapter takes the opportunity to interpret the consultation and modelling results in Chapters 8 and 9, alongside wider appraisal considerations (such as implementation, economy and safety), to refine the five LEZ options and allow for final detailed appraisal of the remaining LEZ option(s).

10.1.2 The five options for consultation and modelling were:

- LEZ Option 1A - Inner Ring Road Bus Only, including bus station (Figure 7.18)
- LEZ Option 1B - Inner Ring Road Bus Only, excluding bus station (Figure 7.19)
- LEZ Option 2A - Inner Ring Road All Vehicles, including all car parks (Figure 7.20)
- LEZ Option 2B - Inner Ring Road All Vehicles, excluding Bell Street and West Marketgait NCP car parks (Figure 7.21)
- LEZ Option 2C - Inner Ring Road All Vehicles, excluding Bell Street, West Marketgait NCP and Wellgate car parks (Figure 11.1)

10.1.3 In addition, the traffic modelling examined possible LEZ options including the Lochee Road corridor with the model results concluding that these were not suitable LEZ options.

Option 1A and 1B – Bus Only Options

10.1.4 Option 1B proposes excluding the bus station from the LEZ area. During the consultation with bus operators it was noted that this may result in different impacts or rules for individual bus operators. By allowing access to the bus stations, Stagecoach, who serve the bus station, may be able to adjust routes to negate the need to enter the LEZ area (for some of their services) while Xplore Dundee, who do not use the bus station, will be forced to fully comply with LEZ restrictions. The NMF analysis has shown that from an air quality perspective and for the LEZ to operate most effectively, all bus services that serve the city should be compliant and therefore any LEZ boundary that allows the possibility for operators to avoid the LEZ while still maintaining their current services should not be progressed.

10.1.5 The NMF identified that improving the bus fleet to LEZ emission standard in Dundee will bring the single biggest benefit to air quality and therefore buses must be included in any LEZ for the city. The inclusion of other vehicle types brings further benefits with diesel cars and HGVs the next largest contributors to NO2, followed by LGVs and petrol cars. The LEZ options for consultation and testing included bus only options and all vehicle options. Results from the consultation and subsequent assessments strongly suggest the LEZ should include all vehicle types where the public consultation favoured an all vehicle LEZ, with 64% of respondents supporting such a LEZ in Dundee, as opposed to a bus only LEZ. An all vehicle LEZ in Dundee would be consistent with the adopted LEZs in Aberdeen, Glasgow and Edinburgh, ensuring a national consistency. By not including all vehicles in its LEZ, Dundee would introduce the smallest geographical LEZ with the least stringent vehicle restrictions.

10.1.6 Through the consultation with bus operators, it is clear that they strongly believe a bus only LEZ is the wrong approach for the city and it would serve to unfairly penalise the bus over other modes. While this view from operators is expected, it is clear from the analysis to date that modern, lower polluting bus services are part of the solution to improve air quality. By only including buses in the LEZ, it could be perceived that buses are the problem and not part of the solution while re-enforcing the historic view that “car is king”. This contradicts current local and national government objectives to reduce private car

use and increase and promote more sustainable modes of transport such as the bus, and walking and cycling.

10.1.7 The traffic modelling focussed on the all vehicle options and the results showed that these options operate with relatively little impact on the wider Dundee road network while significantly reducing traffic volumes inside the inner ring road area. An all vehicle LEZ results in a redistribution of trips along the inner ring road itself and the modelling suggests a reduction in traffic volumes on West Marketgait, north of West Port roundabout, at a location where current NO2 exceeds legal limits.

10.1.8 The consultation and modelling results alongside wider local and national government objectives support an all vehicle LEZ and therefore the bus only LEZ options are removed at this stage as stand-alone options. It should be noted however that the remaining all vehicle LEZ options (2A, 2B and 2C) can be operated as bus only if required either initially through a phased introduction of vehicle type enforcement or at a later date, through the adjustment of LEZ restrictions.

10.1.9 Note, "all vehicle" describes a LEZ where all vehicles are restricted that fail to meet the LEZ emission standards as set in Regulation 2 of the Low Emission Zones (Emission Standards, Exemptions and Enforcement) (Scotland) Regulations 2021, namely:

- Euro VI emission standards for buses, coaches and heavy good vehicles with diesel engines, with retrofitted vehicles to this standard also being acceptable (Euro VI vehicle registrations from 2013
- Minibuses, large vans, taxi's and cars are set at the Euro 6 for diesel and Euro 4 for petrol vehicles (Euro 6 diesel vehicle registrations in 2015, Euro 4 petrol vehicles in 2006).
- Euro 3 for motorcycles and mopeds

Option 2A, 2B and 2C – All Vehicle Options

10.1.10 Traffic modelling results show that the implementation of LEZ Option 2A results in some increased congestion on the inner ring road, particularly the eastern side around East Marketgait and Dock Street. This is primarily a result of the redistribution of parking trips to locations on the periphery of the LEZ area, with all car parks within the bounds of the inner ring road for compliant vehicles only. While mitigation and junction improvements may be possible it is clear the implementation of Option 2A may be the most challenging of the all vehicle options. Conversely, Option 2B and Option 2C do not result in noticeable increases in congestion on the inner ring road due to less redistribution of parking trips.

10.1.11 From a legislative viewpoint there are likely to be difficulties in implementing Option 2A and 2B. The Transport (Scotland) Act 2019 received Royal Assent in November 2019 and this was after the identification of these LEZ options in the Interim NLEF Stage 2 Report and the subsequent consultation period. Section 6 of the Transport (Scotland) Act 2019 details the restrictions on driving within a LEZ. Section 6 states: *A person may not drive a vehicle on a road within a low emission zone in contravention of the terms of a low emission zone scheme unless (a) the vehicle meets the specified emission standard, or (b) the vehicle is exempt (Act 2019 Section 6)*. The stating of road rather than area has implications on the proposed LEZ boundaries identified in the initial option generation exercise. Furthermore, Section 14 of the Act 2019 states that a LEZ may not specify a private or special road as part of the scheme area.

10.1.12 Option 2A includes two car parks with access directly to/from the A991 inner ring road, Bell Street and West Marketgait NCP car parks. A vehicle travelling on the inner ring road is not inside the proposed LEZ area and upon entering either car park cannot then be considered to be on a road inside the LEZ, as the car parks are not classified as adopted DCC roads.

10.1.13 Option 2B includes Wellgate Centre car park and again access to this car park is directly from the A991 inner ring road at Kirk Lane, just north of King Street. The exit for Wellgate car park is on Meadowside, inside the inner ring road area. While Meadowside is an adopted DCC road, Kirk Lane is non-adopted, as shown in Figure 10.1, and therefore to include Wellgate car park as part of the LEZ would include a private road and require enforcement of the LEZ from a third party (Wellgate Centre) and not DCC.

10.1.14 Both Option 2A and 2B therefore contradict the Transport (Scotland) Act 2019.

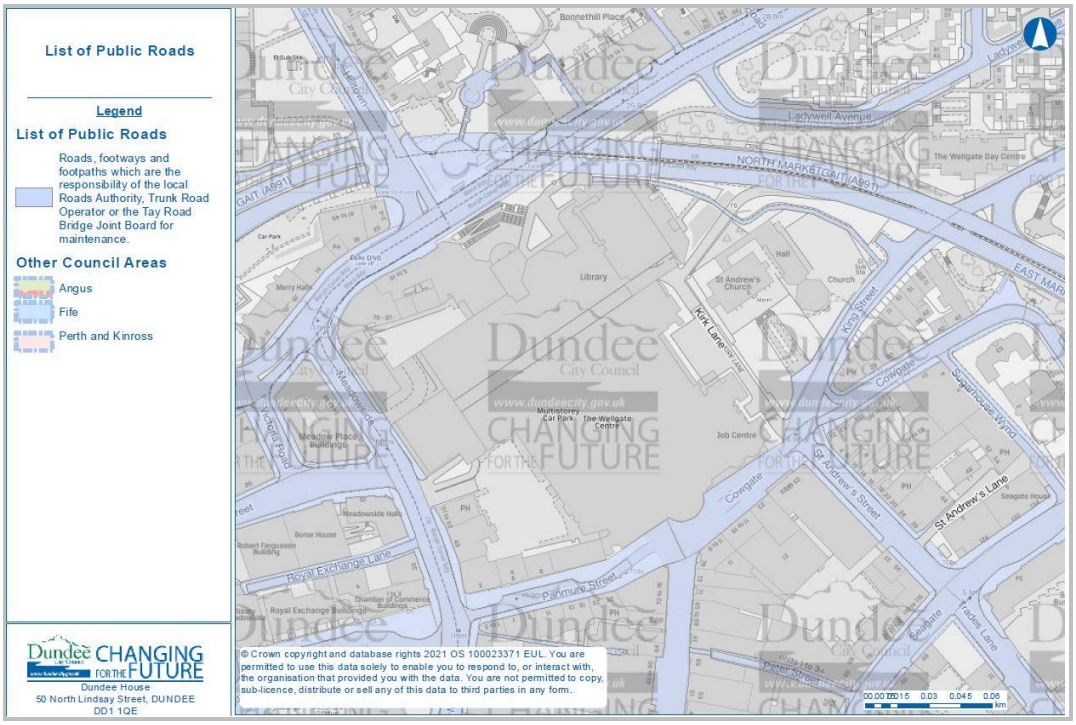


Figure 10.1 : DCC Adopted Roads at Wellgate Car Park

10.1.15 With access to Bell Street, West Marketgait NCP and Wellgate car parks directly from the A991 inner ring road, a non-compliant car can travel on the inner ring road but not exit the inner ring road into a (non-adopted/non-road) multi-story car park without incurring a penalty fine, if these car parks were included in the LEZ option areas. It is possible that some drivers could inadvertently be entrapped by the inclusion of the car parks and penalty fines may be open to challenge. In addition, it is possible that some drivers may perform unsafe manoeuvres to avoid entering the car parks at the final opportunity, such as abrupt braking and reversing on to the A991 dual carriageway. The options were however considered suitable for initial modelling and consultation with expectations that suitable signage and detailed design of these options could have negated such eventualities somewhat.

10.1.16 Option 2A and 2B are therefore not considered fully implementable under current legislation and, together with possible enforcement and safety concerns, it is concluded that Bell Street, West Marketgait NCP and Wellgate car parks should be excluded from any LEZ option area.

10.1.17 Option 2C, which excluded Bell Street, West Marketgait NCP and Wellgate car parks does meet legislative framework and traffic modelling demonstrates the option operates without impacts on the current road network. In addition, Option 2C was the favoured option in the public consultation.

10.2 Final proposed LEZ Option for Dundee

10.2.1 As a result of the above option refinement that considered the consultation, modelling and legislative outcomes, Option 2C is the final remaining LEZ option from the identified options for consultation and testing. It recommended that this option, as shown in Figure

11.1, is presented as the final preferred LEZ option for Dundee, subject to final definition and appraisal against the LEZ objectives.

10.2.2 The option is now renamed as the Dundee LEZ Option.

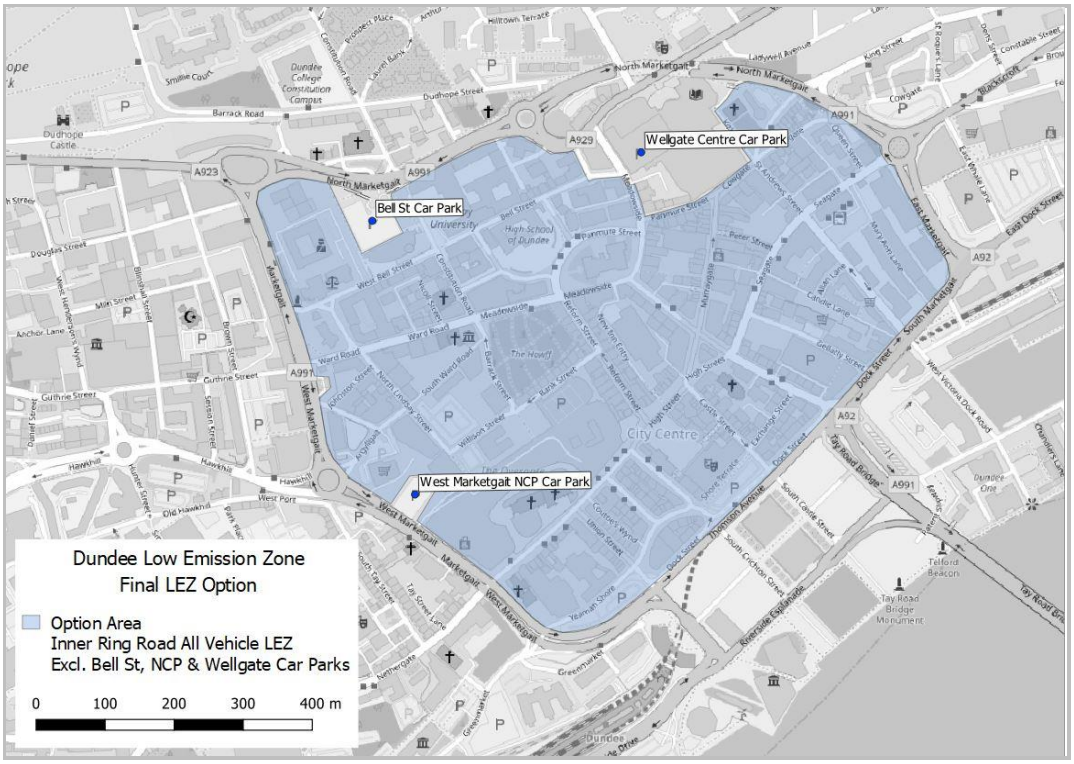


Figure 10.2 : Final Dundee LEZ Option

10.2.3

11. DUNDEE LEZ OPTION DETAIL

11.1 Introduction

11.1.1 The analysis undertaken and summarised in Chapters 8, 9 and 10 has identified a final Dundee LEZ Option. The next stage of the NLEF process is to define the LEZ Option detail prior to a final appraisal against the LEZ objectives

11.1.2 Section 14 of the Transport (Scotland) Act 2019 states the required content of a LEZ, namely:

- The zone to which it relates, which must be specified by
  - i. reference to an area on a map, and
  - ii. specifying the roads (or parts of a road) which form part of the zone
- the types of vehicles to which it applies
- the date on which the scheme comes into effect
- the grace periods applicable
- the LEZ objectives

11.1.3 This chapter will provide information on the required content of Dundee's LEZ.

11.2 Dundee LEZ Area

11.2.1 The final Dundee LEZ Option incorporates the area inside the A991 inner ring road, excluding Bell Street car park, West Marketgait NCP car park and Wellgate Centre car park.

11.2.2 A site visit was undertaken in March 2021 by a member of the Dundee LEZ Delivery Group to ensure the boundary of the final LEZ area took cognisance of any local access or land uses that could not be considered inside the LEZ, in line with Section 14 of the Transport (Scotland) Act 2019. An initial detailed drawing of the final Dundee LEZ is shown in Figure 11.1 and identifies the following accesses/land uses as outside the LEZ area:

- Bell Street car park (labelled A in Figure 11.1)
- West Marketgait NCP car park (B)
- Wellgate Centre and car park (C)
- Shell garage on West Marketgait at Ward Road (D)
- Vehicle access to Dundee House on West Marketgait, south of Argyllgait (E)
- Auto Windscreens business at West Marketgait NCP car park (F)
- Goods delivery access to Overgate Centre (G)
- Arnold Clark storage area on East Marketgait between Seagate and Dock Street (H)

11.2.3 The detail presented in Figure 11.1 is considered appropriate for this stage of the Interim Stage 2 Reporting and subsequent submission to Dundee City Council Committee and for the consultation period thereafter. However, detailed design work will be undertaken prior to final submission of the Dundee LEZ Option to Scottish Ministers that will include aspects such as signage and camera placement and will present a further opportunity to finalise the LEZ boundary. It is anticipated that through the final consultation, locations, accesses or land uses may be identified and require consideration of whether they fall inside or outside the LEZ area.

11.2.4 A list of all roads which form part of the zone, as required by the Transport (Scotland) Act 2019 is included in Appendix D.

Figure 11.1 : Dundee LEZ Option Area

11.3 Vehicles types restricted from entering Dundee LEZ

11.3.1 The Low Emission Zones (Emission Standards, Exemptions and Enforcement) (Scotland) Regulations 2021 sets the emission standards for entry to the LEZ without penalty and allows DCC to define which vehicle types are to be restricted from entering the LEZ area.

11.3.2 NLEF Guidance states *"all vehicle types should be considered for inclusion in a LEZ and be assessed as part of the NLEF appraisal process…a single vehicle type or a combination of vehicle types could be subject to the LEZ requirements"* (NLEF, 2019).

11.3.3 The final decision of the vehicles types restricted from entering Dundee's LEZ is informed therefore by NMF Dundee air quality modelling, traffic modelling and consultation outcomes as well as enforcement considerations.

11.3.4 Analysis of modelled emission by vehicle type in the NMF Dundee Air Quality Model (Chapter 5) concluded that the inclusion of buses in Dundee's LEZ is required to bring the greatest reduction in emissions. Modelling predicts that if all buses were compliant with LEZ emission standards then all NO_2 annual mean exceedance locations inside the inner ring road (i.e. the final LEZ area) would fall below the legal limit of below 40 µg/m^3, though a number of locations would be close to exceeding this legal limit.

11.3.5 If diesel cars and HGVs were compliant with LEZ emission standards, in addition to buses, the modelling predicts that NO_2 levels at all exceedance locations would reduce by approximately an additional 3%, further protecting the city centre from exceeding the legal limits for NO_2. The modelling predicts that if vans and petrol cars were compliant with emission standards, the impact on NO_2 levels would be comparatively small but would ultimately further reduce NO_2 levels in the city centre.

11.3.6 The traffic modelling assessed LEZ options that restricted all vehicles (buses, diesel cars, HGVs, LGVs and petrol cars) from access to the city centre unless they were compliant with LEZ emission standards. All non-compliant vehicles were assumed to remain on the road network and accessed the city centre by utilising car parks on the periphery of the LEZ area. The results show the road network operates without a noticeable impact resulting from introducing the final all vehicle Dundee LEZ Option.

11.3.7 The public and stakeholder consultation showed that 64% of public responses support the introduction of a LEZ applying to all vehicle types. Support for an all vehicle LEZ is strongly favoured by bus operators who feel not including all vehicles would unfairly penalise the bus as a sustainable mode of transport.

11.3.8 In addition to evidence from modelling and consultation, the wider messaging and publicising of the LEZ is simplified if vehicle restrictions apply to all vehicle types that do not meet LEZ emission standards. It is also noted that the three other cities in Scotland (Glasgow, Aberdeen and Edinburgh) plan to introduce a LEZ for all vehicles and introducing an all vehicle LEZ for Dundee would ensure consistency across the country.

It is proposed that the final Dundee LEZ Option applies to all vehicles types as specified in Regulation 2 of the Low Emission Zones (Emission Standards, Exemptions and Enforcement) (Scotland) Regulations 2021.

11.3.9 The LEZ emission standards for Dundee LEZ are therefore:

- Euro VI emission standards for buses, coaches and heavy good vehicles with diesel engines, with retrofitted vehicles to this standard also being acceptable (Euro VI vehicle registrations from 2013)

- Minibuses, large vans, taxis and cars are set at the Euro 6 for diesel vehicles and Euro 4 for petrol vehicles (Euro 6 diesel vehicle registrations in 2015, Euro 4 petrol vehicles in 2006).
- Euro 3 for motorcycles and mopeds

11.3.10 Although the model analysis did not consider motorcycles or mopeds (as they are not generally represented in the traffic or air quality model) these are listed in Regulation 2 and are therefore considered applicable to the emissions standards for Dundee's LEZ.

11.3.11 Section 6(4)(a) of the Transport (Scotland) Act 2019 set enforcement exemptions consistently across Scotland, with the national LEZ exemptions listed in Regulation 3 of the LEZ Regulations and outlined in Table 2.1. Dundee LEZ will operate in accordance with the exemption list.

Table 11.1 : National LEZ Exemptions

Vehicle type of classification	Description
Emergency Vehicles	For or in connection with the exercise of any function of:
	the Scottish Ambulance Service,
	the Scottish Fire and Rescue Service,
	Her Majesty's Coastguard, and
	the National Crime Agency.
Military Vehicles	Vehicles belonging to any of Her Majesty's forces; or used for the purposes of any of those forces
Vehicles of Historic Interest	Vehicles which are 30 years old or older, are no longer in production and historically preserved or maintained
Vehicles for Disabled Persons	Vehicles registered with a 'disabled' or 'disabled passenger vehicles' tax class
	Vehicles being used for the purposes of the 'Blue Badge Scheme'.
Showman Vehicles	Highly specialised vehicles used for the purposes of travelling showmen, where the vehicle is used during the performance, used for the purpose of providing the performance or used for carrying performance equipment.

11.4 Enforcement of Dundee LEZ

11.4.1 DCC will submit its final proposals for the LEZ to Scottish Ministers in late 2021 and, subject to any objection, is required to declare its LEZ by May 2022. While a decision on the final exact date is made, the working assumption for this Interim Stage 2 Report is that DCC will declare the LEZ in May 2022, and that the LEZ will apply to all vehicle types (not meeting LEZ standards) from this date.

11.4.2 The Transport (Scotland) Act 2019 requires a LEZ to specify a grace period before penalty enforcement of the scheme. Section 15 details the scope and time-limits of the grace period. The grace period applicable to non-residents must expire:

- not less than 1 year after it (LEZ declaration) begins, and
- not more than 4 years after it begins.

11.4.3 The grace period applicable to residents (whose registered address is inside the zone) must expire not more than 2 years after the expiry of the grace period applicable to non-residents.

11.4.4 With declaration of Dundee's LEZ in May 2022, the grace period for the LEZ must therefore:

- Not expire before May 2023
- Expire by May 2026 for non-residents
- Expire by May 2028 for residents but can expire from May 2023

11.4.5 To inform the grace period dates, consultation with two key stakeholders, namely bus operators and the business community, was undertaken in March 2021. All bus operators confirmed their full fleet would not be compliant with LEZ emission standards by 2023, the minimum grace period. While a key purpose of any LEZ is to speed up improvements to air quality (through compliance with emission standards) and DCC could enforce the LEZ in 2023, it is considered counter-productive to set a date that bus operators will be unable to meet.

11.4.6 In addition, it is recognised that the Covid-19 pandemic has had an unprecedented impact on society, including on the wider environment and the economy. Cognisance of the difficulties faced by many throughout 2020 and 2021, particularly in the context of a Dundee city centre LEZ and its implications for city businesses and bus operators, suggests that a grace period greater than the required minimum is desirable.

11.4.7 A key theme from consultation with public and key stakeholders was the need for consistency not only of the vehicle types included in the LEZ but also the grace periods applied to the LEZ enforcement. It is therefore considered important that the grace period should be applicable to all vehicle types from the same date to ensure consistency and ease of enforcement and wider communications.

11.4.8 The theme of consistency is also extended to considerations for the grace period applied to residents of the LEZ. As of 2021, approximately 350 resident parking permits have been issued to properties inside the Dundee LEZ area. Based on 2017 vehicle compliance figures (Section 3.3), this would equate to approximately 100 vehicles being non-compliant, although this is likely to be significantly less by 2024 (7 years after compliance figures). There is considered little benefit in defining a separate grace period, that would require a more complicated enforcement process, for less than 100 vehicles. It is proposed therefore not to provide any additional grace period for residents of the zone with enforcement of the LEZ for residents and non-residents of the zone (and all vehicle types) from the same date.

With the above considerations in mind, it is proposed that the grace period for Dundee's LEZ expires in May 2024 for all vehicle types and for residents and non-residents of the zone.

11.4.9 This represents an additional grace period of two year from the declaration of the LEZ in May 2022.

11.4.10 As context, in May 2024, the approximate age of non-compliant vehicles will be as follows:

- Bus – 11 years or older (including those retrofitted to Euro VI standard)
- HGV – 11 years or older
- Diesel car/van – 9 years or older
- Petrol vehicle – 18 years or older

11.4.11 Section 8 of the Transport (Scotland) Act 2019 enables the enforcement of LEZ schemes. The LEZ will be enforced through Automatic Number Plate Recognition (ANPR) cameras with the LEZ Regulations Schedule 6 detailing the approved devices.

11.4.12 ANPR camera enforcement is currently subject to funding decisions from Transport Scotland and procurement procedures with suppliers. The exact number and location of ANPR cameras is therefore not concluded and will be confirmed in the final NLEF Stage 2 Report and submission to Scottish Ministers.

11.4.13 In line with Section 18 of the Transport (Scotland) Act 2019, it is anticipated that the LEZ will be enforced at all times. Section 17 of the Act does allow for DCC to apply time-limited exemptions to enforcement should it be required, for example for road closures and diversion routes.

11.5 Dundee LEZ Objectives

11.5.1 Chapter 4 details the development of the objectives of Dundee's LEZ. They are that Dundee's Low Emission Zone will:

Protect public health through improving air quality in Dundee and achieving air quality compliance for NO_2, PM_{10} and $PM_{2.5}$

Develop an environment that helps promote more active and sustainable travel choices in Dundee and contributes to meeting emission reduction targets set out in Part 1 of the Climate Change (Scotland) Act 2009

Contribute to the ongoing transformational change in Dundee and help promote the city as an inclusive and desirable place to live, invest, visit and learn

11.5.2 The objective were shown to be SMART and align with key DCC plans, polices and strategies. With the final Dundee LEZ now defined, a final appraisal of the LEZ is undertaken against the objectives. While at this stage it is not possible to fully quantify the effectiveness of the final Dundee LEZ in meeting the LEZ objectives, it can be concluded that the introduction of the LEZ will not contradict the objectives and it is likely to positively meet the objectives in the future.

Objective 1: Protect public health through improving air quality in Dundee and achieving air quality compliance for NO_2, PM_{10} and $PM_{2.5}$

11.5.3 Results from the NMF Dundee City air quality model can infer the likely impact on NO_2 levels as a result of introducing the final Dundee LEZ option, as shown in Table 11.2.

11.5.4 The introduction of the Dundee LEZ is predicted to improve NO_2 levels in the city with seven current exceedance locations projected to drop below the legal limit of 40 $\mu g/m^3$ for annual average NO_2. Three locations where NO_2 is predicted to remain above the legal limit are on Lochee Road, although the overall levels of NO_2 are shown to drop closer to 40 $\mu g/m^3$, primarily as a result of all buses on the corridor meeting LEZ emission standards. As discussed in Chapter 9, extending the LEZ to incorporate Lochee Road is not considered viable and instead separate complimentary traffic management measures on the corridor are required. These are noted in Section 11.6 below and are aimed at improving emission levels on the corridor. Traffic modelling also shows a reduction in traffic flow on West Marketgait, at the other remaining exceedance location, and this may result in lower levels of NO_2 than predicted through the existing NMF analysis in Table 11.2, which currently does not account for changes in traffic flow.

11.5.5 At this stage in the NLEF appraisal, it can reasonably be concluded the Dundee LEZ will improve air quality in Dundee but that compliance with the air quality objectives for NO_2 may not be achieved solely through its introduction. It should be noted, as detailed in Chapter 3, that Dundee currently meets legal limits for PM_{10} and $PM_{2.5}$.

11.5.6 This NLEF appraisal has concluded the LEZ detailed in this Chapter is the most suitable scheme for the city and if delivered with targeted traffic management measures on Lochee Road, it is possible that the LEZ Objective is fully satisfied. A definitive conclusion can only be reached through modelling of the LEZ and accompanying traffic management measures in the full NMF Dundee City air quality modelling. This key task will be complete prior to submission of the final scheme to Scottish Ministers (currently delayed due to cyber-attack on SEPA, see Section 2.4 for details).

Table 11.2 : Predicted NO_2 for final Dundee LEZ option

Site Name	Average mean NO2 (µg/m3)	
	2019 Observed	Final Dundee LEZ
Victoria Rd/Hilltown	48.3	33.8
Dock St (57)	44.2	38.4
Lochee Rd (140) Traffic Lts	46.2	40.0
Logie St (114)	47.1	41.5
Lochee Rd (138)	45.8	40.7
West Marketgait/Old Mill (23)	47.1	41.8
Seagate	44.5	27.1
West Marketgait / Guthrie St	38.3	34.9
Lochee Road (CM)	43.0	39.6
Lochee Road (DT)	41.5	35.4
Seagate (99)	37.9	33.3
Whitehall St (1)	40.3	23.0
Forfar Rd (104)	38.1	32.9
Broughty Ferry Rd (141)	36.3	33.6
Whitehall St (5)	35.8	21.4
Rankine St (2)	36.7	33.5
Meadowside Average	37.7	20.5
Nethergate (88)	39.0	26.7
Seagate (97)	41.0	25.1
Seagate Average	39.1	23.7
Broughty Ferry Rd (129)	37.0	34.2
Kingsway East Roundabout	34.1	31.7
Dock St (21)	33.1	22.3
Locations > 40 µg/m3	**11**	**4**
Locations between 36 & 40 µg/m3	**9**	**2**

Objective 2: Develop an environment that helps promote more active and sustainable travel choices in Dundee and contributes to meeting emission reduction targets set out in Part 1 of the Climate Change (Scotland) Act 2009

11.5.7 The introduction of the Dundee LEZ option will ensure Dundee's bus fleet consists of lower emitting vehicles and contributes to a positive change to Dundee's environment. This is particularly true of the city centre where there is high pedestrian activity and where buses may dwell at bus stops for longer or wait at signal controlled junctions with their engines running. Similarly, the environment on key routes in and out of the city, where there are a high proportion of buses, will benefit from this improved fleet and this may contribute to a city where walking and cycling is considered a more attractive mode of transport. Additionally, a bus fleet that contains more modern vehicles that are likely to be more comfortable to travel on and have better facilities, may promote a shift to this more sustainable travel mode, reducing the number of private vehicles on the road network and contributing to an overall improved environment that may in turn incentivise more active and sustainable travel choices.

11.5.8 The Dundee LEZ ensures that all vehicles inside the city centre area are compliant with LEZ emission standards will further develop an environment that promotes more active and sustainable travel choices by removing more polluting vehicles from these central locations. The Dundee LEZ may encourage some people to walk, cycle or use public transport instead of a car for their journeys if these are non-compliant and restricted from entering the city centre area.

11.5.9 At this stage, it is not possible to quantify the effectiveness of Dundee LEZ meeting this LEZ objective but it can be concluded that through its introduction, the LEZ creates a city centre with lower levels of harmful emissions thereby creating an environment for active and sustainable modes of transport to be more attractive for more people. Any resultant reduction in private vehicle trips will directly result in reduced carbon entering the environment and contribute to the city meeting climate change targets.

Objective 3: Contribute to the ongoing transformational change in Dundee and help promote the city as an inclusive and desirable place to live, invest, visit and learn

11.5.10 Dundee has undergone many positive changes in recent years with high profile projects transforming the image of the city. It is anticipated that the introduction of the Dundee LEZ will continue this trend.

11.5.11 For similar reasons stated in the Objective 2 appraisal, improvements to the wider Dundee environment will contribute to making Dundee a more attractive place to live, study and visit and in the longer term, this may lead to the creation of jobs, services and investment that will drive an improved city economy for all. The improved environment and the "green tourist" may increase visitors to the city and continue its transformational change.

11.5.12 Again, it is not possible at this stage to quantify the effectiveness of Dundee LEZ meeting this LEZ objective. The final Dundee LEZ allows for non-compliant vehicles to park on the periphery of the city centre and in the short term will help enable an economic recovery for the city centre from the impact of Covid-19 pandemic restrictions. Throughout the lifetime of the LEZ it is anticipated the LEZ option will positively impact on the city's health and wellbeing, help develop a vibrant, accessible, and safe city centre and contribute to ongoing transformational change in Dundee.

11.6 Additional traffic management Lochee Road

11.6.1 DCC are currently progressing junction and lane capacity improvements and improved sustainable travel provision on the Lochee Road corridor. The full details will be presented to the DCC Community Safety & Public Protection Committee meeting in Report 2021 and will be summarised as part of the final NLEF Stage 2 Report.

12. SUMMARY OF NEXT STEPS

12.1 Timetable of Dundee LEZ

12.1.1 Table 12.1 below presents the proposed timetable from committee submission of the final Dundee LEZ presented in this Interim NLEF Stage 2 Report through to full enforcement of the LEZ after the proposed grace period ends.

Table 12.1 : Timetable towards Dundee LEZ enforcement

Activity	Indicative Date
Community Safety & Public Protection Committee Report recommending final Dundee LEZ as defined in this report	June 2021
Statutory Consultation	Summer 2021
Completion of additional impact assessments (IIA, BRIA, SEA)	Autumn 2021
Community Safety & Public Protection Committee Report on statutory consultation and final LEZ option	Autumn 2021
Submission of final LEZ scheme to Scottish Ministers	End 2021
Scottish Minister approval and DCC declaration of Dundee LEZ	Spring 2022
Enforcement of Dundee LEZ	Spring 2024

12.2 Emissions Analysis and the National Modelling Framework

12.2.1 SEPA, who develop and run the National Modelling Framework (NMF) Dundee City Air Quality Model, were subject to a cyber-attack in late 2020 resulting in the NMF being currently unavailable. The Dundee LEZ option will be assessed in the NMF prior to submission to Scottish Minsters, subject to the availability of the NMF Dundee City Model.

12.2.2 As an interim step to inform the likely impact on emissions resulting from the introduction of the LEZ, analysis of emissions based on traffic model outputs has been undertaken by SEPA using EMIT software. The report *Dundee Emissions Analysis Report (SEPA, May 2021)* provides full details of this analysis with outcomes to be presented in the DCC Community Safety & Public Protection Committee Report in June 2021.

12.2.3 Outcomes from the interim EMIT analysis and from the full NMF modelling will be included as part of the final NLEF Stage 2 Report. Key initial results from the EMIT analysis are:

- Implementation of the proposed LEZ will reduce NOx emissions on key bus routes inside the LEZ boundary by an average of 70%.
- Emissions on Lochee Road outside of the LEZ boundary experience a reduction in NOx emissions by an average of 20%.
- The proposed LEZ results in low levels of traffic displacement, except for an increase in car flow on the inner ring road and surrounding car parks, and a small increase in Goods vehicles on the Kingsway. This is linked to very localised increases in NOx emissions on small sections of road around the edge of the LEZ boundary. These occur on roads that currently have low traffic levels.

12.3 Impact Assessments

12.3.1 NLEF guidance advises that as part of the NLEF Stage 2 Assessment, the final Dundee LEZ should be subject to detailed impact, equality and environmental assessments to ensure any impacts, beyond improvements to air quality, are fully considered.

12.3.2 In line with Transport Scotland's approach to the national introduction of LEZs, Dundee's LEZ will be subject to the following impact assessments:

- Strategic Environmental Assessment (SEA)
- Integrated Impact Assessment (IIA)
- Business and Regulatory Impact Assessment (BRIA)

12.3.3 These assessments are ongoing and it is anticipated that these tasks will be complete prior to the final submission of the Dundee LEZ to Scottish Ministers in Autumn 2021.

12.4 Statutory Consultation

12.4.1 Section 11 of the Transport (Scotland) Act 2019 states that before a local authority submits its final LEZ proposals to Scottish Ministers for approval, it must consult with:

- the Scottish Environment Protection Agency,
- Scottish Natural Heritage (now NatureScot),
- Historic Environment Scotland,
- such persons as the authority considers represent the interests of—
    i. the road haulage industry,
    ii. the bus and coach industry,
    iii. the taxi and private hire car industry,
    iv. local businesses, and
    v. drivers, likely to be affected by the proposal,
- such persons as are specified by the Scottish Ministers in regulations
    i. neighbouring local authorities
    ii. the Regional Transport Partnership (Tactran)
    iii. the local Health Board
- such other persons as the authority considers appropriate

12.4.2 All statutory consultees have been involved in previous consultation and/or are part of the Dundee LEZ Delivery Group. However, in line with The Act 2019, consultation on the final Dundee LEZ will take place from June 2021. Thereafter, DCC will publish a Report on the consultation findings and, if required, take account of any representations received in the course of the consultation.

12.4.3 Once the consultation findings have been taken into consideration, DCC will publish the final proposed Dundee LEZ scheme and, at this time, objections can be made. When the period in which objections can be made has ceased, DCC will publish a report outlining any objections received and its response.

APPENDIX A: NMF HIGH LEVEL SCENARIOS

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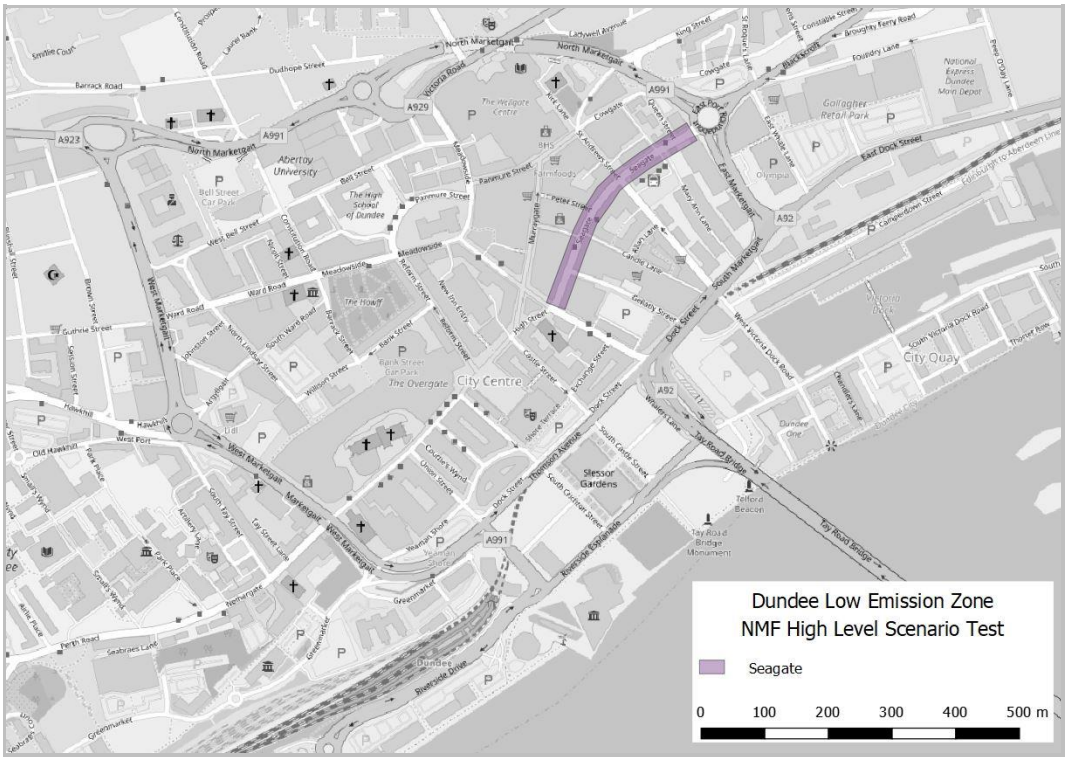

Figure A.1 : NMF Seagate Scenario

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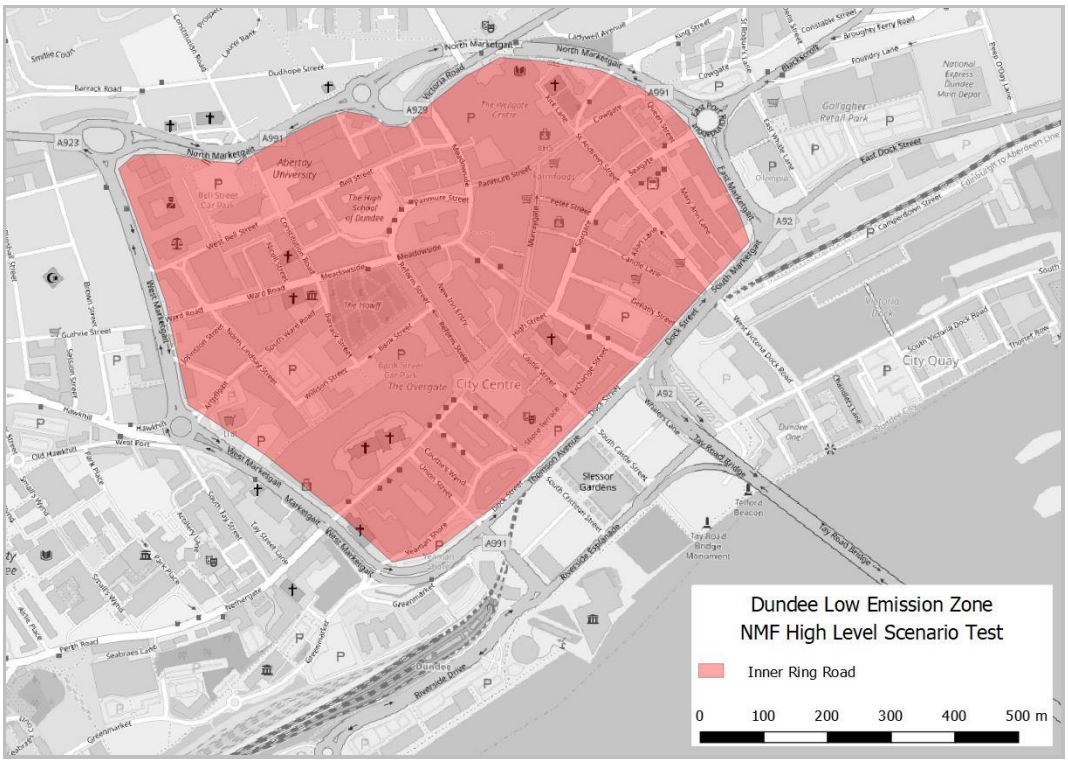

Figure A.2 :NMF Inner Ring Road Scenario

APPENDIX B: LEZ OPTION GENERATION AREAS

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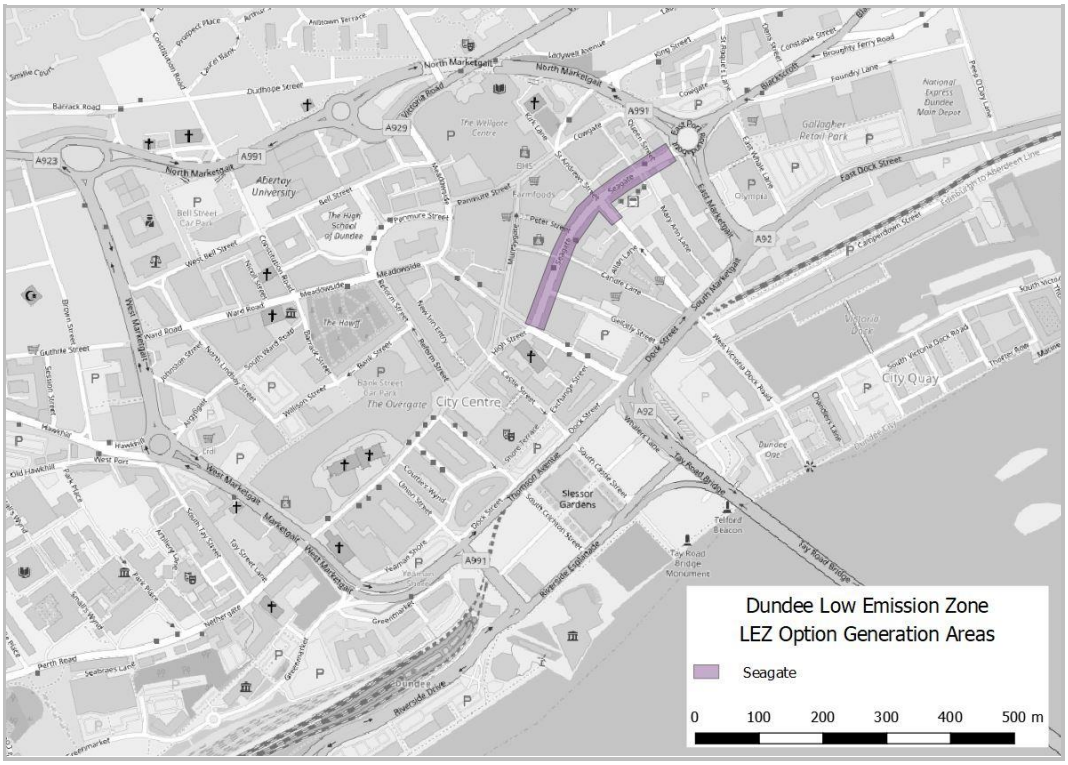

Figure B.1 : Seagate LEZ Option Area

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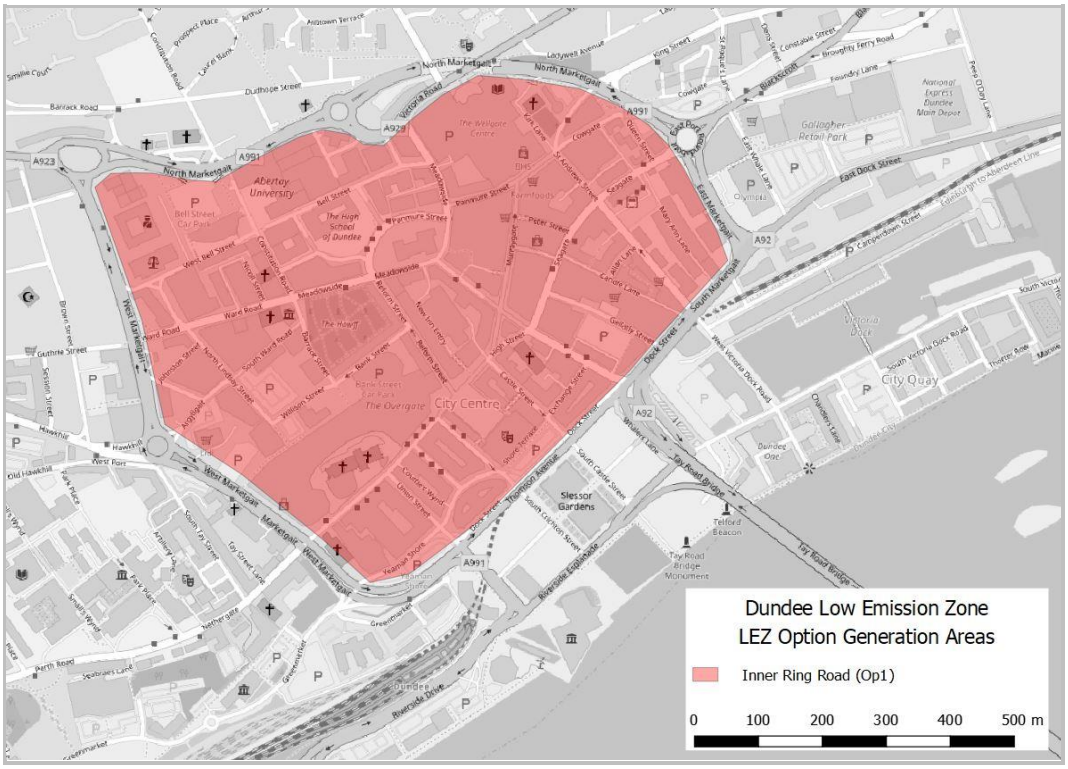

Figure B.2 :Inner Ring Road (Option 1) LEZ Option Area

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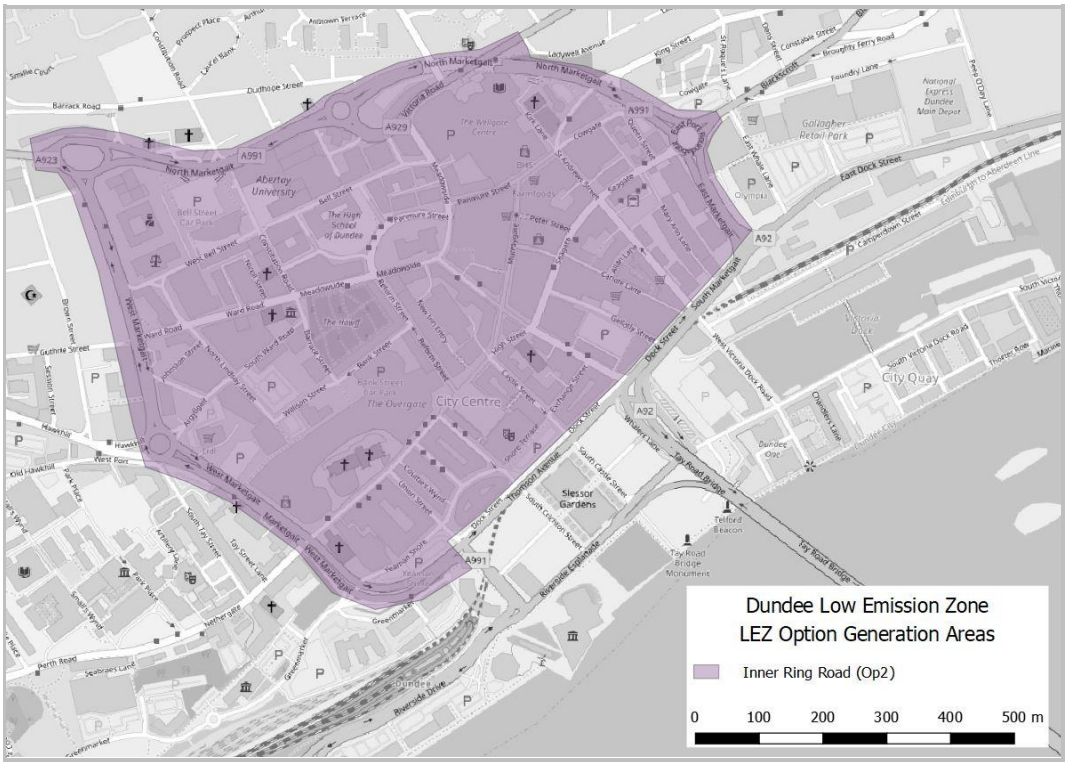

Figure B.3 : Inner Ring Road (Option 2) LEZ Option Area

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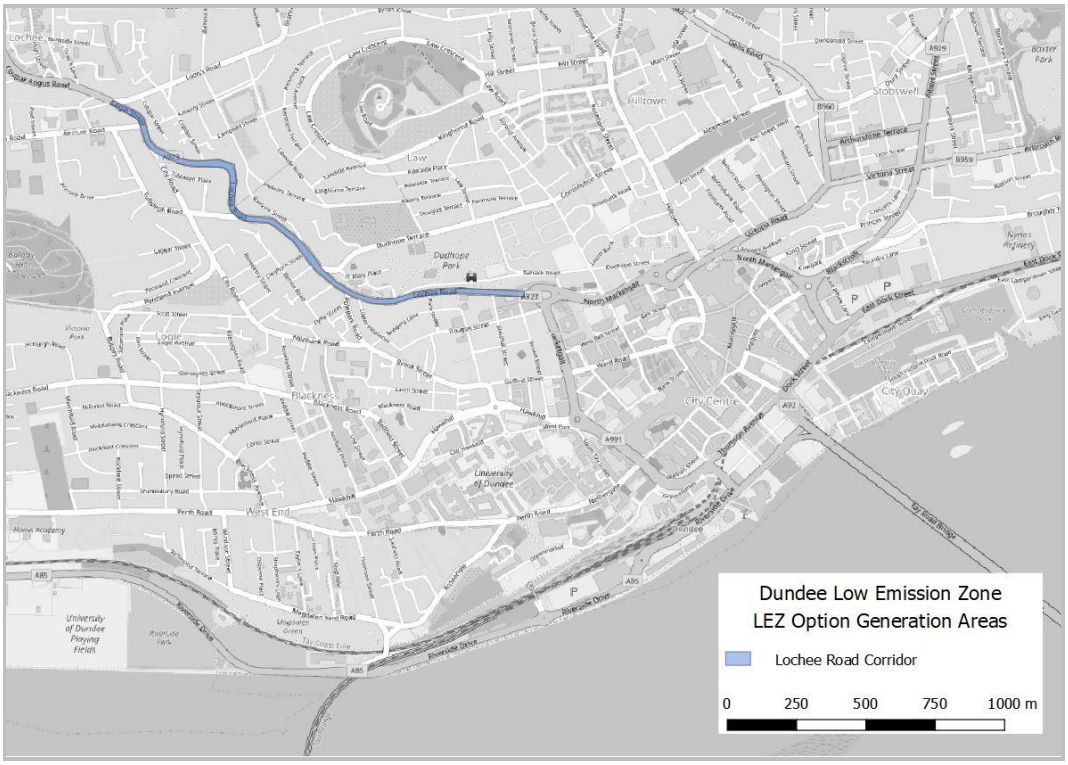

Figure B.4 : Lochee Road Corridor LEZ Option Area

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Figure B.5 : Inner Ring Road (Option 2) and Lochee Road Corridor LEZ Option Area

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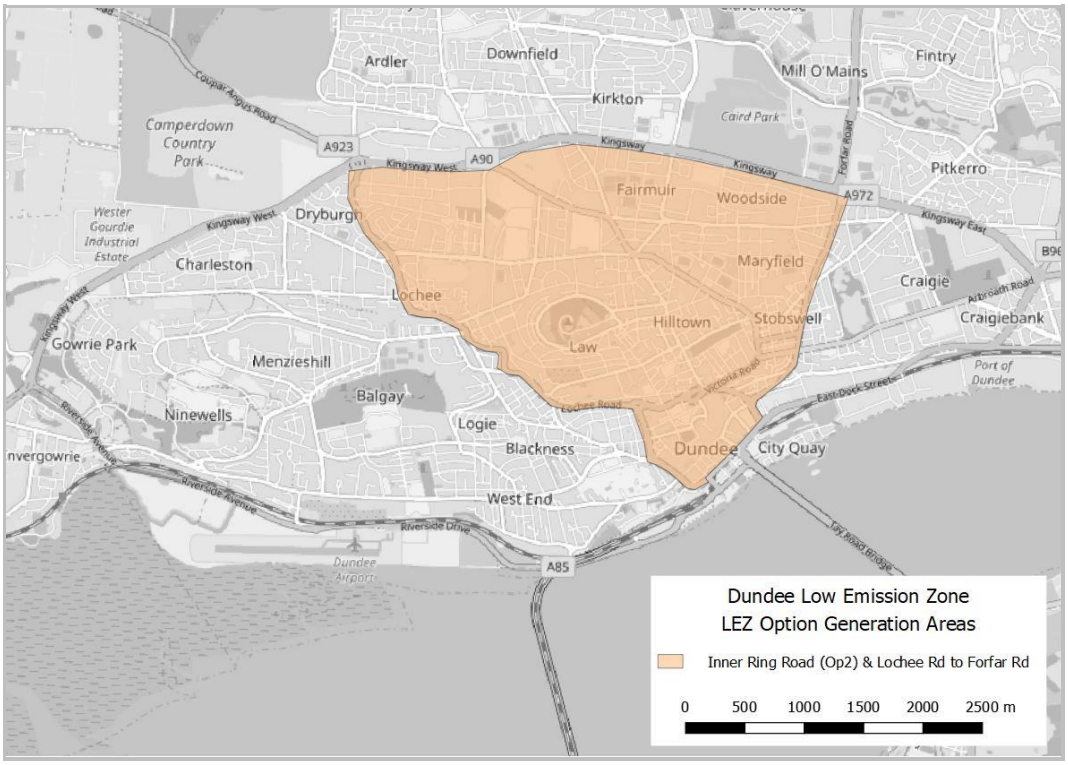

Figure B.6 : Inner Ring Road (Option 2) and Lochee Road to Forfar Road LEZ Option Area

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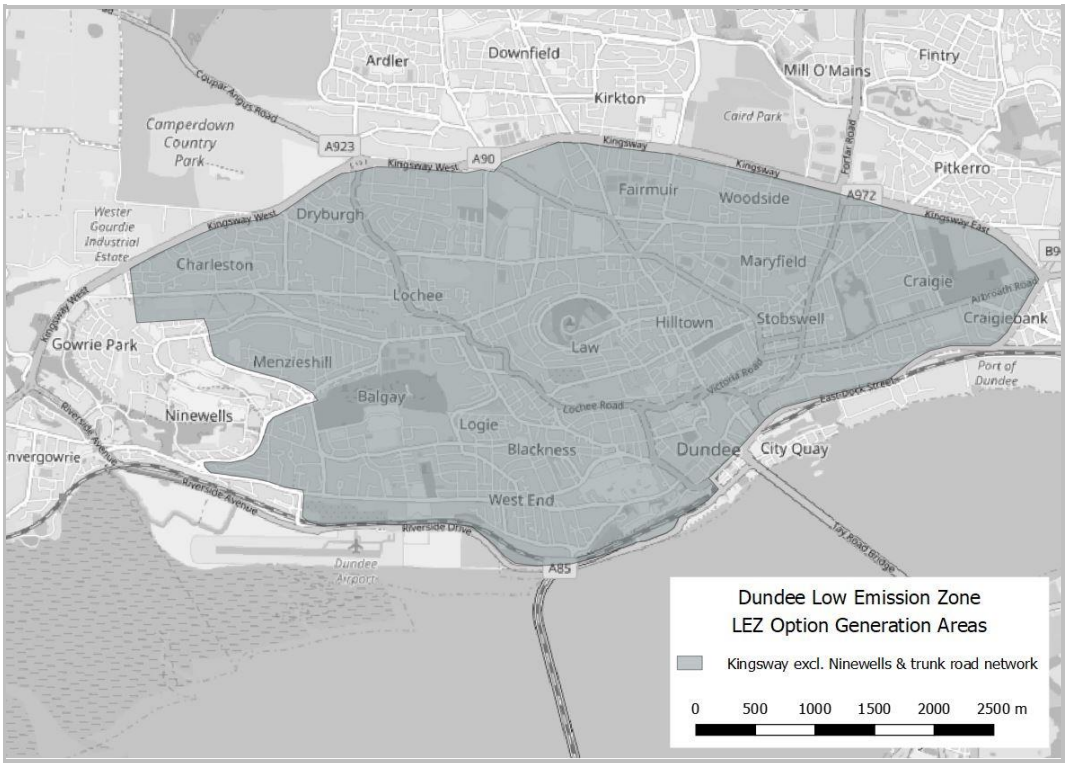

Figure B.7 :Kingsway excluding trunk road network and Ninewells LEZ Option Area

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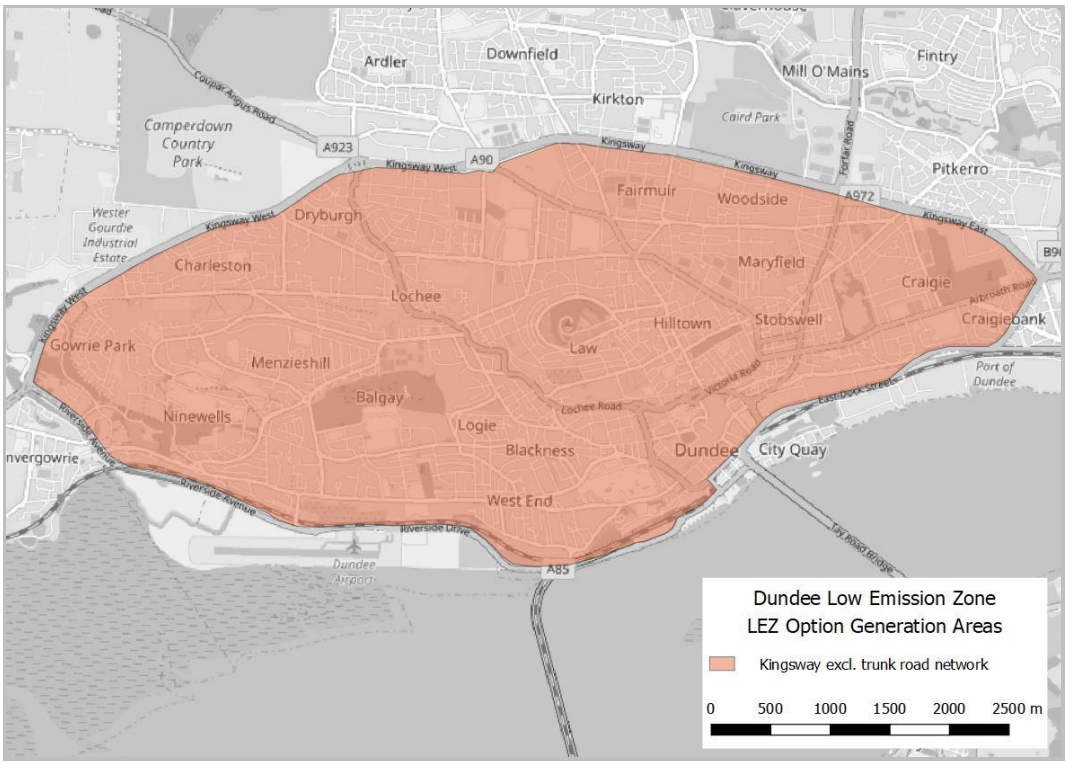

Figure B.8 : Kingsway excluding trunk road network LEZ Option Area

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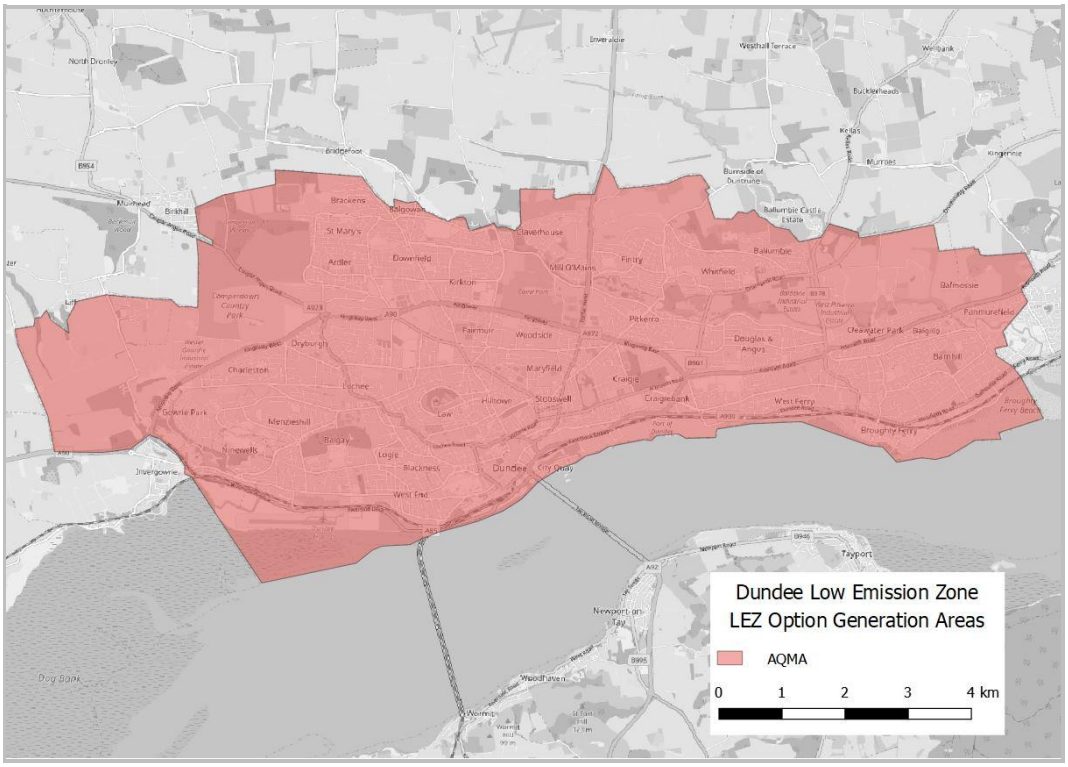

Figure B.9 : AQMA LEZ Option Area

APPENDIX C: DUNDEE LEZ TRAFFIC MODELLING TECHNICAL NOTE

SUMMARY TABLE	
Client/Project owner	Dundee City Council
Project	Dundee Microsimulation Model
Title of Document	LEZ Option Testing Note
Type of Document	Appendix C - Technical Note
Date	07/05/2021
Reference number	GB01T18H31/18/1/2021
Number of pages	52

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1. INTRODUCTION

1.1.1 SYSTRA Ltd (SYSTRA) were commissioned by Dundee City Council (DCC) to develop a microsimulation model of the Greater Dundee City Centre area for the purpose of assessing scenarios associated with the proposed Dundee Low Emission Zone. The project has been managed by Dundee City Council (DCC).

1.1.2 The initial Base Model development is detailed in the report *Dundee Greater City Centre Base Paramics Model Development Report (SYSTRA, November 2019)* and the development of the 2023 reference case model is detailed in the technical note *Dundee Greater City Centre Reference Case Note (SYSTRA, February 2020)*.

1.1.3 This technical note outlines the development of each of the LEZ option models, as defined by DCC and identified in the *National Low Emission Framework - Stage 2 Assessment Report (SYSTRA, July 2019).* It assesses the impact of trips completed by vehicles with non-compliant engine standards, as defined by the Transport (Scotland) Act 2019, being displaced to outside the LEZ. Along with the operational results presented in this report, model outputs have been provided to SEPA for input to the air quality modelling, which will be reported separately by SEPA.

1.2 Model Testing Programme

1.2.1 The 2023 Reference Case, as defined by DCC, reflects infrastructure changes and committed Local Development Plan forecasts to 2023. The 2023 Reference Case Model was used as a basis to develop three core inner ring road LEZ option tests, namely the three all vehicle LEZ options identified through the NLEF high level appraisal:

- LEZ Option 1 (NLEF Ref 2A) - Inner Ring Road area, including all car parks
- LEZ Option 2 (NLEF Ref 2B) - Inner Ring Road area, excluding Bell Street and West Marketgait NCP car parks
- LEZ Option 3 (LEZ Ref 2C) - Inner Ring Road area, excluding Bell Street, West Marketgait NCP and Wellgate car parks

1.2.2 In addition to these three core inner ring road options, two further variants were tested where the LEZ was extended along the Lochee Road corridor, as identified through the NLEF public and stakeholder consultation. The Lochee Road option tests were:

- LEZ Option 1/2/3 (above) plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- LEZ Option 1/2/3 (above) plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road

1.2.3 During this LEZ model testing, it was identified that the assessment of the Lochee Road corridor options was hindered by network congestion primarily resulting from the inclusion of West Marketgait between West Port Roundabout and Dudhope Roundabout in the LEZ area. To ensure a robust LEZ option testing programme, it was agreed with DCC to model further variants of the Lochee Road options, excluding West Marketgait, as follows:

- LEZ Option 1/2/3 (above) plus Lochee Road to Tullideph Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)
- LEZ Option 1/2/3 (above) plus Lochee Road to Loon's Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)

1.3 LEZ Post Covid-19 Uncertainty

1.3.1 The Covid-19 pandemic has had a dramatic impact on travel across all modes and specifically travel in Scotland's city centres. To assist in the development of the LEZs across

Scotland, Transport Scotland commissioned a study to apply the principals of modelling in considering the uncertainty over what travel will look like after the pandemic has ended.

1.3.2 The study set out a framework for embracing uncertainty by consulting with stakeholders on 'what will travel look like post Covid-19'. This framework set out the rationale for any additional modelling required to provide evidence to support the introduction of any LEZ. To assist this process, workshops were held with the local authorities, including DCC, to agree the key metrics to measure against the current LEZ objectives and identify the key disruptors which are likely to have the greatest impact on travel activities within each city centre.

1.3.3 A Scenario Planning Process was developed to allow a range of plausible future scenarios to be defined using important and likely disruptors. These scenarios were used as a reference case against which the anticipated LEZ impacts were applied to understand how an LEZ performs in the context of plausible future scenarios.

1.3.4 The outcomes from the study are detailed in the *LEZ Post-Covid Uncertainty Summary Note (SYSTRA Ref. GB01T20E86/11024112/005, January 2021*). The study concluded that the impact of the LEZs will vary between each city introducing a LEZ, depending on their specific traffic levels and fleet composition. But importantly, the LEZ will protect the city centres by preventing non-compliant vehicles from entering them. Whilst the impact of the LEZ may vary across each city in terms of emissions, the outcome is likely to be very similar with the level of emissions limited to a reduced value compared to pre-LEZ levels.

1.3.5 For Dundee, plausible futures were considered against the core model assessments undertaken (outlined above) and further sensitivity testing of the proposed LEZ schemes was proposed. The reason for undertaking the sensitivity tests is to provide evidence that the LEZ schemes are robust to variations in network conditions that may occur in a post-pandemic world.

1.3.6 As noted above, the core traffic modelling results in this report were developed from one plausible future scenario, defined as the 2023 Reference Case. The LEZ Post-Covid-19 uncertainty study recommended that a sensitivity test was undertaken on one other further plausible future, to ensure a robust set of modelling results to inform Dundee's LEZ.

1.3.7 The sensitivity scenario was defined as "Coping as Best We Can" where, following an economic downturn, the projected rate of change towards a cleaner fleet is lower than pre-Covid-19 forecasts (as provided by SEPA) and traffic shrinkage is experienced, similar to the 2010 economic downturn. The outcomes from this sensitivity testing are detailed in Chapter 8.

2. INNER RING ROAD LEZ OPTION BOUNDARIES

2.1.1 The NLEF process identified three LEZ boundary options to be compared with the 2023 Reference Case model, as follows:

- LEZ Option 1 (NLEF Ref 2A) - Inner Ring Road area, including all car parks (Figure 2.1)
- LEZ Option 2 (NLEF Ref 2B) - Inner Ring Road area, excluding Bell Street and West Marketgait NCP car parks (Figure 2.2)
- LEZ Option 3 (LEZ Ref 2C) - Inner Ring Road area, excluding Bell Street, West Marketgait NCP and Wellgate car parks (Figure 11.1Figure 2.3)

2.1.2 A LEZ, as defined in the Transport (Scotland) Act 2019, prohibits vehicles with petrol and diesel engines that are below Euro 4 and Euro 6/VI, respectively. For each option, model restrictions along the LEZ boundary are put in place prohibiting non-compliant vehicles to enter the LEZ.

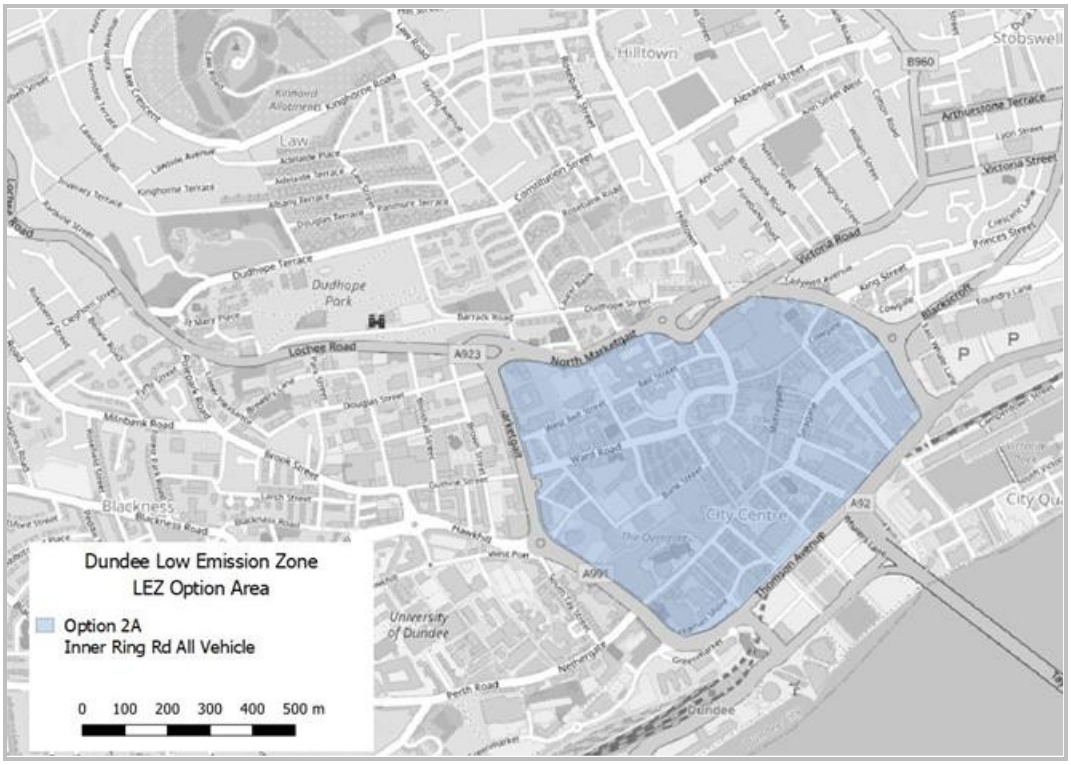

Figure 2.1 : LEZ Option 1 (NLEF Ref. 2A)

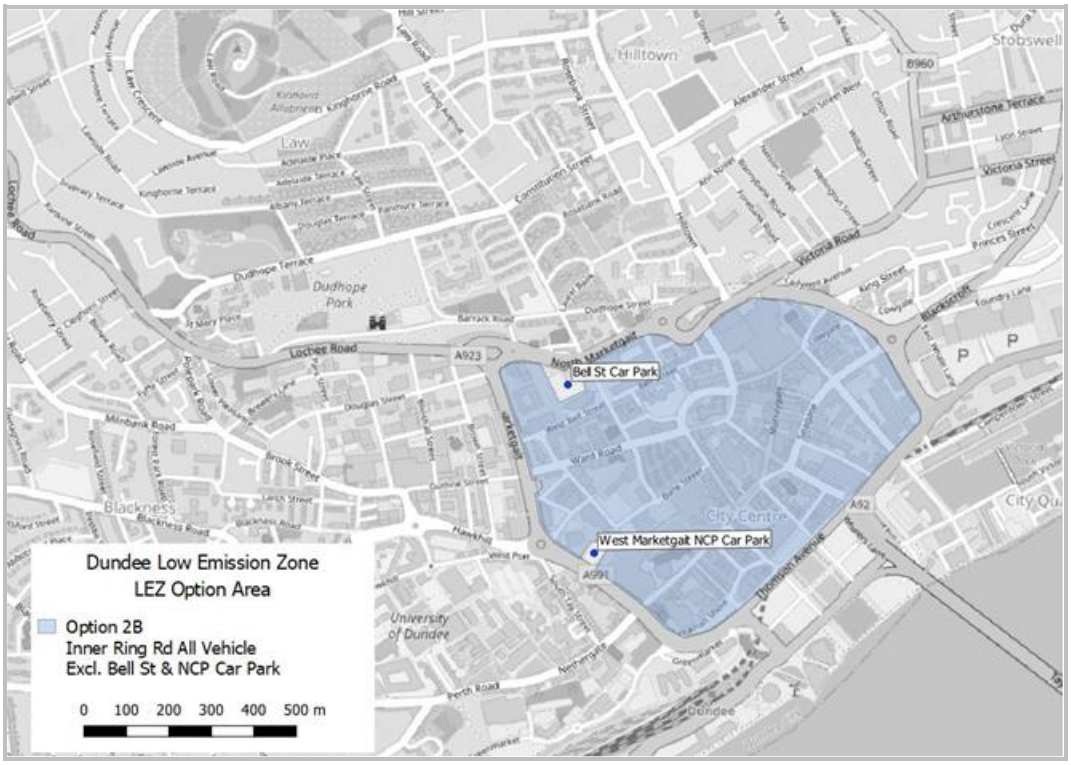

Figure 2.2 : LEZ Option 2 (NLEF Ref. 2B)

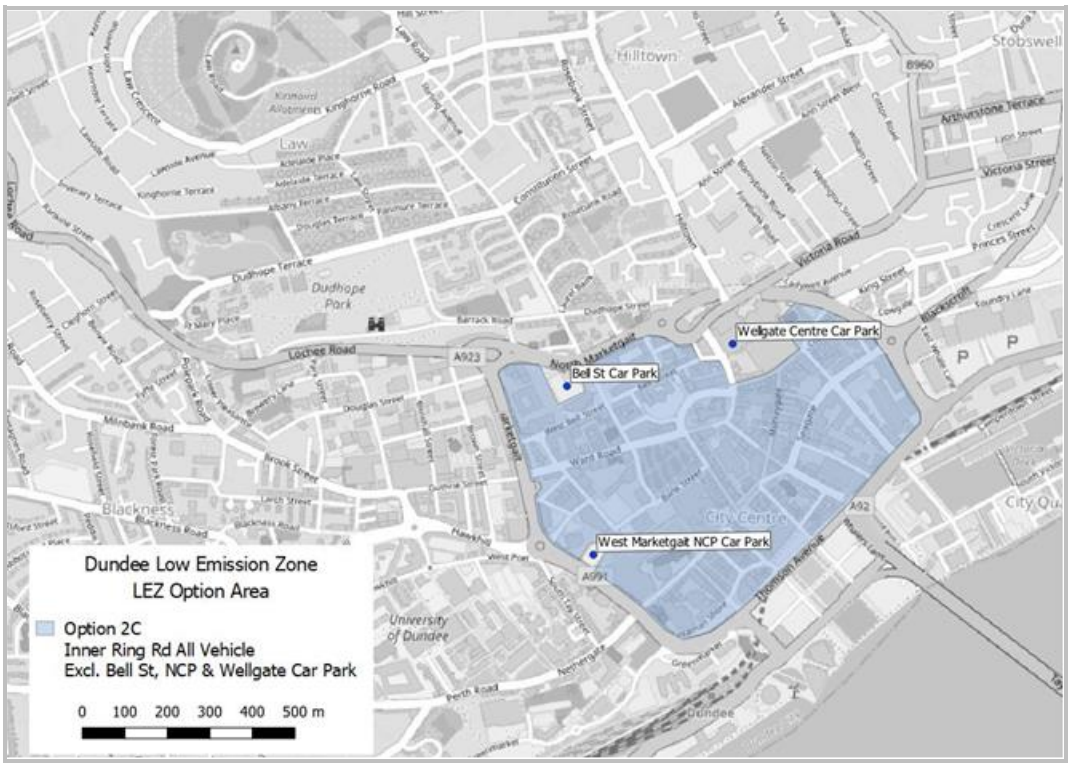

Figure 2.3 : LEZ Option 3 (NLEF Ref. 2C)

3. LEZ OPTION MODEL DEVELOPMENT

3.1 LEZ Assumptions

3.1.1 For all the LEZ Option models the following assumptions were made, following discussions with DCC and Transport Scotland:

- The base year (2017) vehicle fleet has been used to provide a worst case with regards to displaced traffic volumes and resulting impact on emissions.
- No mode shift, or destination shift, reflecting a worst case in terms of vehicles to be displaced.
- Non-compliant cars destinating in the LEZ boundary assumed to move to park out-with the LEZ boundary in the nearest car park available.
- All taxis assumed to be compliant.
- All HGVs originating or destinating within the boundary assumed to be compliant.
- All LGVs originating or destinating the LEZ boundary assumed to be compliant.

3.1.2 In order to prohibit the relevant number of non-compliant vehicles from the LEZ, the proportion of compliant and non-compliant cars, LGVs and HGVs was provided by SEPA, as identified through ANPR traffic surveys. The split for each vehicle type is outlined below in Table 3.1.

Table 3.1 : Engine Type Split

Vehicle Type	Status	Fuel type	Percentage by vehicle class
Car	Compliant	Petrol	51%
		Diesel	17%
	Non-Compliant	Petrol	3%
		Diesel	29%
LGV	Compliant	Petrol	0%
		Diesel	16%
	Non-Compliant	Petrol	1%
		Diesel	83%
HGV	Compliant	Petrol	0%
		Diesel	26%
	Non-Compliant	Petrol	0%
		Diesel	74%

3.1.3 It is assumed that for the LGV and HGV trips that arrived or departed from within the LEZ in the Reference Case model, any non-compliant vehicles would be replaced with compliant ones, as agreed with DCC. The non-compliant cars are assumed to divert to a nearby carpark outside of the LEZ.

3.1.4 In order to facilitate this in the model, the model demands have been split into 9 matrix levels;

- Matrix 1 – Car Compliant
- Matrix 2 – Car Non-Compliant
- Matrix 3 – LGV Compliant
- Matrix 4 – LGV Non-Compliant
- Matrix 5 – HGV Compliant
- Matrix 6 – HGV Non-Compliant
- Matrix 7 – Taxi
- Matrix 8 – Development Cars Compliant
- Matrix 9 – Development Cars Non-Compliant

3.1.5 Table 3.2, Table 3.3 and Table 3.4 details the vehicle numbers by matrix level for the Reference Case and each of the options. The total number of compliant and non-compliant vehicles differs slightly between each LEZ option due to the inclusion or exclusion of city centre car parks, as detailed in Chapter 2.

Table 3.2 : AM Demand Summary by matrix level

Matrix	AM (07:00-10:00)			
	Ref Case	Option 1	Option 2	Option 3
1	51513	51513	51513	51513
2	25012	24905	24911	24908
3	1957	2226	2226	2226
4	10399	10130	10130	10130
5	893	945	945	945
6	2542	2489	2489	2489
7	2111	2111	2111	2111
8	989	989	989	989
9	480	475	479	479

Table 3.3 : IP Demand Summary by matrix level

Matrix	IP (10:00-16:00)			
	Ref Case	Option 1	Option 2	Option 3
1	111001	111001	111001	111001
2	53883	53418	53418	53429
3	4036	4784	4784	4802
4	21438	20690	20690	20672
5	1938	2026	2026	2027
6	5515	5426	5426	5426
7	6457	6457	6457	6457
8	1705	1705	1705	1705
9	828	822	822	826

Table 3.4 : PM Demand Summary by matrix level

Matrix	PM (16:00-19:00)			
	Ref Case	Option 1	Option 2	Option 3
1	71573	71573	71573	71573
2	34744	34468	34468	34480
3	1472	1629	1629	1629
4	7823	7666	7666	7666
5	376	388	388	388
6	1071	1059	1059	1059
7	2373	2373	2373	2373
8	1211	1211	1211	1211
9	588	584	584	587

3.2 LEZ Trip Displacement

3.2.1 Separate matrix levels were used for trips made by non-compliant cars. Trips arriving and departing from zones identified as inside the LEZ in the non-compliant OD Matrix were removed and re-distributed to nearby carparks outside of the LEZ. For each LEZ zone, the nearest carpark zone is defined and the identified non-compliant trips are reassigned to this zone.

3.2.2 Table 3.5, Table 3.6 and Table 3.7 detail the number of non-compliant trips being displaced by the LEZ and the adopted distribution to nearby carparks for each LEZ option based on its proximity to each Paramics zone within the LEZ.

3.2.3 It should be noted that compliant cars access the LEZ area and city centre car parks as normal without restriction. In LEZ Option 3, no additional non-compliant vehicles are redistributed to Bell Street car park, as shown, but existing compliant and non-compliant cars trips assigned here in the Reference Case model access the car park as normal.

Table 3.5 : LEZ Option 1 – New Car Park Trips

LEZ Option 1	AM		IP		PM	
	From	To	From	To	From	To
Greenmarket Carpark	333	803	1552	1655	1123	787
Olympia CarPark	148	268	516	534	322	192
Marketgait Carpark	0	0	0	0	0	0
Bell Street Carpark	0	0	0	0	0	0
Wellgate Carpark	0	0	0	0	0	0
TOTAL	480	1072	2069	2189	1444	978

Table 3.6 : LEZ Option 2 – New Car Park Trips

LEZ Option 2	AM		IP		PM	
	From	To	From	To	From	To
Greenmarket Carpark	19	94	248	288	195	155
Olympia CarPark	50	119	263	226	172	87
Marketgait Carpark	309	519	1158	1109	815	571
Bell Street Carpark	89	193	177	304	131	89
Wellgate Carpark	0	0	0	0	0	0
TOTAL	466	925	1845	1927	1312	902

Table 3.7 : LEZ Option 3 – New Car Park Trips

LEZ Option 3	AM		IP		PM	
	From	To	From	To	From	To
Greenmarket Carpark	19	94	248	288	195	155
Olympia CarPark	30	60	162	210	57	75
Marketgait Carpark	309	519	1158	1109	815	571
Bell Street Carpark	0	0	0	0	0	0
Wellgate Carpark	106	113	185	102	179	45
TOTAL	464	786	1752	1708	1246	846

3.3 Reference Case Network Changes

3.3.1 An issue was identified at the Moffat Road Roundabout on the Kingsway which caused runs to crash sporadically. In order to prevent this, Clear Exit Adherence was added at this location in the Reference Case and all Option models.

4. INNER RING ROAD OPTION PERFORMANCE COMPARISON

4.1.1 The three inner ring road option models were run 10 times each for the three time periods AM (07:00-10:00), IP (10:00-16:00), PM (16:00-19:00) and results averaged across the 10 runs.

4.2 General Model Observations

4.2.1 For the most part, the Option models operate without noticeable difference from the Reference Case model. The notable exception to this is the East Dock Street/East Marketgait junction which sees an increase in congestion, particularly in the AM, as a result of non-compliant vehicles being reassigned to car parks on the periphery of the LEZ inner ring road area. This congestion is worst in Option 1 which has the highest number of displaced vehicles.

4.3 Journey Time Comparisons

4.3.1 Journey Times were collected over 11 routes which were specified by DCC and represent key routes that may be impacted by the LEZ proposals, as shown in Figure 4.1.

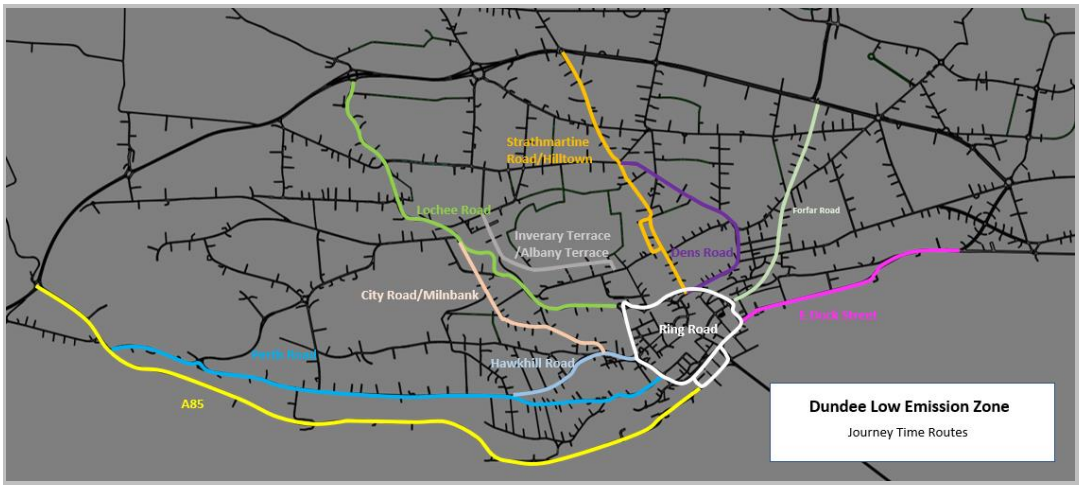

Figure 4.1 : Journey Time Routes

4.3.2 Table 4.1 and Table 4.2 show the average journey time in seconds during the peak hours, 08:00-09:00 and 17:00-18:00 respectively, along these routes for the reference case model and the three LEZ option models.

Table 4.1 : Journey Time Comparison (seconds) 08:00 – 09:00

Route	Ref Case	Op1	Difference (Op1-Ref)	Op2	Difference (Op2-Ref)	Op3	Difference (Op3-Ref)
A85 EB	404	406	1	403	-1	406	2
A85 WB	435	431	-4	433	-2	437	1
City Road/Milnbank Road NB	154	153	-1	154	0	155	1
City Road/Milnbank Road SB	152	150	-3	150	-3	151	-1
Dens Road NB	242	242	0	246	4	242	0
Dens Road SB	253	250	-3	253	1	253	0
East Dock Street EB	177	178	1	177	-1	177	0
East Dock Street WB	199	272	74	230	31	226	27
Forfar Road NB	304	304	0	301	-3	299	-5
Forfar Road SB	278	289	10	277	-1	283	5
Hawkhill Road EB	118	117	-1	118	0	118	0
Hawkhill Road WB	126	129	3	128	1	126	-1
Inverary/Albany/Gardner NB	123	123	1	123	0	123	0
Inverary/Albany/Gardner SB	107	107	0	107	0	107	0
Lochee Road NB	392	390	-2	387	-5	390	-1
Lochee Road SB	400	399	-1	400	0	400	0
Perth Road EB	489	423	-66	459	-31	461	-29
Perth Road WB	419	432	13	428	9	434	15
Ring Road Anticlockwise	373	384	11	376	3	367	-6
Ring Road Clockwise	462	490	29	477	15	474	12
Strathmartine Road SB	343	337	-6	349	6	346	3
Hilltown NB	350	353	3	350	0	347	-3

Table 4.2 : Journey Time Comparison (seconds) 17:00 – 18:00

Route	Ref Case	Op1	Difference (Op1-Ref)	Op2	Difference (Op2-Ref)	Op3	Difference (Op3-Ref)
A85 EB	439	444	5	449	10	447	7
A85 WB	436	440	4	440	3	439	3
City Road/Milnbank Road NB	163	165	2	163	0	161	-2
City Road/Milnbank Road SB	157	156	-1	155	-2	155	-2
Dens Road NB	270	277	7	277	7	275	5
Dens Road SB	315	316	2	314	-1	312	-3
East Dock Street EB	216	236	20	229	13	215	-1
East Dock Street WB	214	278	64	186	-28	199	-14
Forfar Road NB	434	428	-7	431	-3	418	-16
Forfar Road SB	311	327	17	302	-9	306	-4
Hawkhill Road EB	127	126	-1	125	-2	125	-2
Hawkhill Road WB	126	127	1	124	-1	125	0
Inverary/Albany/Gardner NB	164	171	7	173	9	164	0
Inverary/Albany/Gardner SB	111	111	0	111	0	111	0
Lochee Road NB	608	610	3	607	-1	591	-17
Lochee Road SB	450	449	-1	460	10	441	-8
Perth Road EB	468	455	-13	453	-15	471	2
Perth Road WB	459	447	-12	438	-21	455	-4
Ring Road Anticlockwise	415	428	13	431	16	442	27
Ring Road Clockwise	479	499	20	480	2	494	15
Strathmartine Road SB	363	373	10	365	3	364	1
Hilltown NB	373	373	1	365	-7	372	0

4.3.3 In general, the comparisons show that the LEZ proposals have little impact on the average journey time on the majority of routes.

4.3.4 The largest increases in journey time are on East Dock Street Westbound in both periods and the Ring Road in the clockwise direction in the AM which is caused by non-compliant vehicles utilising alternative parking locations on the periphery of the LEZ area, as noted in Section 3.2 above. There is particularly notable queueing around the East Dock Street/East Marketgait junction in Option 1 in in the AM period as noted above,

4.4 General Network Statistics

4.4.1 For the modelled area, average trip distances and speeds for the AM and PM periods were compared in order to assess the overall network impact resulting from the introduction of a LEZ, as shown in Table 4.3

Table 4.3 : Speed and distance comparisons

07:00-10:00	Units	RefCase	Option 1	Option 2	Option 3
Total Compliant Vehicles	vehs	55502	55735	55793	55819
Total Non- Compliant Vehicles	vehs	37091	36548	36667	36638
Compliant Speed	mph	23.2	23.0	23.2	23.3
Non-Compliant Speed	mph	23.7	23.4	23.7	23.7
Compliant Av. Distance	m	4602	4602	4599	4604
Non-Compliant Av. Distance	m	4813	4830	4829	4832

16:00-19:00	Units	RefCase	Option 1	Option 2	Option 3
Total Compliant Vehicles	vehs	75307	75362	75439	75397
Total Non- Compliant Vehicles	vehs	43243	42809	42823	42820
Compliant Speed	mph	21.4	21.0	21.3	21.2
Non-Compliant Speed	mph	22.0	21.6	22.0	21.9
Compliant Av. Distance	m	3984	3985	3982	3984
Non-Compliant Av. Distance	m	4169	4202	4198	4199

4.4.2 The results show that although there is little overall difference in average speed of vehicles across the options, there is a small increase in trip distance for non-compliant vehicles as a result of the LEZ proposals. This increase in trip distance, assuming the same average speed as for the rest of the journey, will lead to a direct increase in carbon emissions for the non-compliant vehicles of between 0.3% and 0.8%. This will be quantified in detail by the SEPA air quality modelling.

4.5 Link Flow Comparisons

4.5.1 Modelled link flows were compared for selected locations on the inner ring road for each inner ring road LEZ option. This was undertaken to understand the localised impact of each option in restricting non-compliant vehicles from accessing the area inside the inner ring road and redistributing trips to car parks on the periphery of the proposed option area.

4.5.2 Table 4.4 shows 12 hour two-way modelled flows at 10 locations on the inner ring road for the Reference Case and each LEZ Option. 12 hour two-way flow is presented to assist with the NLEF appraisal process to identify a preferred LEZ option through, amongst other criteria, potential impacts on NO2 emissions.

Table 4.4 : 12 Hour Two-Way Flow Comparisons on Inner Ring Road (All Vehicles)

Site	Location	Ref Case	Op1	Difference (Op1-Ref)	% Diff
West Marketgait	North of West Bell St	17386	16269	-1118	-6.4%
North Marketgait	West of Ladywell Rbt	23535	22158	-1377	-5.9%
Victoria Road	South of Ladywell Rbt	13344	13014	-330	-2.5%
North Marketgait	North of East Port Rbt	17470	16549	-920	-5.3%
East Marketgait	North of East Dock St	13950	14236	286	2.1%
Dock Street	West of Trades Lane	30051	30804	753	2.5%
Thomson Ave	At Slessor Grdns (1-way)	13609	13989	379	2.8%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	15679	470	3.1%
West Marketgait	South of Nethergate	11901	13815	1915	16.1%
West Marketgait	South of West Port Rbt	12779	13931	1152	9.0%

Site	Location	Ref Case	Op2	Difference (Op2-Ref)	% Diff
West Marketgait	North of West Bell St	17386	16014	-1372	-7.9%
North Marketgait	West of Ladywell Rbt	23535	22972	-562	-2.4%
Victoria Road	South of Ladywell Rbt	13344	12840	-504	-3.8%
North Marketgait	North of East Port Rbt	17470	16977	-493	-2.8%
East Marketgait	North of East Dock St	13950	14308	358	2.6%
Dock Street	West of Trades Lane	30051	30558	507	1.7%
Thomson Ave	At Slessor Grdns (1-way)	13609	14201	592	4.3%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	15395	186	1.2%
West Marketgait	South of Nethergate	11901	13694	1793	15.1%
West Marketgait	South of West Port Rbt	12779	14289	1510	11.8%

Site	Location	Ref Case	Op3	Difference (Op3-Ref)	% Diff
West Marketgait	North of West Bell St	17386	15894	-1492	-8.6%
North Marketgait	West of Ladywell Rbt	23535	22498	-1037	-4.4%
Victoria Road	South of Ladywell Rbt	13344	12977	-367	-2.8%
North Marketgait	North of East Port Rbt	17470	17556	86	0.5%
East Marketgait	North of East Dock St	13950	14313	363	2.6%
Dock Street	West of Trades Lane	30051	30642	591	2.0%
Thomson Ave	At Slessor Grdns (1-way)	13609	14254	645	4.7%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	15402	192	1.3%
West Marketgait	South of Nethergate	11901	13717	1816	15.3%
West Marketgait	South of West Port Rbt	12779	14222	1443	11.3%

4.5.3 The modelled flow compaisons show there to be some redistribution of traffic on the inner ring road as a result of each LEZ option. In all options there is a decrease in traffic flow on West Marketgait north of West Port roundabout due to a reduction in non-compliant vehicles accessing the city centre using West Bell Street and Ward Road. Conversely there is an increase in traffic flow on West Marketgait south of West Port roundabout, primarily due to an increase in non-compliant vehicles, displaced from the city centre to car parks on the periphery of the LEZ area (e.g. Greenmarket or West Marketgait NCP). At all locations the changes in traffic flows are not considered significant for the class of road (dual carriageway) for the two-way 12 hour time period represented.

5. LOCHEE ROAD LEZ OPTION VARIANTS

5.1 Background

5.1.1 In addition to the three core inner ring road options described above, two further variants were tested where the LEZ was extended along the Lochee Road corridor, as identified through the NLEF public and stakeholder consultation. The Lochee Road options tests were:

- Variant 1: LEZ Option 1/2/3 (above) plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- Variant 2: LEZ Option 1/2/3 (above) plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road

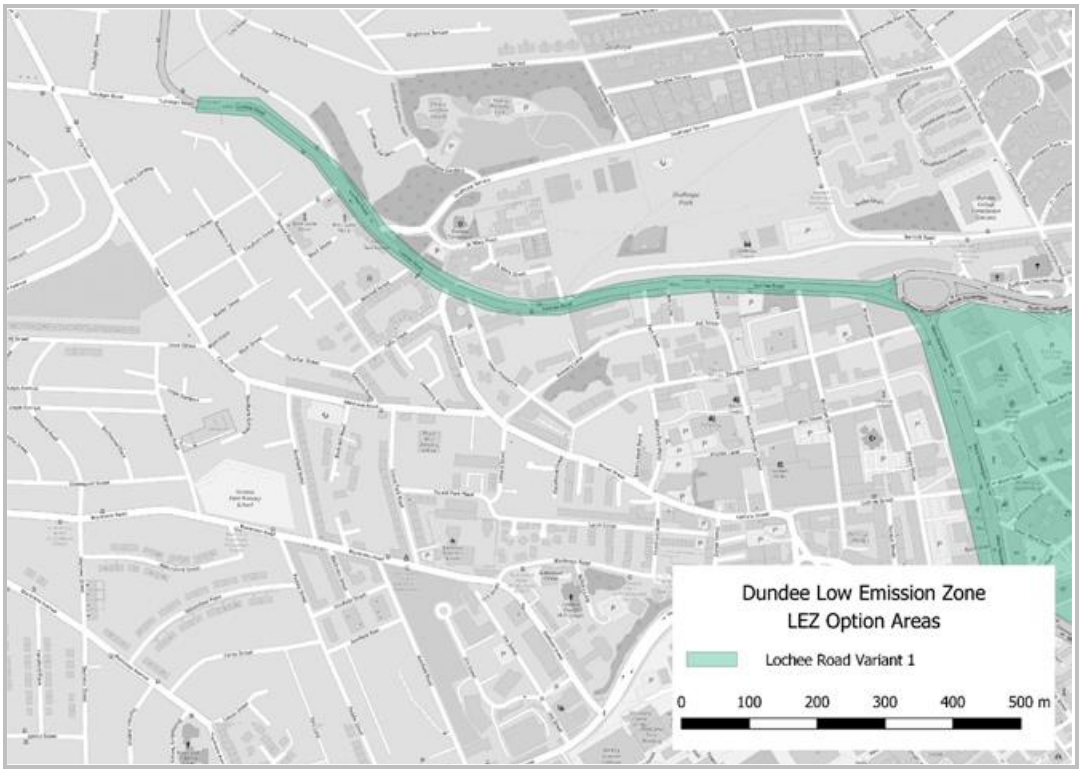

Figure 5.1 : Lochee Road Option Variant 1

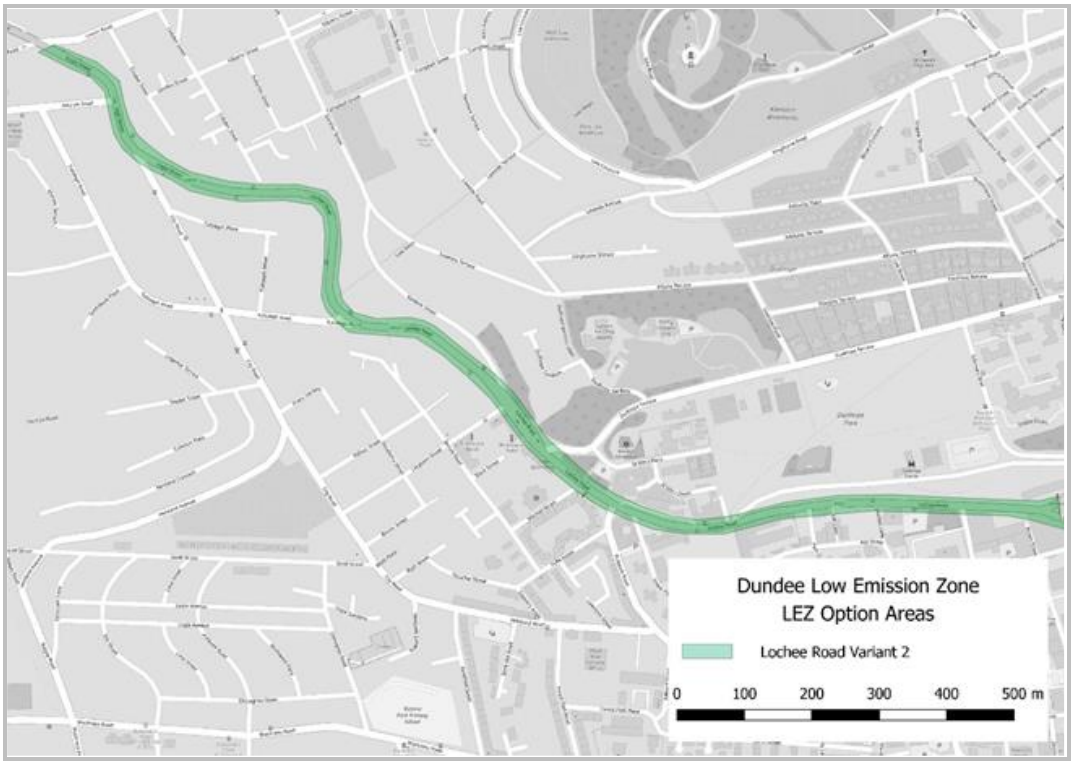

Figure 5.2 : Lochee Road Option Variant 2

5.2 Option Performance Comparisons – Lochee Road Variants

5.2.1 Each of the Lochee Road variants was run 10 times each for the three time periods AM (07:00-10:00), IP (10:00-16:00), PM (16:00-19:00) and results averaged across the 10 runs.

5.3 General Model Observations

5.3.1 The Lochee Road Variant 1 shows increased levels of congestion originating from the East Dock Street/East Marketgait junction, in the PM period the queueing can extend along the waterfront area and past the East Dock Street/Tay Bridge junction and on to the bridge itself. In the PM, there is an also an increase in queueing at the High Street/Loon's Road junction where queueing can extend back on to Ancrum Road and on to Gardner Street northbound on approach to Loon's Road. In general, this option variant has a more localised impact on the road network, due to the shorter extent of the Lochee Road corridor influenced by the LEZ

5.3.2 Extending the LEZ option to incorporate Lochee Road to Loon's Road (variant 2) results in a more significant strategic shift of non-compliant traffic away from the Lochee Road corridor to other key routes in and out of the city such as Riverside Drive, Perth Road/Hawkhill and Strathmartine Road/Hilltown. Variant 2 shows increased congestion compared to the Variant 1 models, however again this is most notable around the East Dock Street/East Marketgait junction with queueing in the PM period extending back on to the Tay Bridge. The queueing at the Loon's Road/High Street junction and Loon's Road/Gardner Street is not present in the these models, as non-compliant vehicles utilise more strategic routes to routes around the city.

5.4 Journey Time Comparisons

5.4.1 Journey Times were collected over the same 11 routes assessed for the core inner ring road options, as specified by DCC and shown in Figure 11.1.

5.4.2 Table 5.1 to Table 5.6 below show the journey time comparisons for the Lochee Road LEZ option variants compared against the 2023 Reference Case.

Table 5.1 : AM Journey Time Comparison for Option 1 Lochee Road Variants (seconds) 08:00-09:00

Route	Ref Case	Op1	Difference (Op1-Ref)	Op1v1	Difference (Op1v1-Ref)	Op1v2	Difference (Op1v2-Ref)
A85 EB	404	406	1	406	2	406	2
A85 WB	435	431	-4	431	-4	432	-4
City Road/Milnbank Road NB	154	153	-1	155	1	148	-6
City Road/Milnbank Road SB	152	150	-3	156	4	149	-4
Dens Road NB	242	242	0	247	5	245	4
Dens Road SB	253	250	-3	244	-9	251	-2
East Dock Street EB	177	178	1	178	1	178	0
East Dock Street WB	199	272	74	355	156	387	188
Forfar Road NB	304	304	0	303	-2	304	0
Forfar Road SB	278	289	10	369	91	570	292
Hawkhill Road EB	118	117	-1	116	-2	116	-2
Hawkhill Road WB	126	129	3	126	0	127	1
Inverary/Albany/Gardner NB	123	123	1	132	10	118	-4
Inverary/Albany/Gardner SB	107	107	0	108	1	108	0
Lochee Road NB	392	390	-2	392	0	357	-34
Lochee Road SB	400	399	-1	381	-19	373	-28
Perth Road EB	489	423	-66	449	-41	468	-21
Perth Road WB	419	432	13	428	9	422	3
Ring Road Anticlockwise	373	384	11	358	-15	359	-14
Ring Road Clockwise	462	490	29	558	96	572	110
Strathmartine Road SB	343	337	-6	349	5	346	2
Hilltown NB	350	353	3	356	6	353	3

Table 5.2 : PM Journey Time Comparison for Option 1 Lochee Road Variants (seconds) 17:00-18:00

Route	Ref Case	Op1	Difference (Op1-Ref)	Op1v1	Difference (Op1v1-Ref)	Op1v2	Difference (Op1v2-Ref)
A85 EB	439	444	5	511	72	694	255
A85 WB	436	440	4	436	0	440	3
City Road/Milnbank Road NB	163	165	2	182	19	152	-11
City Road/Milnbank Road SB	157	156	-1	160	3	158	1
Dens Road NB	270	277	7	285	15	288	18
Dens Road SB	315	316	2	312	-3	329	14
East Dock Street EB	216	236	20	187	-29	177	-39
East Dock Street WB	214	278	64	479	265	504	291
Forfar Road NB	434	428	-7	382	-52	368	-66
Forfar Road SB	311	327	17	622	312	917	606
Hawkhill Road EB	127	126	-1	126	-1	130	3
Hawkhill Road WB	126	127	1	128	2	125	0
Inverary/Albany/Gardner NB	164	171	7	264	100	157	-7
Inverary/Albany/Gardner SB	111	111	0	115	4	112	1
Lochee Road NB	608	610	3	630	22	566	-41
Lochee Road SB	450	449	-1	420	-30	411	-39
Perth Road EB	468	455	-13	505	36	497	28
Perth Road WB	459	447	-12	453	-6	450	-9
Ring Road Anticlockwise	415	428	13	497	82	566	151
Ring Road Clockwise	479	499	20	580	101	615	136
Strathmartine Road SB	363	373	10	385	23	402	39
Hilltown NB	373	373	1	389	16	374	1

Table 5.3 : AM Journey Time Comparison for Option 2 Lochee Road Variants (seconds) 08:00-09:00

Route	Ref Case	Op2	Difference (Op1-Ref)	Op2v1	Difference (Op1v1-Ref)	Op2v2	Difference (Op1v2-Ref)
A85 EB	404	403	-1	405	0	408	3
A85 WB	435	433	-2	433	-2	434	-1
City Road/Milnbank Road NB	154	154	0	156	2	149	-5
City Road/Milnbank Road SB	152	150	-3	155	2	149	-3
Dens Road NB	242	246	4	243	1	245	3
Dens Road SB	253	253	1	244	-9	247	-5
East Dock Street EB	177	177	-1	181	3	181	4
East Dock Street WB	199	230	31	263	64	304	105
Forfar Road NB	304	301	-3	299	-5	300	-4
Forfar Road SB	278	277	-1	304	26	350	72
Hawkhill Road EB	118	118	0	119	1	119	1
Hawkhill Road WB	126	128	1	126	0	127	1
Inverary/Albany/Gardner NB	123	123	0	132	10	119	-3
Inverary/Albany/Gardner SB	107	107	0	108	1	107	0
Lochee Road NB	392	387	-5	395	3	355	-36
Lochee Road SB	400	400	0	379	-21	370	-30
Perth Road EB	489	459	-31	455	-34	433	-56
Perth Road WB	419	428	9	430	11	433	14
Ring Road Anticlockwise	373	376	3	360	-13	363	-11
Ring Road Clockwise	462	477	15	506	44	528	66
Strathmartine Road SB	343	349	6	343	0	344	1
Hilltown NB	350	350	0	357	7	352	3

Table 5.4 : PM Journey Time Comparison for Option 2 Lochee Road Variants (seconds) 17:00-18:00

Route	Ref Case	Op2	Difference (Op1-Ref)	Op2v1	Difference (Op1v1-Ref)	Op2v2	Difference (Op1v2-Ref)
A85 EB	439	449	10	552	113	666	227
A85 WB	436	440	3	445	9	447	11
City Road/Milnbank Road NB	163	163	0	190	27	153	-10
City Road/Milnbank Road SB	157	155	-2	161	4	156	-1
Dens Road NB	270	277	7	284	14	286	16
Dens Road SB	315	314	-1	306	-9	323	8
East Dock Street EB	216	229	13	193	-23	181	-35
East Dock Street WB	214	186	-28	362	149	453	239
Forfar Road NB	434	431	-3	388	-46	375	-60
Forfar Road SB	311	302	-9	426	116	780	469
Hawkhill Road EB	127	125	-2	129	2	133	6
Hawkhill Road WB	126	124	-1	125	0	125	-1
Inverary/Albany/Gardner NB	164	173	9	280	117	160	-4
Inverary/Albany/Gardner SB	111	111	0	115	4	113	2
Lochee Road NB	608	607	-1	637	30	563	-45
Lochee Road SB	450	460	10	431	-19	420	-30
Perth Road EB	468	453	-15	464	-4	462	-7
Perth Road WB	459	438	-21	472	13	448	-11
Ring Road Anticlockwise	415	431	16	516	101	609	194
Ring Road Clockwise	479	480	2	552	73	596	118
Strathmartine Road SB	363	365	3	388	26	394	32
Hilltown NB	373	365	-7	390	18	377	4

Table 5.5 : AM Journey Time Comparison for Option 3 Lochee Road Variants (seconds) 08:00-09:00

Route	Ref Case	Op3	Difference (Op1-Ref)	Op3v1	Difference (Op1v1-Ref)	Op3v2	Difference (Op1v2-Ref)
A85 EB	404	406	2	405	0	408	3
A85 WB	435	437	1	433	-2	434	-1
City Road/Milnbank Road NB	154	155	1	156	2	149	-5
City Road/Milnbank Road SB	152	151	-1	155	2	149	-3
Dens Road NB	242	242	0	243	1	245	3
Dens Road SB	253	253	0	244	-9	247	-5
East Dock Street EB	177	177	0	181	3	181	4
East Dock Street WB	199	226	27	263	64	304	105
Forfar Road NB	304	299	-5	299	-5	300	-4
Forfar Road SB	278	283	5	304	26	350	72
Hawkhill Road EB	118	118	0	119	1	119	1
Hawkhill Road WB	126	126	-1	126	0	127	1
Inverary/Albany/Gardner NB	123	123	0	132	10	119	-3
Inverary/Albany/Gardner SB	107	107	0	108	1	107	0
Lochee Road NB	392	390	-1	395	3	355	-36
Lochee Road SB	400	400	0	379	-21	370	-30
Perth Road EB	489	461	-29	455	-34	433	-56
Perth Road WB	419	434	15	430	11	433	14
Ring Road Anticlockwise	373	367	-6	360	-13	363	-11
Ring Road Clockwise	462	474	12	506	44	528	66
Strathmartine Road SB	343	346	3	343	0	344	1
Hilltown NB	350	347	-3	357	7	352	3

Table 5.6 : PM Journey Time Comparison for Option 3 Lochee Road Variants (seconds) 17:00-18:00

Route	Ref Case	Op3	Difference (Op1-Ref)	Op3v1	Difference (Op1v1-Ref)	Op3v2	Difference (Op1v2-Ref)
A85 EB	439	447	7	566	127	866	427
A85 WB	436	439	3	443	7	447	11
City Road/Milnbank Road NB	163	161	-2	188	25	153	-10
City Road/Milnbank Road SB	157	155	-2	160	3	156	-1
Dens Road NB	270	275	5	282	12	278	8
Dens Road SB	315	312	-3	312	-2	362	47
East Dock Street EB	216	215	-1	191	-25	175	-40
East Dock Street WB	214	199	-14	390	176	435	221
Forfar Road NB	434	418	-16	385	-49	364	-70
Forfar Road SB	311	306	-4	532	222	935	625
Hawkhill Road EB	127	125	-2	129	2	147	20
Hawkhill Road WB	126	125	0	125	0	127	1
Inverary/Albany/Gardner NB	164	164	0	305	141	167	3
Inverary/Albany/Gardner SB	111	111	0	113	2	116	5
Lochee Road NB	608	591	-17	647	39	565	-43
Lochee Road SB	450	441	-8	428	-22	419	-31
Perth Road EB	468	471	2	455	-13	483	14
Perth Road WB	459	455	-4	464	5	451	-8
Ring Road Anticlockwise	415	442	27	523	108	692	277
Ring Road Clockwise	479	494	15	558	79	639	160
Strathmartine Road SB	363	364	1	395	33	425	62
Hilltown NB	373	372	0	392	20	378	5

5.4.3 The comparisons for Lochee Road Variant 1 show decreases in average journey time on Lochee Road Southbound in the AM and PM as non-compliant trips are moved off this route. The inner ring road option 1 model variants see the largest increases in journey times though increases are also reported in options 2 and 3. In the AM period there are notable increases in average journey time on Forfar Road southbound, the Ring Road in a clockwise direction and East Dock Street westbound. The maximum increase is noted in the Option 1 Variant 1 model of over 2 minutes 30 seconds on East Dock Street Westbound. In the PM there are significant notable increases are on A85 Eastbound, East Dock Street Westbound, Forfar Road Southbound, Gardner Street Northbound and the Ring Road in both directions, representing significant network congestion. The maximum increase is noted in the Option 1 Variant 1 model of over 5 minutes on Forfar Road southbound.

5.4.4 The increase in journey times on Forfar Road Southbound, East Dock Street westbound and the Ring Road is a result of the increase in congestion at East Dock Street/Marketgait, which is exacerbated in the Lochee Road Variant 1 models by the inclusion of Lochee Road and West Marketgait in the LEZ. This forces non-compliant vehicles which previously used these routes to find alternative routes. In particular the inclusion of West Marketgait in the LEZ effectively closes a section of the ring road to non-compliant vehicles, causing increased queueing on other routes.

5.4.5 The increase in journey times on Gardner Street Northbound is caused by vehicles rerouting along Inverary Terrace/Gardner Street to avoid the LEZ section of Lochee Road. This causes a queue on Gardner Street at the junction with Loon's Road.

5.4.6 The comparisons for Lochee Road Variant 2 also show decreases in average journey time on Lochee Road Northbound and Southbound in the AM and PM as non-compliant trips are moved off this route. In the AM there are notable increases in average journey time on Forfar Road Southbound, the Ring Road in a clockwise direction and East Dock Street Westbound. In the PM the notable increases are on A85 Eastbound, East Dock Street Westbound, Forfar Road Southbound, Northbound and the Ring Road in both directions. The maximum increase is noted in the Option 1 Variant 2 models approximately 5 minutes in AM period and over 10 minutes in the PM period. In general, the scale of the increases is larger in the variant 2 models due to the wider displacement of non-compliant vehicles.

5.4.7 Again, the increase in journey times on Forfar Road Southbound and East Dock Street westbound and the Ring Road is a result of the increase in congestion at East Dock

Street/Marketgait, this is exacerbated in the Lochee Road Variant 2 models compared to the Variant 1 models as longer section of Lochee Road is included in the LEZ which forces wider rerouting of vehicles. It is noticeable that increases are on routes separate from the Lochee Road corridor and show that the inclusion of Lochee Road in any LEZ has wide ranging implications on the Dundee road network.

5.5 General Network Statistics

5.5.1 For the modelled area, average trip distances and speeds for the AM and PM were compared in order to assess the overall network impact.

5.5.2 Table 5.7 shows average trip distances and speeds for these variants compared with the Reference Case.

5.5.3 The inclusion of Lochee Road in the LEZ leads to a reduction in average speed for all three options, with the Variant 2 models showing the largest decrease in average speed due to the resulting congestion being worse. The average distance driven by non-compliant cars does increase with Lochee Road included in the LEZ boundary, as these vehicles are forced to reroute to avoid Lochee Road. This increase is larger in the Variant 2 models. This suggests that including Lochee Road in the LEZ may in fact result in greater overall CO2 emissions than without due to the additional displacement of the non-compliant traffic. This increase in trip distance, assuming a consistent average speed with the rest of a vehicle trip, will lead to a direct increase in carbon emissions for the non-compliant vehicles of between 1.2% and 2.4% for the Lochee Road Variant 1 models and 2.5% and 4.0% for the Lochee Road Variant 2 models..

Table 5.7 : Speed and Distance comparison for Lochee Road Variants

07:00-10:00	Units	RefCase	Option 1	Option 1 v1	Option 1 v2
Total Compliant Vehicles	vehs	55502	55735	55535	55290
Total Non- Compliant Vehicles	vehs	37091	36548	36460	36328
Compliant Speed	mph	23.2	23.0	22.4	22.1
Non-Compliant Speed	mph	23.7	23.4	22.7	22.5
Compliant Av. Distance	m	4602	4602	4594	4577
Non-Compliant Av. Distance	m	4813	4830	4875	4936

16:00-19:00	Units	RefCase	Option 1	Option 1 v1	Option 1 v2
Total Compliant Vehicles	vehs	75307	75362	75275	75174
Total Non- Compliant Vehicles	vehs	43243	42809	42729	42639
Compliant Speed	mph	21.4	21.0	20.0	19.5
Non-Compliant Speed	mph	22.0	21.6	20.3	19.8
Compliant Av. Distance	m	3984	3985	3995	3992
Non-Compliant Av. Distance	m	4169	4202	4267	4329

07:00-10:00	Units	RefCase	Option 2	Option 2 v1	Option 2 v2
Total Compliant Vehicles	vehs	55502	55793	55770	55677
Total Non- Compliant Vehicles	vehs	37091	36667	36566	36486
Compliant Speed	mph	23.2	23.2	22.7	22.5
Non-Compliant Speed	mph	23.7	23.7	23.0	23.0
Compliant Av. Distance	m	4602	4599	4603	4593
Non-Compliant Av. Distance	m	4813	4829	4883	4947

16:00-19:00	Units	RefCase	Option 2	Option 2 v1	Option 2 v2
Total Compliant Vehicles	vehs	75307	75439	75297	75196
Total Non- Compliant Vehicles	vehs	43243	42823	42780	42643
Compliant Speed	mph	21.4	21.3	20.1	19.6
Non-Compliant Speed	mph	22.0	22.0	20.5	20.0
Compliant Av. Distance	m	3984	3982	3993	3989
Non-Compliant Av. Distance	m	4169	4198	4268	4335

07:00-10:00	Units	RefCase	Option 3	Option 3 v1	Option 3 v2
Total Compliant Vehicles	vehs	55502	55819	55734	55391
Total Non- Compliant Vehicles	vehs	37091	36638	36580	36479
Compliant Speed	mph	23.2	23.3	22.6	22.3
Non-Compliant Speed	mph	23.7	23.7	23.0	22.8
Compliant Av. Distance	m	4602	4604	4603	4586
Non-Compliant Av. Distance	m	4813	4832	4882	4946

16:00-19:00	Units	RefCase	Option 3	Option 3 v1	Option 3 v2
Total Compliant Vehicles	vehs	75307	75397	75303	75090
Total Non- Compliant Vehicles	vehs	43243	42820	42762	42712
Compliant Speed	mph	21.4	21.2	20.0	19.5
Non-Compliant Speed	mph	22.0	21.9	20.4	19.7
Compliant Av. Distance	m	3984	3984	3997	3991
Non-Compliant Av. Distance	m	4169	4199	4266	4337

5.6 Link Flow Comparisons

5.6.1 Modelled link flow were compared for selected locations on the inner ring road, on Lochee Road and on local routes (as defined by DCC) for each LEZ Lochee Road option variant. This was undertaken to understand fully the impact of each option in restricting non-compliant vehicles from the Lochee Road corridor as well as from accessing the area inside the inner ring road and redistributing trips to car parks on the periphery of the proposed option area.

5.6.2 12 hour two-way modelled flows are presented in this section with directional AM and PM peak hour flows presented in Appendix A. 12 hour two-way flow is presented here to assist with the NLEF appraisal process to identify a preferred LEZ option through, amongst other criteria, potential impacts on NO2 emissions.

5.6.3 Table 5.8 and Table 5.9 show the 12 hour two-way modelled flows at 10 locations on the inner ring road for the Reference Case and each LEZ Lochee Road option variant.

5.6.4 The flow comparisons show there to be significant changes in traffic flows on the inner ring road as a result of incorporating Lochee Road in any LEZ option. The largest increase in vehicle flows are on East Marketgait, Dock Street, West Marketgait (south of West Port roundabout) and the waterfront area of between approximately 3000 vehicles and 5300 vehicles over 12 hours. There is a significant reduction in traffic on West Marketgait (north of West Port roundabout) as a result of non-compliant vehicles restricted from this section of the inner ring road. North Marketgait sees as a significant drop in vehicles, primarily due to the restrictions for non-compliant vehicles on the adjacent Lochee Road corridor. While such a reduction here may be welcome, the resultant opposing increases on the southern and eastern sections of the inner ring road result in significant congestion, as noted above, with queues extending along the waterfront area, East Dock Street and the Tay Road Bridge and journey times significantly increasing on the routes approaching these locations (Forfar Road and East Dock Street).

Table 5.8 : 12 Hour Two-Way Flow Comparisons on Inner Ring Road (All Vehicles) – Variant 1

Site	Location	Ref Case	Op1 & Lochee Rd - Tullideph Rd	Difference (Op-Ref)	% Diff
West Marketgait	North of West Bell St	17386	12309	-5078	-29.2%
North Marketgait	West of Ladywell Rbt	23535	18278	-5256	-22.3%
Victoria Road	South of Ladywell Rbt	13344	12491	-852	-6.4%
North Marketgait	North of East Port Rbt	17470	16633	-836	-4.8%
East Marketgait	North of East Dock St	13950	16326	2376	17.0%
Dock Street	West of Trades Lane	30051	34049	3998	13.3%
Thomson Ave	At Slessor Grdns (1-way)	13609	16218	2609	19.2%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	17686	2477	16.3%
West Marketgait	South of Nethergate	11901	13978	2077	17.5%
West Marketgait	South of West Port Rbt	12779	13635	856	6.7%

Site	Location	Ref Case	Op2 & Lochee Rd - Tullideph Rd	Difference (Op-Ref)	% Diff
West Marketgait	North of West Bell St	17386	12532	-4854	-27.9%
North Marketgait	West of Ladywell Rbt	23535	20124	-3410	-14.5%
Victoria Road	South of Ladywell Rbt	13344	12871	-472	-3.5%
North Marketgait	North of East Port Rbt	17470	17754	284	1.6%
East Marketgait	North of East Dock St	13950	17280	3330	23.9%
Dock Street	West of Trades Lane	30051	35463	5412	18.0%
Thomson Ave	At Slessor Grdns (1-way)	13609	16581	2972	21.8%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	18543	3334	21.9%
West Marketgait	South of Nethergate	11901	16112	4211	35.4%
West Marketgait	South of West Port Rbt	12779	16111	3332	26.1%

Site	Location	Ref Case	Op3 & Lochee Rd - Tullideph Rd	Difference (Op-Ref)	% Diff
West Marketgait	North of West Bell St	17386	12558	-4829	-27.8%
North Marketgait	West of Ladywell Rbt	23535	19372	-4163	-17.7%
Victoria Road	South of Ladywell Rbt	13344	12900	-443	-3.3%
North Marketgait	North of East Port Rbt	17470	18270	801	4.6%
East Marketgait	North of East Dock St	13950	17276	3326	23.8%
Dock Street	West of Trades Lane	30051	35336	5285	17.6%
Thomson Ave	At Slessor Grdns (1-way)	13609	16553	2944	21.6%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	18416	3207	21.1%
West Marketgait	South of Nethergate	11901	16106	4206	35.3%
West Marketgait	South of West Port Rbt	12779	16098	3319	26.0%

Table 5.9 : 12 Hour Two-Way Flow Comparisons on Inner Ring Road (All Vehicles) – Variant 2

Site	Location	Ref Case	Op1 & Lochee Rd - Loon's Rd	Difference (Op-Ref)	% Diff
West Marketgait	North of West Bell St	17386	12344	-5042	-29.0%
North Marketgait	West of Ladywell Rbt	23535	18503	-5032	-21.4%
Victoria Road	South of Ladywell Rbt	13344	12929	-415	-3.1%
North Marketgait	North of East Port Rbt	17470	17312	-158	-0.9%
East Marketgait	North of East Dock St	13950	17190	3240	23.2%
Dock Street	West of Trades Lane	30051	34888	4837	16.1%
Thomson Ave	At Slessor Grdns (1-way)	13609	16612	3003	22.1%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	18221	3012	19.8%
West Marketgait	South of Nethergate	11901	14409	2509	21.1%
West Marketgait	South of West Port Rbt	12779	14127	1347	10.5%

Site	Location	Ref Case	Op2 & Lochee Rd - Loon's Rd	Difference (Op-Ref)	% Diff
West Marketgait	North of West Bell St	17386	12338	-5049	-29.0%
North Marketgait	West of Ladywell Rbt	23535	19802	-3733	-15.9%
Victoria Road	South of Ladywell Rbt	13344	12974	-370	-2.8%
North Marketgait	North of East Port Rbt	17470	18007	537	3.1%
East Marketgait	North of East Dock St	13950	17615	3665	26.3%
Dock Street	West of Trades Lane	30051	35247	5196	17.3%
Thomson Ave	At Slessor Grdns (1-way)	13609	16579	2970	21.8%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	18304	3095	20.3%
West Marketgait	South of Nethergate	11901	16320	4419	37.1%
West Marketgait	South of West Port Rbt	12779	16408	3629	28.4%

Site	Location	Ref Case	Op3 & Lochee Rd - Loon's Rd	Difference (Op-Ref)	% Diff
West Marketgait	North of West Bell St	17386	12627	-4759	-27.4%
North Marketgait	West of Ladywell Rbt	23535	19369	-4165	-17.7%
Victoria Road	South of Ladywell Rbt	13344	13450	107	0.8%
North Marketgait	North of East Port Rbt	17470	18930	1461	8.4%
East Marketgait	North of East Dock St	13950	18111	4161	29.8%
Dock Street	West of Trades Lane	30051	36160	6109	20.3%
Thomson Ave	At Slessor Grdns (1-way)	13609	16811	3202	23.5%
Riverside Esplanade	At Slessor Grdns (1-way)	15209	18851	3642	23.9%
West Marketgait	South of Nethergate	11901	16785	4885	41.0%
West Marketgait	South of West Port Rbt	12779	16909	4130	32.3%

5.6.5 Table 5.10 shows the 12 hour two-way modelled flows at 18 locations on the Lochee Road corridor and adjacent local roads for the Reference Case and LEZ core option 3 with Lochee Road option variants 1 and 2. The comparisons for LEZ core options 1 and 2 are presented in Appendix B, with the changes in flows patterns considered consistent between all three core inner ring road options.

Table 5.10 : 12 Hour Two-Way Flow Comparisons on Lochee Rd and adjacent routes (All Vehicles) – Core Option 3, Lochee Rd variants 1 & 2

Site	Location	Ref Case	Op3 & Lochee Rd - Tullideph Rd	Difference (Op-Ref)	% Diff
Lochee Road	North of Loon's Road	10171	9834	-337	-3.3%
Lochee Road	South of City Road	8223	5700	-2523	-30.7%
Lochee Road	North of Dudhope Terr	15905	11324	-4580	-28.8%
Lochee Road	West of Dudhope Rbt	13764	9875	-3889	-28.3%
Dudhope Terrace	At Lochee Road	3120	2143	-977	-31.3%
Inverary Terrace	South of Rankine Street	2631	3640	1008	38.3%
Rankine Street	South of Inverary Terr	4420	3036	-1384	-31.3%
Tullideph Road	At Lochee Road	3535	2542	-992	-28.1%
City Road	South of Tullideph Road	5756	8289	2533	44.0%
Milnbank Road	At Polepark Road	3627	4830	1202	33.2%
Gardner Street	South of Loon's Road	6284	6221	-62	-1.0%
Loon's Road	At Lochee Road	7358	9623	2265	30.8%
Brook Street	East of Edward Street	4437	5409	972	21.9%
Ancrum Road	At Lochee Road	5920	5869	-51	-0.9%
Hawkhill	East of Hunter Street Rbt	11847	12651	805	6.8%
Blackness Road	East of Forest Park Road	3273	3354	81	2.5%
Bellfield Street	At Hawkhill	2391	2501	111	4.6%
Balfield Road	North of Loon's Road	6500	6083	-418	-6.4%

Site	Location	Ref Case	Op3 & Lochee Rd - Loon's Rd	Difference (Op-Ref)	% Diff
Lochee Road	North of Loon's Road	10171	9335	-836	-8.2%
Lochee Road	South of City Road	8223	5671	-2552	-31.0%
Lochee Road	North of Dudhope Terr	15905	11286	-4618	-29.0%
Lochee Road	West of Dudhope Rbt	13764	9830	-3934	-28.6%
Dudhope Terrace	At Lochee Road	3120	2139	-981	-31.4%
Inverary Terrace	South of Rankine Street	2631	3504	872	33.1%
Rankine Street	South of Inverary Terr	4420	3215	-1205	-27.3%
Tullideph Road	At Lochee Road	3535	2400	-1134	-32.1%
City Road	South of Tullideph Road	5756	6731	975	16.9%
Milnbank Road	At Polepark Road	3627	4420	793	21.9%
Gardner Street	South of Loon's Road	6284	6253	-31	-0.5%
Loon's Road	At Lochee Road	7358	7615	257	3.5%
Brook Street	East of Edward Street	4437	5128	690	15.6%
Ancrum Road	At Lochee Road	5920	4688	-1231	-20.8%
Hawkhill	East of Hunter Street Rbt	11847	12931	1084	9.2%
Blackness Road	East of Forest Park Road	3273	3447	174	5.3%
Bellfield Street	At Hawkhill	2391	2588	197	8.2%
Balfield Road	North of Loon's Road	6500	5842	-659	-10.1%

5.6.6 The flow comparisons in Table 5.10 show there to be significant reductions in vehicle flow on Lochee Road, as expected, with non-compliant vehicles restricted from utilising the corridor. The results show however, that non-compliant vehicles shift from Lochee Road to a number of other adjacent routes. When the LEZ is extended along Lochee Road to Tullideph Road (variant 1), the largest increases in vehicles are seen on City Road and Loon's Road, of over 2000 vehicles over 12 hours. This represents at 44% increase in traffic on City Road and a 30% increase on Loon's Road. When the LEZ is extended to Loon's Road (variant 2), the impact on local routes is dampened somewhat as the larger LEZ results in a more strategic shift of trips to routes such as Perth Road/Hawkhill, where flows increase by over 1000 vehicles over 12 hours. Analysis of the vehicles switching routes

from Lochee Road confirm these to be non-compliant vehicles meaning the local adjacent routes are seeing a significant increase in the most polluting vehicles.

6. WEST MARKETGAIT VARIANTS

6.1 Background

6.1.1 During the LEZ model testing, it was identified that the performance of the Lochee Road corridor options was hindered by network congestion primarily resulting from the inclusion of West Marketgait between West Port Roundabout and Dudhope Roundabout in the LEZ area. With West Marketgait included in the LEZ area, non-compliant vehicles using the inner ring road are forced either clockwise or anti-clockwise around the ring road, away from West Marketgait, resulting in significant congestion at the junctions on the eastern side of the inner ring road, primarily East Marketgait/Dock Street. With West Marketgait excluded from the LEZ area, the full inner ring road is available to non-compliant vehicles and thus less displacement results to key junctions on the eastern side of the inner ring road, and therefore less network congestion stemming from this location. To ensure a robust LEZ option testing programme, it was agreed with DCC to model further variants of the Lochee Road options, excluding West Marketgait from the LEZ area.

6.1.2 To asses this, six additional test models were created based on each of the Lochee Road variants above, but excluding West Marketgait from the LEZ. This effectively means that in these models there are two LEZs, one covering Lochee Road and a second covering the area inside the inner ring road.

6.1.3 Appendix C details the outcomes from these model option tests and concludes that while the options operate with less congestion around the inner ring road area due to the full inner ring road route being available to non-compliant vehicles, the continued inclusion of the Lochee Road corridor still results in a shift of non-compliant vehicles from Lochee Road to adjacent local routes. The largest increases in traffic flow are recorded on Perth Road/Hawkhill of over 2000 vehicles over 12 hours.

7. OUTCOMES FROM TRAFFIC MODELLING OF PROPOSED LEZ OPTIONS

7.1 Summary of Results

7.1.1 15 LEZ options were tested in the Dundee City Paramics traffic model and the model results clearly show there to be considerable impacts on the Dundee Road network if Lochee Road is included in any LEZ option.

7.1.2 The modelling of the three core inner ring road LEZ option boundaries, has shown that, in general the LEZ options operate similarly to the Reference Case but there are some impacts of the proposals on traffic conditions in the city, most notably around the East Dock Street East Marketgait junction, particularly in LEZ Option 1 (including all car parks). This is a result of non-compliant vehicles being reassigned to car parks on the periphery of the LEZ inner ring road area. In Option 2 and 3, where fewer vehicles are displaced due to greater car park availability in these options, general network conditions are similar to Reference Case conditions.

7.1.3 The model results clearly show there to be considerable impacts on the Dundee Road network if Lochee Road is included in any LEZ option. Flow comparisons show there to be significant changes in traffic flows on the inner ring road and on local routes adjacent to as a result of incorporating Lochee Road in any LEZ option. The Lochee Road options also show there are large increases in network modelled journey times when the corridor is included.

7.1.4 The core boundaries do not result in significant extra distance being driven within the city, suggesting that CO2 emissions should remain broadly consistent. Including Lochee Road within the boundary does however result in a small additional distance due to the wider displacement introduced, suggesting a small increase in CO2 emissions would result.

7.2 NLEF Outcomes

7.2.1 The modelling results presented in this report have been used to inform the NLEF appraisal process to help identify the final proposed LEZ for Dundee. From the modelling results, the NLEF process recommended that the core inner ring road LEZ Options 1, 2, and 3 be progressed to further detailed appraisal. All option variants including Lochee Road have been removed and not recommended for further appraisal based on the model outcomes summarised above.

7.2.2 Following the progression of LEZ Option 1, 2 and 3 in the NLEF process, Option 3 has been identified has the final preferred LEZ Option. Full details on this outcome can be found in the NLEF Stage 2 Report.

8. POST COVID-19 UNCERTAINTY (SCENARIO PLANNING)

8.1 Background

8.1.1 The Covid-19 pandemic has had a dramatic impact on travel across all modes and specifically travel in Scotland's city centres. To assist in the development of the LEZs across Scotland, Transport Scotland commissioned a Scenario Planning study to apply the principals of modelling in considering the uncertainty over what travel will look like after the pandemic has ended.

8.1.2 The outcomes from the study are detailed in the *LEZ Post-Covid Uncertainty Summary Note (SYSTRA Ref. GB01T20E86/11024112/005, January 2021*). The core traffic modelling results presented in Chapters 2 to 7 in this report are undertaken based on one plausible future scenario, as defined as the 2023 Reference Case. The Covid-19 study recommended that a sensitivity test was undertaken on one other further plausible future, to ensure a robust set of modelling results to inform Dundee's LEZ.

8.1.3 The sensitivity scenario was defined as "Coping as Best We Can" where, following an economic downturn, the projected rate of change towards a cleaner fleet is lower than pre-Covid-19 forecasts (as provided by SEPA) and traffic shrinkage is experienced, similar to the 2010 economic downturn.

8.1.4 To inform a reduction in traffic, DCC's Road Traffic Reduction Act monitoring data was utilised. The data provides surveyed AM and PM peak and Annual Average Daily Traffic (AADT) flows from the city from 1996 to 2020. The data shows a reduction in traffic from pre financial crisis in 2006 to a lowest point in 2012 of around 9% in the AM peak hour and 7.5% in the PM Peak Hour. It was agreed with DCC that a 10% reduction would be applied to the traffic model demands for the 2023 Reference Case and appropriate LEZ Option models.

8.1.5 Following the NLEF process identifying LEZ Option 3 as the preferred final LEZ option for Dundee, it was agreed with DCC that this option would be assessed under the alternative forecast sensitivity test. Although the NLEF process did not recommend any Lochee Road option variants, it was considered important to assess the Lochee Road variants using the lower demand forecasts to understand their impacts in a network with lower levels of traffic. As such, it was agreed with DDC that Covid-19 sensitivity tests were undertaken on the following models:

- Reference Case
- LEZ Option 3 - Inner Ring Road area, excluding Bell Street, West Marketgait NCP and Wellgate car parks
- LEZ Option 3 Lochee Road Variant 1 – Op3 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- LEZ Option 3 Lochee Road Variant 2 – Op3 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road

8.1.6 To create the sensitivity test models, the demand matrices in each of scenario models developed for the core testing (outlined in Chapters 2 to 7) were simply reduced globally by 10%. No other changes were made to the models.

8.2 General Network Observations

8.2.1 For the most part, the Option models operate without noticeable difference from the Reference Case model. With the reduction in demand, the increase in congestion at East Dock Street/East Marketgait while still present in the Option models is less significant in all variants.

8.3 Journey Time Comparisons

8.3.1 Journey Times were collected over the same 11 routes assessed in the core testing above, as specified by DCC and which represent the relevant routes relating to the LEZ proposals.

8.3.2 Table 8.1 and Table 8.2 show the average journey time in seconds during the peak hours, 08:00-09:00 and 17:00-18:00 respectively, along these routes for the reference case model and the Covid-19 sensitivity test models.

Table 8.1 : AM Journey Time Comparison for Scenario Planning Variants (seconds) 08:00-09:00

	AM (08:00-09:00)			
	Ref Case	Option 3	Option 3 v1	Option 3 v2
A85 EB	400	401	403	403
A85 WB	411	412	412	415
City Road/Milnbank Road NB	152	152	154	147
City Road/Milnbank Road SB	149	147	152	148
Dens Road NB	240	238	241	241
Dens Road SB	239	239	237	244
East Dock Street EB	171	170	172	174
East Dock Street WB	170	170	189	210
Forfar Road NB	289	290	289	294
Forfar Road SB	266	267	273	290
Hawkhill Road EB	116	116	117	118
Hawkhill Road WB	128	126	126	126
Inverary/Albany/Gardner NB	118	119	122	116
Inverary/Albany/Gardner SB	106	107	106	107
Lochee Road NB	368	366	374	351
Lochee Road SB	388	387	371	368
Perth Road EB	455	427	468	444
Perth Road WB	428	429	424	432
Ring Road Anticlockwise	347	353	344	348
Ring Road Clockwise	431	435	463	480
Strathmartine Road SB	332	334	336	338
Hilltown NB	345	342	340	344

Table 8.2 : AM Journey Time Comparison for Scenario Planning Variants (seconds) 08:00-09:00

	PM (17:00-18:00)			
	Ref Case	Option 3	Option 3 v1	Option 3 v2
A85 EB	414	414	425	440
A85 WB	409	409	415	416
City Road/Milnbank Road NB	157	156	162	152
City Road/Milnbank Road SB	153	153	156	150
Dens Road NB	262	263	263	267
Dens Road SB	294	283	286	284
East Dock Street EB	174	183	177	174
East Dock Street WB	154	179	167	177
Forfar Road NB	343	347	333	340
Forfar Road SB	283	288	288	297
Hawkhill Road EB	120	120	120	123
Hawkhill Road WB	125	123	124	125
Inverary/Albany/Gardner NB	139	140	174	133
Inverary/Albany/Gardner SB	109	108	109	109
Lochee Road NB	463	454	464	426
Lochee Road SB	413	410	396	386
Perth Road EB	465	453	443	437
Perth Road WB	429	436	431	431
Ring Road Anticlockwise	375	393	425	474
Ring Road Clockwise	424	434	449	464
Strathmartine Road SB	343	343	349	338
Hilltown NB	333	342	342	337

8.3.3 In general, the comparisons show that the Option 3 model operates with similar journey times on these routes to the Reference Case. The Option 3 Lochee Road Variant 1 model has increases in journey time of over 30 seconds in the AM on the Ring Road in a clockwise direction and in the PM on the Ring Road in both directions. The Option 3 Lochee Road Variant 2 model has increases in journey time of over 30 seconds in the AM on the Ring Road in a clockwise direction and East Dock Street Westbound and in the PM on the Ring Road in both directions.

8.4 General Network Statistics

8.4.1 For the modelled area, average trip distances and speeds for the AM and PM were compared in order to assess the overall network impact.

8.4.2 Table 8.3 shows average trip distances and speeds for these variants compared with the Reference Case.

Table 8.3 : Speed and Distance Comparison – Scenario Planning Variants

07:00-10:00	Units	RefCase	Option 3	Option 3 v1	Option 3 v2
Total Compliant Vehicles	vehs	50073	50328	50348	50323
Total Non- Compliant Vehicles	vehs	33453	33076	33035	33010
Compliant Speed	mph	25.9	25.9	25.7	25.6
Non-Compliant Speed	mph	26.5	26.6	26.2	26.2
Compliant Av. Distance	m	4592	4589	4590	4589
Non-Compliant Av. Distance	m	4801	4819	4869	4937

16:00-19:00	Units	RefCase	Option 3	Option 3 v1	Option 3 v2
Total Compliant Vehicles	vehs	67810	67995	67953	67910
Total Non- Compliant Vehicles	vehs	38917	38596	38525	38541
Compliant Speed	mph	24.6	24.5	24.1	23.9
Non-Compliant Speed	mph	25.2	25.1	24.7	24.4
Compliant Av. Distance	m	3963	3962	3963	3965
Non-Compliant Av. Distance	m	4137	4167	4226	4289

8.4.3 The comparisons show that the network average speeds are consistent between the Reference Case and Option 3 model. The Lochee variants show a reduction in in average speed for compliant and non-compliant vehicles and an increase in average trip distance for non-compliant vehicles.

8.5 Link Flow Comparisons

8.5.1 Modelled link flow were compared for selected locations on Lochee Road and on local adjacent routes (as defined by DCC) for each Covid-19 test model. Link flows have been extracted for the AM (08:00-09:00) and PM (17:00-18:00) peak hours and presented in Appendix D.

8.5.2 Although the general network conditions are considered comparable between the Covid-19 sensitivity Reference Case and option models, the flow comparisons highlight that there remains significant changes to localised traffic flows as a result of the Lochee Road corridor being included in any LEZ. In a similar manner to the “full” forecast scenarios reported above, significant increases in traffic flow is recorded on routes such as City Road (up to approximately 60% increase), Loon’s Road (up to approximately 50% increase) and Brook Street (up to approximately 80% increase). Clearly, even under a future where traffic demand is at the lower end of forecast predictions, the inclusion of Lochee Road in any LEZ will still result in localised rerouting of non-compliant vehicles.

9. SUMMARY AND CONCLUSIONS

9.1 Summary

9.1.1 Dundee City Council commissioned the development of a traffic microsimulation model of the Dundee Greater City Centre area for the purpose of assessing the LEZ options identified through the NLEF appraisal process.

9.1.2 An 2019 Base Model was developed (as detailed in the report *Dundee Greater City Centre Base Paramics Model Development Report (SYSTRA, November 2019)* and from this a future year 2023 Reference Case Model was created (as detailed in the technical note *Dundee Greater City Centre Reference Case Note (SYSTRA, February 2020))*. The 2023 Reference Case, as defined by DCC, reflects infrastructure changes and committed Local Development Plan forecasts to 2023.

9.1.3 The 2023 Reference Case Model was used as a basis to develop three LEZ option tests, namely the three all vehicle LEZ options identified through the NLEF high level appraisal:

- LEZ Option 1 (NLEF Ref 2A) - Inner Ring Road area, including all car parks
- LEZ Option 2 (NLEF Ref 2B) - Inner Ring Road area, excluding Bell Street and West Marketgait NCP car parks
- LEZ Option 3 (LEZ Ref 2C) - Inner Ring Road area, excluding Bell Street, West Marketgait NCP and Wellgate car parks

9.1.4 In addition to these three core inner ring road options, two further variants were tested where the LEZ was extended along the Lochee Road corridor, as identified through the public and stakeholder consultation. The Lochee Road options tests were:

- LEZ Option 1/2/3 (above) plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- LEZ Option 1/2/3 (above) plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road

9.1.5 During the LEZ model testing, it was identified that the performance of the Lochee Road corridor options was hindered by network congestion primarily resulting from the inclusion of West Marketgait between West Port Roundabout and Dudhope Roundabout in the LEZ area. To ensure a robust LEZ option testing programme, it was agreed with DCC to model further variants of the Lochee Road options, excluding West Marketgait, as follows:

- LEZ Option 1/2/3 (above) plus Lochee Road to Tullideph Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)
- LEZ Option 1/2/3 (above) plus Lochee Road to Loon's Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)

9.1.6 A Transport Scotland study assessing the uncertainties around future traffic demand in Scotland, as reported in *LEZ Post-Covid Uncertainty Summary Note (SYSTRA Ref. GB01T20E86/11024112/005, January 2021*), recommended that sensitivity testing was undertaken against another further plausible future scenario, to ensure a robust set of modelling results to inform Dundee's LEZ.

9.1.7 It was agreed with DCC that a 10% reduction would be applied to the traffic model demands for the 2023 Reference Case and appropriate LEZ Option models to create a set of Covid-19 alternative scenario models. It was agreed with DDC that Covid-19 sensitivity tests were undertaken on the following model:

- Reference Case
- LEZ Option 3 - Inner Ring Road area, excluding Bell Street, West Marketgait NCP and Wellgate car parks

- LEZ Option 3 Lochee Road Variant 1 – Op3 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- LEZ Option 3 Lochee Road Variant 2 – Op3 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road

9.2 Conclusions

9.2.1 The modelling of the three core inner ring road LEZ option boundaries has shown that, in general, the LEZ options operate similarly to the Reference Case but there are some impacts of the proposals on traffic conditions in the city, most notably around the East Dock Street East Marketgait junction, particularly in LEZ Option 1 (including all car parks). This is a result of non-compliant vehicles being reassigned to car parks on the periphery of the LEZ inner ring road area. In Option 2 and 3, where fewer vehicles are displaced due to greater car park availability in these options, general network conditions are more similar to Reference Case conditions.

9.2.2 The model results show there to be considerable impacts on the Dundee Road network if Lochee Road is included in any LEZ option. Flow comparisons show there to be significant changes in traffic flows on the inner ring road and on local routes adjacent to Lochee Road as a result of incorporating Lochee Road in any LEZ option. The Lochee Road options also show there are large increase in network modelled journey times when the corridor is included.

9.2.3 Although the general network conditions are considered comparable between the Covid-19 sensitivity Reference Case and option models, the flow comparisons highlight that there remains significant changes to localised traffic flows as a result of the Lochee Road corridor being included in any LEZ. It is concluded that even under a future where traffic demand is at the lower end of forecast predictions, the inclusion of Lochee Road in any LEZ will still result in localised rerouting of non-compliant vehicles.

MODELLING APPENDIX A – LINK FLOW COMPARISONS

The link flow comparisons presented in Table A.1to Table A.6 are for the following models

- Reference Case

- Op1 - Inner Ring Road area, including all car parks
- Op1v1– Op1 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- Op1v1a - Op1 plus Lochee Road to Tullideph Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)
- Op1v2– Op1 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road
- Op1v2a - Op1 plus Lochee Road to Loon's Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)

- Op2 - Inner Ring Road area, excluding Bell Street and West Marketgait NCP car parks
- Op2v1– Op2 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- Op2v1a – Op2 plus Lochee Road to Tullideph Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)
- Op2v2– Op2 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road
- Op2v2a – Op2 plus Lochee Road to Loon's Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)

- Op3 - Inner Ring Road area, excluding Bell Street, West Marketgait NCP and Wellgate car parks
- Op3v1– Op3 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Tullideph Road
- Op3v1a – Op3 plus Lochee Road to Tullideph Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)
- Op3v2– Op3 plus West Marketgait between West Port Roundabout and Dudhope Roundabout and Lochee Road to Loon's Road
- Op3v2a – Op3 plus Lochee Road to Loon's Road (excluding West Marketgait between West Port Roundabout and Dudhope Roundabout)

Table A.1 : Link Flow Comparisons Option 1 AM

Site	Location	Direction	AM (08:00-09:00)					
			Ref Case	Op1	Op1 v1	Op1 v1a	Op1 v2	Op1 v2a
Lochee Road	North of Loons Road	Northbound	372	366	315	330	325	299
		Southbound	547	538	513	519	460	454
Lochee Road	South of City Road	Northbound	383	370	266	255	244	252
		Southbound	430	425	280	289	281	280
Lochee Road	North of Dudhope Terrace	Northbound	755	746	507	502	462	506
		Southbound	790	784	564	571	569	570
Lochee Road	West of Dudhope Roundabout	Westbound	715	691	484	499	460	489
		Eastbound	619	609	438	447	449	452
Dudhope Terrace	At Lochee Road	Westbound	168	167	114	110	95	110
		Eastbound	148	149	101	105	97	97
Inverary Terrace	South of Rankine Street	Northbound	121	117	139	142	146	162
		Southbound	121	118	139	142	146	162
Rankine Street	South of Inverary Terrace	Northbound	151	149	102	109	96	97
		Southbound	226	232	166	163	174	175
Tullideph Road	At Lochee Road	Westbound	178	181	126	124	112	125
		Eastbound	179	173	125	126	125	125
City Road	South of Tullideph Road	Northbound	269	261	318	306	248	254
		Southbound	288	283	446	375	313	292
Milnbank Road	At Polepark Road	Westbound	125	113	145	159	133	156
		Eastbound	221	226	295	258	256	252
Gardner Street	South of Loon's Road	Northbound	204	206	228	221	195	194
		Southbound	312	312	286	289	306	320
Loon's Road	At Lochee Road	Westbound	338	334	430	380	312	270
		Eastbound	374	363	447	419	335	337
Brook Street	East of Edward Street	Westbound	113	112	130	146	124	152
		Eastbound	307	318	376	336	336	331
Ancrum Road	At Lochee Road	Westbound	343	339	316	316	252	234
		Eastbound	269	270	260	262	175	176
Hawkhill	East of Hunter Street	Westbound	569	571	575	698	603	737
		Eastbound	540	535	616	594	614	641
Blackness Road	East of Forest Park Road	Westbound	133	133	123	150	139	165
		Eastbound	189	189	205	205	216	217
Bellfield Street	At Hawkhill	Northbound	108	110	106	133	121	147
		Southbound	120	123	139	138	142	142
Ballfield Road	North of Loon's Road	Northbound	246	246	250	246	195	209
		Southbound	273	278	248	249	245	258

Table A.2 : Link Flow Comparisons Option 1 PM

Site	Location	Direction	PM (17:00-18:00)					
			Ref Case	Op1	Op1 v1	Op1 v1a	Op1 v2	Op1 v2a
Lochee Road	North of Loons Road	Northbound	557	549	478	502	498	481
		Southbound	597	593	633	601	609	535
Lochee Road	South of City Road	Northbound	471	462	298	336	329	350
		Southbound	435	422	287	282	299	282
Lochee Road	North of Dudhope Terrace	Northbound	873	871	564	602	582	626
		Southbound	809	811	619	606	663	601
Lochee Road	West of Dudhope Roundabout	Westbound	723	706	480	518	491	531
		Eastbound	583	584	448	436	482	432
Dudhope Terrace	At Lochee Road	Westbound	175	179	116	122	121	118
		Eastbound	311	309	223	211	242	213
Inverary Terrace	South of Rankine Street	Northbound	135	138	222	186	208	184
		Southbound	135	138	222	186	207	184
Rankine Street	South of Inverary Terrace	Northbound	150	151	81	102	107	119
		Southbound	213	212	143	153	160	163
Tullideph Road	At Lochee Road	Westbound	209	199	149	141	122	135
		Eastbound	194	200	140	140	155	139
City Road	South of Tullideph Road	Northbound	320	319	439	376	320	313
		Southbound	303	296	383	360	320	308
Milnbank Road	At Polepark Road	Westbound	232	223	306	289	241	278
		Eastbound	207	210	216	217	211	220
Gardner Street	South of Loon's Road	Northbound	244	248	215	230	243	255
		Southbound	331	328	369	341	366	348
Loon's Road	At Lochee Road	Westbound	375	370	424	391	361	328
		Eastbound	494	493	627	549	497	446
Brook Street	East of Edward Street	Westbound	315	310	353	336	301	339
		Eastbound	233	233	247	255	245	266
Ancrum Road	At Lochee Road	Westbound	315	304	282	302	275	247
		Eastbound	365	352	301	317	255	236
Hawkhill	East of Hunter Street	Westbound	691	646	656	721	644	758
		Eastbound	782	760	877	857	957	925
Blackness Road	East of Forest Park Road	Westbound	206	197	190	200	191	217
		Eastbound	234	218	244	239	246	251
Bellfield Street	At Hawkhill	Northbound	152	146	137	151	144	159
		Southbound	169	164	179	184	185	196
Ballfield Road	North of Loon's Road	Northbound	366	361	340	353	307	314
		Southbound	266	253	183	221	225	233

Table A.3 : Link Flow Comparisons Option 2 AM

Site	Location	Direction	AM (08:00-09:00)					
			Ref Case	Op2	Op2 v1	Op2 v1a	Op2 v2	Op2 v2a
Lochee Road	North of Loons Road	Northbound	372	360	342	330	334	304
		Southbound	547	543	575	510	451	440
Lochee Road	South of City Road	Northbound	383	362	282	258	257	259
		Southbound	430	432	307	281	281	278
Lochee Road	North of Dudhope Terrace	Northbound	755	738	562	511	487	505
		Southbound	790	790	628	563	573	571
Lochee Road	West of Dudhope Roundabout	Westbound	715	683	549	495	485	485
		Eastbound	619	627	494	444	450	459
Dudhope Terrace	At Lochee Road	Westbound	168	174	114	112	95	111
		Eastbound	148	149	111	101	94	95
Inverary Terrace	South of Rankine Street	Northbound	121	122	154	151	146	167
		Southbound	121	122	154	151	146	168
Rankine Street	South of Inverary Terrace	Northbound	151	146	113	106	97	99
		Southbound	226	226	182	160	173	172
Tullideph Road	At Lochee Road	Westbound	178	178	143	123	114	122
		Eastbound	179	183	143	125	123	122
City Road	South of Tullideph Road	Northbound	269	274	352	309	248	248
		Southbound	288	287	478	380	325	293
Milnbank Road	At Polepark Road	Westbound	125	124	155	162	138	160
		Eastbound	221	245	325	255	258	247
Gardner Street	South of Loon's Road	Northbound	204	206	255	219	194	199
		Southbound	312	314	315	296	306	317
Loon's Road	At Lochee Road	Westbound	338	334	473	387	309	269
		Eastbound	374	365	506	415	332	326
Brook Street	East of Edward Street	Westbound	113	119	140	151	130	150
		Eastbound	307	327	403	331	338	322
Ancrum Road	At Lochee Road	Westbound	343	338	352	324	254	244
		Eastbound	269	267	284	255	184	182
Hawkhill	East of Hunter Street	Westbound	569	553	636	660	588	709
		Eastbound	540	557	679	624	613	654
Blackness Road	East of Forest Park Road	Westbound	133	131	139	144	126	153
		Eastbound	189	190	221	213	216	224
Bellfield Street	At Hawkhill	Northbound	108	105	122	126	112	135
		Southbound	120	122	141	143	143	147
Ballfield Road	North of Loon's Road	Northbound	246	251	281	242	194	211
		Southbound	273	281	260	258	237	256

Table A.4 : Link Flow Comparisons Option 2 PM

Site	Location	Direction	PM (17:00-18:00)					
			Ref Case	Op2	Op2 v1	Op2 v1a	Op2 v2	Op2 v2a
Lochee Road	North of Loon's Road	Northbound	557	549	474	515	514	493
		Southbound	597	593	646	579	592	525
Lochee Road	South of City Road	Northbound	471	458	308	341	343	352
		Southbound	435	438	281	276	301	288
Lochee Road	North of Dudhope Terrace	Northbound	873	863	576	611	598	630
		Southbound	809	815	617	604	654	613
Lochee Road	West of Dudhope Roundabout	Westbound	723	711	494	524	493	539
		Eastbound	583	586	448	431	462	432
Dudhope Terrace	At Lochee Road	Westbound	175	174	116	116	130	116
		Eastbound	311	318	233	229	252	222
Inverary Terrace	South of Rankine Street	Northbound	135	144	234	186	218	200
		Southbound	135	145	233	186	218	199
Rankine Street	South of Inverary Terrace	Northbound	150	154	75	98	105	120
		Southbound	213	200	143	148	154	165
Tullideph Road	At Lochee Road	Westbound	209	209	149	142	122	138
		Eastbound	194	202	135	155	150	137
City Road	South of Tullideph Road	Northbound	320	336	426	381	322	314
		Southbound	303	293	382	363	324	298
Milnbank Road	At Polepark Road	Westbound	232	239	294	290	247	277
		Eastbound	207	196	211	209	207	209
Gardner Street	South of Loon's Road	Northbound	244	240	219	230	239	254
		Southbound	331	324	375	338	377	362
Loon's Road	At Lochee Road	Westbound	375	365	429	399	356	334
		Eastbound	494	492	626	537	495	448
Brook Street	East of Edward Street	Westbound	315	318	345	336	309	333
		Eastbound	233	213	239	240	241	255
Ancrum Road	At Lochee Road	Westbound	315	306	293	307	253	244
		Eastbound	365	362	299	325	260	241
Hawkhill	East of Hunter Street	Westbound	691	659	658	735	631	752
		Eastbound	782	771	893	861	946	914
Blackness Road	East of Forest Park Road	Westbound	206	198	186	213	190	215
		Eastbound	234	231	250	241	237	245
Bellfield Street	At Hawkhill	Northbound	152	148	139	157	137	160
		Southbound	169	165	180	183	183	194
Ballfield Road	North of Loon's Road	Northbound	366	371	327	346	293	316
		Southbound	266	260	186	226	227	244

Table A.5 : Link Flow Comparisons Option 3 AM

Site	Location	Direction	AM (08:00-09:00)					
			Ref Case	Op3	Op3 v1	Op3 v1a	Op3 v2	Op3 v2a
Lochee Road	North of Loons Road	Northbound	372	363	339	319	368	302
		Southbound	547	543	586	508	514	450
Lochee Road	South of City Road	Northbound	383	375	283	255	283	249
		Southbound	430	432	315	282	307	279
Lochee Road	North of Dudhope Terrace	Northbound	755	735	569	511	538	498
		Southbound	790	789	641	579	626	570
Lochee Road	West of Dudhope Roundabout	Westbound	715	695	557	486	517	483
		Eastbound	619	621	505	457	496	459
Dudhope Terrace	At Lochee Road	Westbound	168	166	115	116	115	110
		Eastbound	148	146	108	100	106	95
Inverary Terrace	South of Rankine Street	Northbound	121	129	157	147	161	164
		Southbound	121	129	156	147	161	164
Rankine Street	South of Inverary Terrace	Northbound	151	143	112	102	109	96
		Southbound	226	215	181	165	190	169
Tullideph Road	At Lochee Road	Westbound	178	174	145	128	118	122
		Eastbound	179	182	141	133	130	123
City Road	South of Tullideph Road	Northbound	269	262	350	302	279	250
		Southbound	288	283	495	382	356	294
Milnbank Road	At Polepark Road	Westbound	125	121	150	150	154	171
		Eastbound	221	225	337	262	291	249
Gardner Street	South of Loon's Road	Northbound	204	198	258	212	228	196
		Southbound	312	306	315	293	339	314
Loon's Road	At Lochee Road	Westbound	338	331	473	382	342	276
		Eastbound	374	371	495	418	376	327
Brook Street	East of Edward Street	Westbound	113	105	137	138	147	160
		Eastbound	307	313	424	332	376	321
Ancrum Road	At Lochee Road	Westbound	343	345	356	326	290	239
		Eastbound	269	278	282	259	202	173
Hawkhill	East of Hunter Street	Westbound	569	539	637	666	661	732
		Eastbound	540	546	676	605	686	646
Blackness Road	East of Forest Park Road	Westbound	133	132	140	144	146	159
		Eastbound	189	197	224	203	231	212
Bellfield Street	At Hawkhill	Northbound	108	105	122	127	129	139
		Southbound	120	125	150	131	151	136
Ballfield Road	North of Loon's Road	Northbound	246	241	277	239	226	204
		Southbound	273	265	261	249	272	253

Table A.6 : Link Flow Comparisons Option 3 PM

Site	Location	Direction	PM (17:00-18:00)					
			Ref Case	Op3	Op3 v1	Op3 v1a	Op3 v2	Op3 v2a
Lochee Road	North of Loons Road	Northbound	557	543	474	509	517	484
		Southbound	597	597	644	595	596	537
Lochee Road	South of City Road	Northbound	471	454	310	336	336	348
		Southbound	435	440	283	284	294	280
Lochee Road	North of Dudhope Terrace	Northbound	873	858	579	613	593	613
		Southbound	809	828	629	603	660	607
Lochee Road	West of Dudhope Roundabout	Westbound	723	706	497	532	510	524
		Eastbound	583	604	456	432	495	445
Dudhope Terrace	At Lochee Road	Westbound	175	170	119	115	132	117
		Eastbound	311	314	236	223	242	212
Inverary Terrace	South of Rankine Street	Northbound	135	137	238	190	203	186
		Southbound	135	137	237	190	202	186
Rankine Street	South of Inverary Terrace	Northbound	150	147	75	105	112	111
		Southbound	213	205	145	149	162	162
Tullideph Road	At Lochee Road	Westbound	209	201	159	142	120	131
		Eastbound	194	196	144	143	152	145
City Road	South of Tullideph Road	Northbound	320	320	435	367	319	324
		Southbound	303	299	401	367	314	299
Milnbank Road	At Polepark Road	Westbound	232	228	302	277	253	270
		Eastbound	207	196	226	226	200	225
Gardner Street	South of Loon's Road	Northbound	244	241	208	234	252	250
		Southbound	331	326	381	344	367	353
Loon's Road	At Lochee Road	Westbound	375	368	431	396	370	335
		Eastbound	494	484	644	545	499	454
Brook Street	East of Edward Street	Westbound	315	304	344	324	312	331
		Eastbound	233	217	252	257	236	268
Ancrum Road	At Lochee Road	Westbound	315	307	282	301	276	248
		Eastbound	365	354	308	325	264	234
Hawkhill	East of Hunter Street	Westbound	691	643	645	727	604	758
		Eastbound	782	758	899	896	904	938
Blackness Road	East of Forest Park Road	Westbound	206	197	192	208	193	210
		Eastbound	234	230	241	240	249	257
Bellfield Street	At Hawkhill	Northbound	152	143	139	155	136	151
		Southbound	169	171	183	187	191	198
Ballfield Road	North of Loon's Road	Northbound	366	356	331	340	321	315
		Southbound	266	247	185	218	234	247

MODELLING APPENDIX B – LINK FLOW COMPARISON LOCHEE ROAD VARIANTS (OP1 & OP2)

Table B.1 : 12 Hour Two-Way Flow Comparisons on Lochee Rd and adjacent routes (All Vehicles) – Core Option 1, Lochee Rd variants 1 & 2

Site	Location	Ref Case	Op1 & Lochee Rd - Tullideph Rd	Difference (Op-Ref)	% Diff
Lochee Road	North of Loon's Road	10171	9528	-643	-6.3%
Lochee Road	South of City Road	8223	5509	-2714	-33.0%
Lochee Road	North of Dudhope Terr	15905	10953	-4952	-31.1%
Lochee Road	West of Dudhope Rbt	13764	9488	-4277	-31.1%
Dudhope Terrace	At Lochee Road	3120	2087	-1033	-33.1%
Inverary Terrace	South of Rankine Street	2631	3509	877	33.3%
Rankine Street	South of Inverary Terr	4420	3006	-1414	-32.0%
Tullideph Road	At Lochee Road	3535	2454	-1081	-30.6%
City Road	South of Tullideph Road	5756	8022	2266	39.4%
Milnbank Road	At Polepark Road	3627	4675	1048	28.9%
Gardner Street	South of Loon's Road	6284	6106	-178	-2.8%
Loon's Road	At Lochee Road	7358	9313	1955	26.6%
Brook Street	East of Edward Street	4437	5291	853	19.2%
Ancrum Road	At Lochee Road	5920	5695	-225	-3.8%
Hawkhill	East of Hunter Street Rbt	11847	12333	486	4.1%
Blackness Road	East of Forest Park Road	3273	3270	-3	-0.1%
Bellfield Street	At Hawkhill	2391	2446	56	2.3%
Balfield Road	North of Loon's Road	6500	6005	-495	-7.6%

Site	Location	Ref Case	Op1 & Lochee Rd - Loon's Rd	Difference (Op-Ref)	% Diff
Lochee Road	North of Loon's Road	10171	9030	-1142	-11.2%
Lochee Road	South of City Road	8223	5469	-2754	-33.5%
Lochee Road	North of Dudhope Terr	15905	10952	-4953	-31.1%
Lochee Road	West of Dudhope Rbt	13764	9476	-4289	-31.2%
Dudhope Terrace	At Lochee Road	3120	2047	-1073	-34.4%
Inverary Terrace	South of Rankine Street	2631	3449	818	31.1%
Rankine Street	South of Inverary Terr	4420	3164	-1256	-28.4%
Tullideph Road	At Lochee Road	3535	2371	-1163	-32.9%
City Road	South of Tullideph Road	5756	6543	787	13.7%
Milnbank Road	At Polepark Road	3627	4253	626	17.3%
Gardner Street	South of Loon's Road	6284	6137	-147	-2.3%
Loon's Road	At Lochee Road	7358	7367	9	0.1%
Brook Street	East of Edward Street	4437	4984	547	12.3%
Ancrum Road	At Lochee Road	5920	4537	-1383	-23.4%
Hawkhill	East of Hunter Street Rbt	11847	12632	786	6.6%
Blackness Road	East of Forest Park Road	3273	3379	106	3.2%
Bellfield Street	At Hawkhill	2391	2559	168	7.0%
Balfield Road	North of Loon's Road	6500	5725	-775	-11.9%

Table B.2 : 12 Hour Two-Way Flow Comparisons on Lochee Rd and adjacent routes (All Vehicles) – Core Option 2, Lochee Rd variants 1 & 2

Site	Location	Ref Case	Op2 & Lochee Rd - Tullideph Rd	Difference (Op-Ref)	% Diff
Lochee Road	North of Loon's Road	10171	9825	-346	-3.4%
Lochee Road	South of City Road	8223	5644	-2579	-31.4%
Lochee Road	North of Dudhope Terr	15905	11251	-4654	-29.3%
Lochee Road	West of Dudhope Rbt	13764	9789	-3975	-28.9%
Dudhope Terrace	At Lochee Road	3120	2143	-977	-31.3%
Inverary Terrace	South of Rankine Street	2631	3703	1071	40.7%
Rankine Street	South of Inverary Terr	4420	3046	-1375	-31.1%
Tullideph Road	At Lochee Road	3535	2533	-1002	-28.3%
City Road	South of Tullideph Road	5756	8221	2465	42.8%
Milnbank Road	At Polepark Road	3627	4797	1170	32.2%
Gardner Street	South of Loon's Road	6284	6302	19	0.3%
Loon's Road	At Lochee Road	7358	9609	2251	30.6%
Brook Street	East of Edward Street	4437	5403	966	21.8%
Ancrum Road	At Lochee Road	5920	5836	-84	-1.4%
Hawkhill	East of Hunter Street Rbt	11847	12704	857	7.2%
Blackness Road	East of Forest Park Road	3273	3335	62	1.9%
Bellfield Street	At Hawkhill	2391	2505	114	4.8%
Balfield Road	North of Loon's Road	6500	6089	-411	-6.3%

Site	Location	Ref Case	Op2 & Lochee Rd - Loon's Rd	Difference (Op-Ref)	% Diff
Lochee Road	North of Loon's Road	10171	9092	-1079	-10.6%
Lochee Road	South of City Road	8223	5539	-2684	-32.6%
Lochee Road	North of Dudhope Terr	15905	10991	-4914	-30.9%
Lochee Road	West of Dudhope Rbt	13764	9557	-4208	-30.6%
Dudhope Terrace	At Lochee Road	3120	2078	-1042	-33.4%
Inverary Terrace	South of Rankine Street	2631	3491	859	32.7%
Rankine Street	South of Inverary Terr	4420	3107	-1314	-29.7%
Tullideph Road	At Lochee Road	3535	2354	-1181	-33.4%
City Road	South of Tullideph Road	5756	6619	863	15.0%
Milnbank Road	At Polepark Road	3627	4309	682	18.8%
Gardner Street	South of Loon's Road	6284	6116	-168	-2.7%
Loon's Road	At Lochee Road	7358	7364	6	0.1%
Brook Street	East of Edward Street	4437	4989	552	12.4%
Ancrum Road	At Lochee Road	5920	4556	-1363	-23.0%
Hawkhill	East of Hunter Street Rbt	11847	12649	802	6.8%
Blackness Road	East of Forest Park Road	3273	3330	57	1.7%
Bellfield Street	At Hawkhill	2391	2510	119	5.0%
Balfield Road	North of Loon's Road	6500	5644	-856	-13.2%

MODELLING APPENDIX C – RESULTS FOR WEST MARKETGAIT VARIANTS

C1 - General Network Observations

For the most part, the Option models operate without noticeable difference from the Reference Case model. The notable exception to this is the East Dock Street/East Marketgait junction which sees an increase in congestion, particularly in the AM. This congestion is worst in Option 1 which has the highest number of displaced vehicles.

C2 - Journey Time Comparisons

Journey Times were collected over 11 routes which were specified by DCC and which represent the relevant routes relating to the LEZ proposals. The without West Marketgait variants are:

- Option 1 v1a
- Option 1 v2a
- Option 2 v1a
- Option 2 v2a
- Option 3 v1a
- Option 3 v2a

Journey time comparisons are shown in Table C.1 to Table C.6.

Table C.1 : AM Journey Time Comparison for Option 1 West Marketgait Variants (seconds) 08:00-09:00

	AM (08:00-09:00)					
	Ref Case	Option 1	Option 1 v1	Option 1 v1a	Option 1 v2	Option 1 v2a
A85 EB	404	406	406	408	406	407
A85 WB	435	431	431	435	432	434
City Road/Milnbank Road NB	154	153	155	155	148	148
City Road/Milnbank Road SB	152	150	156	153	149	149
Dens Road NB	242	242	247	245	245	251
Dens Road SB	253	250	244	252	251	262
East Dock Street EB	177	178	178	178	178	180
East Dock Street WB	199	272	355	279	387	279
Forfar Road NB	304	304	303	303	304	303
Forfar Road SB	278	289	369	289	570	296
Hawkhill Road EB	118	117	116	117	116	118
Hawkhill Road WB	126	129	126	127	127	128
Inverary/Albany/Gardner NB	123	123	132	126	118	118
Inverary/Albany/Gardner SB	107	107	108	108	108	109
Lochee Road NB	392	390	392	383	357	360
Lochee Road SB	400	399	381	381	373	375
Perth Road EB	489	423	449	441	468	448
Perth Road WB	419	432	428	432	422	445
Ring Road Anticlockwise	373	384	358	377	359	386
Ring Road Clockwise	462	490	558	493	572	488
Strathmartine Road SB	343	337	349	349	346	350
Hilltown NB	350	353	356	355	353	354

Table C.2 : PM Journey Time Comparison for Option 1 West Marketgait Variants (seconds) 17:00-18:00

	PM (17:00-18:00)					
	Ref Case	Option 1	Option 1 v1	Option 1 v1a	Option 1 v2	Option 1 v2a
A85 EB	439	444	511	444	694	453
A85 WB	436	440	436	442	440	439
City Road/Milnbank Road NB	163	165	182	164	152	154
City Road/Milnbank Road SB	157	156	160	159	158	156
Dens Road NB	270	277	285	293	288	307
Dens Road SB	315	316	312	330	329	337
East Dock Street EB	216	236	187	222	177	225
East Dock Street WB	214	278	479	262	504	310
Forfar Road NB	434	428	382	440	368	475
Forfar Road SB	311	327	622	314	917	351
Hawkhill Road EB	127	126	126	127	130	129
Hawkhill Road WB	126	127	128	126	125	126
Inverary/Albany/Gardner NB	164	171	264	191	157	158
Inverary/Albany/Gardner SB	111	111	115	112	112	112
Lochee Road NB	608	610	630	591	566	553
Lochee Road SB	450	449	420	420	411	416
Perth Road EB	468	455	505	470	497	466
Perth Road WB	459	447	453	468	450	455
Ring Road Anticlockwise	415	428	497	426	566	450
Ring Road Clockwise	479	499	580	492	615	535
Strathmartine Road SB	363	373	385	384	402	375
Hilltown NB	373	373	389	380	374	380

Table C.3 : AM Journey Time Comparison for Option 2 West Marketgait Variants (seconds) 08:00-09:00

	AM (08:00-09:00)					
	Ref Case	Option 2	Option 2 v1	Option 2 v1a	Option 2 v2	Option 2 v2a
A85 EB	404	403	405	404	408	405
A85 WB	435	433	433	433	434	435
City Road/Milnbank Road NB	154	154	156	154	149	150
City Road/Milnbank Road SB	152	150	155	152	149	147
Dens Road NB	242	246	243	252	245	250
Dens Road SB	253	253	244	259	247	274
East Dock Street EB	177	177	181	179	181	177
East Dock Street WB	199	230	263	199	304	247
Forfar Road NB	304	301	299	301	300	301
Forfar Road SB	278	277	304	276	350	279
Hawkhill Road EB	118	118	119	118	119	120
Hawkhill Road WB	126	128	126	127	127	128
Inverary/Albany/Gardner NB	123	123	132	124	119	118
Inverary/Albany/Gardner SB	107	107	108	109	107	108
Lochee Road NB	392	387	395	381	355	356
Lochee Road SB	400	400	379	378	370	377
Perth Road EB	489	459	455	436	433	460
Perth Road WB	419	428	430	425	433	437
Ring Road Anticlockwise	373	376	360	366	363	375
Ring Road Clockwise	462	477	506	457	528	475
Strathmartine Road SB	343	349	343	353	344	348
Hilltown NB	350	350	357	354	352	352

Table C.4 : PM Journey Time Comparison for Option 2 West Marketgait Variants (seconds) 17:00-18:00

	PM (17:00-18:00)					
	Ref Case	Option 2	Option 2 v1	Option 2 v1a	Option 2 v2	Option 2 v2a
A85 EB	439	449	552	440	666	464
A85 WB	436	440	445	447	447	438
City Road/Milnbank Road NB	163	163	190	163	153	154
City Road/Milnbank Road SB	157	155	161	158	156	157
Dens Road NB	270	277	284	303	286	301
Dens Road SB	315	314	306	329	323	341
East Dock Street EB	216	229	193	217	181	226
East Dock Street WB	214	186	362	243	453	249
Forfar Road NB	434	431	388	425	375	424
Forfar Road SB	311	302	426	307	780	309
Hawkhill Road EB	127	125	129	126	133	128
Hawkhill Road WB	126	124	125	125	125	126
Inverary/Albany/Gardner NB	164	173	280	179	160	159
Inverary/Albany/Gardner SB	111	111	115	112	113	112
Lochee Road NB	608	607	637	582	563	547
Lochee Road SB	450	460	431	422	420	421
Perth Road EB	468	453	464	456	462	448
Perth Road WB	459	438	472	470	448	470
Ring Road Anticlockwise	415	431	516	442	609	460
Ring Road Clockwise	479	480	552	483	596	506
Strathmartine Road SB	363	365	388	383	394	372
Hilltown NB	373	365	390	374	377	382

Table C.5 : AM Journey Time Comparison for Option 3 West Marketgait Variants (seconds) 08:00-09:00

	AM (08:00-09:00)					
	Ref Case	Option 3	Option 3 v1	Option 3 v1a	Option 3 v2	Option 3 v2a
A85 EB	404	406	405	407	406	406
A85 WB	435	437	433	436	432	436
City Road/Milnbank Road NB	154	155	158	155	149	150
City Road/Milnbank Road SB	152	151	154	153	148	149
Dens Road NB	242	242	244	248	253	245
Dens Road SB	253	253	243	255	255	260
East Dock Street EB	177	177	178	179	180	177
East Dock Street WB	199	226	284	207	379	227
Forfar Road NB	304	299	303	300	306	300
Forfar Road SB	278	283	312	278	478	278
Hawkhill Road EB	118	118	119	118	118	120
Hawkhill Road WB	126	126	127	128	127	127
Inverary/Albany/Gardner NB	123	123	128	123	120	119
Inverary/Albany/Gardner SB	107	107	108	108	107	108
Lochee Road NB	392	390	394	381	361	358
Lochee Road SB	400	400	382	379	371	374
Perth Road EB	489	461	464	462	440	438
Perth Road WB	419	434	427	428	430	424
Ring Road Anticlockwise	373	367	362	368	358	373
Ring Road Clockwise	462	474	515	461	544	470
Strathmartine Road SB	343	346	345	350	350	350
Hilltown NB	350	347	354	354	351	351

Table C.6 : PM Journey Time Comparison for Option 3 Lochee Road Variants (seconds) 17:00-18:00

	PM (17:00-18:00)					
	Ref Case	Option 3	Option 3 v1	Option 3 v1a	Option 3 v2	Option 3 v2a
A85 EB	439	447	566	452	866	455
A85 WB	436	439	443	444	447	435
City Road/Milnbank Road NB	163	161	188	160	153	153
City Road/Milnbank Road SB	157	155	160	160	156	155
Dens Road NB	270	275	282	286	278	293
Dens Road SB	315	312	312	316	362	360
East Dock Street EB	216	215	191	212	175	213
East Dock Street WB	214	199	390	236	435	282
Forfar Road NB	434	418	385	454	364	443
Forfar Road SB	311	306	532	326	935	325
Hawkhill Road EB	127	125	129	127	147	129
Hawkhill Road WB	126	125	125	126	127	125
Inverary/Albany/Gardner NB	164	164	305	182	167	149
Inverary/Albany/Gardner SB	111	111	113	113	116	112
Lochee Road NB	608	591	647	585	565	567
Lochee Road SB	450	441	428	422	419	415
Perth Road EB	468	471	455	452	483	460
Perth Road WB	459	455	464	448	451	462
Ring Road Anticlockwise	415	442	523	441	692	456
Ring Road Clockwise	479	494	558	494	639	499
Strathmartine Road SB	363	364	395	378	425	376
Hilltown NB	373	372	392	387	378	380

C3 - General Network Statistics

For the modelled area, average trip distances and speeds for the AM and PM were compared in order to assess the overall network impact.

Table C.7 shows average trip distances and speeds for these variants compared with the Reference Case.

Table C.7 : Speed and Distance Comparisons – Marketgait Variants

07:00-10:00	Units	RefCase	Option 1	Option 1 v1	Option 1 v1a	Option 1 v2	Option 1 v2a
Total Compliant Vehicles	vehs	55502	55735	55535	55780	55290	55719
Total Non- Compliant Vehicles	vehs	37091	36548	36460	36599	36328	36612
Compliant Speed	mph	23.2	23.0	22.4	22.8	22.1	22.7
Non-Compliant Speed	mph	23.7	23.4	22.7	23.2	22.5	23.2
Compliant Av. Distance	m	4602	4602	4594	4599	4577	4598
Non-Compliant Av. Distance	m	4813	4830	4875	4865	4936	4916

16:00-19:00	Units	RefCase	Option 1	Option 1 v1	Option 1 v1a	Option 1 v2	Option 1 v2a
Total Compliant Vehicles	vehs	75307	75362	75275	75430	75174	55719
Total Non- Compliant Vehicles	vehs	43243	42809	42729	42823	42639	36612
Compliant Speed	mph	21.4	21.0	20.0	21.0	19.5	22.7
Non-Compliant Speed	mph	22.0	21.6	20.3	21.6	19.8	23.2
Compliant Av. Distance	m	3984	3985	3995	3959	3992	4598
Non-Compliant Av. Distance	m	4169	4202	4267	4208	4329	4916

07:00-10:00	Units	RefCase	Option 2	Option 2 v1	Option 2 v1a	Option 2 v2	Option 2 v2a
Total Compliant Vehicles	vehs	55502	55793	55770	55766	55677	55763
Total Non- Compliant Vehicles	vehs	37091	36667	36566	36566	36486	36613
Compliant Speed	mph	23.2	23.2	22.7	23.1	22.5	23.0
Non-Compliant Speed	mph	23.7	23.7	23.0	23.5	23.0	23.6
Compliant Av. Distance	m	4602	4599	4603	4604	4593	4599
Non-Compliant Av. Distance	m	4813	4829	4883	4866	4947	4908

16:00-19:00	Units	RefCase	Option 2	Option 2 v1	Option 2 v1a	Option 2 v2	Option 2 v2a
Total Compliant Vehicles	vehs	75307	75439	75297	75404	75196	75373
Total Non- Compliant Vehicles	vehs	43243	42823	42780	42824	42643	42781
Compliant Speed	mph	21.4	21.3	20.1	21.0	19.6	21.0
Non-Compliant Speed	mph	22.0	22.0	20.5	21.6	20.0	21.7
Compliant Av. Distance	m	3984	3982	3993	3961	3989	3979
Non-Compliant Av. Distance	m	4169	4198	4268	4211	4335	4275

07:00-10:00	Units	RefCase	Option 3	Option 3 v1	Option 3 v1a	Option 3 v2	Option 3 v2a
Total Compliant Vehicles	vehs	55502	55819	55734	55813	55391	55801
Total Non- Compliant Vehicles	vehs	37091	36638	36580	36594	36479	36584
Compliant Speed	mph	23.2	23.3	22.6	23.1	22.3	23.2
Non-Compliant Speed	mph	23.7	23.7	23.0	23.5	22.8	23.8
Compliant Av. Distance	m	4602	4604	4603	4601	4586	4596
Non-Compliant Av. Distance	m	4813	4832	4882	4860	4946	4913

16:00-19:00	Units	RefCase	Option 3	Option 3 v1	Option 3 v1a	Option 3 v2	Option 3 v2a
Total Compliant Vehicles	vehs	75307	75397	75303	75381	75090	75382
Total Non- Compliant Vehicles	vehs	43243	42820	42762	42810	42712	42788
Compliant Speed	mph	21.4	21.2	20.0	20.9	19.5	20.9
Non-Compliant Speed	mph	22.0	21.9	20.4	21.5	19.7	21.6
Compliant Av. Distance	m	3984	3984	3997	3984	3991	3953
Non-Compliant Av. Distance	m	4169	4199	4266	4234	4337	4245

The comparisons show that the 'a' options which exclude West Marketgait from the LEZ have increased network average speed for compliant and non-compliant vehicles when compared to the equivalent Lochee Road variants. The network average speed for the 'a' variants is similar to that shown in the city centre only LEZ options.

C4 - Link Flow Comparisons

In order to assess the impact of the LEZ Lochee Road variants excluding West Marketgait, on local routes, link flows for selected locations have been extracted for the AM (08:00-09:00) and PM (17:00-18:00) peak hours. The results are presented in Table A.1 to Table A.6 in Appendix A.

The results show that while the options operate with less congestion around the inner ring road area due to the full inner ring road route being available to non-compliant

vehicles, the continued inclusion of the Lochee Road corridor still results in a shift of non-compliant vehicles from Lochee Road to adjacent local routes. The largest increases in traffic flow are recorded on Perth Road/Hawkhill of over 2000 vehicles over 12 hours.

MODELLING APPENDIX D – LINK FLOW COMPARISONS (COVID-19 SENSITIVITY TESTS)

Table D.1 : Link Flow Comparisons Covid-19 Sensitivity Tests – Option 3 AM

Site	Location	Direction	AM (08:00-09:00)			
			Ref Case	Op3	Op3 v1	Op3v2
Lochee Road	North of Loons Road	Northbound	335	335	294	293
		Southbound	487	480	465	411
Lochee Road	South of City Road	Northbound	338	326	233	227
		Southbound	395	388	259	251
Lochee Road	North of Dudhope Terrace	Northbound	676	660	468	454
		Southbound	745	736	523	523
Lochee Road	West of Dudhope Roundabout	Westbound	647	628	455	450
		Eastbound	590	574	410	414
Dudhope Terrace	At Lochee Road	Westbound	140	138	99	82
		Eastbound	135	130	89	84
Inverary Terrace	South of Rankine Street	Northbound	107	105	133	137
		Southbound	107	106	133	138
Rankine Street	South of Inverary Terrace	Northbound	136	132	92	88
		Southbound	214	218	153	157
Tullideph Road	At Lochee Road	Westbound	160	165	119	116
		Eastbound	163	163	109	114
City Road	South of Tullideph Road	Northbound	231	235	281	230
		Southbound	256	255	399	295
Milnbank Road	At Polepark Road	Westbound	114	111	119	130
		Eastbound	196	198	267	229
Gardner Street	South of Loon's Road	Northbound	186	178	198	176
		Southbound	287	295	274	280
Loon's Road	At Lochee Road	Westbound	309	312	414	270
		Eastbound	334	329	414	313
Brook Street	East of Edward Street	Westbound	100	105	109	121
		Eastbound	268	282	338	293
Ancrum Road	At Lochee Road	Westbound	305	311	295	210
		Eastbound	252	251	244	157
Hawkhill	East of Hunter Street	Westbound	515	501	517	556
		Eastbound	480	487	543	542
Blackness Road	East of Forest Park Road	Westbound	118	124	120	122
		Eastbound	175	178	179	187
Bellfield Street	At Hawkhill	Northbound	100	103	102	111
		Southbound	109	113	119	126
Ballfield Road	North of Loon's Road	Northbound	223	216	215	184
		Southbound	257	259	244	224

Table D.2 : Link Flow Comparisons Covid-19 Sensitivity Tests – Option 3 AM

Site	Location	Direction	PM (17:00-18:00)			
			Ref Case	Op3	Op3 v1	Op3v2
Lochee Road	North of Loons Road	Northbound	503	509	456	452
		Southbound	479	477	496	449
Lochee Road	South of City Road	Northbound	425	423	295	309
		Southbound	369	365	251	245
Lochee Road	North of Dudhope Terrace	Northbound	799	798	555	571
		Southbound	744	736	558	542
Lochee Road	West of Dudhope Roundabout	Westbound	683	678	477	489
		Eastbound	559	561	415	409
Dudhope Terrace	At Lochee Road	Westbound	133	140	92	90
		Eastbound	251	250	178	171
Inverary Terrace	South of Rankine Street	Northbound	126	115	178	172
		Southbound	126	115	177	172
Rankine Street	South of Inverary Terrace	Northbound	170	171	112	136
		Southbound	192	196	136	146
Tullideph Road	At Lochee Road	Westbound	181	181	132	121
		Eastbound	191	186	134	131
City Road	South of Tullideph Road	Northbound	285	287	396	291
		Southbound	259	259	364	272
Milnbank Road	At Polepark Road	Westbound	213	202	268	239
		Eastbound	158	164	189	174
Gardner Street	South of Loon's Road	Northbound	260	265	236	260
		Southbound	309	303	321	330
Loon's Road	At Lochee Road	Westbound	334	338	404	292
		Eastbound	411	412	533	402
Brook Street	East of Edward Street	Westbound	283	275	317	296
		Eastbound	188	183	218	206
Ancrum Road	At Lochee Road	Westbound	281	282	260	197
		Eastbound	316	313	293	223
Hawkhill	East of Hunter Street	Westbound	591	566	559	573
		Eastbound	647	640	702	729
Blackness Road	East of Forest Park Road	Westbound	177	174	167	170
		Eastbound	193	196	206	208
Bellfield Street	At Hawkhill	Northbound	135	124	127	124
		Southbound	139	145	158	160
Ballfield Road	North of Loon's Road	Northbound	352	352	339	309
		Southbound	258	260	209	236

APPENDIX D: ROAD WHICH FORM PART OF DUNDEE LEZ

A list of all roads which form part of the final Dundee LEZ, as required by the Transport (Scotland) Act 2019 is provided below.

Roads forming part of Dundee LEZ	Section of Road
Allan Lane	Full Length
Albert Square	Full Length
Argyllgait	Full Length
Bank Street	Full Length
Barrack Street	Full Length
Bell Street	Between Victoria Road and Constitution Road
Cameron's Close	Full Length
Candle Lane	Full Length
Castle Street	Full Length
Chapel Street	Full Length
Commercial Court	Full Length
Commercial Street	Full Length
Constitution Road	Full Length
Courthouse Square	Full Length
Couttie's Wynd	Full Length
Cowgate	Full Length
Crichton Street	Full Length
Dock Street	Between Whitehall Street and Commercial Street/A991 junction
Euclid Crescent	Full Length
Euclid Street	Full Length
Exchange Court	Full Length
Exchange Street	Full Length
Forester Street	Full Length
Gellatly Street	Full Length
High Street	Full Length
Irvine's Square	Full Length
Johnston Street	Full Length
King Street	Full Length
Malthouse Close	Full Length
Mary Ann Lane	Full Length
Meadow Entry	Full Length
Meadowside	Between Meadow Lane and Panmure Street
Murraygate	Full Length
Nethergate	Between West Marketgait and Crichton Street
Nicoll Street	Full Length
North Lindsay Street	Full Length
Panmure Street	Full Length
Peter Street	Full Length
Pullar's Close	Full Length
Queen Street	Full Length
Rattray Street	Full Length
Reform Street	Full Length
Royal Exchange Lane	Full Length

Seagate	Between East Marketgait and Commercial Street
Shore Terrace	Full Length
Soapwork Lane	Full Length
South Ward Road	Full Length
St Andrew's Lane	Full Length
St Andrew's Street	Full Length
Sugarhouse Wynd	Full Length
Trades Lane	Full Length
Union Street	Full Length
Ward Road	Full Length
West Bell Street	Full Length
Whitehall Crescent	Full Length
Whitehall Street	Full Length
Willison Street	Full Length
Yeaman Shore	Full Length