Údarás Náisiúnta Iompair
National Transport Authority

Waterford Metropolitan Area Transport Strategy

Transport Modelling Assessment Report

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1 Introduction

1.1 Background

The National Transport Authority (NTA) is a public body set up under statute and established in December 2009. The role and functions of the NTA are set out in three Acts of the Oireachtas: the Dublin Transport Authority Act 2008, the Public Transport Regulation Act 2009 and the Taxi Regulation Act 2013. In August 2015, the Department of Transport, Tourism and Sport (DTTaS) published its policy document *"Investing in our Transport Future - Strategic Investment Framework for Land Transport"*. Action 4 of that framework states that: *"Regional transport strategies will be prepared by the NTA and provide an input to regional spatial and economic strategies".*

Having regard to its role in relation to transport, and the action placed upon it in the DTTaS policy document, the NTA, in collaboration with Waterford City and County Council, Kilkenny County Council, Southern Regional Assembly and Transport Infrastructure Ireland (TII), is developing a Transport Strategy for the Waterford Metropolitan Area (WMATS henceforth) covering the period up to 2040. The strategy will provide a framework for the planning and delivery of transport infrastructure and services in the Waterford Metropolitan Area (WMA) over the next two decades. It will also provide a planning policy with which other agencies can align their future policies and infrastructure investment.

1.2 Strategy Development Methodology

WMATS has been developed to provide an efficient transport network to underpin the population and employment growth envisaged for the Waterford Metropolitan Area under the NPF to 2040 and beyond. Table 1.1 outlines the key steps involved in developing the Transport Strategy which follows the Department of Transport's National Investment Framework for Transport in Ireland (NIFTI) modal and intervention hierarchies. It focused on developing active travel and public transport solutions first, along with maintaining and optimising existing infrastructure, before investigating the potential need for new road infrastructure.

Table 1.1 WMATS Development Methodology

Step	Task
1	Determine 2040 Land Use Scenario
2	Test an Idealised Public Transport Network (one in which there are no capacity or frequency limits) in order to determine Maximum Potential Demand for public transport across each part of the WMA
3	Develop a Package of Public Transport Measures to meet this Demand
4	Test the Appropriateness of these Measures in terms of Capacity, Viability and Deliverability
5	Incorporate the Waterford City and Environs Cycle Network Plan, Park & Ride plans and other committed infrastructure / service proposals
6	Develop a Package of Climate Action Measures
7	Test the Requirement for New Road Infrastructure Schemes
8	Assemble and Assess the Final Draft Transport Strategy

1.3 Modelling Methodology

Throughout the WMATS development, modelling analysis was undertaken using the NTA's Regional Modelling System (RMS) and the South-East Regional Model (SERM) at various stages to assess options and determine the optimal transport strategy measures to support the development of the Waterford Metropolitan Area.

1.3.1 NTA Regional Modelling System

The NTA RMS comprises of the following three main components, namely:

- The National Demand Forecasting Model (NDFM);
- 5 Regional Models (including the SERM); and
- A suite of Appraisal Modules

The NDFM takes input attributes such as land-use data, population etc., and estimates the total quantity of daily travel demand produced by, and attracted to, each of the 18,488 Census Small Areas in Ireland.

1.3.2 South-East Regional Model (SERM)

The SERM is a strategic multi-modal transport model representing travel by all the primary surface modes – including, walking and cycling (active modes), and travel by car, bus, rail, tram, light goods and heavy goods vehicles, and broadly covers the southeast of Ireland including the counties of Waterford, Wexford, Kilkenny and Tipperary.

The SERM is comprised of the following key elements:

- **Trip End Integration:** The Trip End Integration module converts the 24 hour trip ends output by the NDFM into the appropriate zone system and time period disaggregation for use in the Full Demand Model (FDM);
- **The Full Demand Model (FDM):** The FDM processes travel demand, carries out mode and destination choice, and outputs origin-destination travel matrices to the assignment models. The FDM and assignment models run iteratively until an equilibrium between travel demand and the cost of travel is achieved; and
- **Assignment Models:** The Road, Public Transport, and Active Modes assignment models receive the trip matrices produced by the FDM and assign them in their respective transport networks to determine route choice and the generalised cost for each origin and destination pair.

Destination and mode choice parameters within the SERM have been calibrated using two main sources: Census 2016 Place of Work, School or College - Census of Anonymised Records (2016 POWSCAR), and the Irish National Household Travel Survey (2017 NHTS). The NTA's RMS is the most sophisticated modelling tool available for assessing complex multi modal movements within an urban context. This provides a consistent framework for transport assessment. Therefore, the SERM is the ideal tool to estimate the multi-modal impact of transport proposals for the Waterford Metropolitan Area[1].

[1] Further information on the NTA's RMS and SERM is available at: https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/

1.3.3 Modelling Methodology

The overall modelling methodology is illustrated in Figure 1.1, overleaf, and includes the following key steps:

- **Demand Analysis**: The SERM was run with a 2040 land-use and an idealised public transport network to identify the maximum potential demand for public transport that would need to be served by the WMATS.
- **Testing PT Measures**: Using the demand analysis, an optimal public transport network was developed. This was tested in the SERM, along with alternative measures, to determine the optimal solution for the Waterford Metropolitan Area.
- **Testing Climate Action Measures**: The SERM was used to assess a variety of measures to support a shift to sustainable travel and assist in achieving ambitious climate action targets.
- **Road Infrastructure Testing:** In-line with NIFTI, one of the last elements for testing was the construction of new road infrastructure. A number of new bridge crossing options were tested in the SERM to identify if they should be included in the final transport strategy.
- **Sensitivity Testing & Appraisal:** Once the draft transport strategy was identified, it was passed through a detailed appraisal in-line with the Department of Transport's Common Appraisal Framework (CAF) guidance to determine its performance in achieving the objectives of the strategy.

The following sections of this report provide further details on each of the key modelling stages described above and outlined in Figure 1.1.

Please note that this report should be read in conjunction with the *WMATS Transport Options Report* and *WMATS Demand Analysis Report.*

Figure 1.1 Modelling Methodology

1.4 Report Structure

- **Section 2** describes the 2040 land use assumptions used in the modelling, and presents the results of future travel demand
- **Section 3** outlines the modelling undertaken to assess and refine the optimal public transport network for Waterford
- **Section 4** describes the results of testing undertaken on a series of climate action measures aimed at promoting sustainable travel
- **Section 5** outlines the testing of various road infrastructure proposals
- **Section 6** sets out the sensitivity testing undertaken on the strategy to account for changes in travel patterns post COVID and a behavioural change towards cycling
- **Section 7** outlines the results of the appraisal of WMATS under each of the CAF criteria
- **Section 8** concludes the report.

2 Demand Analysis

2.1 Introduction

The following sections provide an overview of the initial analysis undertaken to establish a thorough understanding of the future travel demand and movement patterns within the study area. This informed the development of transport options, networks and supporting proposals for further testing. Further details on the demand analysis can be found in the *WMATS Demand Analysis Report.*

2.2 2040 Land Use

The NTA, in association with Waterford City and County Council (WCCC) and Kilkenny County Council (KCC) prepared an initial Planning Datasheet for the 2040 Baseline Land-use Scenario for the application within the WMA Transport Strategy. The Planning Datasheet includes forecast of population, employment and education levels up to 2040 for Counties Waterford and Kilkenny, Waterford Metropolitan Area (WMA) and the CSO Waterford City and Suburbs Boundary. Figure 2.1 outlines the WMA along with the defined Waterford City and Suburbs boundary within counties Kilkenny and Waterford.

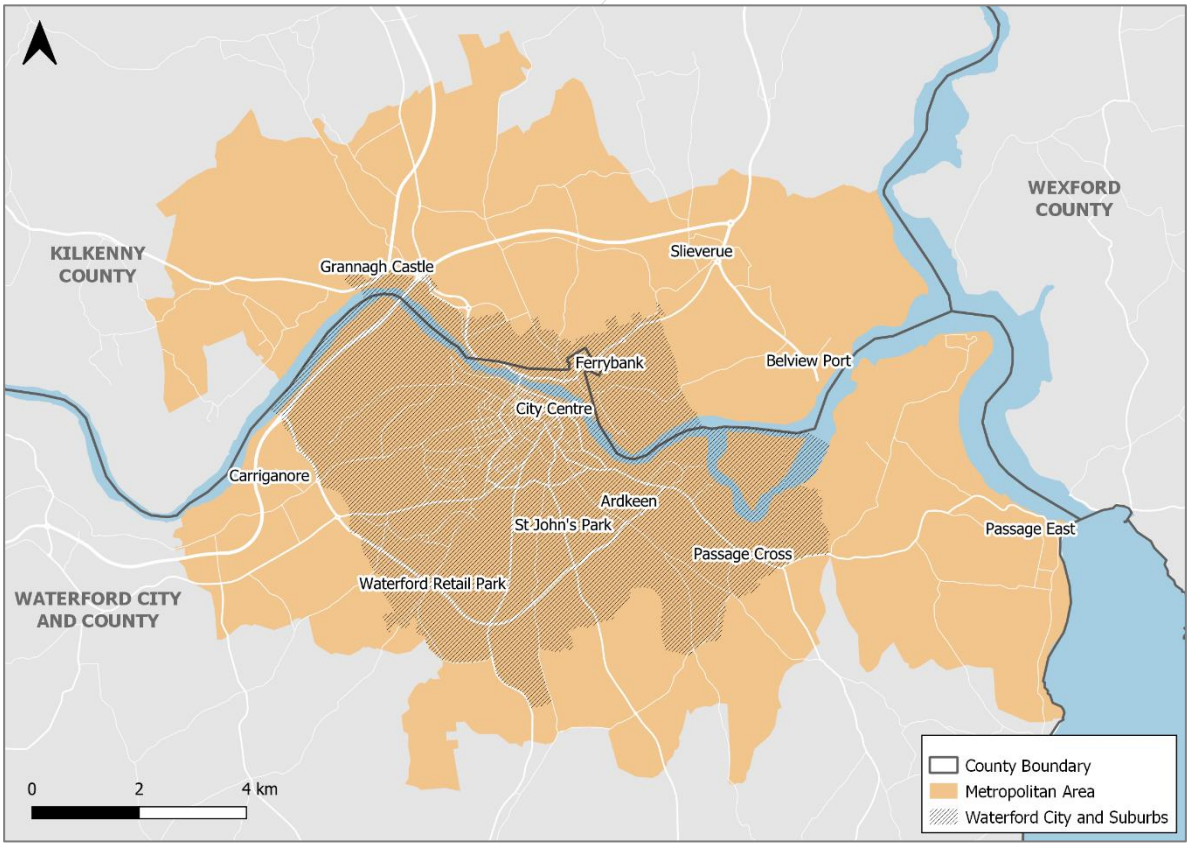

Figure 2.1 Waterford Metropolitan Area Boundaries

2.2.1 Population

Table 2.1 provides a comparison between the 2016 and the 2040 population for counties Waterford and Kilkenny, along with the defined metropolitan area. It is forecast that the population of the CSO defined Waterford City and Suburbs will increase by 60% between 2016 and 2040. This is in-line with targets set out in the Project Ireland 2040 National Planning Framework (NPF) which outlines a population growth of 30,000 – 35,000 people for this area.

One of the core Waterford Metropolitan Area Strategic Plan (MASP) objectives is to create a more balanced concentric city north and south of the river Suir. The 2040 population levels in Table 2.1 are in-line with this objective, with significantly higher growth in the Kilkenny County section of the defined Waterford City and Suburb (+137%) where the North Quay SDZ, and other developments in areas such as Ferrybank and Kilculliheen will notably deliver new residential units.

Within the remaining Metropolitan Area, the population increase of 30% is in-line with targets set out in the MASP.

Table 2.1: Population Comparison

County	Population		Population Growth	
	2016	2040	2016 to 2040	
Waterford City and County	116,176	146,794	30,618	26%
Kilkenny County	99,232	116,721	17,489	18%
Metropolitan Areas				
WMATS Area	59,854	93,740	33,886	57%
-Waterford City and Suburbs	53,462*	85,461	31,999	60%
-Waterford City and Suburbs (Waterford)	48,216	73,029	24,813	51%
-Waterford City and Suburbs (Kilkenny)	5,246	12,432	7,186	137%
-Remaining Metropolitan Area	6,392	8,279	1,887	30%

*It should be noted that the CSO Waterford City and Suburbs boundary does not align with the boundaries of CSO Small Areas. For the purposes of this comparison the population by SA was needed to compare to 2040. Thus, the population figure given is marginally lower than the official Census population for Waterford City and Suburbs (53,504).

2.2.2 Employment

Table 2.2 provides a comparison between the 2016 and the 2040 Planning Datasheet employment levels for the WMA and counties Waterford and Kilkenny. The employment within the Metropolitan Area is forecast to increase by 43%, representing 11,346 additional jobs in 2040 which is in-line with targets set out in the NPF. This growth will be driven by the North Docks SDZ which includes commercial, retail and offices buildings, along with infill opportunities to intensify employment throughout the city centre and inner suburban areas. The high level of employment growth in the Remaining Metropolitan Area is primarily driven by proposed developments at the Belview Port industrial lands.

Table 2.2: Job Comparison

County	Employment		Employment Growth	
	2016	2040	2016 to 2040	
Waterford City and County	35,396	44,484	9,088	26%
Kilkenny County	26,352	33,467	7,115	27%
Metropolitan Areas				
WMATS Area	26,545	37,891	11,346	43%
-Waterford City and Suburbs	23,761	32,494	8,733	37%
-Waterford City and Suburbs (Waterford)	22,903	30,982	8,079	35%
-Waterford City and Suburbs (Kilkenny)	858	1,512	654	76%
-Remaining Metropolitan Area	2,784	5,397	2,613	94%

2.2.3 Education

Table 2.3 provides a comparison between the 2016 and the 2040 Planning Datasheets for education places which includes primary, secondary and tertiary education. Education places within the Metropolitan Area are forecast to increase by 83%, representing an additional 13,677 students in 2040. This growth will be located for the most part in the urban locations of the Metropolitan Area as education places within the defined Waterford City and Suburbs are forecast to grow by 13,303 (+85%) by 2040. This increase will see the expansion of Waterford Institute of Technology and the provisions of new primary and secondary schools to service growing populations and increased rates of residential development.

Table 2.3: Education Comparison

County	Education		Education Growth	
	2016	2040	2016 to 2040	
Waterford City and County	26,896	39,647	12,751	47%
Kilkenny County	17,647	22,315	4,668	26%
Metropolitan Areas				
WMATS Area	16,482	30,159	13,677	83%
-Waterford City and Suburbs	15,661	28,964	13,303	85%
-Waterford City and Suburbs (Waterford)	14,947	26,323	11,376	76%
-Waterford City and Suburbs (Kilkenny)	714	2,641	1,927	270%
-Remaining Metropolitan Area	821	1,195	374	46%

2.3 Idealised Network Scenario

The Idealised Network scenario facilitates an unconstrained analysis of potential public transport demand on key corridors in the WMA. In modelling the idealised network, it has been assumed that each corridor on the network will operate with optimal characteristics in terms of frequency, capacity, coverage, interchange opportunity, directness and speed. This will ensure that public transport represents a highly attractive mode for those travelling along the corridor.

Adopting this approach allows for the maximum potential for public transport use on each corridor to be ascertained, prior to the inclusion of other demand management strategies aimed at further encouraging sustainable travel.

2.3.1 Travel Demand

In total, there are approximately 270,000 trips originating within the WMA over the 24-hour period in both the 2040 Do Minimum and Idealised scenarios, which represents a 37% increase compared to the equivalent 2016 base year model figure of 197,000. The percentage breakdown of demand between the five modelled time periods is approximately equal in both scenarios and is presented below in Figure 2.2. The busiest period in terms of total demand is the morning (AM) peak, although the afternoon inter-peak and afternoon (PM) peak periods both also exhibit high trip demand. Over 70% of all trips originating from within the WMA occur within these three time periods.

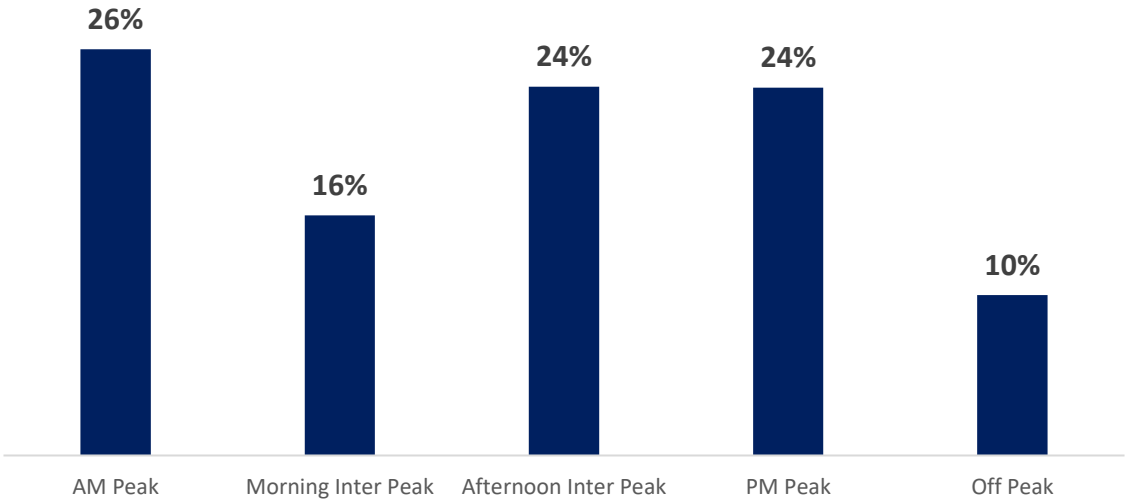

Figure 2.2: Percentage of 2040 Demand by Time Period

2.3.2 Mode Share

The mode shares under the Do Minimum and Idealised model scenarios for the 24-hour period are shown below in Figure 2.3. The results indicate a reduction in car mode share in the 2040 Idealised Network scenario, decreasing from 67% to 58% compared to the Do Minimum scenario, with an uplift in the public transport mode share from 4% to 20%. Figure 2.3 also shows decreases in the walking mode share in the Idealised scenario, which likely result from the high frequency and coverage of the unconstrained public transport network in the Idealised Network scenario.

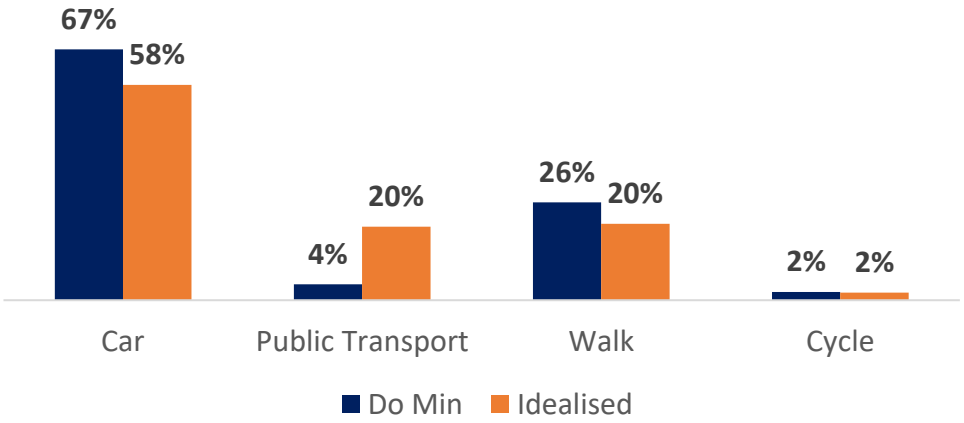

Figure 2.3: Waterford Metropolitan 2040 24-Hour Mode Share Split Comparison

It should be noted that whilst the Idealised Scenario does include significant public transport provision and a representation of the Waterford Cycle Network Plan, it does not contain any significant demand management measures, and thus the shift from private car to public transport is somewhat limited.

2.4 Spider-Web Analysis

To facilitate analysis of 2040 travel demand within the WMA, the area was divided into several corridors (illustrated in Figure 2.4) based on the national and regional transport networks around a central 'city centre' core. Areas outside of the defined metropolitan boundary such as Tramore, Passage East and Dunmore East were also included to reflect the strong linkages between these areas and Waterford City and ensure that this demand is catered for in the transport strategy.

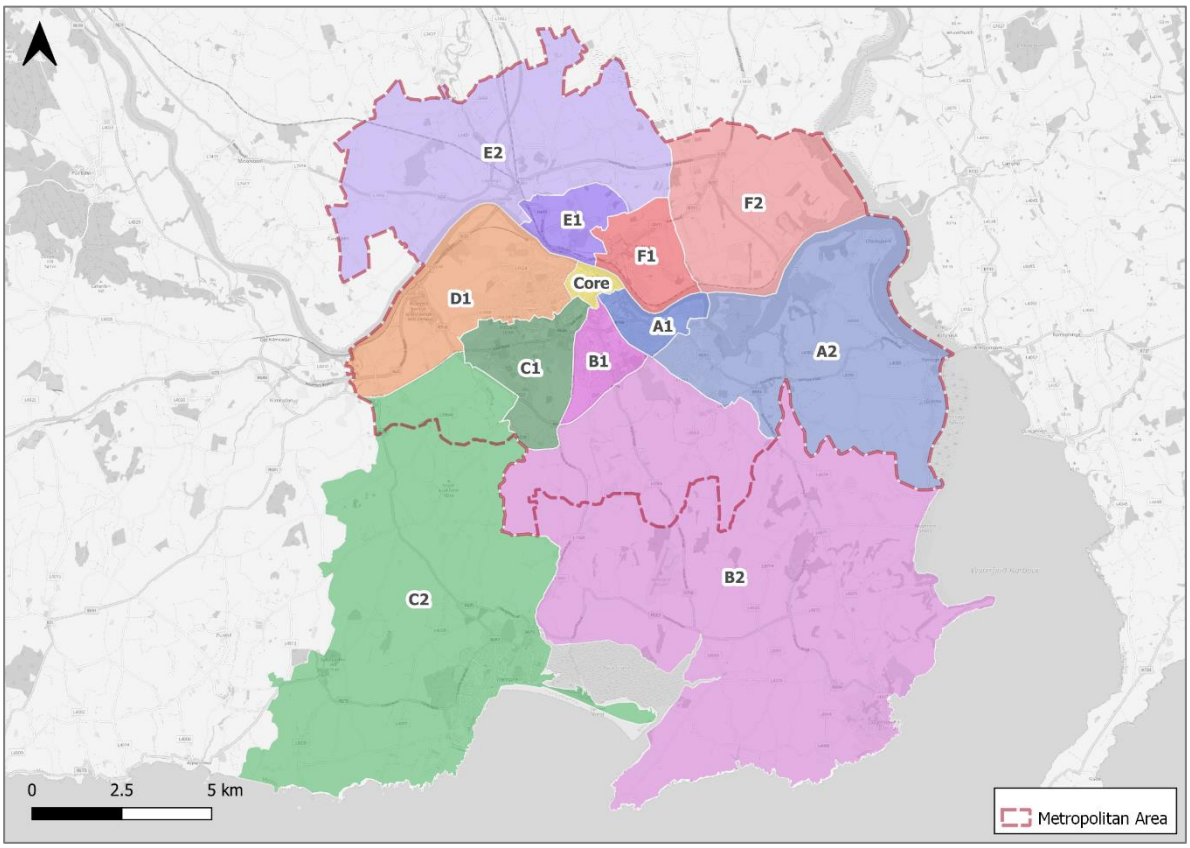

Figure 2.4 WMA Corridors and Segments

2040 travel demand between each of these corridors was investigated in further detail to gain an understanding of key desire lines and the demand that would need to be served by a public transport network.

To further refine the 2040 corridor demand into a more understandable and coherent framework, the demand was assigned onto a simplified 'Spider's Web Network'. Demand by each mode was assigned onto the 'Network' using the following assumptions:

- For car travel, it was assumed that demand would use the quickest path based on journey time. Generally, demand was routed orbitally around the city unless travelling to a destination on the direct opposite side of the City Core, in which case it was assigned through the City Core. For example, demand from A1 to D1 would travel via A1-B1-C1-D1 and demand from A1 to E1 would travel via A1-Core to E1;
- For public transport demand, it was assumed that demand from each corridor could travel orbitally to an adjacent corridor. All other demand was routed radially through the city core. For example, public transport demand from Segment C1 would travel orbitally to Segment D1. But demand from C1 to A1 would travel through the City Core as C1 is not an adjacent segment to A1. The assumption is that due to generally higher frequencies and levels of service on radial routes, it would be quicker to travel into the Core and out to A1 rather than

travel orbitally on PT. Exceptions are made where road links do not exist. For example, public transport demand between D1 and E1 is routed through the core as it is unlikely that buses would travel via the N25 toll road;

- Active mode demand, i.e. walking and cycling, were assumed to take the most direct route in terms of distance to their destination segment.

The 'Spider's Web Network' created using this approach for the AM peak hour for public transport demand is shown in Figure 2.5, overleaf. In terms of public transport demand, there is an emerging corridor from A2-A1-D1 via the city centre. There is also strong demand between C1 and the city centre, and from B1 to the city centre. North of the River Suir, due to the layout of the road network it is likely that the majority of public transport services would travel via the Dock Road and Rice Bridge. As such the demand from E1 and F1 to the Core could be combined giving an overall high level of public transport demand (1,648 passengers) travelling via the Dock Road to the city centre and beyond. The 'Spider's Web' analysis results fed into the Option Development stage of the Transport Strategy development process, identifying public transport demand which needs to be served by the future network.

2.5 Summary

The previous sections provide a brief overview of the initial 2040 demand analysis undertaken using the SERM to feed into the transport options development. In summary:

- A 2040 planning sheet forecasting population, employment and education levels in-line with the NPF was developed.
- This data was run through the NDFM to generate future model travel demand and tested with an 'Idealised' public transport network.
- Demand analysis was undertaken at a corridor level to determine desire lines and travel patterns.
- 'Spider-web' analysis was used to identify key corridors where travel demand is greatest, and therefore, where additional capacity may be needed across the transport network to accommodate the trips forecast to occur by 2040.
- The analysis provided information on estimated future transport demand, trip patterns across the network and potential mode splits, all of which informed the subsequent Options Development stage of the Transport Strategy development process.

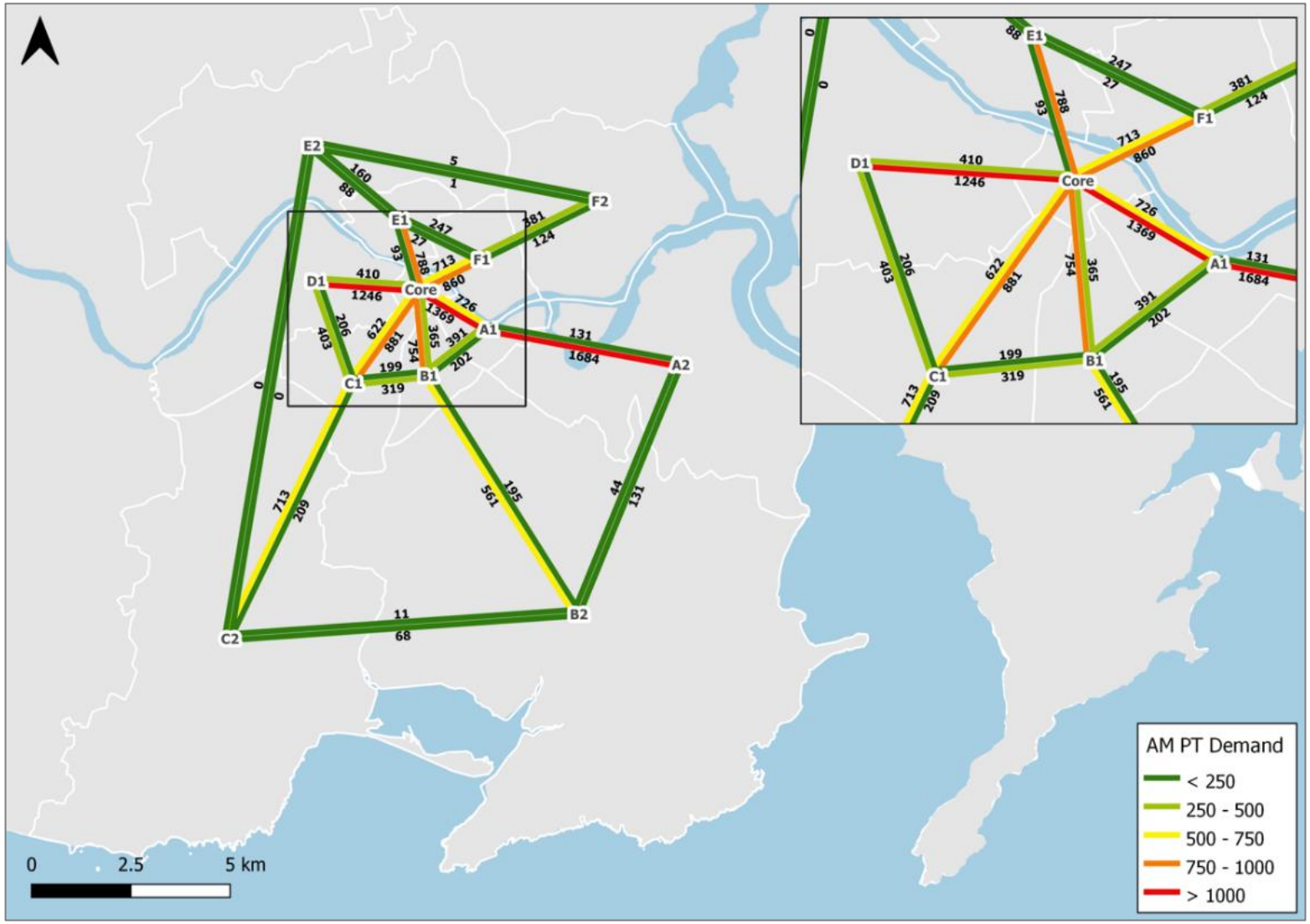

Figure 2.5 2040 AM Peak Hour Public Transport Demand 'Spider's Web Network'

3 Active Mode and Public Transport Testing

3.1 Introduction

The following section provides a high-level overview of the supporting modelling undertaken using the NTA's SERM to aid the active mode and public transport options development and assessment.

3.2 Options for Testing

The *WMATS Transport Options Report* identified an upgraded Walking and Cycling network for the Waterford Metropolitan Area. It also used the demand analysis outlined in Chapter 2 to identify public transport options to support the sustainable development of the WMA. Table 3.1 outlines the public transport options tested using the SERM.

Table 3.1 Public Transport Options

Scheme	Do Min	Scenario 1	Scenario 2
2021 Road Network	✓	✓	✓
Updated Cycle Network	✗	✓	✓
Revised Bus Network	✗	✓	✓
New Bus Lanes	✗	✓	✓
Bus Gate Merchants Quay	✗	✓	✓
Clock Tower Active Bridge	✗	✓	✓
Rice Bridge (4 lanes traffic)	✓	✗	✗
Rice Bridge (2 lanes + 2 lanes PT)	✗	✓	✓
Improved rail services	✗	✗	✓

The options for testing included the following key elements:

Updated Cycle Network

The proposed cycle network for the WMATS is based on the draft Cycle Network Plan for Waterford City and Environs 2014. Additional cycle links have been identified to align with the WMATS proposed transport networks.

Revised Bus Network

The proposed WMATS Bus Network, illustrated in Figure 3.1, includes a comprehensive network of frequent radial and orbital bus routes developed to meet targeted maximum public transport

demand outlined in the Demand Analysis Report and in accordance with the principles outlined in Options Development Report. [2]

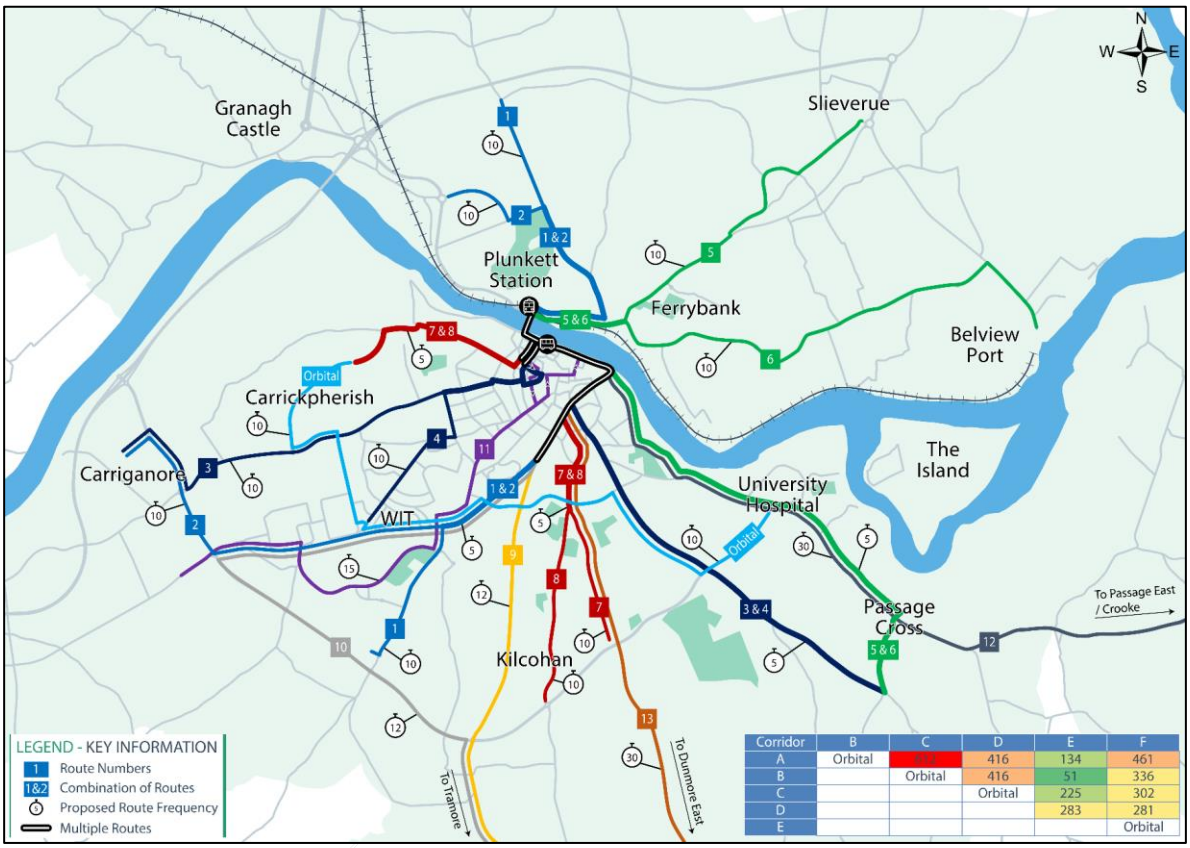

Figure 3.1 Proposed WMATS Bus Network

Bus Priority Measures

To support a shift to sustainable travel, increased public transport priority is required to achieve high speed, high frequency, reliable public transport services. The priority may be in the form of bus lanes, priority signals or bus gates. For WMATS the following key measures have been identified:

- **Merchant's Quay Bus Gate:** A number of proposed bus services converge on Merchant's Quay within Waterford City Centre. Based on the identified service frequencies, it is estimated that there could be up to one bus every minute operating in the AM peak. In order to achieve this target headway, it was determined that a Bus Gate would be required on Merchant's Quay to remove general vehicular traffic from the area and provide priority for bus services through this congested location. This would also provide the opportunity to enhance the public realm along the waterfront.
- **New Bus Lanes:** Where possible, bus lanes should be provided along the key radial routes accessing the city centre – e.g. Cork Road, Dock Road etc. Where there is insufficient space to provide dedicated bus lanes along the entire route, priority could be provided through queue jump lanes at junctions and advanced signal priority.
- **Bus Lanes on Rice Bridge:** Currently all buses travelling north/south of the River Suir must use Edmund Rice Bridge which can be quite heavily congested during the peak periods. Therefore,

[2] Further details on the development of the Bus Network, including route alignments, capacities and frequencies of service is provided in the WMATS Transport Options Report

to promote public transport usage, it is proposed to reduce Rice Bridge to 1-lane of vehicular traffic in each direction with a dedicated bus lane provided.

Clock Tower Active Bridge

Waterford City and County Council have secured funding for a River Suir Sustainable Transport Bridge, which accommodates pedestrians, cyclists and an electric shuttle bus service linking the South Quays to the Strategic Development Zone (SDZ) located to the north of the river.

Improved Rail Services

The Transport Options Report identified that a bus-based solution would be optimal for Waterford based on the idealised public transport demand. However, in-line with the NIFTI guidance, the modelling assessment was used to test an option which seeks to make best use of the existing rail infrastructure in the area. This included the following key elements:

- Increased service frequency Dublin to Waterford (2 trains per hour)
- Provide a commuter service (3 trains per hour) between Carrick on Suir and Belview and on to Rosslare Europort stopping at:
  - Carrick on Suir,
  - Fiddown,
  - Waterford Plunkett,
  - Belview (for commuter & freight),
  - Campile,
  - Ballycullane,
  - Wellingtonbridge,
  - Bridgetown,
  - Rosslare Strand,
  - Rosslare Europort
- Provide a commuter service (3 trains per hour) between Waterford and New Ross stopping at:
  - Waterford Plunkett,
  - Bellfield/Ferrybank development lands,
  - New Ross
- Move Waterford Plunkett Station to the proposed North Quays development site
- Improved speeds on the rail network to match other commuter and intercity services

3.3 Modelling Results

3.3.1 Scenario 1

The modelling results for Scenario 1 focused on the following key elements:

- **Mode Share:** The percentage of people choosing active modes, public transport and the private car;
- **Bus Operations:** Identifying potential bus usage and capacity analysis; and
- **Public Transport Journey Times:** Modelled journey times via public transport to Waterford City Centre.

Mode Share

The Mode Share results for Scenario 1 and the 2040 Do Minimum scenario are illustrated in Figure 3.2. The results indicate that the improved bus network leads to an approx. 200% increase in public transport trips when compared to the Do Minimum.

The increase in public transport reduces the mode share for private vehicles, removing around 4,300 car trips from the network in the 24-hr period. However, it also leads to a reduction in active modes, with a number of walking trips in particular transferring to the improved bus service.

In general, the significant improvement proposed for the bus network has a relatively limited impact on car mode share as:

- The average journey time by car within the metropolitan area is less than 15 minutes which makes it difficult for public transport to compete; and
- There is a high level of either cheap, or free, parking throughout the metropolitan area providing ease of access to the city centre for car based trips.

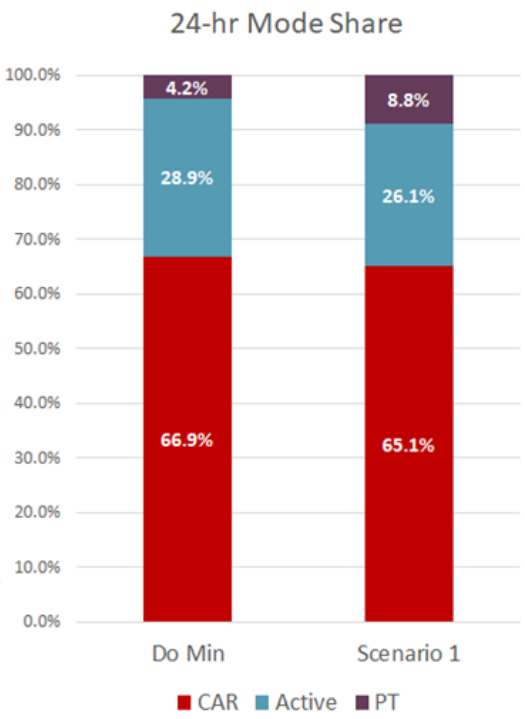

Figure 3.2 Scenario 1 Mode Share Results

Bus Operations

In order to determine the efficiency of the proposed bus network, the maximum patronage along each of the new routes in the AM peak hour was extracted from the SERM. The results are illustrated in Figure 3.3, overleaf, along with passenger volumes as a percentage of overall capacity in Figure 3.4. The bus route capacity was calculated using the proposed service frequencies outlined in the *WMATS Transport Options Report* based on an assumed double decker bus with a maximum capacity of 88 passengers.

The results indicate that the proposed bus services are well used during the morning peak hour, particularly routes travelling to the southwest of the city to Waterford IT and the IDA business park. The one service that is operating with a significantly low patronage is the purple route. This route was primarily identified to serve a strategic Park and Ride site to the northwest of the city which hasn't been included in this initial modelling analysis. For it to be successful, the Park and Ride will need a relatively high-frequency bus service operating to the city centre with priority available to improve bus journey times and reliability.

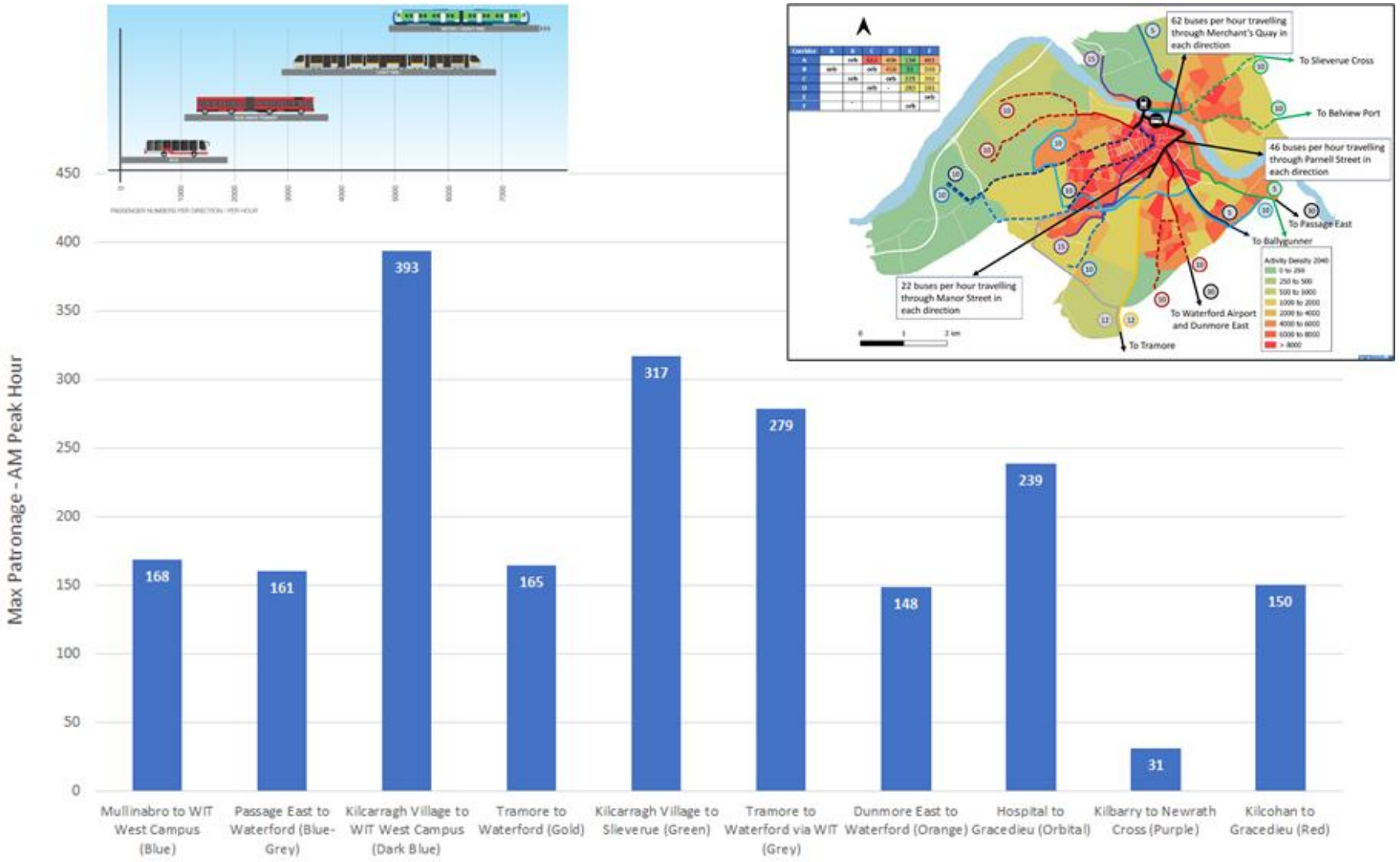

Figure 3.3 Waterford City Bus Network – Max Patronage AM Peak Hour

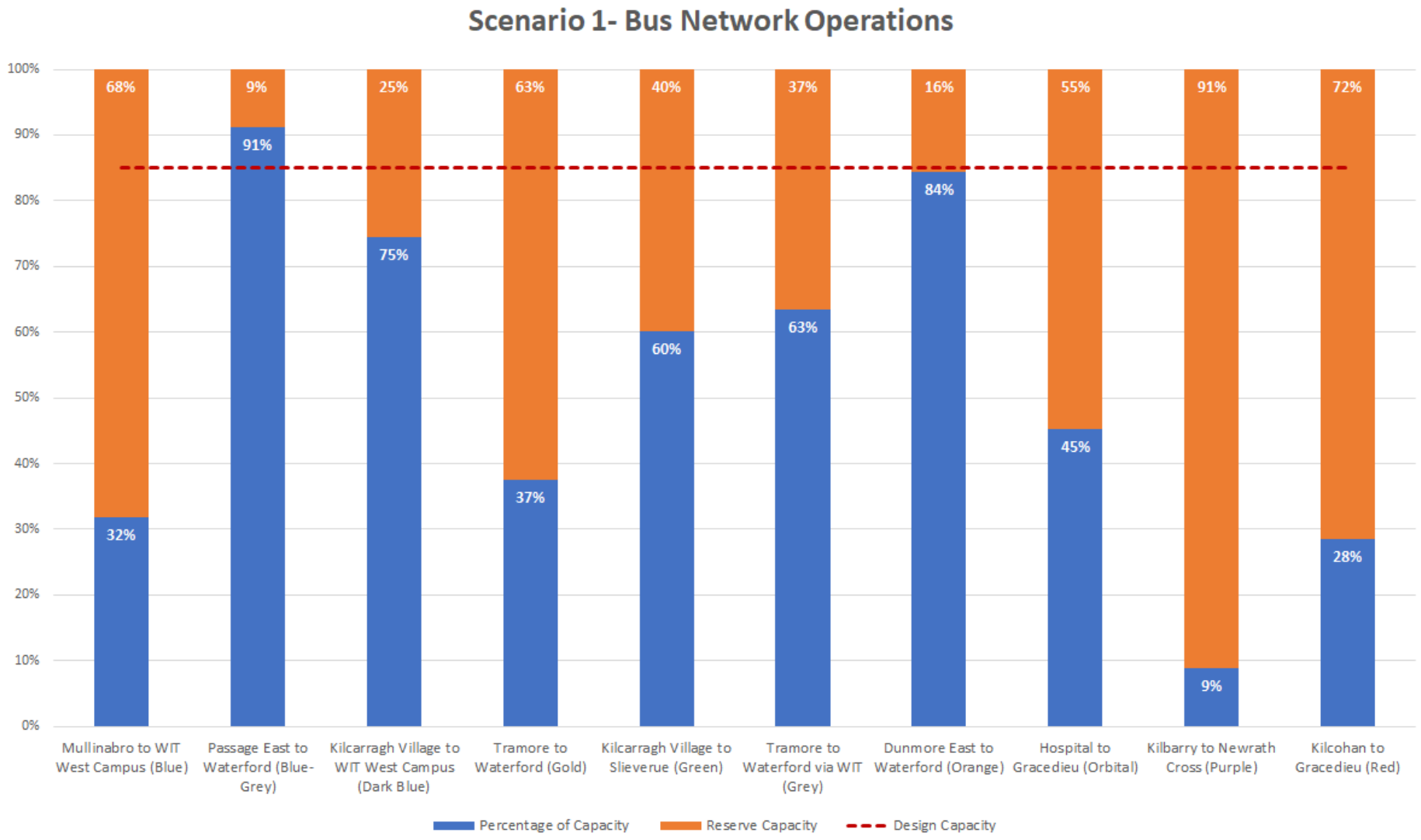

Figure 3.4 Waterford City Bus Network – % Reserve Capacity

Public Transport Journey Times

3.3.2 Scenario 2

As outlined previously, Scenario 2 was focused on trying to make best use of existing infrastructure by expanding rail services to the city centre. This included higher frequency services along the Waterford to Dublin line, along with the creation of a commuter rail network to Carrick-on-Suir, Rosslare and New Ross.

The additional rail services were tested in the SERM, and the maximum patronage in the AM peak hour is illustrated in Figure 3.5.

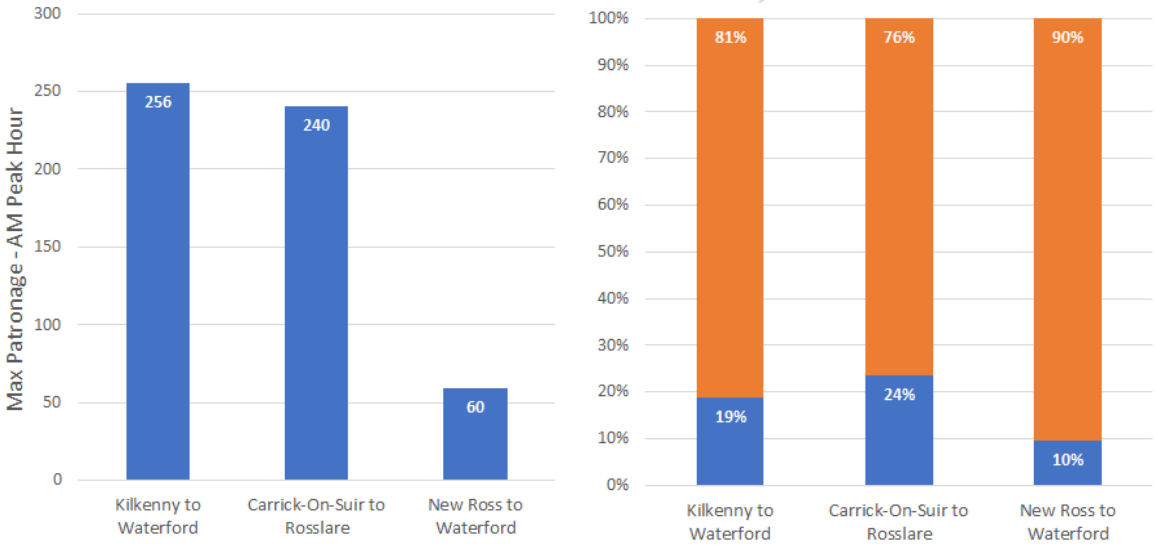

Figure 3.5 Proposed Rail Network Upgrades – Max Patronage & Capacity

The results indicate that the proposed additional rail services are not well utilised. The commuter rail service between Carrick-on-Suir and Rosslare has a maximum of 240 passengers in the AM peak, which equates to approx. 24% of its capacity, whilst the proposed New Ross line only attracts 60 passengers. At these levels, the upgrade to the rail network is not effective or efficient and will not provide value for money due to high costs and low demand. The identified passenger flows could be accommodated by a bus based solution far more efficiently.

However, upgrades to the Waterford – Kilkenny rail service could be improved at a relatively low cost and provide opportunities for travel between the two cities. This could include some additional services, along with a re-adjustment of the timetabling to allow passengers departing Kilkenny in the AM to arrive in to Waterford before 09:00 for work.

3.4 Summary & Conclusions

The *WMATS Transport Options Report* undertook a detailed multi-criteria analysis to identify the optimal public transport network that could meet an idealised demand in Waterford. It defined a bus-based solution for the city with a series of frequent radial and orbital routes supported by priority measures to improve journey times and reliability. This network of services was tested within the NTA's SERM to identify the impacts including changes in demand for public transport, journey time improvements and usage of the bus services. In summary:

- The improved bus network leads to an approx. 200% increase in public transport trips when compared to the Do Minimum.
- The increased bus usage leads to a reduction in car demand, however, this is relatively limited. Further measures would be required to encourage a shift away from the car e.g. parking controls.
- The proposed bus network reduces journey times by public transport to the city centre across the Metropolitan Area.
- The majority of the proposed bus services operate efficiently with good patronage levels in the AM peak hour. All of the modelled public transport flows sit comfortably within the range that can be accommodated by a bus-based solution.

In order to ensure that existing assets were being utilised optimally, service improvements were tested on the rail network. The modelling analysis indicated that the patronage levels were not sufficient to support the introduction of a commuter rail service to Carrick-on-Suir, Rosslare or New Ross.

In summary, the modelling results indicate that the bus-based solution identified within *Transport Options Report* is the optimal public transport network to support demand within the Waterford Metropolitan Area. Along with the proposed priority measures, it significantly reduces public transport journey times increasing its attractiveness when compared to the private car. However, average car journey times remain relatively quick across the network, and as such, a series of demand management measures are required to encourage a further shift to sustainable travel and help achieve climate action targets.

4 Climate Action Measures

4.1 Introduction

Ireland is currently in the midst of a climate crisis. The Government, through the Climate Action Plan 2021, has outlined decisive action to achieve a 51% reduction in overall greenhouse gas emissions by 2030, setting Ireland on a path to reach net-zero emissions by no later than 2050. Key to achieving these targets is facilitating additional walking, cycling and public transport journeys. Expanding sustainable mobility options to provide meaningful alternatives to everyday private car journeys is necessary to reduce transport emissions.

As outlined in the previous chapter, an upgraded bus network has been identified to support the growing population in the Waterford Metropolitan Area. The comprehensive high frequency services lead to a significant increase in bus usage, however, there is a limited reduction in car mode share overall. Even with the improvement to the public transport network, on average it is still quicker to travel by private car. As such, additional measures are required to support a shift to sustainable travel and help achieve our climate action targets. The following sections outline the testing undertaken in the SERM to identify the optimal package of climate action measures to achieve the overall objectives for WMATS.

4.2 Scenario Development

The SERM was used to initially compare overall journey times by car and public transport within the Metropolitan Area for the following scenarios:

- **AAA**: 2040 Do Minimum – existing transport network plus committed schemes
- **AAB**: 2040 Emerging Strategy for Public Transport, Walking and Cycling
- **AAH**: Idealised Scenario with the cycle time at key junctions reduced to 60 seconds to reflect additional priority for sustainable modes. Within this scenario buses operate every 2 minutes with unlimited capacity and full coverage across the network. The impact of these high frequency buses on capacity of the road network has also been included as a proxy for demand management in-line with the GDA Strategy methodology.

The average journey times (JT) by Car and Public Transport within the Waterford Metropolitan Area for each of the scenarios are outlined in Table 4.1 below. Please note that Public Transport journey time includes walk to/from bus stops, wait time for services and travel time. The overall AM (07:00-10:00) mode share within the Metropolitan Area for each of the scenarios is presented in Figure 4.1

Table 4.1 Waterford Metropolitan Area Journey Times (SERM)

Scenario Description	Code	Avg. Car JT (mins)	Avg. PT JT (mins)	Difference (mins)
2040 Do Minimum	AAA	15.03	61.86	46.83
2040 run with PT, Walk & Cycle Strategy	AAB	17.00	35.34	18.34
Idealised PT Scenario + 60sec Cycle Time	AAH	24.10	25.16	1.07

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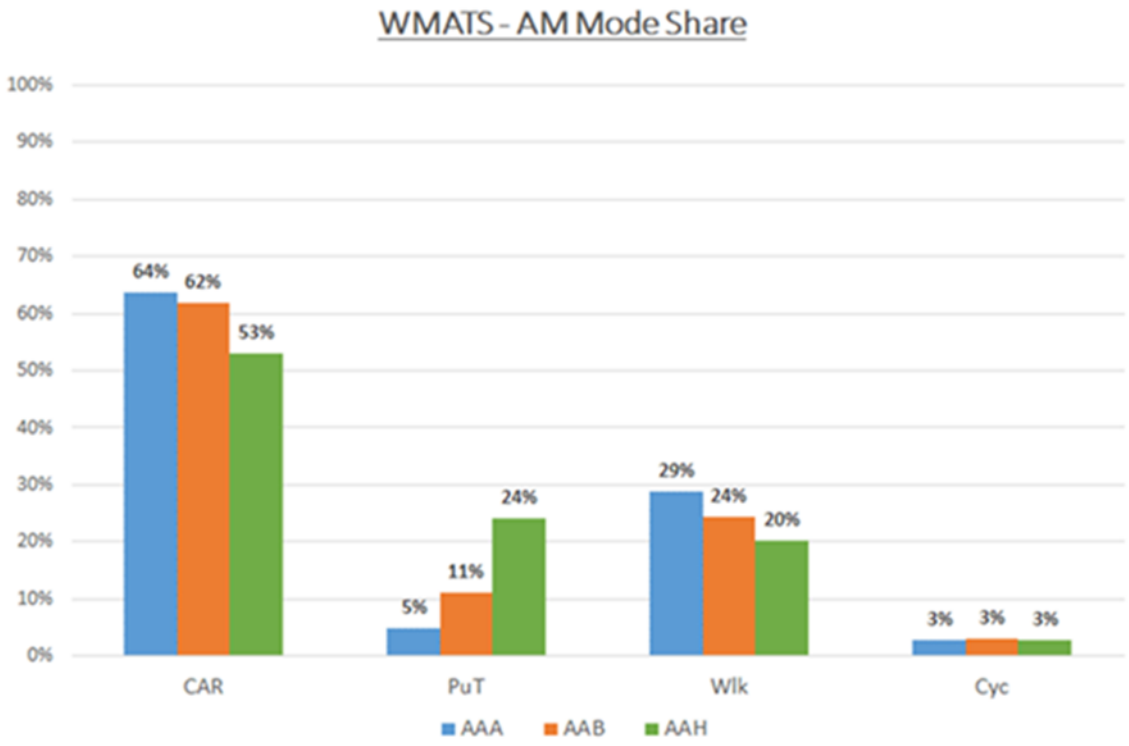


Figure 4.1 AM Mode Share – 'Do Strategy' vs 'Idealised'

As illustrated in Table 4.1, even with the improvements to the bus network (AAB), travel times by public transport are twice as long as car journey times on average. As such, the impact on car mode share is relatively limited with an approx. 2% reduction when compared to the Do Minimum (AAA).

In the Idealised scenario (AAH), the improved frequency of bus services, along with capacity reductions on the road network, lead to comparable journey times between car and public transport. This scenario results in a significant reduction (9%) in car mode share in the AM period with 47% of trips undertaken by sustainable modes. The overall reduction in car mode share is limited by:

- **Coverage**: Even in the idealised scenario there are likely to be areas of the network which do not have direct access to public transport services.; and
- **Perception**: In general, people have a preference to travel via private car rather than public transport. This behavioural response is built into the mode choice within the SERM, and as such, even if there are comparable journey times, people are more likely to choose the private car.

Therefore, for a city of Waterford's scale, given the relatively short trip lengths and accessibility by car across the network, the 53% AM car mode share was identified as an achievable target to support climate action objectives.

With the latest emerging active modes and public transport measures (AAB), the journey times by public transport are significantly longer than by car. In order to encourage a shift to sustainable modes, additional climate action measures are required to increase the overall cost[3] of travel by car. This is important for achieving climate action targets, along with supporting investment in public transport, walking and cycling infrastructure.

[3] Within transport modelling, people make a choice on their mode of transport based on the cost of travel. For car, this cost is usually represented in generalised minutes and includes aspects such as journey times, parking charges, tolling etc. For public transport this cost includes journey times, wait times, walk times, fares, crowding etc.

The following measures outlined in Table 4.2 were tested to increase the cost of travel by car and support a shift to sustainable modes:

Table 4.2 Climate Action Measures

Measure	Rationale
Reduction in Free Workplace Parking (FWPP)	- Initial model analysis indicates that approx. 90% of people commuting within the Metropolitan area have access to free parking at work. - The GDA strategy outlines measures to manage destination parking levels and reduce public sector parking availability. - The Five Cities Demand Management Study identifies the implementation of a Workplace Parking Levy as a recommended Demand Management Measure.
Parking charges	- The Five Cities Demand Management Study highlights public parking controls and pricing as a key element of demand management - Currently, along the South Quays the parking charge is €2 per hour with a heavily reduced rate for all day parking. As part of this modelling assessment, it is proposed that this daily discount rate be removed to reduce the attractiveness of all day parking. - Currently, destination parking charges are applied mainly within the core city centre area. However, there are a number of large employment destinations that are located on the outskirts of the city centre. Therefore, in-line with proposals for Workplace Parking Levies it is proposed that the €2 parking charge is extended to these locations with some level of free parking still available.
Reduction in parking spaces along the South Quays	- The South Quays area within Waterford is a prime location for redevelopment with potential for shops, restaurants, cafes etc. providing a vibrant atmosphere along the riverside. However, currently this prime waterfront land is being used for large quantums of car parking. - To support the redevelopment of this area, and the potential re-location of some parking, a 50% reduction in car parking capacity within the South Quays city centre area has been assumed in our Climate Action Measure tests.
60 Second Traffic Signal Cycle Time	- In-line with the GDA Strategy testing, a 60 second traffic signal cycle time has been implemented at all key signalised junctions within the city centre where walk, cycling and public transport improvements are proposed. - This reduced signal timing for vehicular traffic acts as a proxy for increasing priority for pedestrian and cyclist movements and supporting bus priority measures.

4.3 Modelling Results

A series of iterative tests, outlined in Table 4.3, were undertaken in the SERM to assess the impact of various climate action measures on overall mode shares within the Metropolitan Area.

Table 4.3 Climate Action Tests

Climate Action Measure	AAG (Iteration 1)	AAI (Iteration 2)	AAJ (Iteration 3)
50% Reduction in Free Workplace Parking	✓	✓	✓
€2/hour Parking Charge (City Centre)[4]	✓	✓	✓
€2/hour Parking Charge (City & Suburbs)[5]	✗	✗	✓
50% Reduction in Parking on South Quays	✗	✓	✓
60 Second Traffic Signal Cycle Times	✗	✓	✓

Figure 4.2 outlines the AM peak period mode share across the Metropolitan Area for each of the scenarios in Table 4.3. The results are compared to the emerging preferred walk, cycle and public transport strategy (AAB) along with the 'Idealised' scenario described previously (AAH).

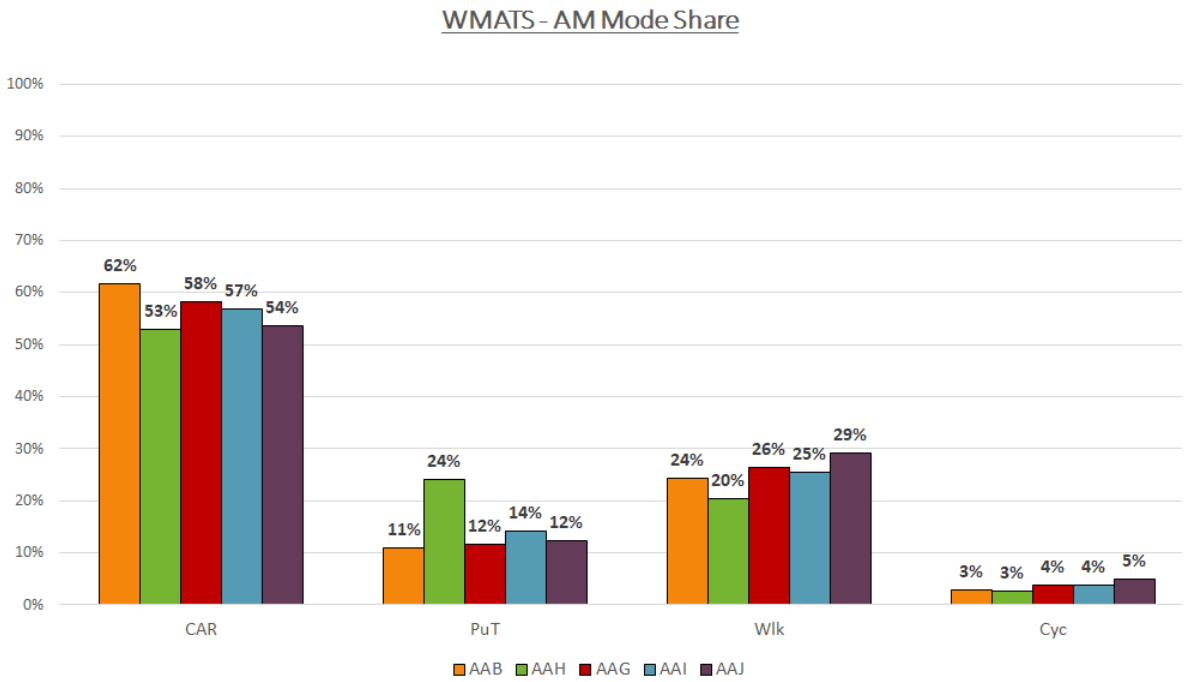


Figure 4.2 AM Mode Share – Climate Action Measure Testing

[4] Includes removal of all-day parking discounts currently in operation

[5] Includes extension of paid parking to wider Waterford City & Suburbs region

Iteration 1 - AAG

The first scenario focused on the reduction in Free Workplace Parking (FWPP) and removing the heavily reduced rate for all day parking. FWPP is parking that is provided free of charge to employees or students. In the model this allows for a set number of trips to park at their destination for free in the commute and education user classes. A reduction in FWPP forces trips to find alternative paid parking or swap modes, as such it is an effective means of reducing car attractiveness for commute and education purposes.

The results in Figure 4.2 indicate that the proposed climate action measures have a positive impact reducing car mode share to 58% when compared to the emerging preferred active modes and public transport strategy (AAB). However, the measures fall short of achieving the target car mode share identified within the 'Idealised' model scenario (AAH).

Iteration 2 - AAI

To further support the shift towards sustainable modes, additional climate action measures were proposed. This included a reduction in parking availability on the South Quays to support the redevelopment of the area along with a general reduction in traffic signal cycle times within the city. The reduction in signal timings within the SERM acts as a proxy for improving priority for pedestrians, cyclist and public transport at junctions, supporting sustainable travel.

The modelling results indicate a very minor change in mode shares when compared to Iteration 1 (AAG). The reason for this is the proposed measures were mainly focused within the city centre where parking charges are currently applied. However, a large proportion of trips to Waterford are not actually travelling to the city centre. There are a number of key trip attractors located on the outskirts of the city which were not being captured by the measures proposed in Iteration 1 and 2 e.g. IDA Business Park, University Hospital Waterford, Waterford IT etc.

Iteration 3 - AAJ

To overcome the issues identified in Iteration 2, the parking charge proposals were extended to cover the entire Waterford City and Suburbs region. The results in Figure 4.2 indicate that the introduction of the full set of Climate Action measures significantly reduce the AM peak car mode share (54%) almost in line with the 'Idealised' scenario (AAH).

When compared to the initial Emerging Preferred Strategy (AAB), the climate action measures lead to a minor increase in public transport use, and a significant increase in walking and cycling. This suggests that a number of the shorter distance trips which were undertaken by car switch to active modes when measures are implemented to manage vehicular traffic.

Overall, the analysis above indicates that the proposed suite of climate action measures will help maximise the potential for sustainable travel and assist in achieving the overarching objectives of the Waterford Metropolitan Area Transport Strategy. It should be noted that these measures represent those that could be modelled within the SERM. There are a host of further non-modelled supporting measures within the WMATS aimed at encouraging sustainable travel including the promotion of car clubs, workplace and school travel planning, Mobility as a Service (MaaS) etc. Further details are provided in the *WMATS Supporting Measures Report*.

4.4 2030 Emissions Assessment

The climate action plan requires the transport sector to achieve a reduction in emissions of 51% by 2030 relative to 2018 values. Testing was undertaken to understand the performance of the proposed climate action measures above, and the emerging preferred active modes and public transport strategies, in achieving these emission targets.

4.4.1 Fleet Assumptions

The fleet assumptions used in this test are in line with those adopted for the Climate Action Plan project. A breakdown of this fleet is shown in Table 4.4 below. The bus fleet is assumed to be converted to zero emission vehicles by 2030 through battery electric, hydrogen fuel cell or hybrid buses running on battery within the WMA.

Table 4.4 2030 Fleet Profile

	Petrol	Diesel	Hybrid	Zero
Car	32.6%	24.7	16.1%	26.5%
LGV	0.0%	86.7%	0.0%	13.3%
HGV	0.0%	91.0%	0.0%	9.0%

4.4.2 Approach

In order to tie into the Climate Action Plan work, the emissions were calculated using a 'stepping stone' approach, which sequentially examines the impact of changes in land use, improvements in vehicle technology and the transport strategy measures.

Emissions were calculated using the NTA's Environment Module which uses ENEVAL to calculate emissions by road link based on speed and flow. In total, the following four steps were included in the test results:

- **Step 1: Background Growth** – As set out within Section 2 of this report, the WMATS area is set to undergo a substantial increase in population and employment by 2040. Based on a linear growth profile, it is assumed a proportion of this growth will be achieved by 2030. This will result in a growth in demand for travel and increase in vehicle km between 2018 and 2030. The initial growth in demand for travel and resultant increase in vehicle km has been tested by using a 2030 Do Minimum model and the base year fleet in ENEVAL.

- **Step 2: Fleet Improvements** – As set out above, changes in fleet technology with zero or lower emission vehicles will take place between the base year and 2030. This was tested by running the 2030 Do Minimum model with the 2030 Fleet in ENEVAL.

- **Step 3: Biofuels** – Biofuels allow for a carbon offset based on their proportion of diesel and petrol fuel versus fossil fuels. While Biofuels still produce CO_2, the process of making the fuels removes CO_2 from the atmosphere making it carbon neutral. In 2018, 7% of Diesel was biofuel, this is expected to rise to 20% by 2030. For petrol there is currently no biofuel, this is expected to increase to 5% by 2030.

- **Step 4: Strategy Impacts** – Finally, the impact of the strategy measures on CO_2 reduction was examined. This was tested by using the 2030 Strategy run and the base year fleet profile.

4.4.3 Results

The overall 2030 emission results are outlined in Table 4.5 below. The results indicate that the planned growth in population and employment by 2030 will lead to an overall 26% increase in CO_2 emissions by 2030 based on the existing fleet profile and without the implementation of the proposed strategy measures.

Table 4.5 Climate Impact Assessment for 2030 – CO_2 emission percentage changes 2018-2030

Measure	Individual Impacts				Cumulative Impacts			
	Car	Goods	Bus	Total	Car	Goods	Bus	Total
Background Growth	18%	41%	40%	26%	18%	41%	40%	26%
Fleet Improvements	-39.5%	-11.1%	-100.0%	-30.0%	-28.7%	25.1%	-100%	-11.5%
Biofuels	-6.2%	-11.0%	-11.0%	-8.2%	-33.1%	11.3%	-100%	-18.8%
Strategy Measures	-19.7%	-2.0%	-22.0%	-12.9%	-46.3%	9.1%	-100%	-29.3%

The planned fleet improvements, and transition to hybrid and zero emission vehicles, will have the most significant impact on CO_2 emissions with an estimated 30% reduction when compared to 2018 levels. The further roll-out of Biofuels will lead to an 8% reduction in CO_2 through carbon offset when tested in isolation, and the proposed WMATS active modes, public transport and climate action measures will lead to a further 12.9% reduction.

Cumulatively, the estimated growth in population/ employment combined with the expected changes in fleet profile, the inclusion of Biofuels, and the introduction of the strategy measures will lead to a 29.3% reduction in overall CO_2 emissions when compared to 2018 levels. This equates to a reduction from 0.094MT of CO_2 in the 2018 base year to 0.067MT in 2030. This leaves a shortfall of 22% or 0.021MT of CO_2 when compared to the Governments 2030 climate action targets.

Much of this shortfall is driven by the growth in goods emissions between the base and 2030 which itself is tied to economic growth within the WMA. Several additional measures were tested to understand what is required to make up the shortfall. These tests covered three areas:

- Fuel price increase;
- Additional zero emission vehicles; and
- Road pricing.

The first measure exploring fuel price increase, looks at a percentage increase in the price of fuel relative to 2016 values. Fuel price increases are effective at reducing emissions as they encourage mode shift toward sustainable modes, more efficient use of Internal Combustion Engine (ICE) vehicles and the uptake of zero emission vehicles.

More efficient use of vehicles for private car can be achieved by driving at lower speeds and making less trips. While for goods vehicles, efficiency gains can be achieved through higher utilisation of vehicles, reduction in empty running and consolidation of logistics lines.

The scale of fuel price increase required to achieve the 51% target is substantial but could be phased in over time leading up to 2030. Fuel price increases are a national government mater rather than a regional strategy one and will be considered further under the Climate Action Plan reviews.

The second measure (additional zero emission vehicles), looks at the possibility of accelerating the adoption of zero emissions vehicles, particularly among the goods sector. With goods traffic expected to grow substantially between the base and 2030, focusing this growth on zero emission vehicles would have a substantial impact.

Battery electric goods vehicles are currently feasible in LGVs, however battery operated HGVs is not yet a viable solution due to the vehicle weight and long ranges involved. Instead, adoption of hydrogen technology for HGVs presents a potentially feasible option though high costs are currently associated with hydrogen fuel.

The final option tested was road pricing, this is the introduction of tolling or congestion charging to promote a mode shift towards sustainable modes. One option explored is to toll radial and orbital routes in conjunction with the implementation of park and ride sites. The intention being that this will encourage use of park and ride for the last leg of journeys into Waterford. This is, however, only one of the options that could be explored and would require detailed evaluation in conjunction with the national strategies being delivered under the Climate Action Plan.

4.5 Summary & Conclusions

The previous sections provide an overview of the testing undertaken in the SERM to identify a suite of climate action measures to support a shift to sustainable modes. The impact of these measures on achieving identified 2030 CO_2 emission targets has also been presented. In summary:

- Even with the improvement to the public transport network, on average it is still far quicker to travel by private car within the Waterford Metropolitan Area. As such, additional measures are required to support a shift to sustainable travel and help achieve climate action targets.
- A series of iterative tests were undertaken which identified the following proposed modelled climate action measures for inclusion in WMATS:
  - 50% Reduction in Free Workplace Parking;
  - €2/hour Parking Charge across the Waterford City and Suburbs with no discounted daily rate;
  - 50% Reduction in Parking on the South Quays; and
  - 60 Second Traffic Signal Cycle Times within Waterford City centre.
- A host of further non-modelled supporting measures have also been included within the WMATS aimed at encouraging sustainable travel. Further details are provided in the *WMATS Supporting Measures Report*.
- The modelling results indicate that the introduction of the full set of Climate Action measures significantly reduce the AM peak car mode share to 54%, with 46% of trips undertaken by sustainable modes.
- The expected changes in fleet profile, the inclusion of Biofuels, and the introduction of the WMA strategy measures will lead to a 29.3% reduction in overall CO_2 emissions when compared to 2018 levels.

5 Road Infrastructure Testing

5.1 Introduction

National, Regional and Local Policy including the National Development Plan (NPD), the Waterford City and County Development Plan, Waterford Metropolitan Area Strategic Plan (MASP) and the Waterford Planning Land Use and Transportation Strategy (PLUTS) all identified additional bridge crossing options over the river Suir. Figure 5.1 outlines these proposed bridge crossing options identified for testing as part of the WMATS, and includes:

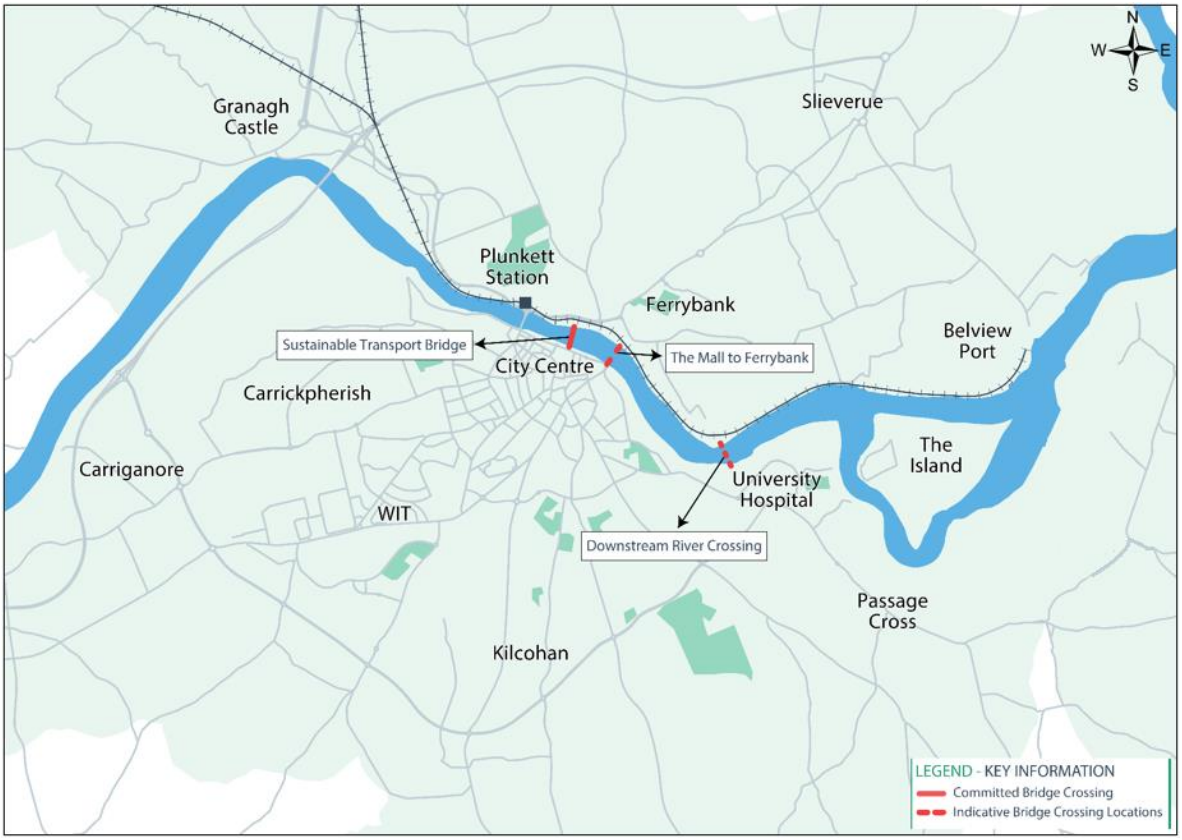


Figure 5.1 WMATS Bridge Crossing Options

Sustainable Transport Bridge

Waterford City and County Council have secured funding for a River Suir Sustainable Transport Bridge. The proposed bridge will accommodate pedestrians, cyclists, and an electric shuttle bus connecting the South Quays with the SDZ lands to the north of the river.

The Mall to Ferrybank (Tower Bridge)[6]

This bridge crossing is included in the Waterford MASP and is proposed to link Ferrybank to the City Centre, via The Mall to the south of the River Suir and Abbey Road to the north. It aims to provide additional road capacity north/south across the river, helping to alleviate congestion issues on Edmund Rice Bridge and Merchant's Quay.

[6] For brevity, this will be referenced as the 'Tower Bridge' throughout the modelling results

Downstream River Crossing[7]

The Waterford MASP includes information on the provision of an additional Downstream River Crossing in the vicinity of Maypark or Ardkeen. This Downstream Crossing is proposed to extend the Outer Ring Road northwards, linking the two sides of Waterford City. This bridge crossing would also serve to curb the future growth of traffic within the City Centre, as it would provide an alternative routing option across the River Suir. The Downstream River Crossing would also link future development sites on the Outer Ring Road to the Port of Waterford and the North Quays, as well as improve access to the University Hospital.

The Downstream River Crossing aims to:

- Complete the orbital road network and provide a compact shape in which the City will develop;
- Provide a distributor route around the City;
- Link development areas to the north of the River Suir to housing and other developments to the south;
- Provide traffic relief for the City Centre; and
- Provide a further alternative crossing point of the River.

5.2 Assessment Methodology

Figure 5.2 provides an overview of the methodology used to assess the bridge crossing options outlined above and determine the emerging preferred solution which should be included in the WMATS.

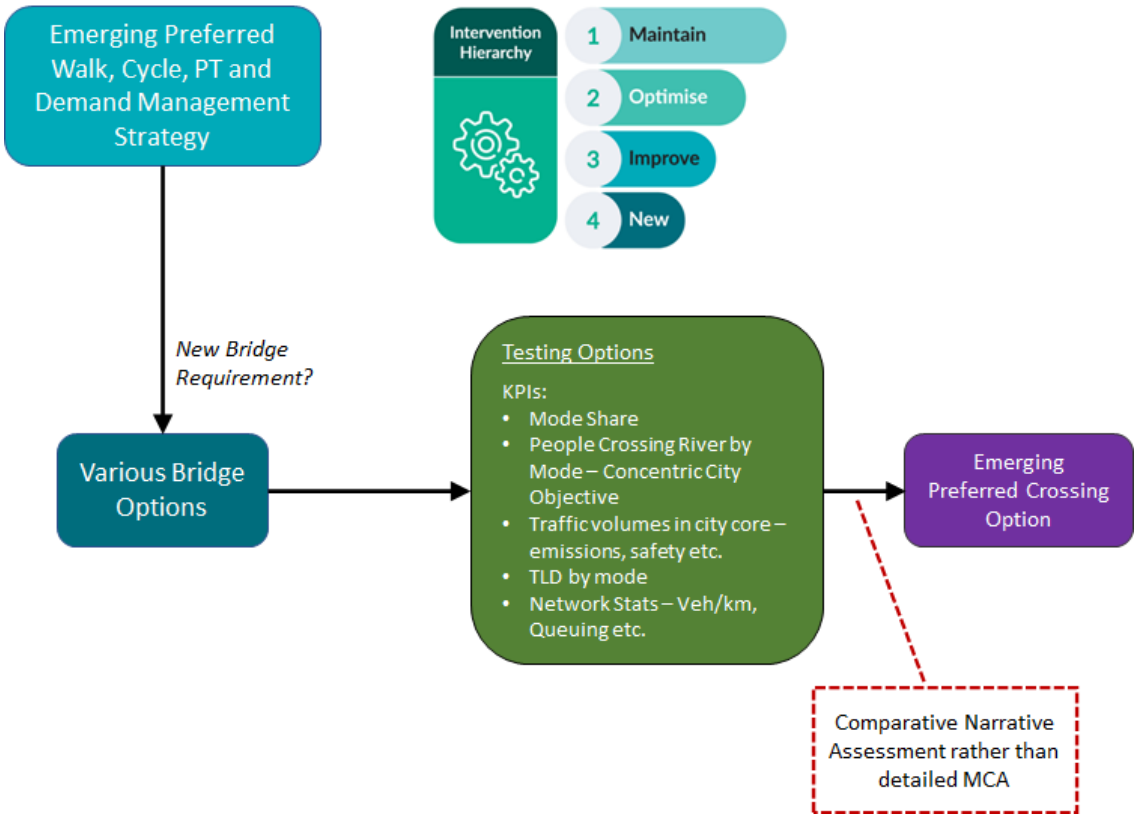


Figure 5.2 Bridge Crossing Options Assessment

[7] For brevity, this will be referenced as the 'Hospital Bridge' throughout the modelling results

As outlined previously, the development of WMATS followed the NIFTI modal and intervention hierarchies. As such, the optimal active modes, public transport and climate action measures were identified before testing the requirement for additional road infrastructure.

Each of the proposed bridge options were tested within the SERM, with the following Key Performance Indicators (KPIs) used as part of the assessment:

- **Mode Share**: identifying the impact the provision of additional bridge crossings have on mode share within the Metropolitan Area. The provision of new road infrastructure can lead to an increase in private car use which may undermine the sustainable transport objectives of the strategy.
- **People Crossing the River**: focuses on the total movement of people north and south of the river across all modes. The 'Concentric City' is one of the key objectives of the Waterford City and County Development Plan, with the aim of supporting balanced development and connectivity north and south of the river Suir.
- **Traffic Volumes in the City Core**: testing the impact the additional bridges have on traffic volumes within Waterford City Centre. One of the key benefits of providing new crossing points is that traffic with a destination on the periphery of the city can avoid travelling through the city centre.
- **Trip Length Distribution (TLD)**: outlining the impact additional road infrastructure will have on overall TLD. The provision of additional river crossings may lead to increased car usage and distance travelled which can have an environmental impact on emissions.
- **Network Statistics**: general statistics including queuing and travel time outlining the impact of the additional bridge crossing on the road network performance within the Metropolitan Area.

The following sections present the results of the bridge crossing assessment and identifies the emerging preferred solution for WMATS. All model results are compared against the 2040 Do Minimum (existing committed schemes only) and what's referenced as the 'Do Strategy' which includes the emerging preferred active modes, public transport and climate action measures.

5.3 Modelling Results

5.3.1 Mode Share

Figure 5.3 outlines the 24-hour mode share results for the Waterford Metropolitan Area. As highlighted in the previous chapter, the emerging preferred active modes, public transport and climate action measures lead to a significant reduction in car mode share (10.7%) when compared to the Do Minimum.

The proposed bridge at the University Hospital leads to a very minor increase in car mode share when compared to the 'Do Strategy'. However, generally the use of public transport, walking and cycling is similar across the scenarios. Therefore, the modelling results indicate that the provision of an additional bridge crossing does not lead to a major shift back to private car use which would undermine the benefits of the core strategy.

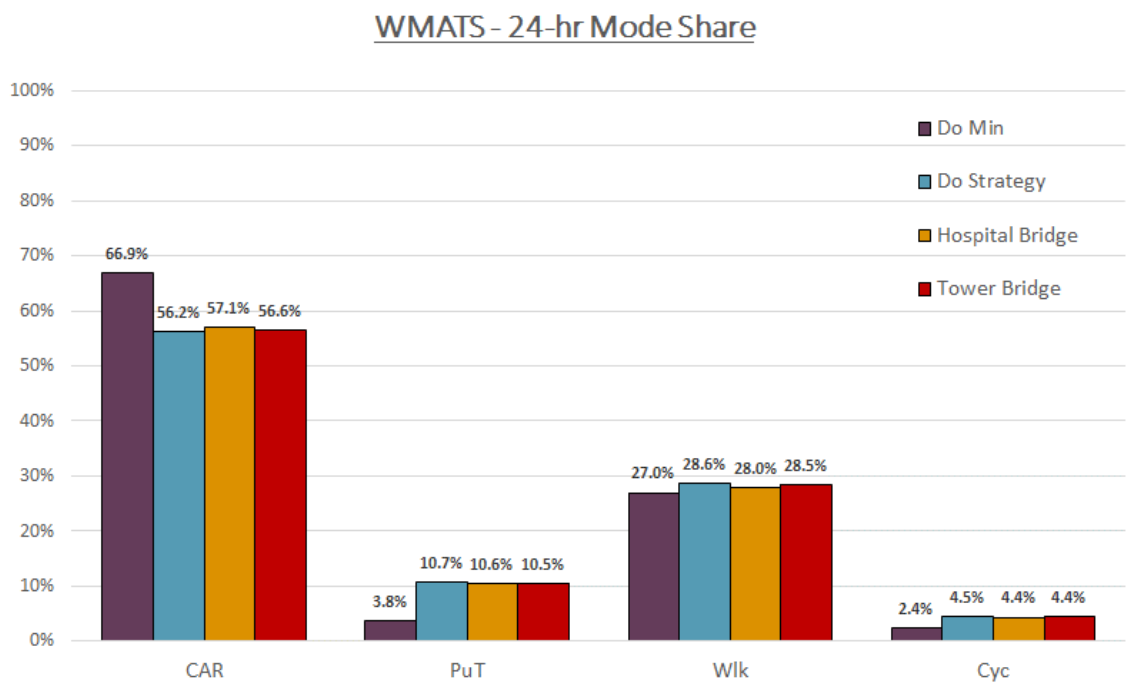


Figure 5.3 Bridge Crossing Mode Share Results

5.3.2 People Crossing the River Suir

Figure 5.4 illustrates the total people movements by car, public transport and active modes (walking and cycling) north and south of the River Suir in the AM peak.

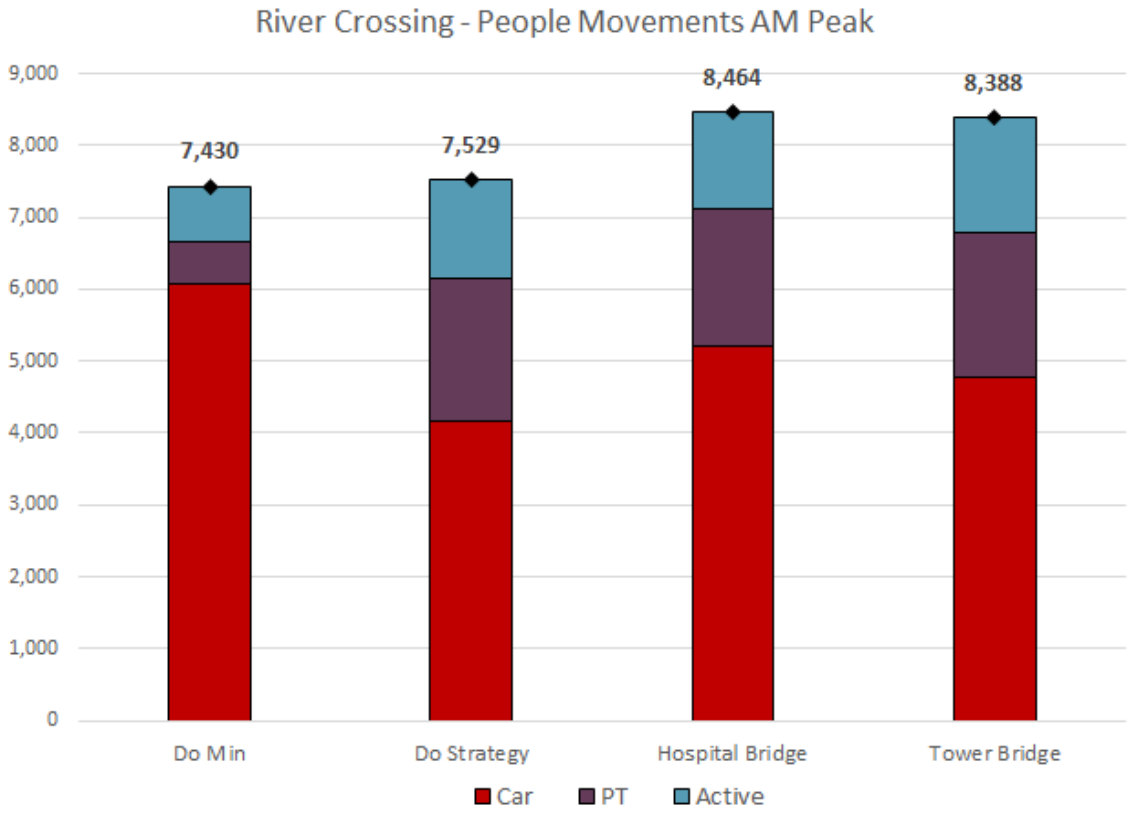


Figure 5.4 River Crossing People Movements AM Peak

The results indicate that the provision of additional bridges will significantly increase people movements across the river. Currently, there are only two options for travel across the River Suir in Waterford – the N25 toll road and Edmund Rice Bridge. The 'Do Strategy' further reduces the road capacity by introducing bus lanes on Rice Bridge, however, the modelling results indicate that overall people movements remain relatively unchanged with more people using public transport and active modes.

The limited crossing options somewhat suppress travel demand north and south of the river, with increased travel times and congestion leading to more local trip making. However, the provision of the additional bridges helps release additional capacity supporting increased people movements. In total, the 'Hospital Bridge' facilitates approx. 8,464 person trips across the river in the AM which is a 12% increase when compared to the 'Do Strategy'. The 'Hospital Bridge' provides an alternative route option which is remote from the core Waterford City Centre area and can accommodate more strategic travel around the city. For example, providing a direct linkage between proposed developments at Kilculliheen with the Hospital, Waterford IT and employment to the southwest of the city. Similarly, it provides an improved connection between residential areas to the southeast of the city with employment at Belview Port. This aligns with the 'Concentric City' objective promoting greater connectivity north and south of the river.

5.3.3 City Centre Traffic Volumes

This criterion focused on the impact of additional bridge infrastructure on traffic volumes within the Waterford City Centre – defined as the area illustrated in Figure 5.5.

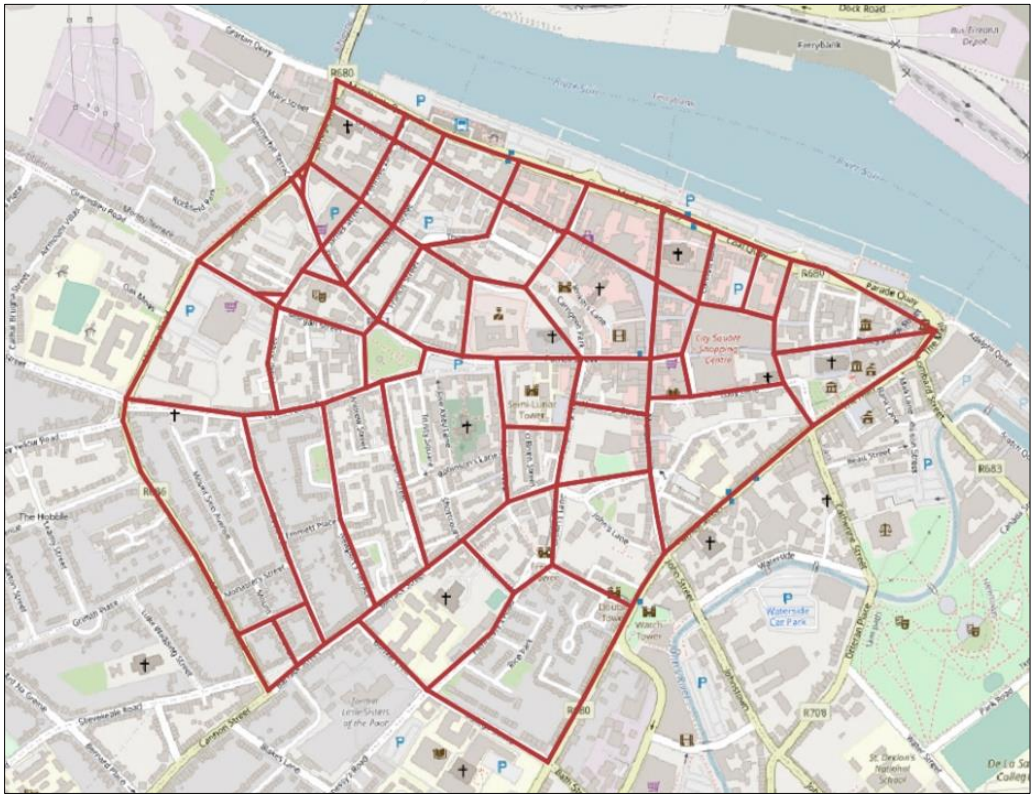


Figure 5.5 Waterford City Centre Analysis Area

Figure 5.6, overleaf, outlines the total traffic flows within the city centre during the AM peak hour across the various modelled scenarios. The modelling results indicate a significant reduction in traffic volumes across all scenarios when compared to the 2040 Do Minimum.

The 'Do Strategy' leads to a 26% reduction in traffic flows, primarily due to the following:

- **Mode Shares**: the 'Do Strategy' measures including improved active modes and public transport networks, along with climate action measures such as parking controls. This leads to a significant reduction in car trips within the Metropolitan Area; and
- **Road Capacity Changes**: measures in the 'Do Strategy' aim to promote sustainable travel. As such, proposals such as bus lanes on Rice Bridge, and the Bus Gate on Merchant's Quay reduce the available road capacity for private cars.

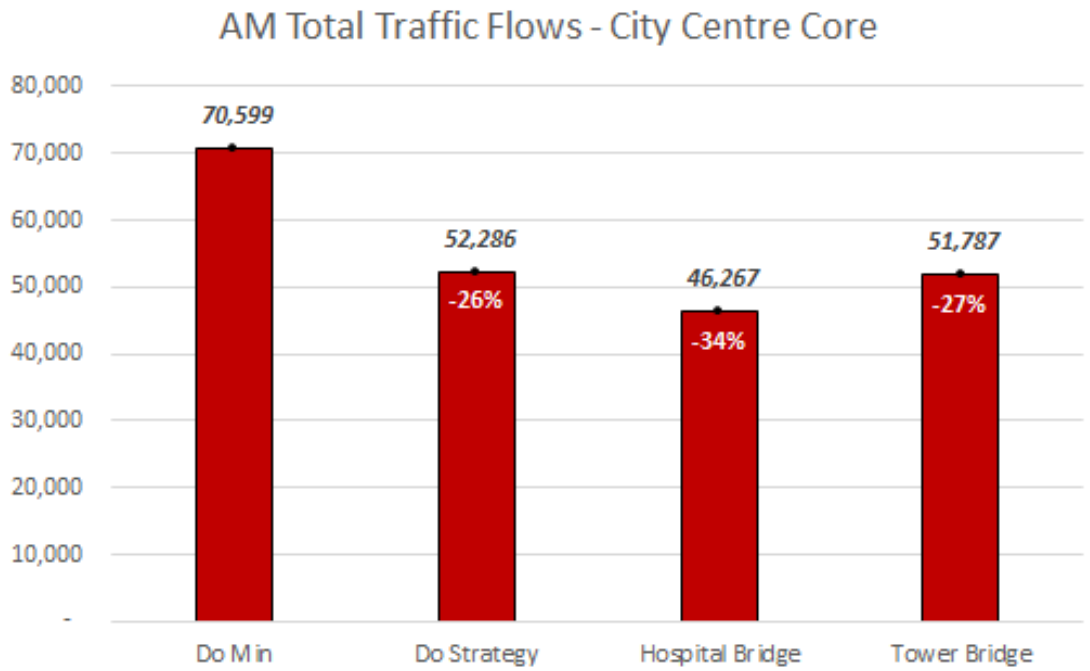


Figure 5.6 City Centre Traffic Flows – AM Peak Hour

The provision of the downstream river crossing at the University Hospital leads to a further decrease in city centre traffic volumes of approx. 12% when compared to the 'Do Strategy'. This provides an alternative route for more strategic traffic not destined for the city centre. As such, this helps to:

- remove unnecessary traffic from Waterford city;
- provides a safer environment for pedestrians and cyclists;
- reduces city centre congestion and vehicle emissions; and
- supports active travel and PT priority measures within the city.

The modelling results suggest that the provision of the bridge at the Tower Hotel will lead to a very minor reduction in core city centre traffic volumes when compared to the 'Do Strategy'. Due to its location (See Figure 5.1), traffic is still required to use congested routes on access to the city core to cross the river. A bridge crossing at this location will not significantly remove unnecessary strategic traffic from the city centre area.

5.3.4 Trip Length Distribution and Network Statistics

Figure 5.7, overleaf, displays the overall AM peak car Trip Length Distribution (TLD) across the bridge option scenarios. In general, the results indicate no substantial change in TLD across the scenarios tested. The provision of the additional bridge crossings does not lead to a significant increase in longer distance car trips. There is likely to be a redistribution across the network, however, this will be balanced. For example, there may be some re-routing to avoid the N25 toll or congested city centre, however, there will also be more direct access between the northeast and southeast/southwest of the city.

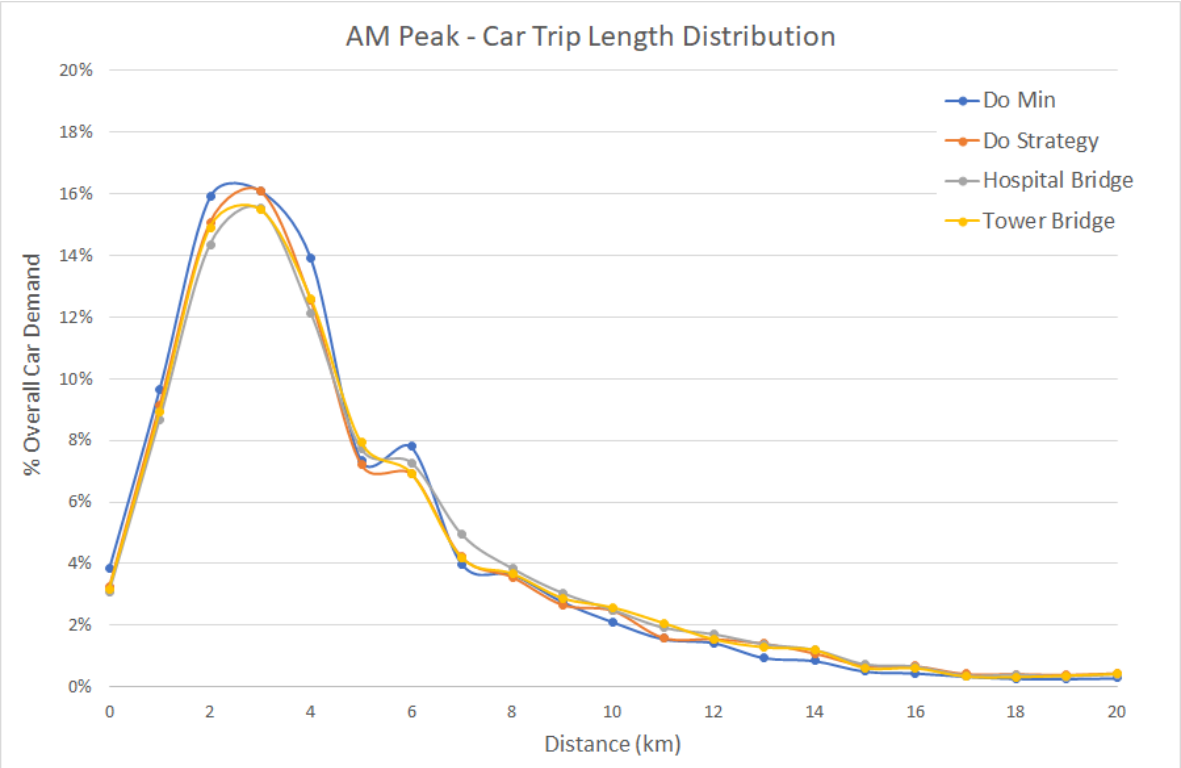


Figure 5.7 Waterford Metropolitan Area Car Trip Length Distribution – AM Peak Hour

Table 5.1 outlines some high level road network statistics derived from the SERM for the Metropolitan Area including average car vehicle km travelled, total queuing on the network and total travel time.

Table 5.1 Road Network Statistics

Scenario	Avg. Car Veh Km	% Change	Total Queuing (pcu.hrs)	% Change	Total Travel Time (pcu.hrs)	% Change
Do Min	6.30		1,602		4,828	
Do Strategy	7.26	15%	1,091	-32%	3,915	-19%
Hospital Bridge	7.31	16%	1,052	-34%	3,944	-18%
Tower Bridge	7.20	14%	1,110	-31%	3,949	-18%

In general, the 'Do Strategy' and bridge option scenarios lead to an average increase in car vehicle km travelled when compared to the Do Minimum. However, this is primarily due to the fact that there is a significant increase in public transport and active travel for shorter distance trips in these scenarios.

The overall reduction in car mode share in the 'Do Strategy' due to the active modes, public transport and climate action measures leads to a substantial decrease in queuing and delay across the road network when compared to the 2040 Do Minimum.

The inclusion of the 'Hospital Bridge' helps to further reduce this delay as it removes unnecessary traffic from the congested links within the city centre, without undermining the sustainable mode

share benefits of the strategy. The 'Tower Bridge' doesn't significantly reduce traffic volumes in the city, and as such, performs similarly to the 'Do Strategy' scenario in terms of queuing, delay and journey times.

5.4 Summary & Conclusions

The previous sections presented the results of modelling undertaken in the SERM for additional bridge crossing options over the River Suir. In summary:

- The analysis indicates a potential rationale for additional bridge infrastructure as a longer term measure in the strategy as:
  - Provision of the additional bridges doesn't undermine the sustainable mode share benefits from walk, cycle, public transport and climate action measures.
  - The proposed bridge crossings increase the overall people movements north and south of the river thus aligning with the concentric city objective in the Waterford City and County Development Plan.
  - The additional bridges don't significantly increase vehicle km travelled for residents within the Metropolitan Area, which would impact on transport emissions.
  - The downstream bridge crossing helps remove strategic through traffic from the city entre core providing a safer environment for pedestrians and cyclists, reducing city centre congestion and emissions, and supporting active travel and PT priority measures within the city.
- Of the two proposals, the bridge at University Hospital Waterford provides the most benefits as:
  - It significantly reduces traffic volumes in the city centre when compared to the Tower Hotel bridge;
  - It performs better in reducing traffic congestion within the study area; and
  - The Tower Hotel bridge doesn't provide many additional benefits to the city centre area as:
    - Buses will still need to route via Merchants Quay and Dock Rd to hit key destinations; and
    - The proposed Sustainable Transport Bridge is in relatively close proximity facilitating pedestrian and cyclist movements.

It should be noted that the location of the downstream bridge crossing is indicative and has been identified at the Hospital for modelling purposes only. The modelling results suggests that the provision of a bridge remote from the city centre will have greater benefits, however, further analysis is required to determine the optimal location.

In the later stages of the Strategy period, following the completion of the substantive public transport elements of the WMATS, the NTA will support the preparation of a study to examine the need and location for an additional river crossing downstream of Rice Bridge.

6 Final Strategy Modelling

6.1 Overview

The previous sections of this report outline the modelling analysis undertaken to determine the optimal package of measures that form the WMATS. The full set of measures are presented in *Waterford Metropolitan Area Transport Strategy* report. In summary it includes:

Walking:

- Upgrades and Improvements to Pedestrian Infrastructure
- Key junction improvements to prioritise pedestrian connectivity and permeability, including reduced wait times at crossings
- Improvement of key radial pedestrian routes to the City Centre
- Measures to improve permeability for pedestrians
- Construction of the Sustainable Transport Bridge connecting the south Quays with the SDZ lands north of the river

Cycling:

- Delivery of a safe, comprehensive and attractive cycle network based on the Cycle Network Plan for Waterford City and Environs which has been aligned with other transport proposals in the WMATS
- Improved cycle parking at key locations

Public Transport:

- BusConnects Waterford network upgrades
- Implementation of bus priority measures including bus lanes, bus gates, bus-only links and traffic signal priority
- Relocation of Plunkett Station to the North Quays SDZ
- Support the recommendations from All Island Strategic Rail Review including the potential twin-tracking and electrification of the Dublin-Waterford rail line

Parking Measures

- Delivery of a Strategic Park and Ride facility in the vicinity of the N25-N9 junction at Granagh
- identify potential sites for Park & Stride/ local Park & Ride on the outskirts of Waterford city and in other settlements in the WMA
- Reduction in the availability of Free Workplace Parking
- Reduction/removal of the heavily discounted daily parking rate in Waterford city
- Reduction/reallocation of parking spaces on the South Quays to facilitate public realm upgrades and redevelopment of the area along the riverfront.

Road and Streets

- Development of a City Centre Traffic Management Strategy
- Junction upgrades to support walking, cycling and bus priority
- Progress and delivery of a Downstream River Crossing
- Progress and delivery of WMA National and Regional Road schemes

Other Supporting Measures

- Mobility Management Measures
- Wayfinding
- Intelligent Traffic Systems
- Cycle & Car Share Schemes
- Improved Public Transport Stops
- Integrated/Smart Ticketing
- Real Time Passenger Information
- Public Realm Enhancements

Sensitivity tests were undertaken on the final strategy for the following scenarios:

- **Cycle Propensity**: testing the impact of a step-change in perception and behavioural attitudes towards cycling associated with significant improvements in cycle infrastructure.
- **Alternative future scenario**: testing the robustness of the strategy measures in a post-COVID scenario with an accelerated transition to remote working and a change in travel behaviour.

6.2 Cycle Propensity

6.2.1 Overview

NTA policy objectives, including those in support of climate change action, are seeking to encourage rapid growth in cycle use through the removal of barriers to cycling.

This is likely to be driven by the availability of cycle facilities (such as cycle hire schemes, cycle parking and shower facilities), infrastructure improvements, and also by changes in behavioural attitudes. Most of the impacts of these drivers of cycle demand are not easily captured in generalised cost changes currently used as inputs to the NTA's Regional Model System (RMS) suite of transport modelling and forecasting tools.

In response to this, the NTA has developed a version of its Regional Modelling System which adjusts behavioural parameters that feed its standard forecasting mechanisms to take account of higher propensity to cycle among the general population. These adjustments are based on extensive research[8], that concluded there is significant potential to increase cycle mode shares by:

- Increasing female cycle share to match that of male (through appropriate policies focussing on cycle safety and security, amongst others);
- Increasing urban cycling rates amongst under-20s and over 40s to be closer to those of 20-39 year olds (especially primary students, again through dedicated cycleway provision, safety and security measures as well as attitudinal campaigns);
- Increasing use of cycle by part-time workers;
- Promoting cycle use for trips where a car is available;
- Increasing cycle use in lower income bands (possibly through purchase schemes, increased cycle hire provision and promotional campaigns); and
- Facilitating household cycle availability through purchase schemes, cycle parking and storage provision and promotional campaigns.

[8] For further information see NTA report 20210820_NTA_CyclingModelling_v6.1_issue.docx

6.2.2 Model Results

The overall 24-hour mode share results for the Waterford Metropolitan Area are presented in Figure 6.1 for the 2040 Do Minimum, Do Strategy and Do Strategy with a higher propensity to cycle scenarios.

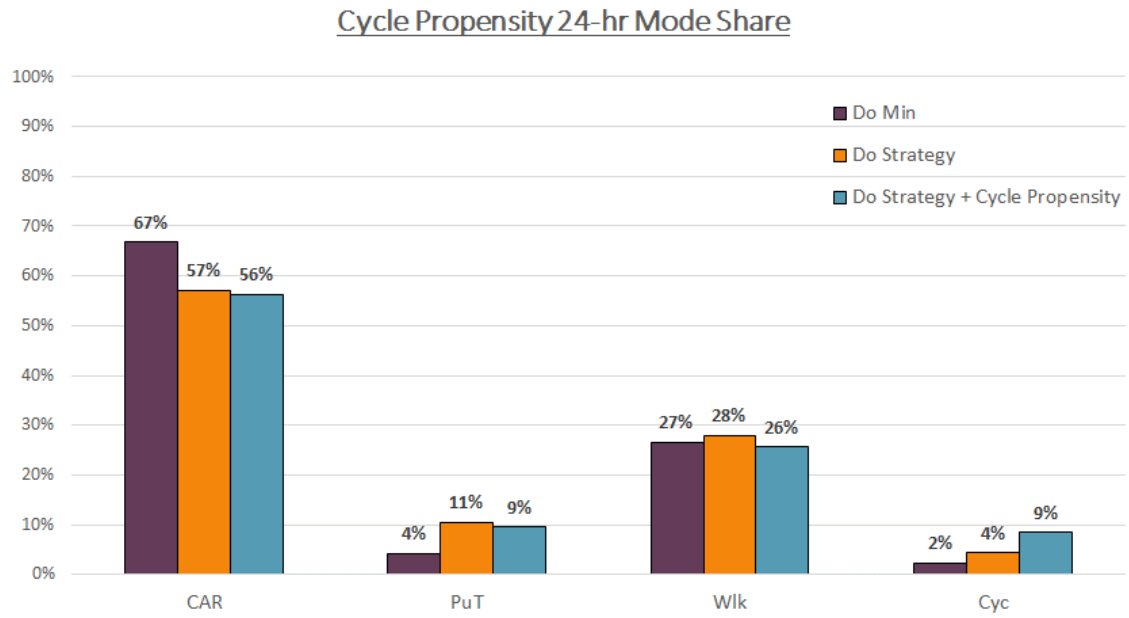


Figure 6.1 Cycle Propensity Testing – 24 hour Mode Share

The results indicate a significant increase in cycle mode share in the 'Cycle Propensity' scenario representing 9% of all trips undertaken. This results in an additional 11,000 cycle trips across the day when compared to the standard Do Strategy scenario – an almost doubling in cycle usage. This increase in cycle usage is drawn from all other modes with an associated reduction in demand across car, public transport and walking.

The increase in cycle mode share is reflective of the proposed investment in cycling outlined in WMATS with significant improvements in cycle safety, infrastructure, segregated cycle routes, cycle parking etc. It is also the intention of the strategy to encourage behavioural change with respect to cycling with promotional events and marketing campaigns such as:

- Smarter Travel Workplaces and Campuses;
- Bicycle Sharing Schemes;
- School Cycle Bus;
- Green Schools Travel Module;
- Regular 'Dr Bike' maintenance;
- One-off events such as Car-Free Day, EU Mobility Week, Cyclovia and other conferences such as POLIS and Velo-city; and
- Cycle training provided in schools, workplaces and community centres

Therefore, the 9% all-day cycle mode share represents a minimum objective target for WMATS to support the proposed investment in cycling infrastructure and encourage active travel.

6.3 Alternative Future Scenario

6.3.1 Overview

The results of the modelling scenarios presented in this report thus far have been based on a 'Business as Usual' (BAU) demand, which reflects travel behaviours observed in 2016 (Pre-pandemic).

In order to account for uncertainty in future transport demand, for example the impact of behavioural change (as evidenced through the Pandemic where more people may decide to work from home), an Alternative Future demand scenario was tested with the Do Minimum scenario and Final Emerging Strategy.

To achieve this the trips rates were adjusted according to the NTA research paper titled 'Alternative Futures'[9].

6.3.2 Results

The results of the Alternative Future (AltF) sensitivity tests on mode shares are presented below in Figure 6.2 and Figure 6.3.

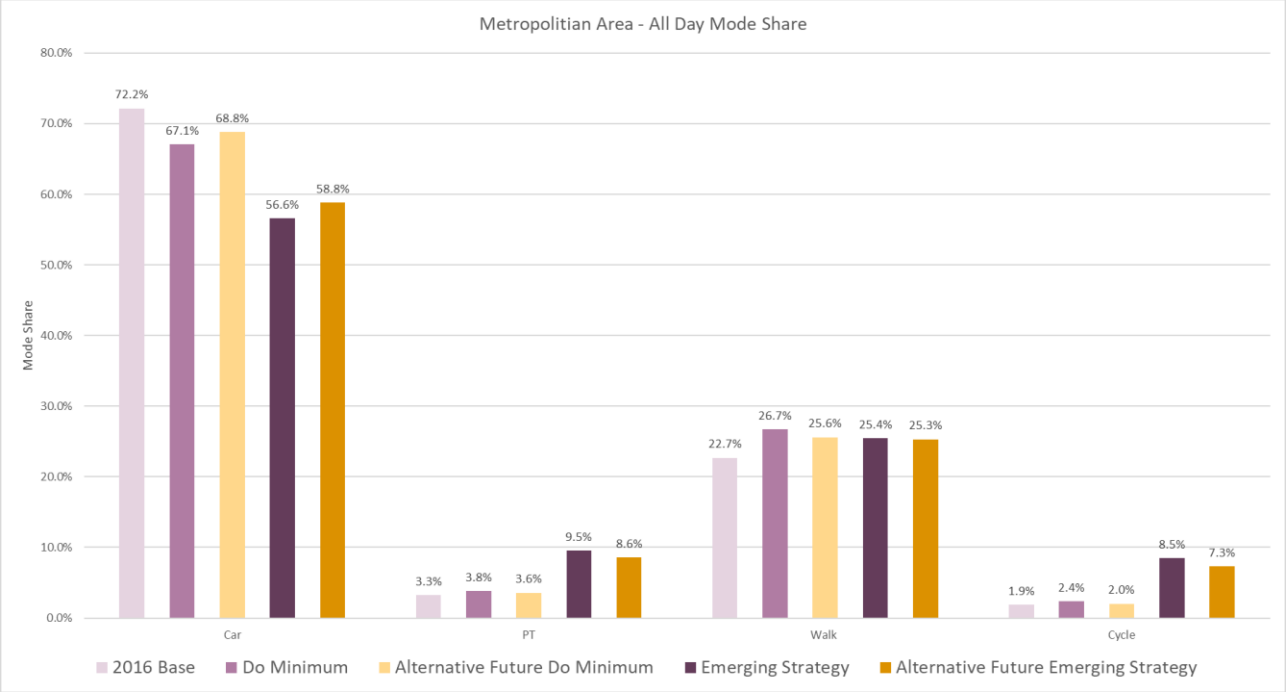


Figure 6.2 **Alternative Future Sensitivity Test Origin Mode Shares**

[9] https://www.nationaltransport.ie/wp-content/uploads/2021/03/Alternative-Scenario-Development-Note-v-6.1_Final.pdf

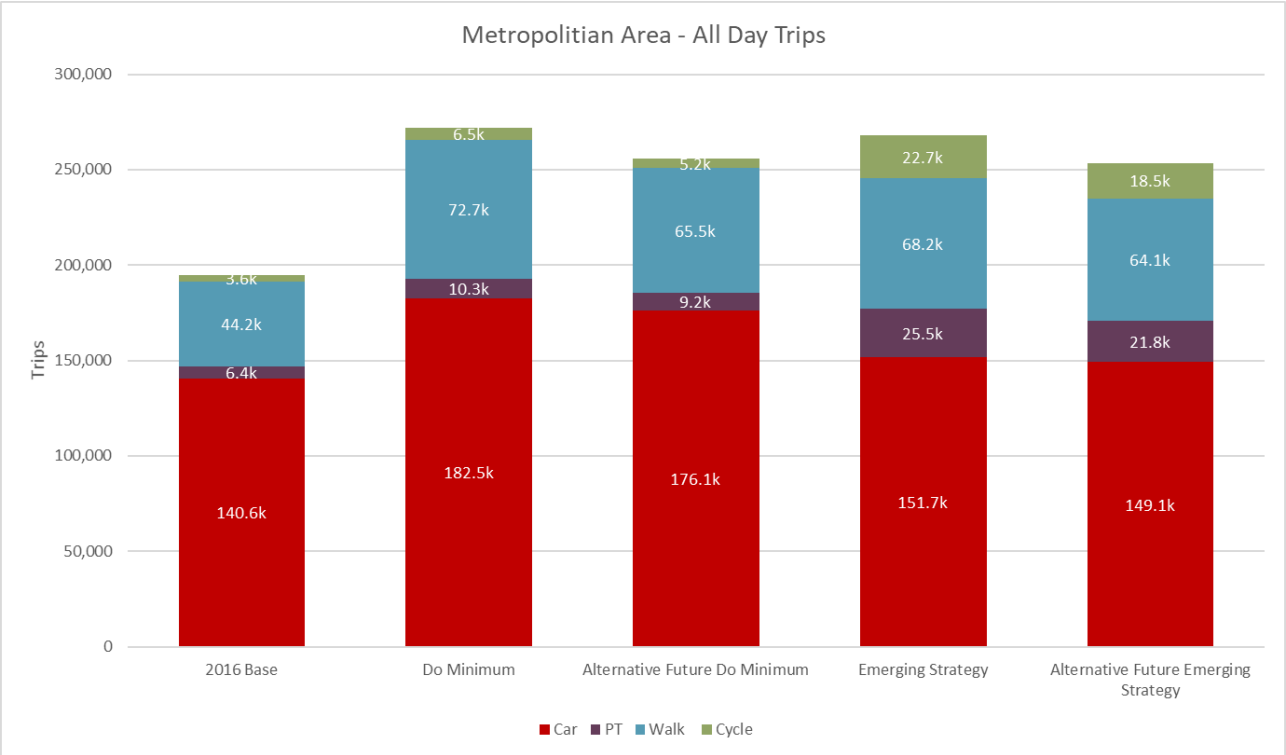


Figure 6.3 **Alternative Future Sensitivity Test Origin Trips**

The Emerging Strategy results in less of an increase in sustainable mode shares in the AltF scenario than the BAU scenario when compared against the 2016 base. Notwithstanding this, it still represents a considerable increase in travel by sustainable modes.

The reasons for the lower increase in sustainable mode trips in the AltF scenario is that the overall demand for travel in the AltF scenario is lower than the BAU scenario. The AltF Do minimum scenario has approximately 16,000 less trips than the BAU Do Minimum for the WMA. This lower rate of trips reduces the overall demand for vehicular travel, which in turn lowers delays across the road network thereby making car a more attractive mode.

While the AltF test results do not provide the same level of shift from car to sustainable modes it should be noted that substantial gains have still been made towards reduced car mode share and onto PT and active modes, and that overall car trip rates are substantially lower across the WMA.

Whilst the AltF scenario does result in a reduction in PT demand when compared to the BAU scenario, the proposed bus prioritised network with targeted rail enhancements remains an appropriate strategy to support the sustainable growth of Waterford in either forecast year scenario.

7 Final WMA Transport Strategy Appraisal

7.1 Introduction

This section of the report outlines the appraisal methodology and appraisal criteria that have been used to determine the performance of the WMATS strategy measures. The results of the evaluation are presented for the Base Scenario, the Do-Minimum Scenario and Do-Strategy for each criterion identified.

7.2 Strategy Appraisal Methodology

7.2.1 Methodology

The procedure for the assessment of WMATS is guided by the 'Common Appraisal Framework (CAF) for Transport Projects and Programmes, March 2016' published by the Department of Transport, Tourism and Sport (DTTAS), which requires schemes to be appraised under the objective headings below:

- Safety;
- Physical Activity;
- Environment;
- Integration;
- Accessibility and Social Inclusion; and
- Economy.

It should be noted that a more detailed appraisal of the individual public transport schemes identified within WMATS will be required at a later stage in the planning process for each scheme. The WMATS has been assessed under the 6 CAF criteria with the Key Performance Indicators (KPIs) and method of measurement for each KPI displayed in Table 7.1**Error! Reference source not found.**.

Table 7.1: WMATS CAF Criteria and KPIs

CAF Criteria	KPI	Measure
Safety	Safety improvements as a result of the Strategy implementation	Monetised benefits as output from COBALT software within the NTA Safety Appraisal Tool
Physical Activity (Health)	Health Benefits	Monetised Health benefits calculated using the NTA Health Appraisal Tool
Environment	Change in Transport Emissions related to the Strategy implementation	Transport emissions from the ENEVAL Appraisal Tool
Integration	Public Transport Integration	Number of public transport interchange trips
	Transport Policy Integration	Average Mode Shift to Public Transport
Accessibility and Social Inclusion	Accessibility to Key Attractors	Trips to Key Attractors (schools, hospitals etc.) by Public Transport
	Accessibility by PT from Socially Deprived Areas	Trips by Public Transport from Socially Deprived Areas
Economy	Improve access to employment opportunities	Population living within commuting distance of Waterford by public Transport
	Change in sustainable travel for business /commute trips	Mode shift for business /commute trips

In addition to the CAF assessment the transport modelling results have been analysed further to examine the difference in performance compared to the Do-Minimum scenario. This additional analysis is undertaken on selective model outputs and used to better understand the impact of the WMATS measures. The following additional indicators were assessed using SERM outputs:

- Demand and Mode Share Analysis;
- Public Transport Network Operations;
- Active Mode Network Operations; and
- Road Network Operations.

7.3 Safety

7.3.1 Road Safety

The Safety Appraisal Module within the RMS Appraisal toolkit was used to assess the Safety benefits associated with the WMATS measures. The Safety Appraisal Module process is based on a bespoke version of the COBALT spreadsheet. The bespoke version of the COBALT Ireland spreadsheet has been developed by Transport Infrastructure Ireland (TII) for use with the regional transport models. COBALT (Cost and Benefit to Accidents – Light Touch) is a computer program developed by the UK

Department of Transport (DfT) to undertake the analysis of the impact on accidents as part of economic appraisal for a road scheme.

Table 7.2 below displays the Safety Appraisal results across a 30 year appraisal period comparing the Do-Minimum and the Do-Strategy scenarios.

Table 7.2: WMATS Safety Appraisal Results

Item	Do-Minimum (DM)	Do-Strategy	Savings (DS vs DM)
Economic Summary	€554,031,400	€549,742,900	€4,288,500
Total Accidents	17,000.1	16,786.8	213.3
Fatal Injuries (Person)	300.8	300.2	0.6
Serious Injuries (Person)	1,034.2	1,024.5	9.7
Slight Injuries (Person)	23,772.8	23,488.7	284.1

In the table above accidents refer to the incident, while the total rate of injury and fatalities are higher than total accidents accounting for involvement of multiple cars and car occupancy.

As shown in the table above, the WMATS strategy measures result in minor savings (approx. €4.3m) in collision costs. There are also reductions in the levels of casualties on the road network, with the reductions of approximately 1 fatal, 10 serious and 284 slight casualties.

7.4 Physical Activity (Health Appraisal)

An increase in walking and cycling can bring about significant benefits for our health and environment. The consideration of health benefits arising from transport is an integral part of the appraisal process adopted to inform transport policy and investment decisions.

Transport related changes to the following factors can have health impacts and have been assessed for WMATS:

- Physical activity – increased levels of activity can positively impact on reducing the risk of death and occurrence diseases such as heart, diabetes and cancer related illnesses; and
- Absenteeism – this is expected to decrease when more people walk or cycle. Moderate physical activity can lead to a reduction in the number of sick days and a healthier workforce can, in turn, provide benefit to employers and overall economy;

7.4.1 Physical Activity Benefits

The health benefits associated with physical activity are derived from a reduction in the relative risk of premature death - the 'Relative Risk of Mortality' is directly linked to the time spent walking and cycling based on the average length, speed and frequency of new trips encouraged by active travel modes. This indicator provides a calculation of the lives saved due to the health benefits of cycling

and walking. The benefits include walking trips associated with Public Transport (e.g. walking to bus stop).

These benefits also include absenteeism benefits which are derived from the assumption that less time will be lost in sick days because of the resultant increase in health associated with physical activity.

Table 9-3 shows the monetised benefits of the change in walking and cycling based on the relative difference between the Do-Minimum and Do-Strategy scenario. The results of the assessment show moderate positive benefits in the Do Strategy scenario with more significant benefits in the Do-Strategy Plus scenario.

This is as a result of the more significant shift in sustainable mode share as a result of the decrease in car mode share. Whilst there is mode shift in the Do-Strategy scenario it is more modest and results in less physical activity.

Table 7.3: WMATS Monetised Physical Activity Health Benefits

Net Impact per annum (€)		Do Strategy
Physical Activity	Cyclists	€1,282,394
	Walkers	€382,010
Absenteeism		€ 1,494,017
Total		**€ 3,158,420**

It should be noted that the attractiveness of walking and cycling is not fully represented within the SERM and mode choice is based predominantly on perceived cost of travel. In reality, many people may choose to walk or cycle for the health benefits regardless of perceived journey costs particularly given the proposed improvements in the walking and cycling network.

7.5 Environment

7.5.1 Emissions

In both the Do-Minimum and Do-Strategy Scenarios it has been assumed that the composition of the fleet will change in line with government policy on Climate Action, with the vast majority of the car fleet assumed to be electric by 2040, given the ban of the sale of diesel and petrol by 2030. Table 9-4 shows the estimated fleet composition for cars, LGV's and HGV's by 2040. As a result, the change in carbon emissions from 2016-2040 is primarily as a result of the widespread adoption of electric vehicles (EV) with an 84% reduction expected in private car CO_2 emissions. The change in EV uptake is assumed to happen with or without the strategy in place. However, the measures within the strategy relating to EV and EV charging will likely have an impact on the success of the adoption of EV within WMA and the wider region.

Table 7.4 Fleet Profile for 2040

	Petrol	Diesel	Hybrid	Zero
Car	6.7%	2.2%	9.1%	81.9%
LGV	0.0%	33.6%	0.0%	66.4%
HGV	0.0%	71.0%	0.0%	29.0%

The percentage change in transport emissions arising from the transport strategy has been estimated from modelling outputs using the Environmental module of the RMS appraisal toolkit. The toolkit estimates emission levels for the following emission categories:

- Nitrogen Oxides;
- Particulate Emissions;
- Carbon Monoxide
- Carbon Dioxide;
- Benzene;
- Methane; and
- Butadiene.

Table 7.5 below provides a summary of the annual air quality emissions levels for the 2016 Base and Do-Strategy 2040 in tons. With WMA measures in place in 2040 there is an 83% and 13% reduction in key air quality emissions of Nitrogen Oxides (NO_x) and Particulate Matter (PM) respectively. The reduction of PM is less than that of NO_x due to tyre and brake abrasion which remains a source of pollution with zero emission vehicles.

Table 7.6 below show that a 58% reduction in CO_2, and 76% reduction in Methane can be achieved between 2016 and 2040 with the strategy in place. It should be noted that this accounts for the proposed 57% increase in population and 43% increase in employment, forecast for the Waterford Metropolitan area over this period.

Table 7.5: WMATS Environmental Air Quality Emissions Summary

Emissions (Tons)	Nitrogen Oxides	Particulate Matter	Carbon Monoxide	Benzene	Butadiene 1,3
2016 Base	245.92	18.19	152.29	0.24	0.15
2040 Do-Strategy	41.39	15.80	36.28	0.02	0.03
% Difference	-83%	-13%	-76%	-91%	-83%

Table 7.6: WMATS Environmental Green House Gas Emissions Summary

Emissions (Tons)	Carbon Dioxide	Methane
2016 Base	88,139.02	1,105.15
2040 Do-Strategy	36,585.22	270.45
% Difference	-58%	-76%

7.6 Accessibility and Social Inclusion

The SERM model has been used to assess the Accessibility and Social Inclusion benefits associated with the implementation of WMATS.

Transport investment, by its nature, has a particularly strong role to play in respect of improving accessibility for people living in rural areas with poor access, people who suffer from mobility and sensory deprivation, connecting young people, particularly those who live in disadvantaged areas, to services, education and work opportunities.

To quantify this, public transport accessibility changes have been extracted from the SERM for the Do-Minimum and Do-Strategy scenarios and are discussed further below.

7.6.1 Accessibility by Public Transport to Key Attractors

The change in public transport mode share to key trip attractors across the WMA, has been used to assess accessibility. A summary of the AM Trips to Key Attractors undertaken by public transport for the Do-Minimum and Do-Strategy is presented in Table 7.7 below.

Table 7.7 PT Demand to Key Attractors

Key Attractor	Do-Minimum	Do-Strategy
City Centre	5.7%	11.2%
University Hospital	2.9%	7.8%
Waterford IT	7.0%	19.4%
IDA Business Park	1.1%	5.4%
Belview Port	1.6%	4.8%
Waterford Retail Park	1.0%	6.0%
Kingsmeadow	3.6%	7.4%

The results of the assessment show substantial improvements in public transport mode share for trips to the key attractors outlined above. Overall, the morning peak public transport mode share increases from 4.3% to 11.5% across the metropolitan area in the Do-Strategy Scenario.

7.6.2 Public Transport Accessibility to Socially Deprived Areas

The social inclusiveness of the transport networks provided in each scenario has been measured by assessing the change in public transport mode share for trips from socially deprived areas across the Waterford Metropolitan Area. Areas across the WMA have been classified based on the POBAL Deprivation Index[10]. The index provides a method of measuring the relative affluence or disadvantage of a particular geographical area using data compiled from various censuses.

Table 7.8 below represents the Average All Day PT mode shift between the Do-Minimum and Do-Strategy scenarios disaggregated by social category areas across the WMA.

[10] Haase, T. and Pratschke, J. (2017) The 2016 Pobal HP Deprivation Index, provide by the NTA under their agreement.

Table 7.8 Average All Day PT mode shift between the Do-Minimum and Do-Strategy by area type

Min	Max	Description	Counts	Change in PT Mode Share DS - DM
-30	-20	very disadvantaged	33	3.6%
-20	-10	disadvantaged	58	4.5%
-10	0	marginally below average	103	3.4%
0	10	marginally above average	85	3.8%
10	20	affluent	17	3.4%
20	30	very affluent	2	3.3%
-30	30	**Average of CSAs in WMA**	**298**	**3.7%**

The results of the assessment show that the overall All Day PT mode share changes on average by 3.7% in the WMA Do-Strategy compared to the Do Minimum. The highest PT mode shift is in areas considered 'disadvantaged' with a 4.5% increase in mode share.

7.7 Integration

WMATS aims to support integration between Sustainable Transport and Land Use. In order to assess the integration performance of WMATS, the percentage change in the modelled sustainable mode share was calculated for each scenario to assess the compatibility with national Smarter Travel policies. In addition, the level of interchange between public transport modes was measured for the Do-Minimum and Do-Strategy scenarios to assess how well the WMATS proposals integrate with one another.

7.7.1 Policy Integration

The percentage change in the modelled sustainable mode share was calculated for each scenario to assess the compatibility with Sustainable Mobility policy, which aims to prioritise sustainable modes.

Table 7.9 below shows the public transport mode share for the Do-Minimum and Do-Strategy scenarios for both the AM peak hour and over a full day for the WMA. The results show substantial improvement in PT mode share between the two scenarios.

Table 7.9 AM PT mode shift between the Do-Minimum and Do-Strategy- Metropolitan Area

	Do-Minimum	Do-Strategy
AM PT Mode Share	4.3%	11.5%
24hr PT Mode Share	3.8%	9.5%

The PT mode shares for Waterford City and Suburbs are also shown below in Table 7.10 and show a slightly greater increase in PT demand proportionally across the full day.

Table 7.10 Average AM PT mode shift between the Do-Minimum and Do-Strategy- City & Suburbs

	Do-Minimum	Do-Strategy
AM PT Mode Share	4.0%	11.0%
24hr PT Mode Share	3.8%	9.7%

7.8 Economy

7.8.1 Accessibility to employment centres by Public Transport

Efficient and reliable public transport plays a major role in supporting a city's economy, providing access to employment and encouraging spend in local businesses. The bus network enhancements proposed under WMATS seek to deliver a step change in public transport provision, providing existing and future residents with efficient access to employment opportunities across the city and wider region.

Table 7.11 below shows the WMA population residing within a 30-minute catchment of major employment centres by public transport in the AM period. The City Centre, University Hospital and Waterford IDA Business and Technology Park were selected due to their high levels of employment and importance in the local economy.

For this assessment the 30-minute journey time includes vehicle travel time, time to walk to and from public transport access points and an average wait time for each service. This provides a total door to door journey time including time spent waiting on services.

Table 7.11 WMA population within 30 mins AM commute by Public Transport

	City Centre	University Hospital	IDA Business and Technology Park
Do Minimum	35.8%	32.4%	8.5%
Strategy	94.7%	89.3%	91.5%

With the strategy in place, the City Centre falls within a 30-minute public transport commute for 95% of the WMA population and within a 20-minute public transport commute for 68% of the WMA population. This represents an increase from 36% and 6% respectively in the Do Minimum scenario. The average reduction in commute times for public transport trips to the City Centre with the strategy in place is 19 minutes.

For the University hospital 89% of the WMA population falls within a 30-minute commute. This compares to only 32% without the strategy in place. The average reduction in commute time for public transport trips to University Hospital with the strategy in place is 15 minutes.

In the Do Minimum scenario the IDA Business and Technology Park perform particularly poorly for public transport service with only 8.5% of the WMA within a 30-minute catchment. This is a result of infrequent services which contribute to long wait times pushing up overall commute times to the site. With the strategy in place, the provision of more frequent services significantly reduces wait times and results in 92% of the WMA residing within 30 minutes PT catchment of the business park.

Figure 7.1 to Figure 7.6 below show the change in PT commute catchments for each of the three sites. The figures demonstrate that the strategy will result in substantial improvements in public transport accessibility levels across the metropolitan area.

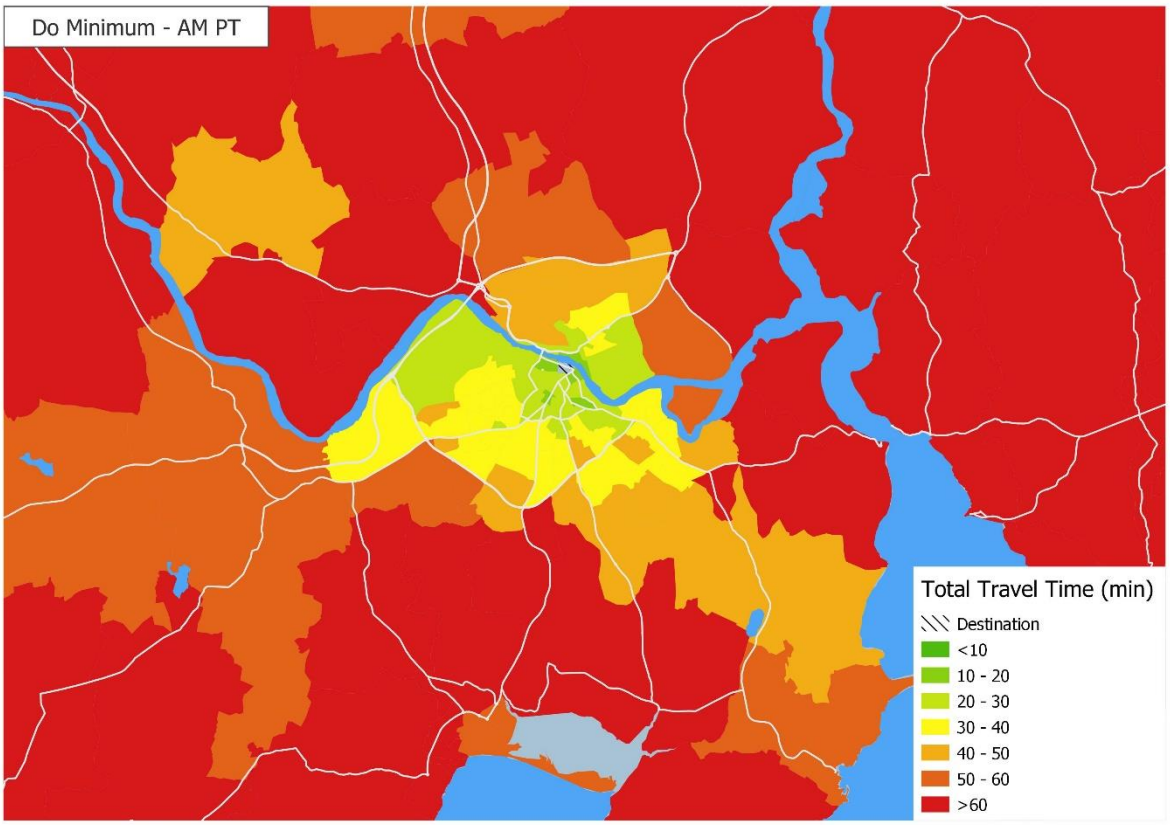


Figure 7.1 Do Minimum AM PT commute times to City Centre

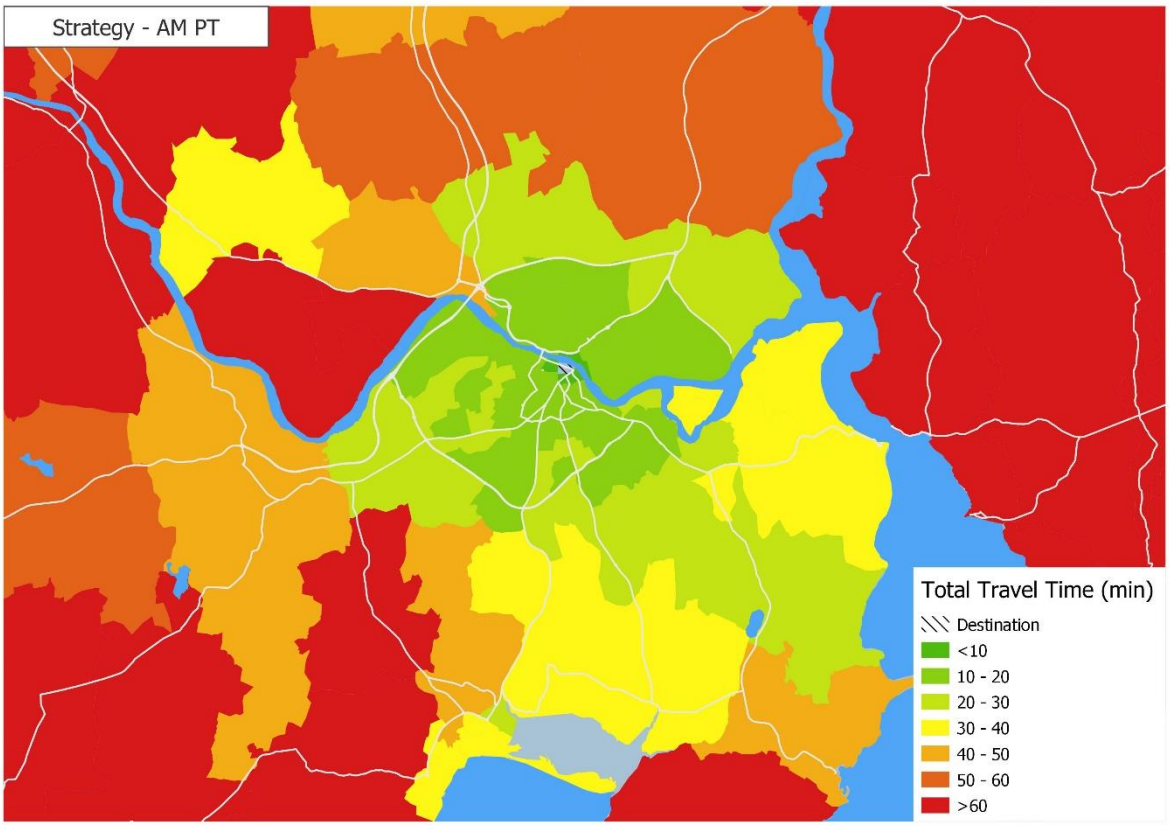


Figure 7.2 Strategy AM PT commute times to City Centre

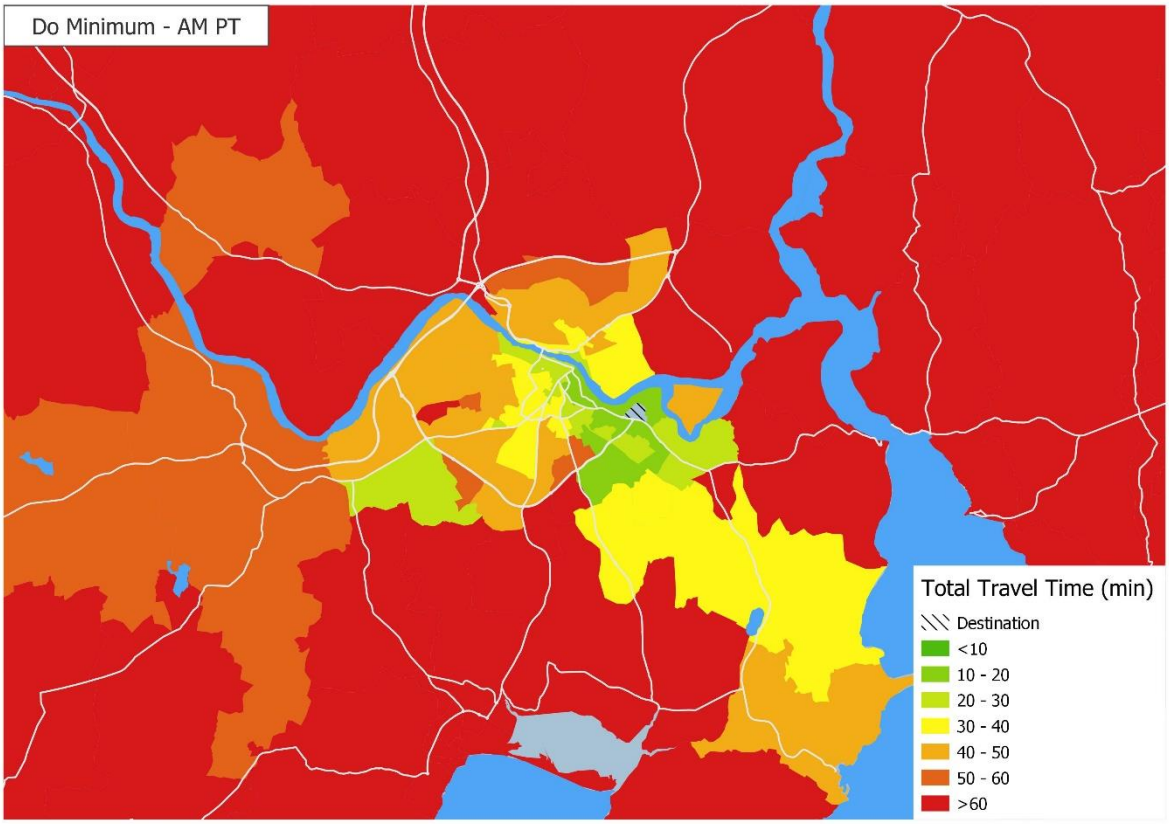


Figure 7.3 Do Minimum AM PT commute times to University Hospital

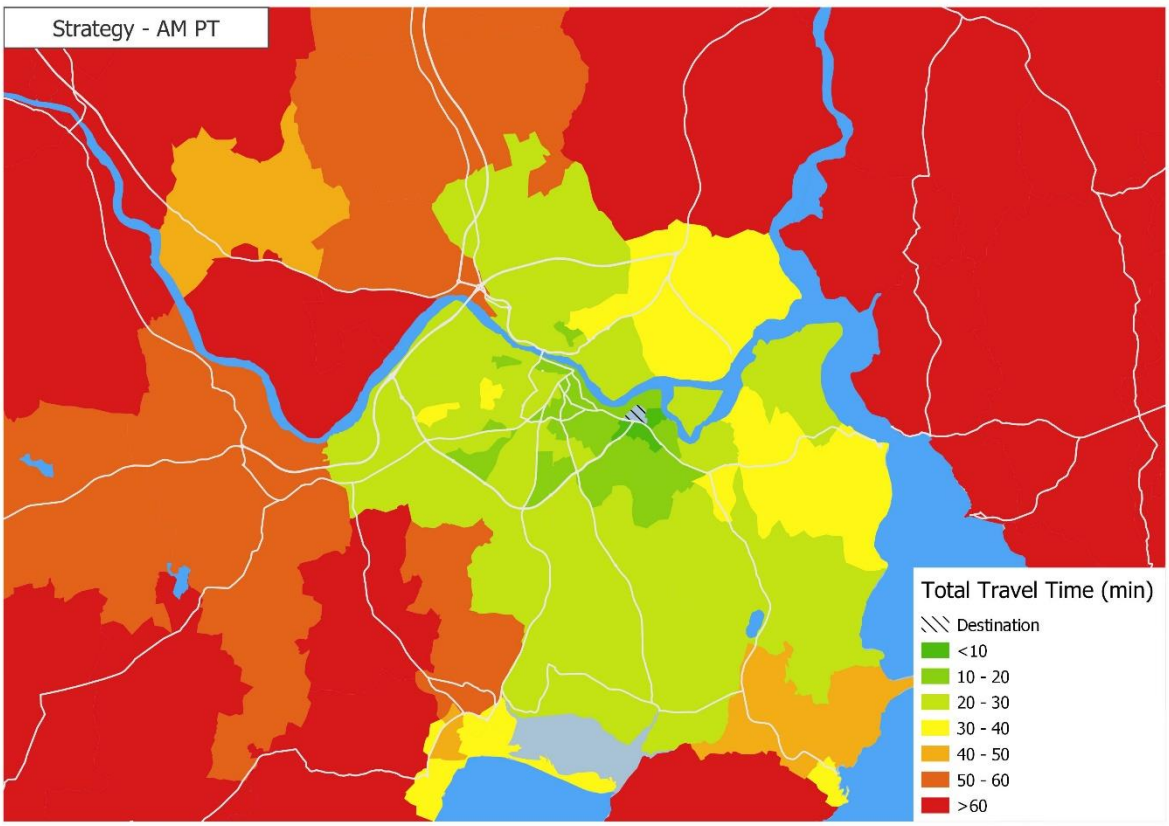


Figure 7.4 Strategy AM PT commute times to University Hospital

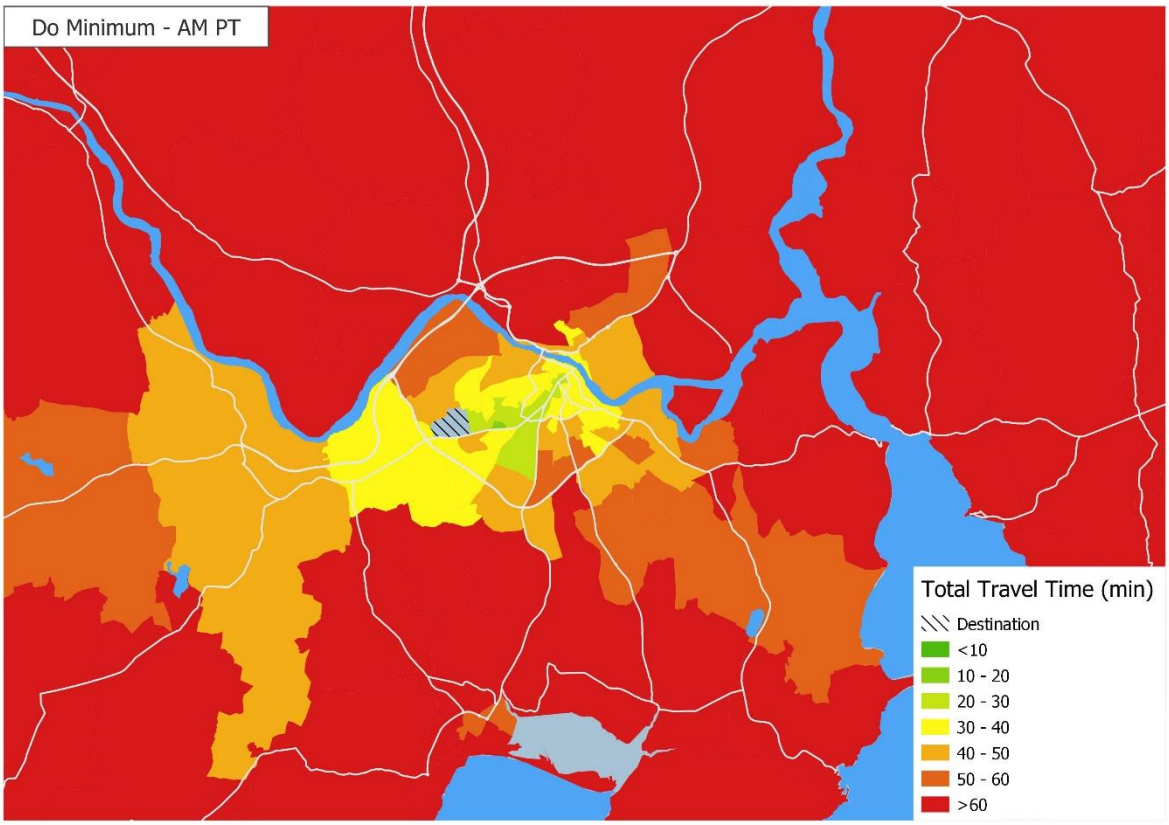


Figure 7.5 Do Minimum AM PT commute times to IDA Business and Technology Park

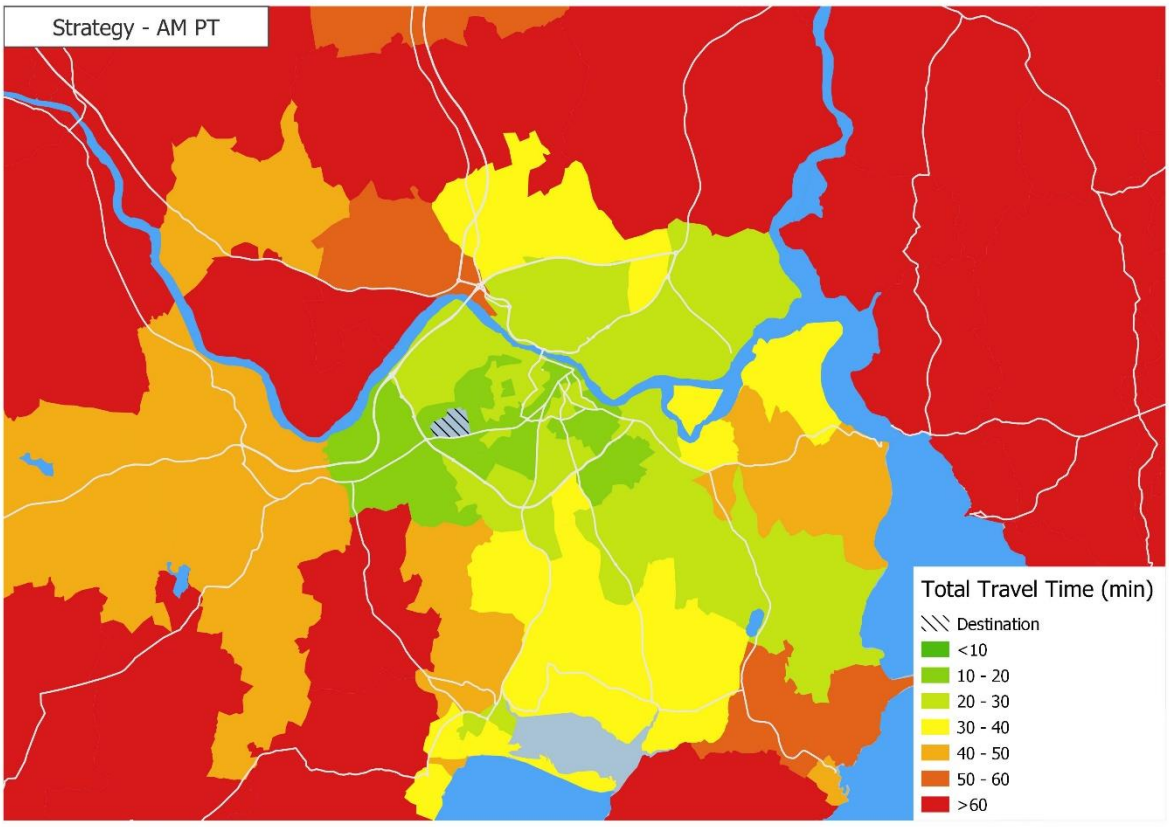


Figure 7.6 Strategy AM PT commute times to IDA Business and Technology Park

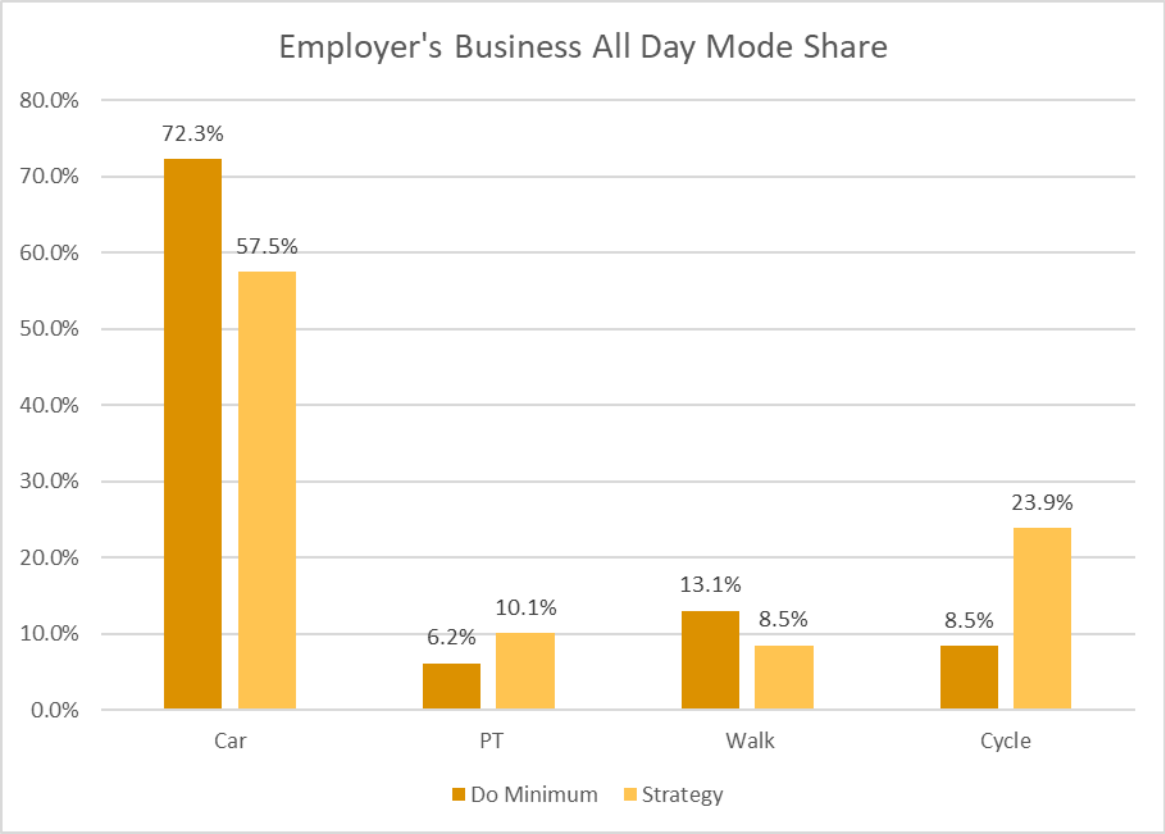
7.8.2 Sustainable Mode Shares

The Transport Strategy is forecast to facilitate a greater level of business travel, and a much greater amount of this travel will be undertaken by sustainable transport. Table 7.12 below presents the sustainable mode shares for employer's business trips and commute to work trips.

Table 7.12 Sustainable Mode share for Employer's Business and Commute

	Do-Minimum	Do-Strategy
Employers Business	27.7%	42.5%
Commute	22.6%	43.8%

These are presented in more detail in Figure 7.7 below which shows the mode share for employer's business trips within the WMA.



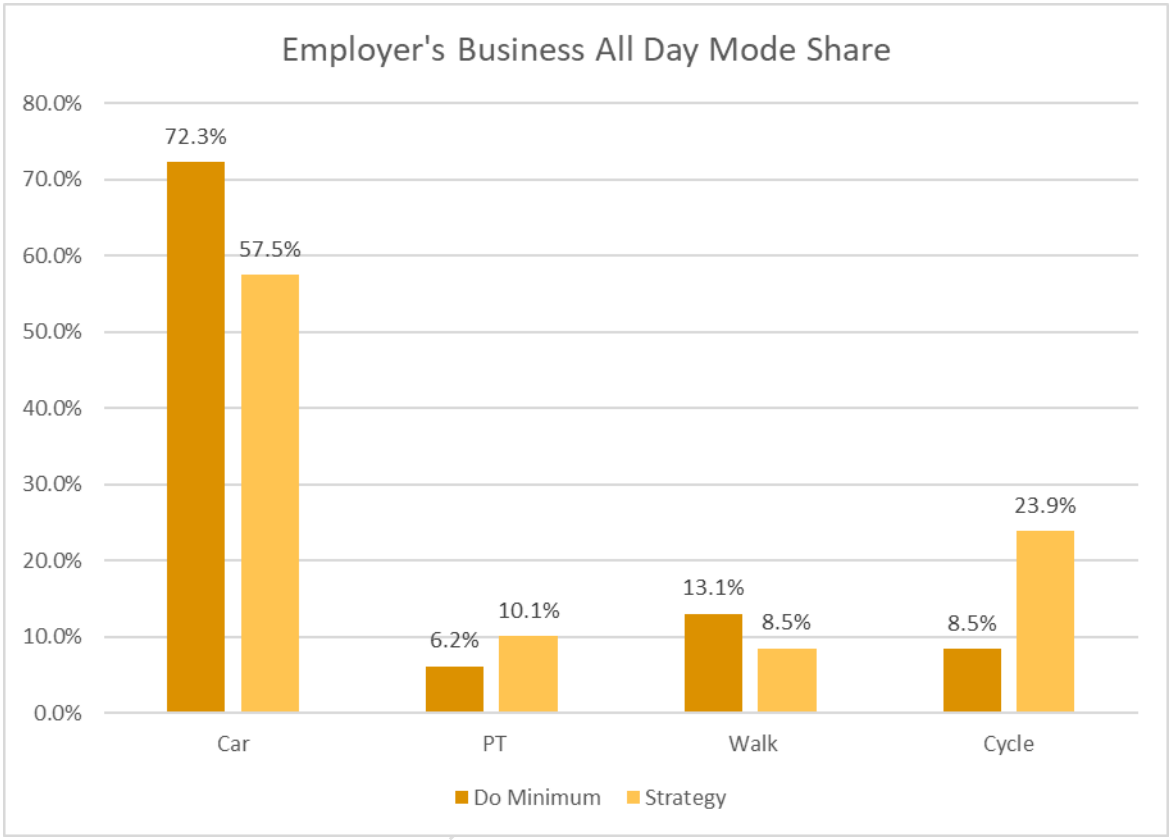


Figure 7.7 Employer's Business all day mode share

As can be seen from the figure above there is a substantial drop in car mode share amongst business trips with over 10% of business trips being undertaken by public transport. While there is a reduction in walk trips amongst business users, these trips are primarily transferring to cycle as a result of the proposed investment in cycle infrastructure in the city.

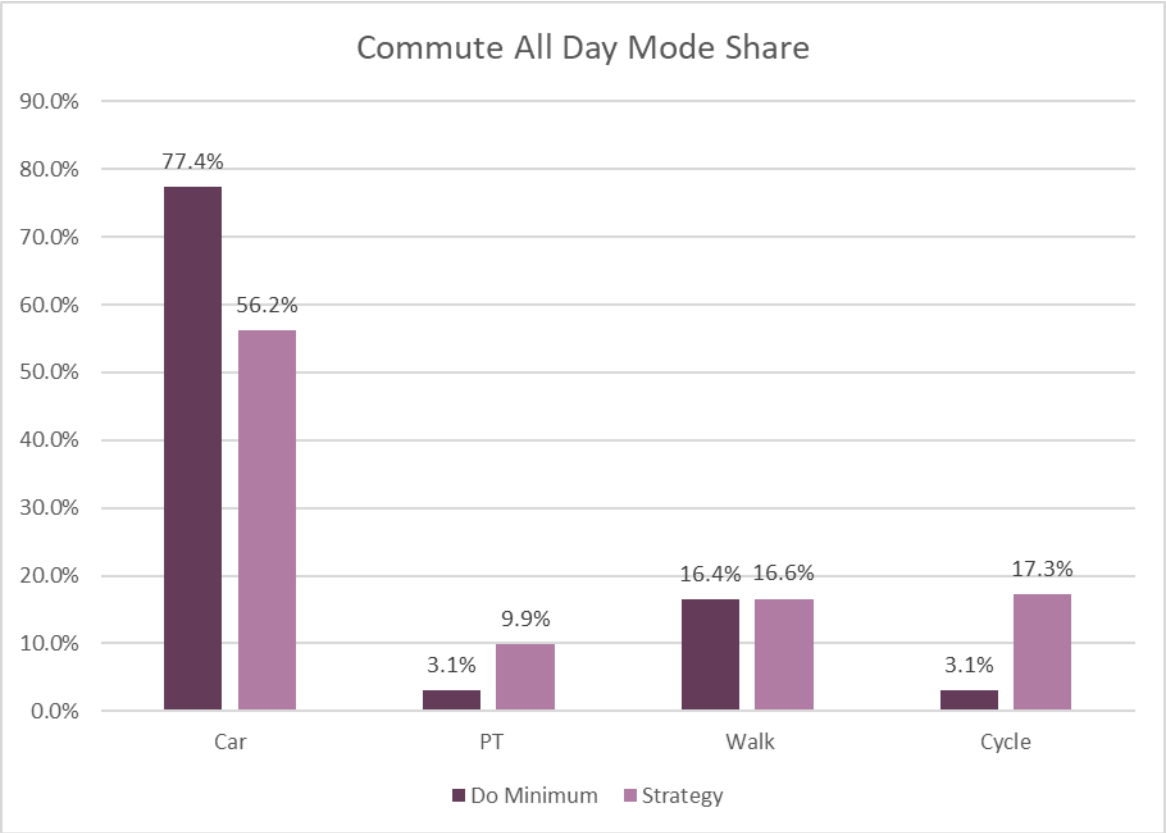


Figure 7.8 **Commute All Day mode share**

Figure 7.8 shows that there is also a substantial drop in car mode share amongst commuters. Unlike Employer's business however there is little change in the walk mode share, but still a substantial increase in the cycle mode share. This indicates that commuters, who currently take short car journeys to work, will transfer to cycling with the planned investment in cycle infrastructure in place.

Figure 7.9 presents the overall number of daily trips in the WMA undertaken for Employers Business and Commute purposes. Employer's Business makes up a small proportion of the overall trips, at 6% contribution, while commuting trips contribute to 28% of the overall trips.

The proposed transport strategy seeks to deliver an inclusive transport network, capturing the diverse transport needs and journey purposes across the WMA, thus supporting its sustainable economic growth.

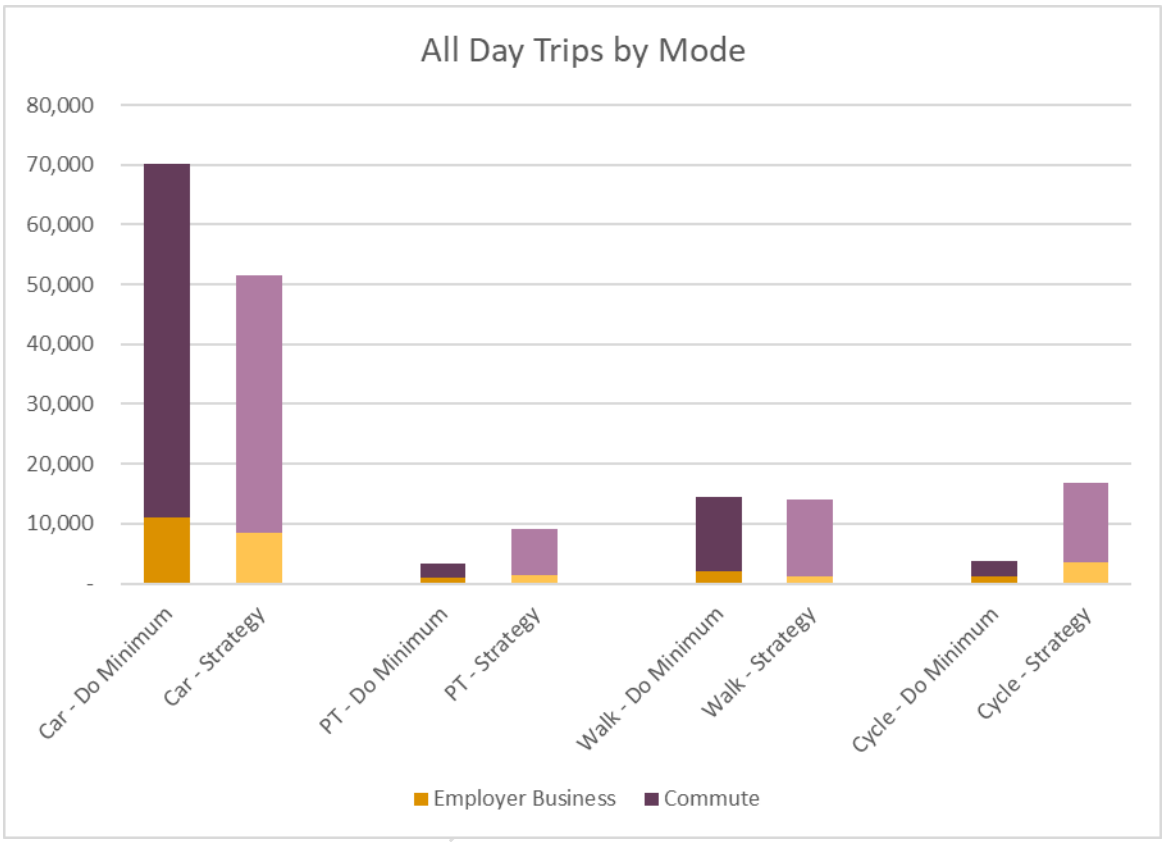


Figure 7.9 All day trips for Employer Business and Commute

7.9 Demand and Mode Share Analysis

7.9.1 Demand Analysis

Figure 7.10 and Figure 7.11 below show the Waterford Metropolitan Area (WMA) 24Hr and AM Demand Distribution by mode for the Base Year (2016) and the forecast (2040) Do-Minimum and Do-Strategy. The analysis shows an increase in overall trips within the WMA from approximately 195k trips in the base year 2016 to 270k trips in 2040 – representing a 40% increase in demand.

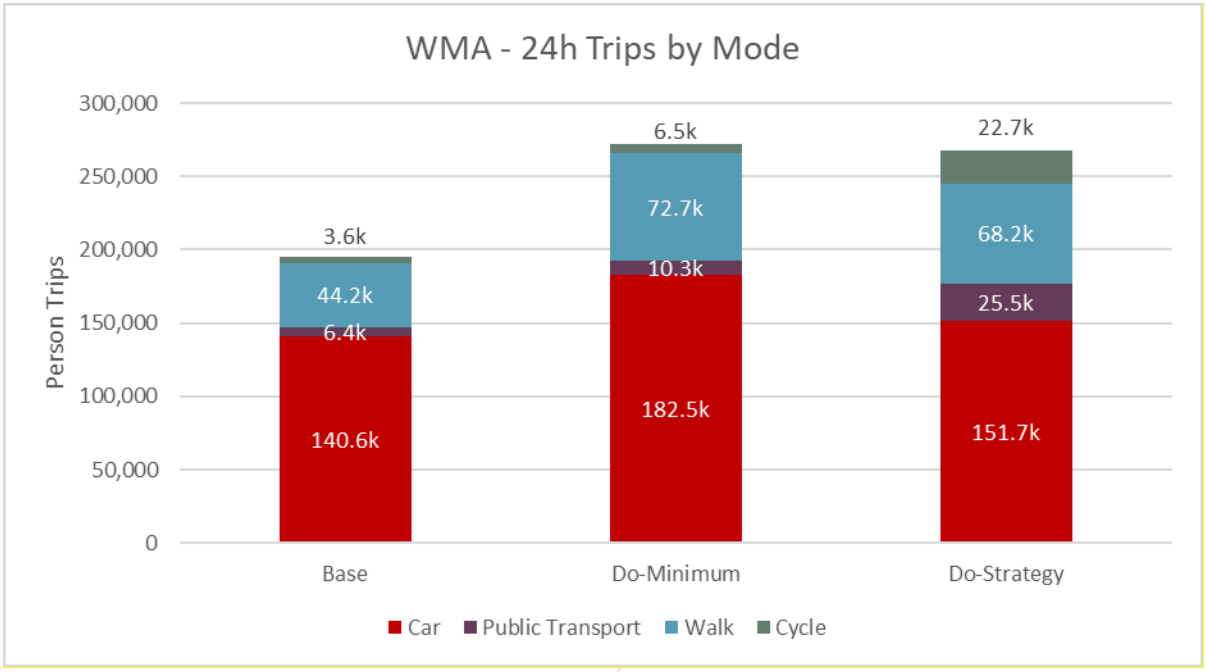


Figure 7.10: WMA 24Hr Demand Distribution of trips by mode

Trips within the AM time period across the WMA increase from approximately 49k in the base year 2016 to 72k trips in 2040 – representing a 46% increase in demand.

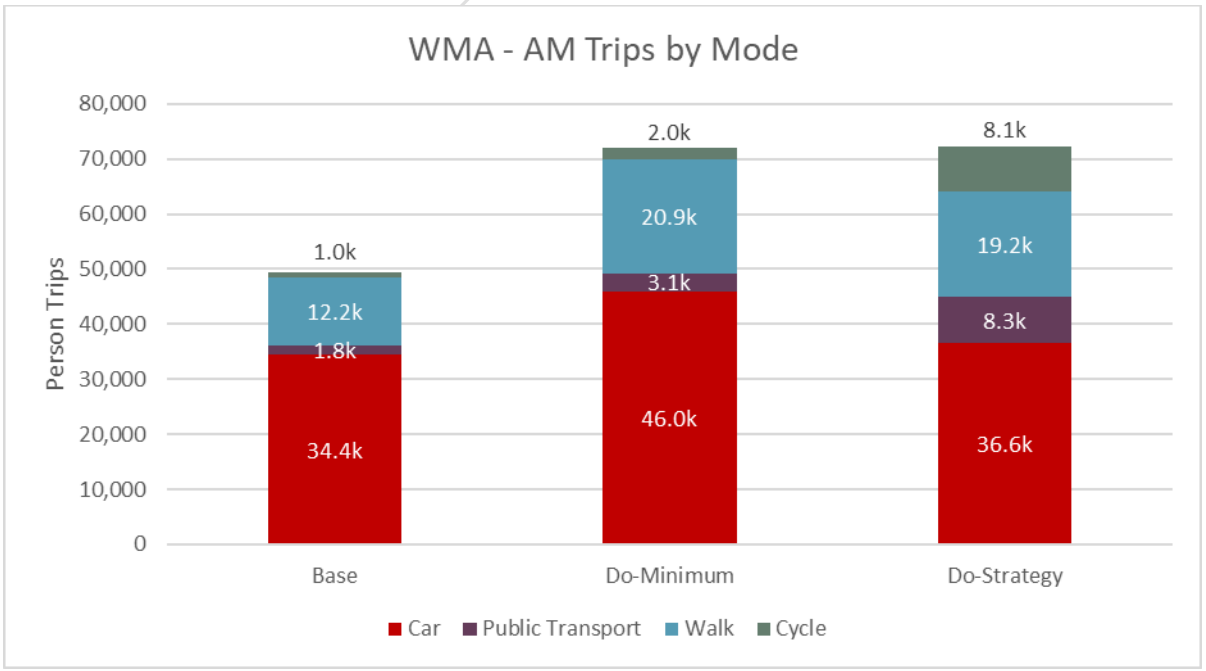


Figure 7.11: WMA - AM Demand Distribution of trips by mode

While overall trips increase by over one third by 2040, the Strategy results in only a marginal increase in car trips, favouring sustainable modes as shown in Table 7.13, which shows the percentage increase in all day trips for each mode between 2016 and 2040 for the Do Minimum and Do Strategy scenarios.

Table 7.13: Trip Growth between 2016 and 2040 – All Day

	Car	PT	Walk	Cycle
Do Minimum	30%	61%	64%	78%
Do Strategy	8%	299%	54%	527%

7.9.2 Mode Share Analysis

This section provides an analysis of mode share for trips within the WMA in 2040. The mode shares for 24-hour, each individual time period and by area for the Base, Do-Minimum and Do-Strategy scenarios are shown in Figure 7.12 to Figure 7.20.

In the Do-Strategy scenario the overall 24-hour public transport and cycling mode shares increase by 5.7%, and 6.1% respectively against the Do-Minimum. There is a similar pattern observed in each modelled time period and across each area within the WMA.

This combined shift to sustainable modes results in an 11% drop in metropolitan area car mode share over 24-hours against the Do-Minimum, and a 16% drop against the base. There is a similar shift in each time period with the AM car mode share dropping from 70% to 51%.

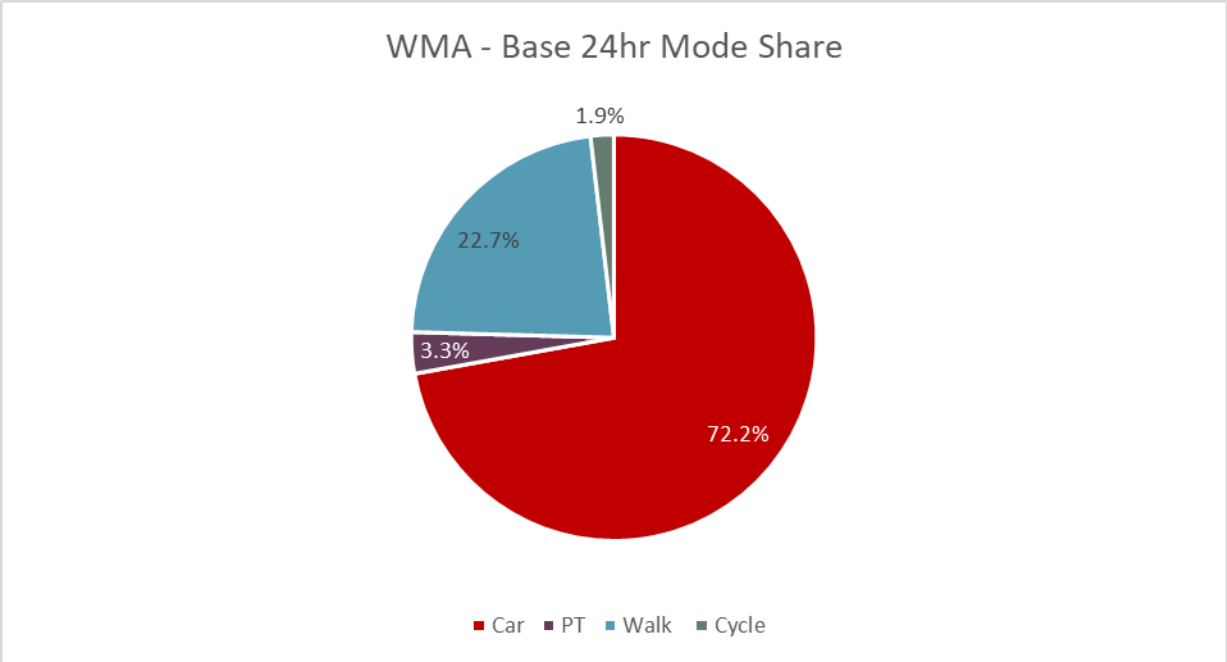


Figure 7.12: 2016 Base - 24 Hr Metropolitan Area Mode Share

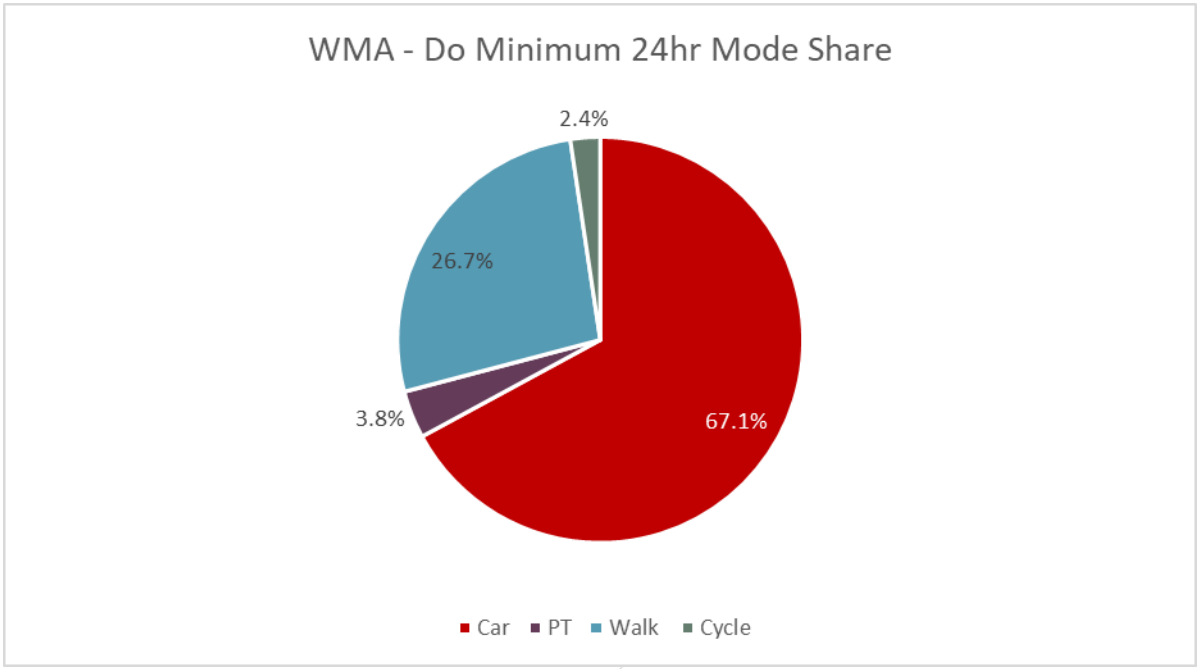


Figure 7.13: Do-Minimum - 24 Hr Metropolitan Area Mode Share

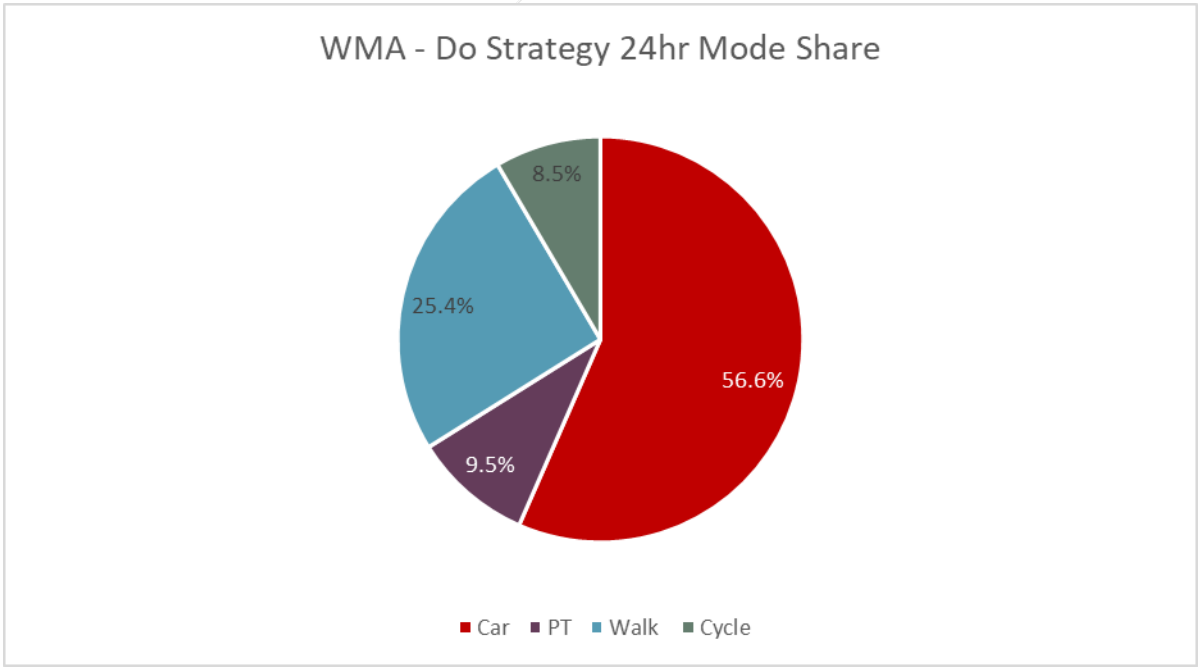


Figure 7.14: Do-Strategy - 24 Hr Metropolitan Area Mode Share

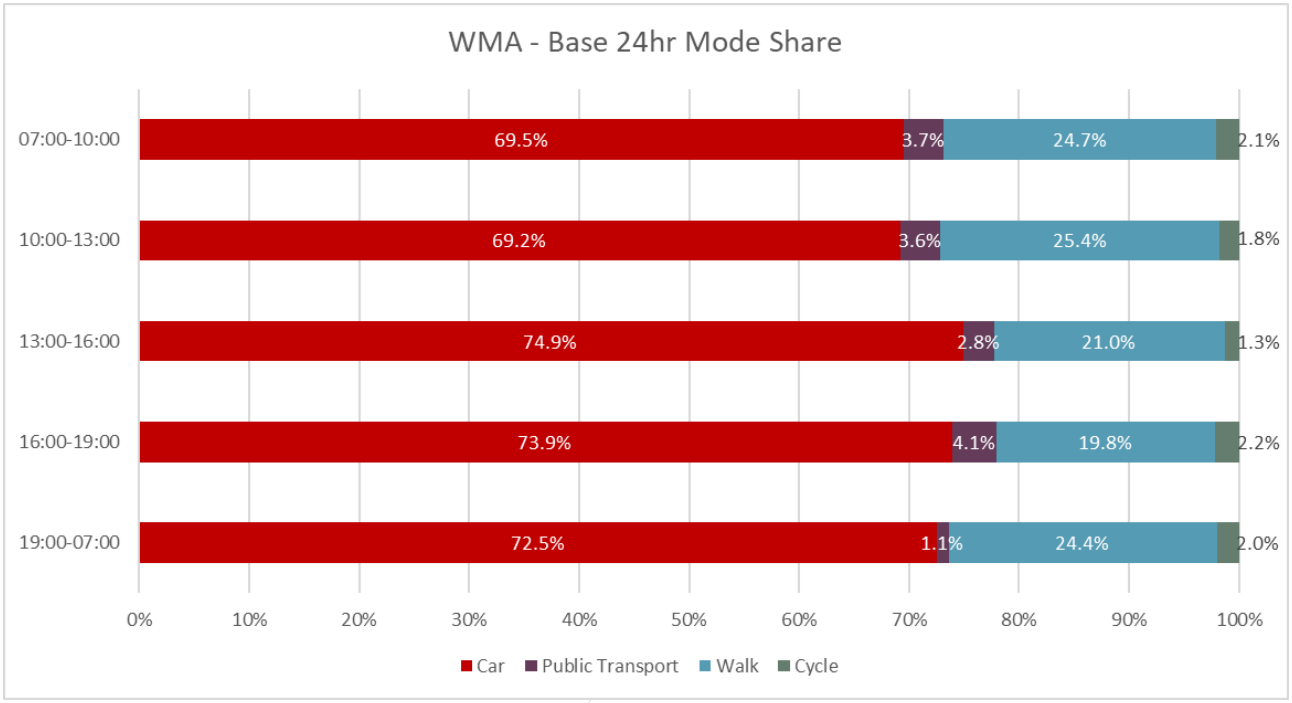


Figure 7.15: Base Metropolitan Area Mode Share by Time Period

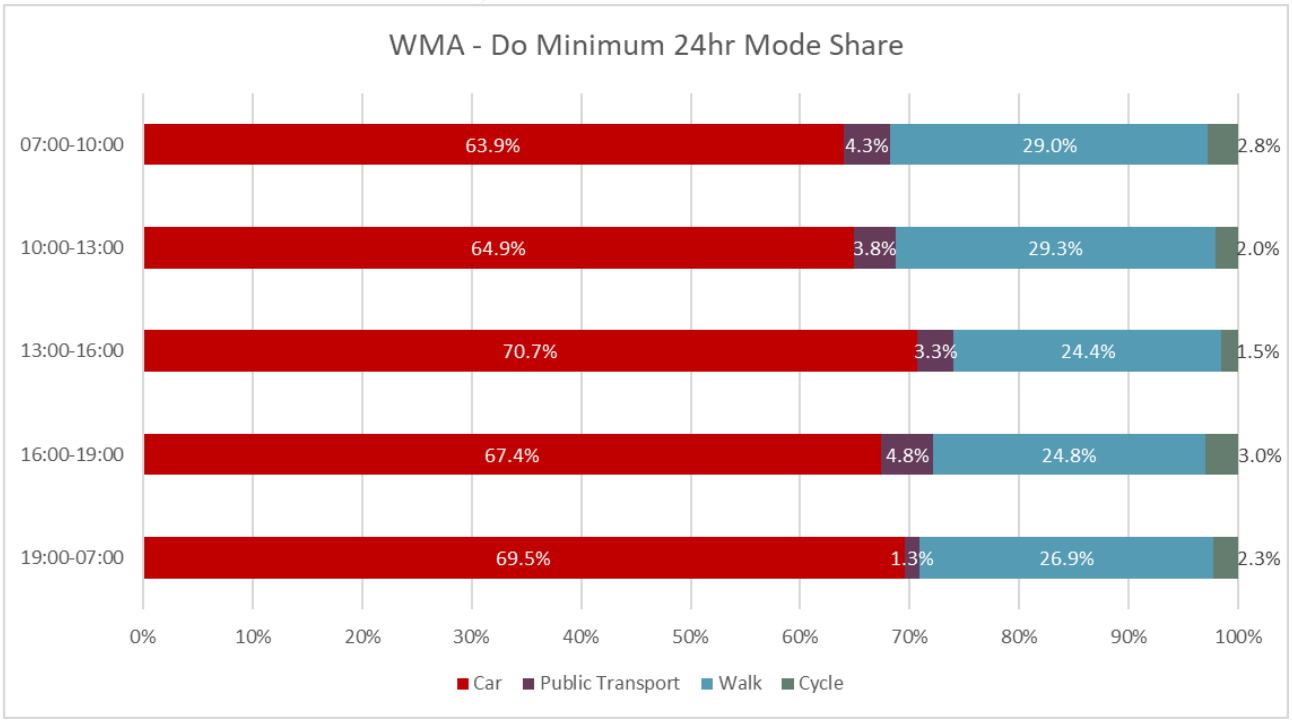


Figure 7.16: Do-Minimum Metropolitan Area Mode Share by Time Period

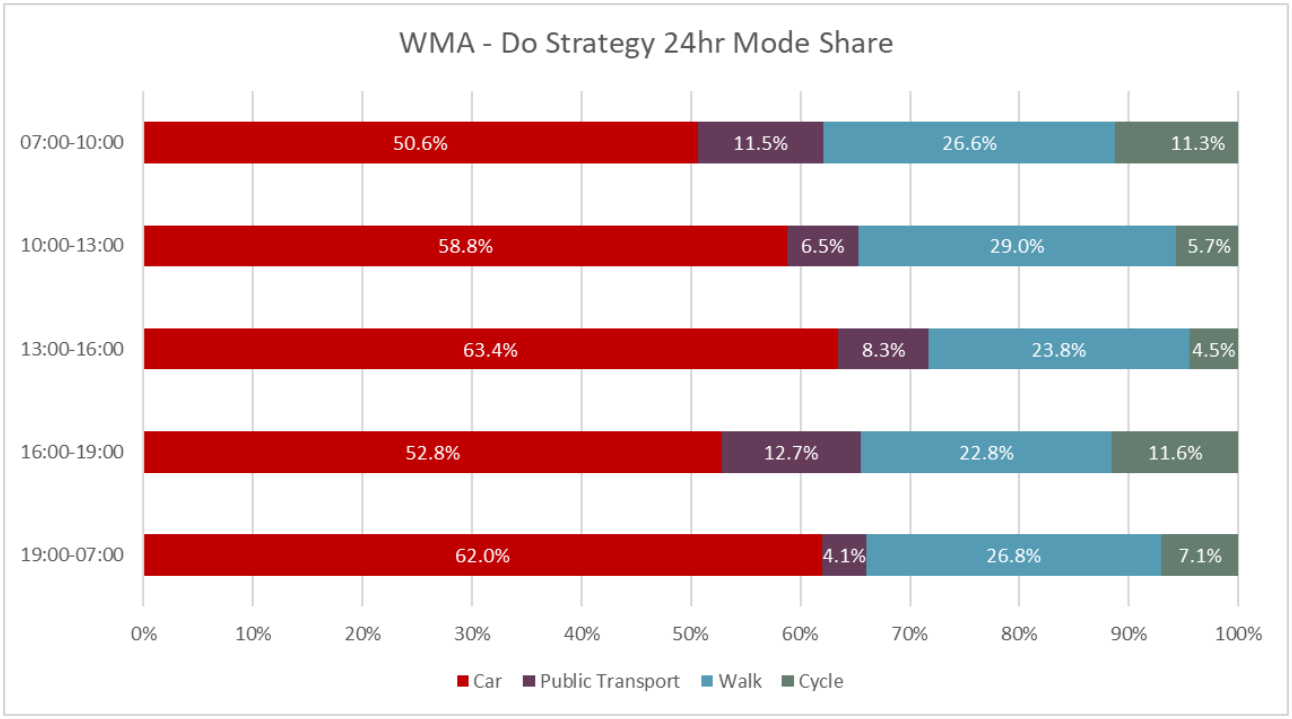


Figure 7.17: Do-Strategy Metropolitan Area Mode Share by Time Period

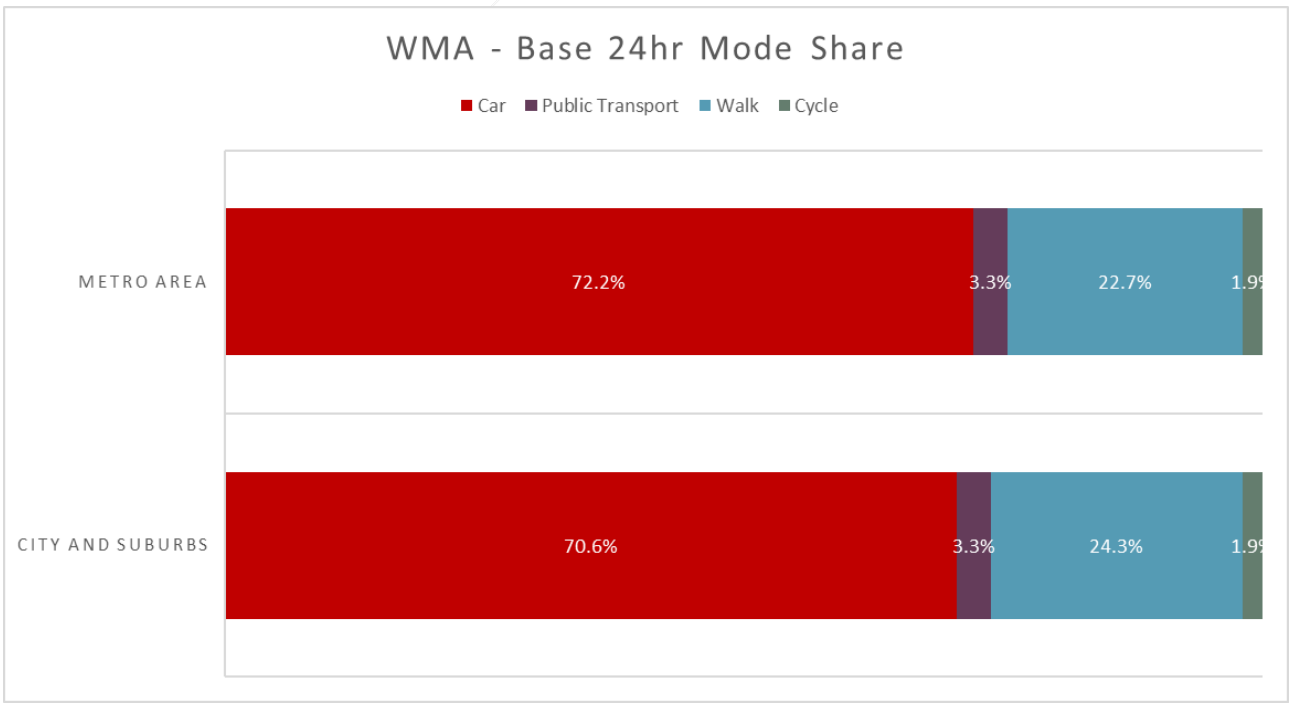


Figure 7.18: Base Metropolitan Area AM Mode Share by Area

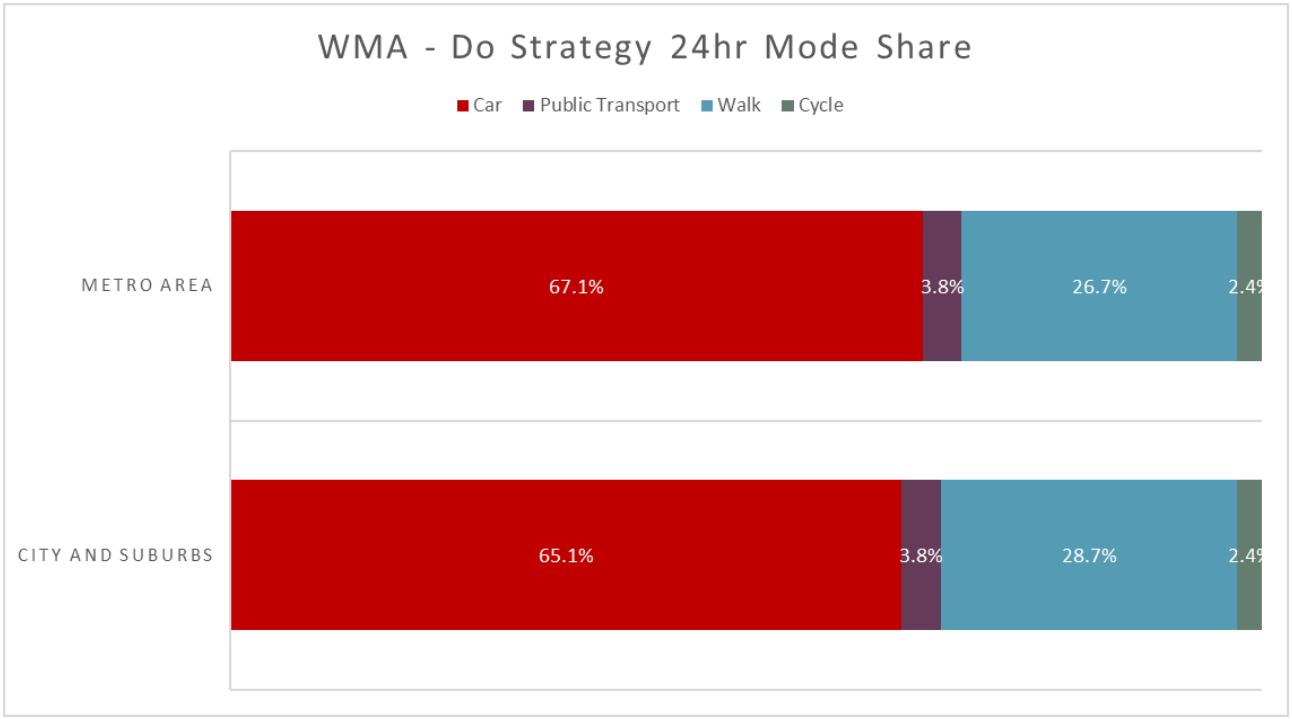


Figure 7.19: Do-Minimum Metropolitan Area AM Mode Share by Area

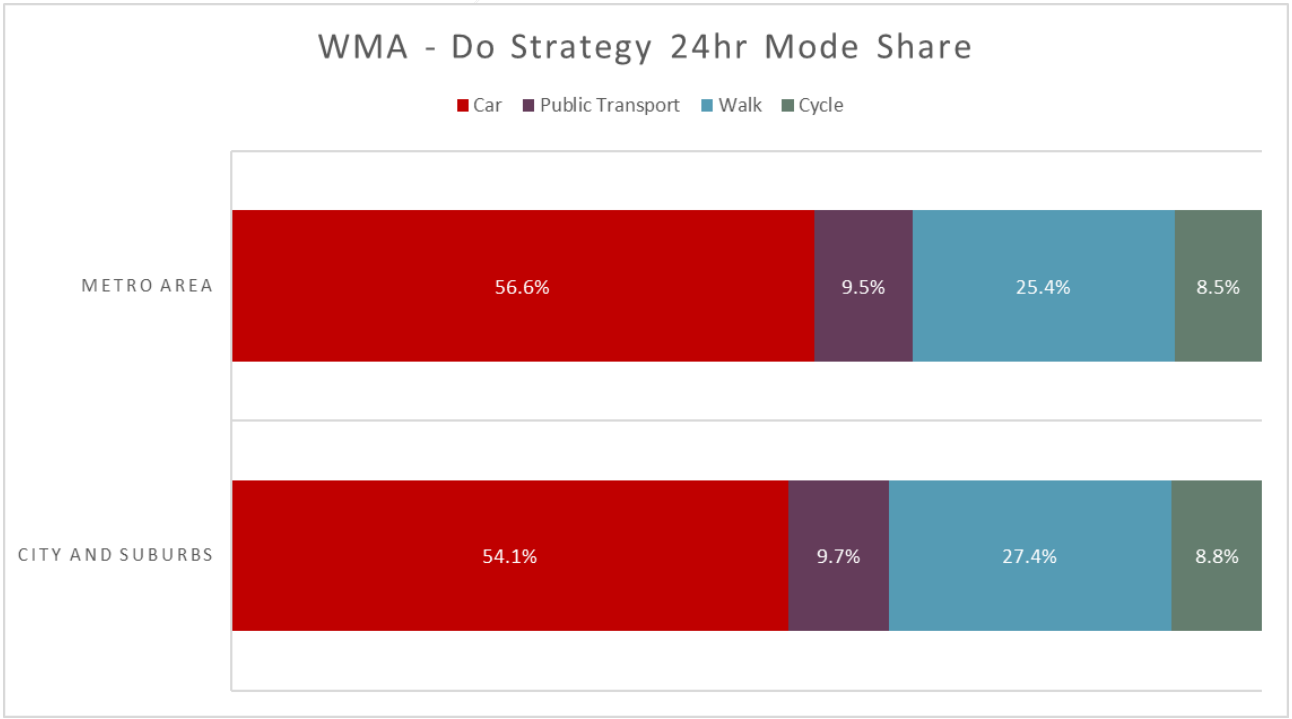


Figure 7.20: Do-Strategy Metropolitan Area AM Mode Share by Area

The mode share for each scenario by SERM model zone is mapped in Figure 7.21 and Figure 7.22. As shown, there are improvements across the Metropolitan Area in the Do-Strategy Scenario relative to the Do-Minimum. The greatest improvement is within the City area as would be expected.

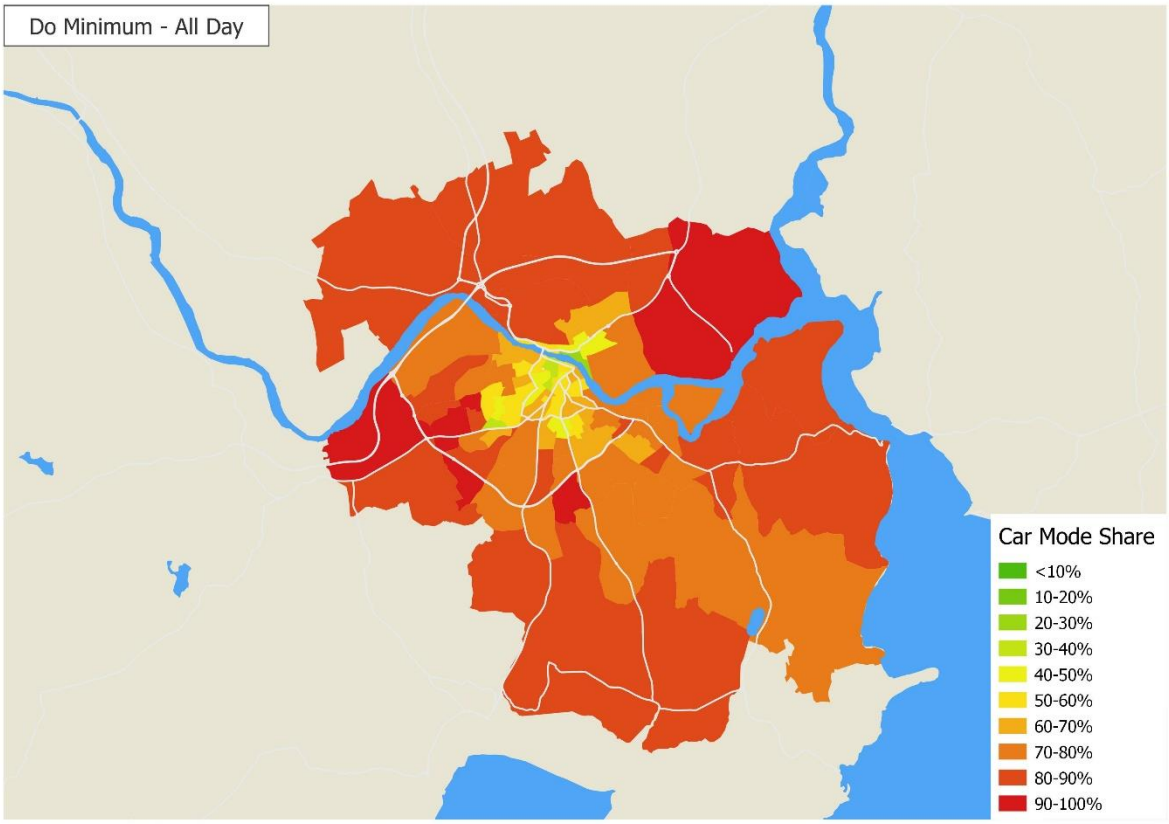


Figure 7.21: Do-Minimum Metropolitan Area All Day Mode Share by SERM Zone

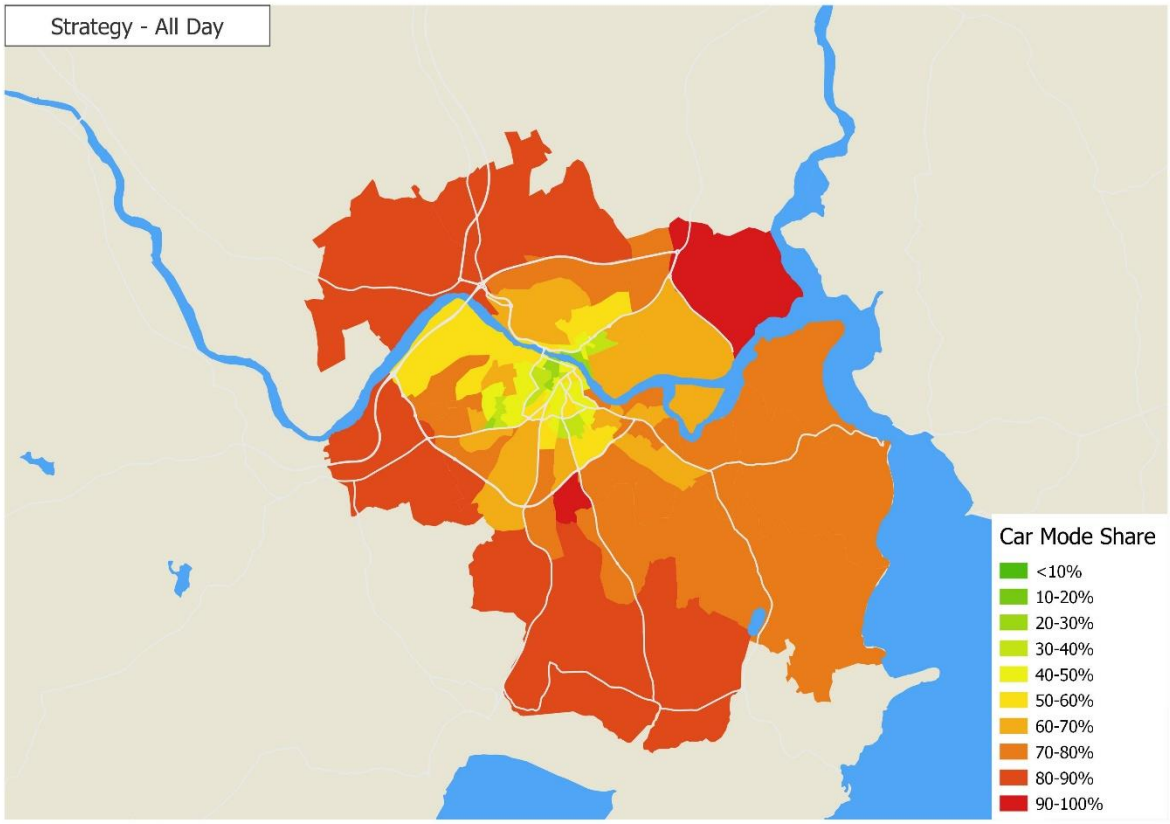


Figure 7.22: Do-Strategy Metropolitan Area All Day Mode Share by SERM Zone

7.9.3 Trip Length Distribution

Another Key Performance Indicator (KPI) used in the assessment is Trip Length Distribution (TLD). TLDs provide detail on the number of trips by journey length for each mode. They can be used to compare scenarios and indicate how trip patterns are changing. The Trip Length Distribution for the Do-Minimum and Do-Strategy for all AM peak trips is displayed in the **Error! Reference source not found.** below. Overall, the distribution of trips lengths is similar with a slight increase in mid-range length trips, 8-12km, in both Do-Strategy scenarios compared to the Do-Minimum.

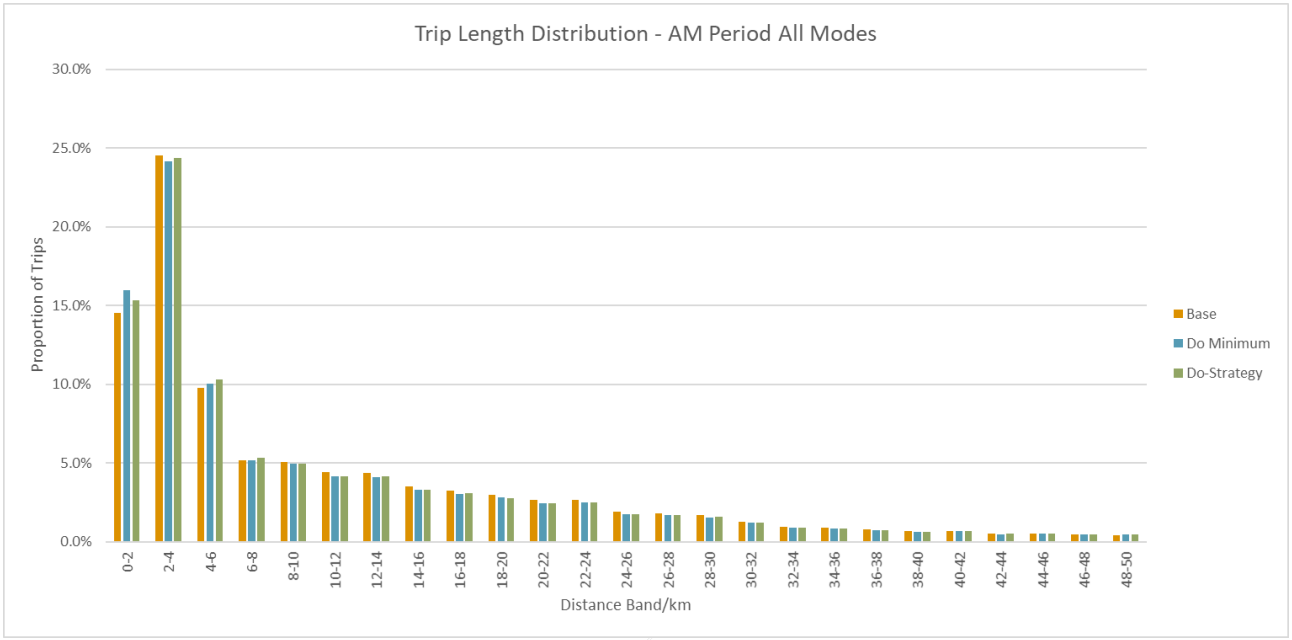


Figure 7.23: Do-Minimum, Do-Strategy Trip Length Distribution

The Trip Length Distribution for each Mode - Car, PT, Walk and Cycle are presented in Figure 7.24, Figure 7.25, Figure 7.26 and Figure 7.27 respectively below.

The results show an increase in short PT trips, under 10km, while car trips between the 2-6km reduce but retain a similar distribution at other distances. With active modes, while there is limited redistribution of walk trip distances, there is as redistribution of short cycle trips into medium length trips. These results suggest that the strategy is having a positive impact on providing PT for short trips and increasing range coverage of cycle trips.

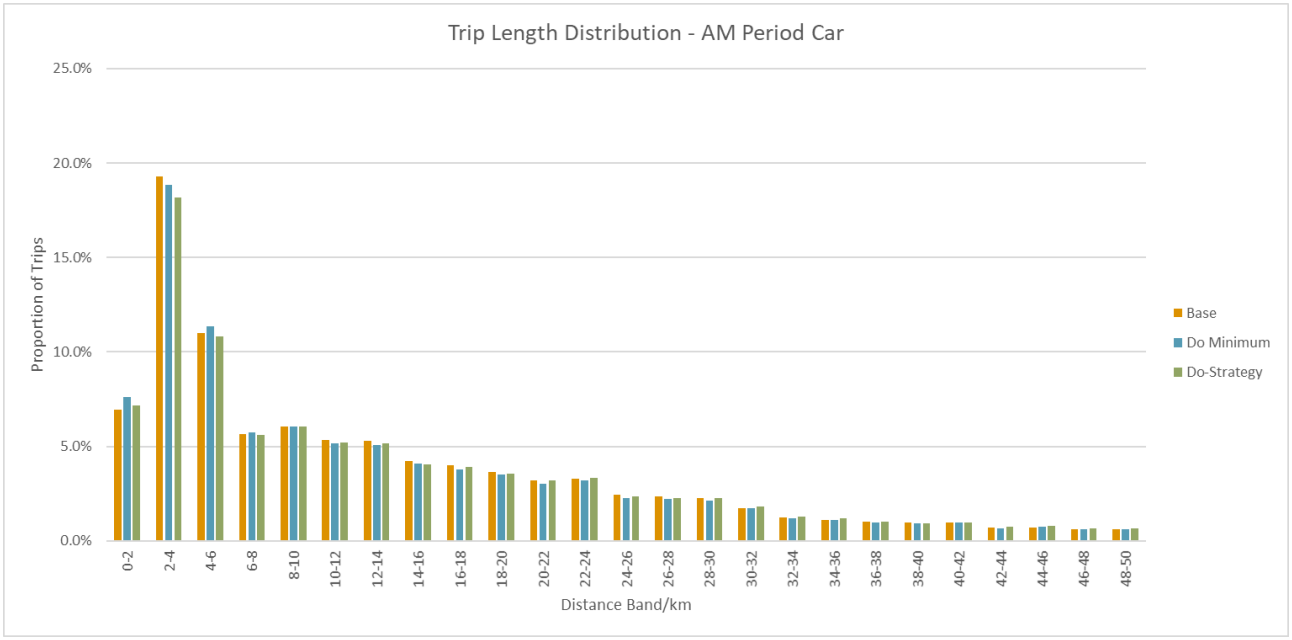


Figure 7.24: Road Trip Length Distribution

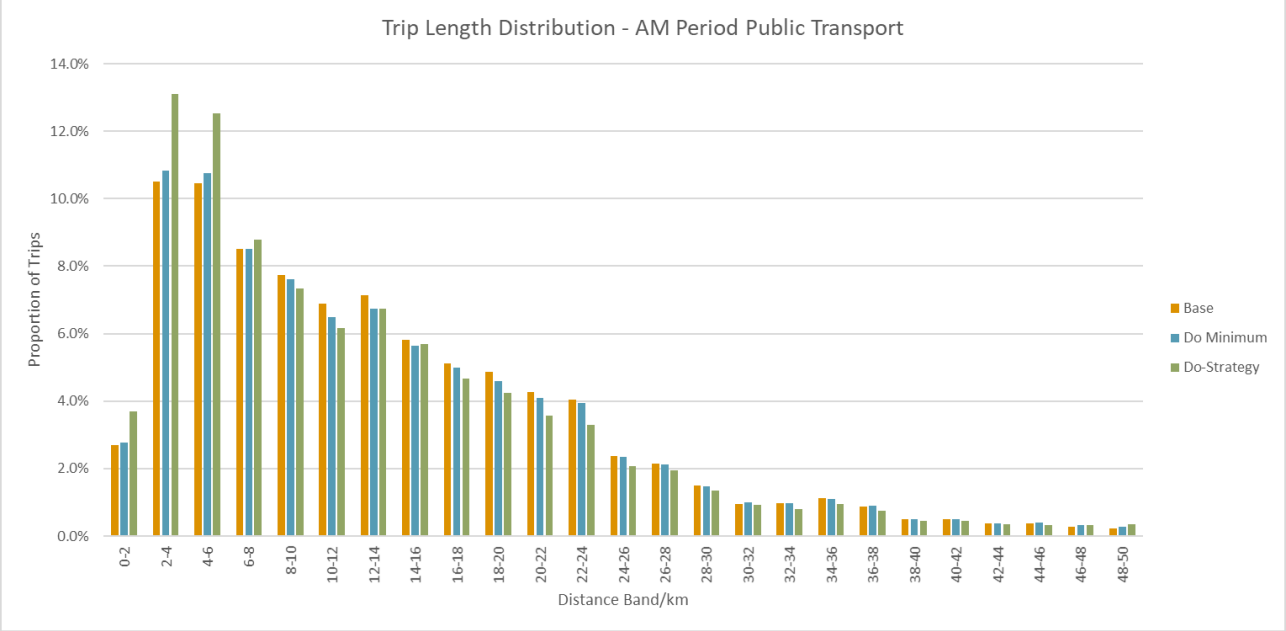


Figure 7.25: PT Trip Length Distribution

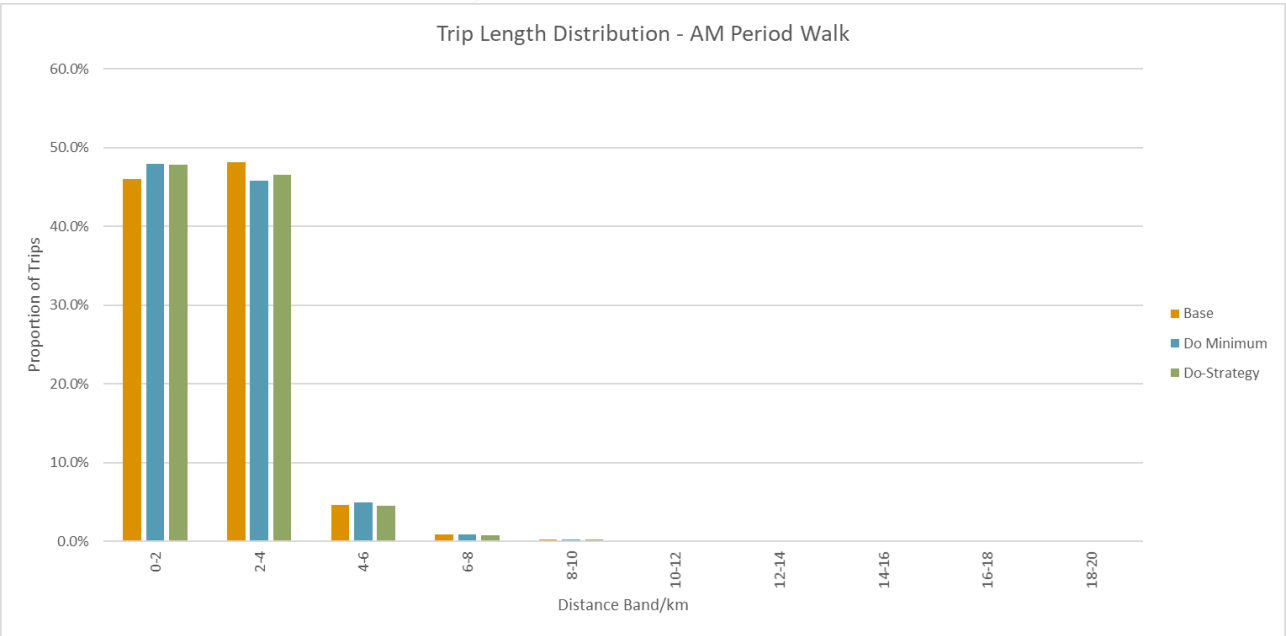


Figure 7.26: Walk Trip Length Distribution

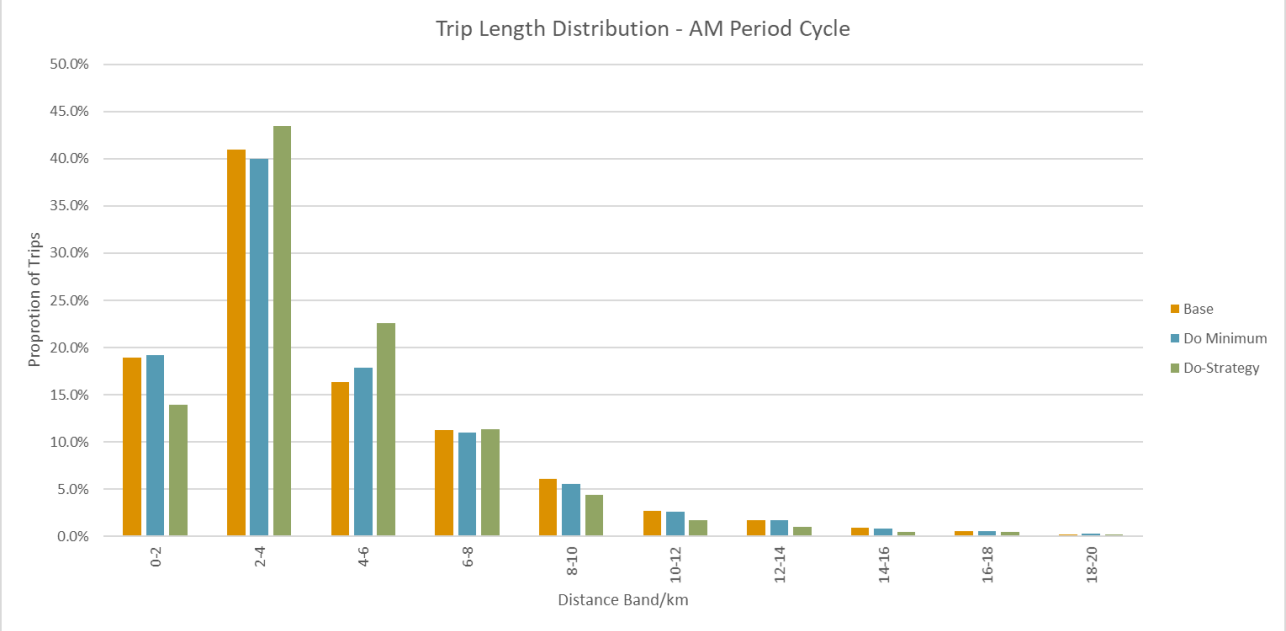


Figure 7.27: Cycle Trip Length Distribution

7.10 Public Transport Network Analysis

This section provides further detail on the performance of the WMATS Do-Strategy public transport network compared to the Do-Minimum scenario. In the Do-Strategy scenario there is a 147% increase in public transport trips across the 24hr period in the WMA (15k additional trips) compared to the Do-Minimum scenario.

7.10.1 Bus Network Service Operational Assessment

This section provides a summary of the performance of the proposed BusConnects network within WMATS.

Figure 7.28: Do Minimum AM Peak Hour - PT Flow Bandwidths

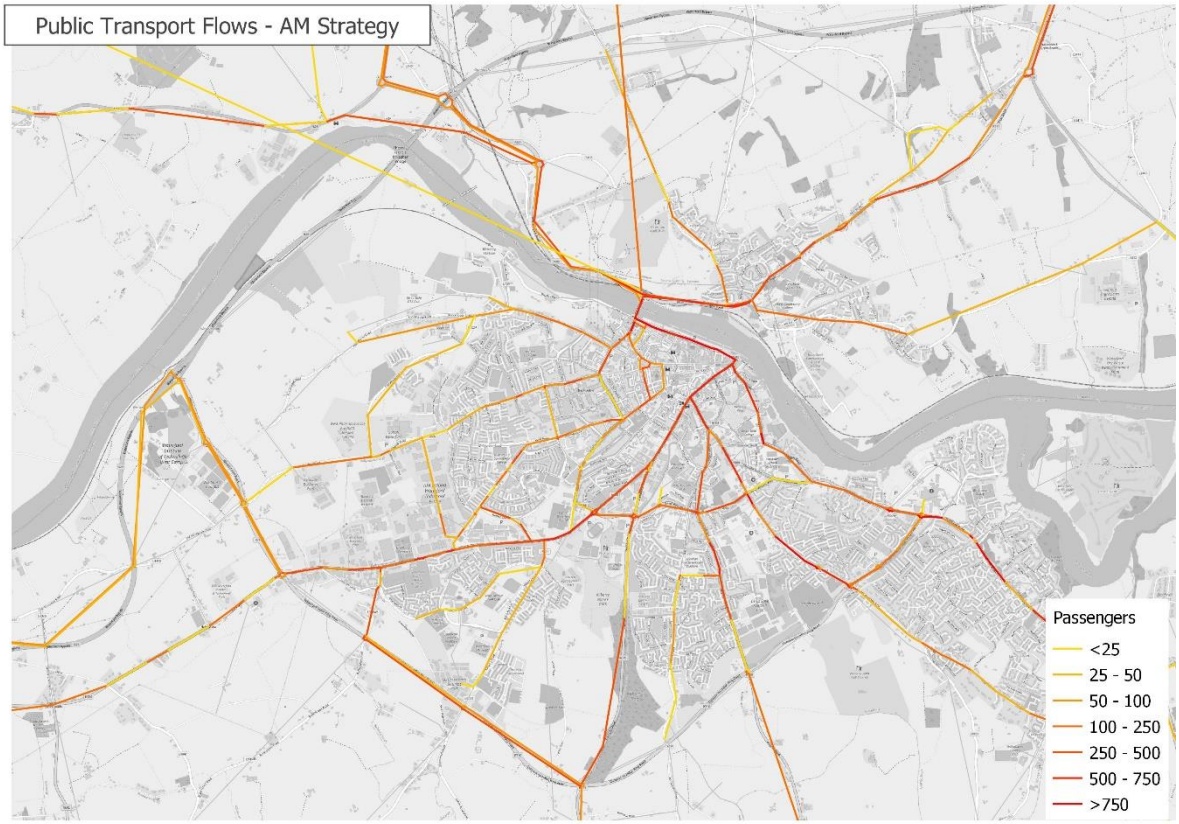


Figure 7.29: Do Strategy AM Peak Hour – PT Flow Bandwidths

Figure 7.28 and Figure 7.29 show the AM peak hour flows on the PT network in the Do Minimum and Do Strategy respectively. The figures show substantial increases in bus network activity across the WMA. There is a strong increase in demand for bus trips radially into the city, particularly trips crossing the Suir River, with the Edmund Rice Bridge seeing an increase from 584 to 1,729 passengers in the AM peak hour. This and other select routes are shown in Table 7.14 below.

Table 7.14: Select Route Bus Flow in AM Peak Hour

Passenger Flow **Both Directions**	Edmund Rice Bridge	William Street Bridge	Manor Street (Morris's)	Barrack Street (Spar)	Cleaboy Road (Pairc Ui Murchu)	Gracedieu Road (Credit Union)	**Total**
Do Minimum	584	210	519	34	22	14	**1,383**
Do Strategy	1,729	787	989	356	372	222	**4,455**

This shows a substantial usage of the bus network across the WMA with the strategy in place.

7.11 Active Modes Network Operations

7.11.1 Active Modes Assignment

This section provides a summary of the performance of the Active Modes (Walking and Cycling) network within WMATS. Figure 7.30 and Figure 7.31 present the combined active flows (Walk and Cycle) in the AM Peak hour across the WMA for the Do-Minimum and Do-Strategy respectively. As shown, there are significant volumes of pedestrians and cyclists throughout Waterford City, particularly through the city centre and along each main arterial route to the city. A selection of these routes is shown in Table 7.15.

Table 7.15: Active Flow on select routes in AM Peak Hour

Active Flow **Both Directions**	Edmund Rice Bridge	New Suir Bridge	William Street Bridge	Manor Street (Morris's)	Barrack Street (Spar)	Cleaboy Road (Pairc Ui Murchu)	Gracedieu Road (Credit Union)	**Total**
Do Minimum	753	0	256	263	439	282	460	**2,453**
Do Strategy	209	1,294	464	428	829	610	604	**4,438**

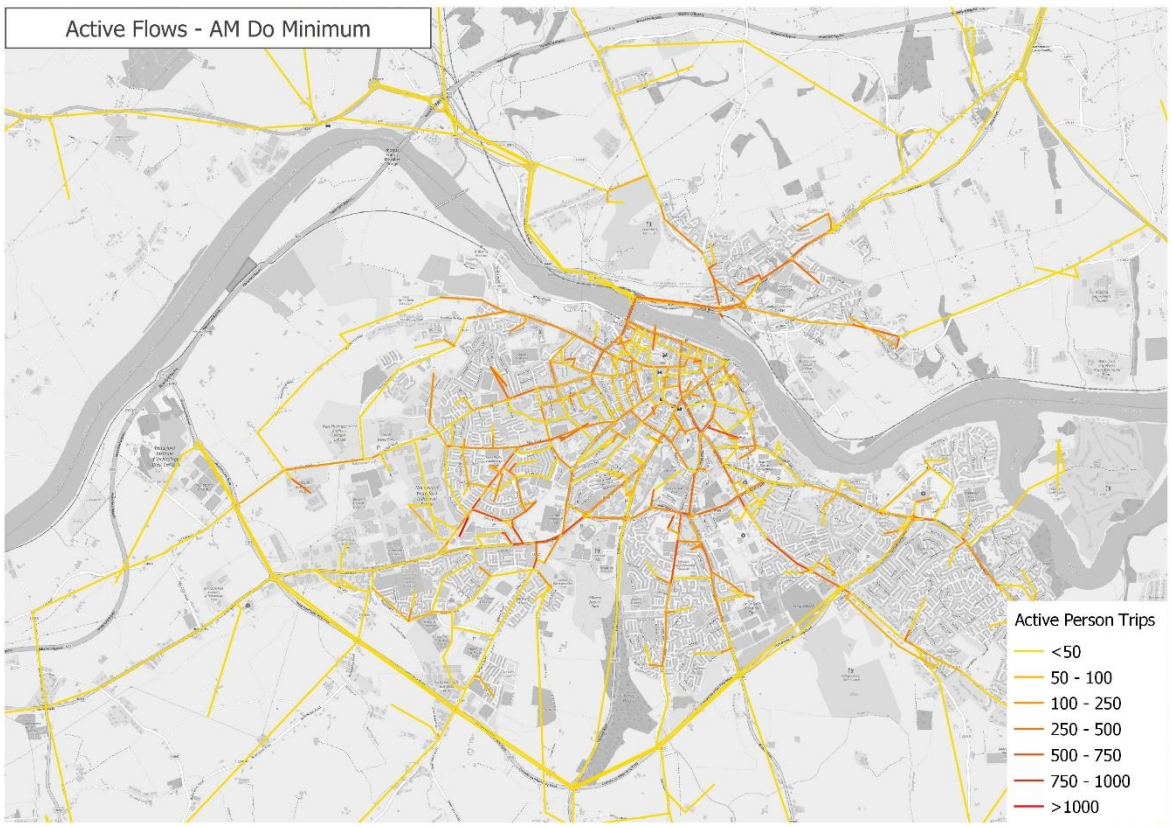


Figure 7.30: Do-Minimum AM Peak Hr Active Mode Flows

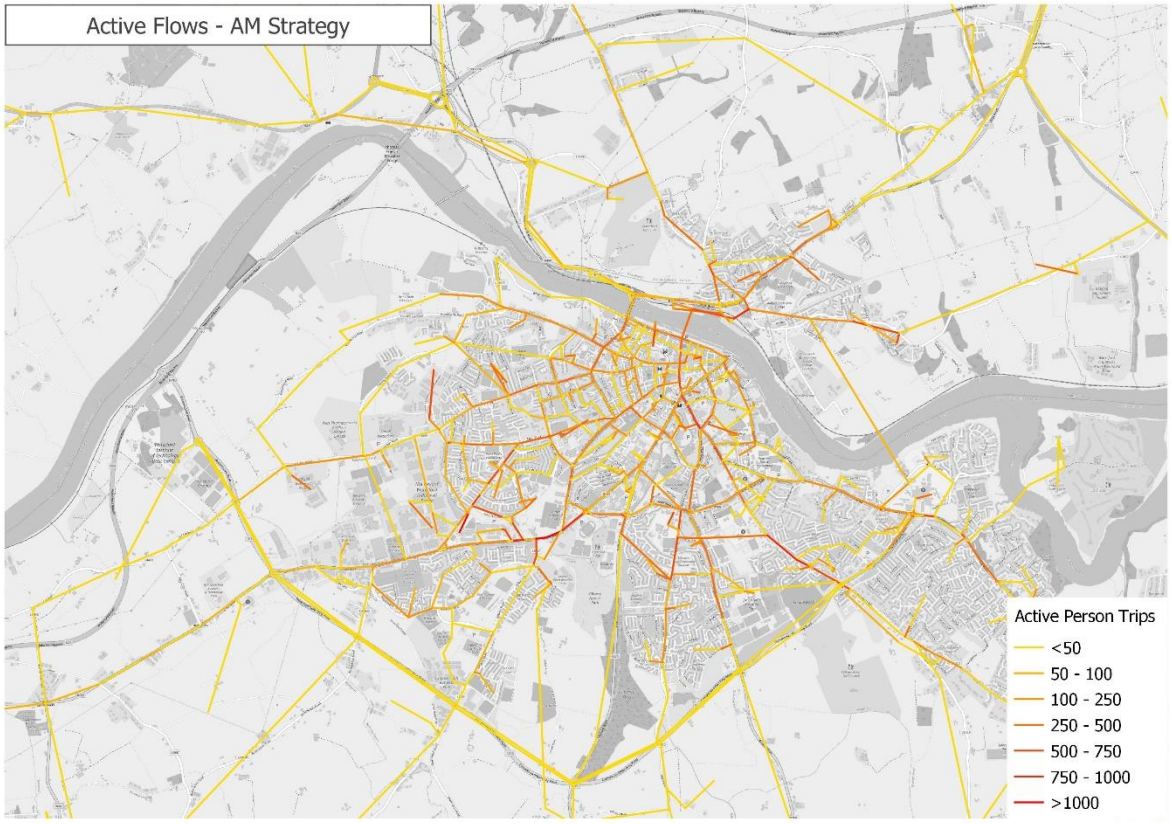


Figure 7.31: Do-Strategy AM Peak Hr Active Mode Flows

7.12 Road Network Operations

This section provides detail on the performance of the road network. Table 7.16 below presents High-Level Road Network statistics for the Do-Minimum and Do-Strategy extracted from the SERM SATURN road model in the AM peak hour for the simulation area, this area includes the WMA and some additional hinterland.

Table 7.16 AM Road Network Assignment Statistics for the Simulation Area

Assignment Stats	Do-Minimum	Do-Strategy	% Change
Transient Queues (PCU.HRS)	1,218.3	784.6	-36%
Over-Capacity Queues (PCU.HRS)	582.9	535.5	-8%
Total Travel Time (PCU.HRS)	5,121.2	4,233.3	-17%
Travel Distance (PCU.KMS)	189,023.1	171,807.0	-9%
Average Speed (KPH)	36.9	40.6	10%

The results show reasonable improvements in road network performance between the Do-Minimum and Do-Strategy scenario. Over-capacity queueing – a measure of congestion on the wider road network shows a reduction of 8% in the Do-Strategy compared to the Do-Minimum. In addition, average speed increases by 10% as a result of the lower levels of congestion.

Table 7.17 shows the change in daily Vehicle KM within the WMA by vehicle type versus the base and the Do Minimum. Overall, Vehicle KM increase with both the Strategy and Do Minimum against the base, however the Veh KM in the strategy are 9.2% lower than that of the Do Minimum.

Table 7.17: Daily Vehicle KM by vehicle type in WMA

Vehicle KMs	Car	Light Goods	Heavy Goods	Total
Base 2016	830,830	2,316	147,108	980,255
Do Minimum 2040	1,025,047	2,881	238,151	1,266,079
Strategy	908,743	2,793	237,605	1,149,141
Strategy Difference to Base	9.4%	20.6%	61.5%	17.2%
Strategy Difference to Do Min	-11.3%	-3.1%	-0.2%	-9.2%

8 Summary & Conclusions

A detailed assessment of the transport proposals outlined as part of the Waterford Metropolitan Area Transport Strategy (WMATS) was undertaken using outputs from the South-East Regional Model.

As a result of this assessment, the main impacts of the Strategy can be summarised as follows:

- A substantial proportion of projected growth in travel demand in the WMA will be accommodated by sustainable transport modes;
- The Strategy is forecast to provide an increase in mode share for sustainable transport modes and a reduction in the demand to travel by private car;
- The public transport network is forecast to have very high usage with a significant increase in total passenger boardings;
- Journey times to the city centre by public transport are forecast to reduce significantly compared to the Do-Minimum;
- Travel times on the road network are forecast to reduce as a result of the Strategy – compared to the Do-Minimum;
- The Strategy is forecast to reduce transport related emissions, particularly with the additional supporting parking policies;
- The Strategy is forecast to improve accessibility by reducing severance and increasing the accessibility to public transport, particularly from socially deprived areas across the WMA;
- A more integrated public transport network provided by the Strategy results in an increased level of public transport interchange; and
- The Strategy represents a worthwhile investment with transport user benefits forecast to exceed the outline estimate cost of delivering the Strategy.