Waterford Metropolitan Area Transport Strategy

Demand Analysis Report

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CONTENTS

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 Purpose of this Report

The methodology for the development of the WMA Transport Strategy 2040 is undertaken on a step-by-step basis, from: reviewing the existing policy and transport baseline, undertaking a detailed future demand analysis, developing transport options, developing the draft Strategy for public consultation, and subsequently finalising the Strategy. Figure 1-1 outlines the proposed methodology.

Figure 1-1: Waterford Metropolitan Area Transport Strategy Methodology

This report is focused on the second task in the preparation of the Strategy - an assessment of the travel demand within the WMA in 2040. The report outlines the methodology adopted to estimate future land use within the WMA. The NTA's South East Regional Model (SERM) has been used to assess the likely future 2040 travel demand.

The aim of this stage of the Strategy is to establish a thorough understanding of the future travel demand and movement patterns to inform the development of transport options, network and supporting proposals for further testing. The demand and movement patterns have been assessed using individual and combined corridor analyses, the details of which are outlined in this report.

1.3 Report Structure

The following provides a description of the contents of each section of the report;

- **Section 2:** Outline of the estimated 2040 modelled land use data;
- **Section 3:** Overview of the NTA modelling system and how travel demand is generated from the 2040 land use data;
- **Section 4:** Comparison of the high-level results from the two scenarios modelled using the 2040 travel demand;
- **Section 5:** Detailed analysis of the future travel demand at a corridor level for the idealised network scenario;
- **Section 6:** Summary of the combined demand from all corridors and the indicative strategic network required to meet this demand.

2 Planning Data Section

2.1 Overview

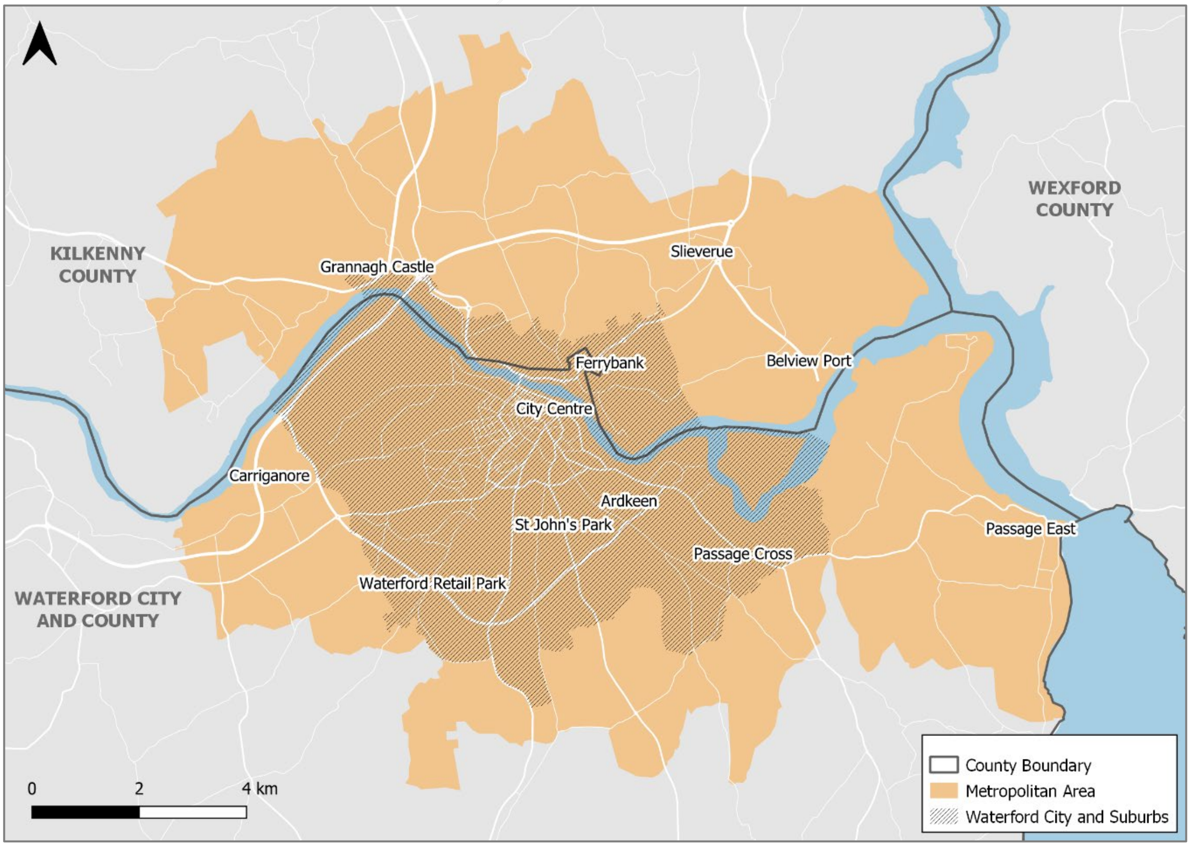
In June 2021, the NTA, in association with Waterford City and County Council (WCCC) and Kilkenny County Council (KCC) prepared an initial Planning Datasheet for the 2040 Baseline Land-use Scenario for the application within the WMA Transport Strategy. This Planning Datasheet has been used for the purpose of the following analysis.

The Planning Datasheet contains data at a Central Statistics Office (CSO) Small Area (SA) level on population, employment and education. This section provides a summary of the 2040 Planning Sheet demographics at a city, county, metropolitan and settlement level and the growth from 2016-2040.

2.2 2040 Planning Datasheet Summary

The section below presents population, employment and education numbers for the derived 2040 Baseline Land Use Scenario at a high level for Counties Waterford and Kilkenny, Waterford Metropolitan Area (WMA) and the CSO Waterford City and Suburbs Boundary. Comparison between 2016 and 2040 scenario are also made to present the growth between the two scenarios. 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. A more detailed breakdown of population growth by area is provided later in this chapter.

Table 2-1: Population Comparison

County	Population		Population Growth 2016 to 2040	
	2016	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.

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%

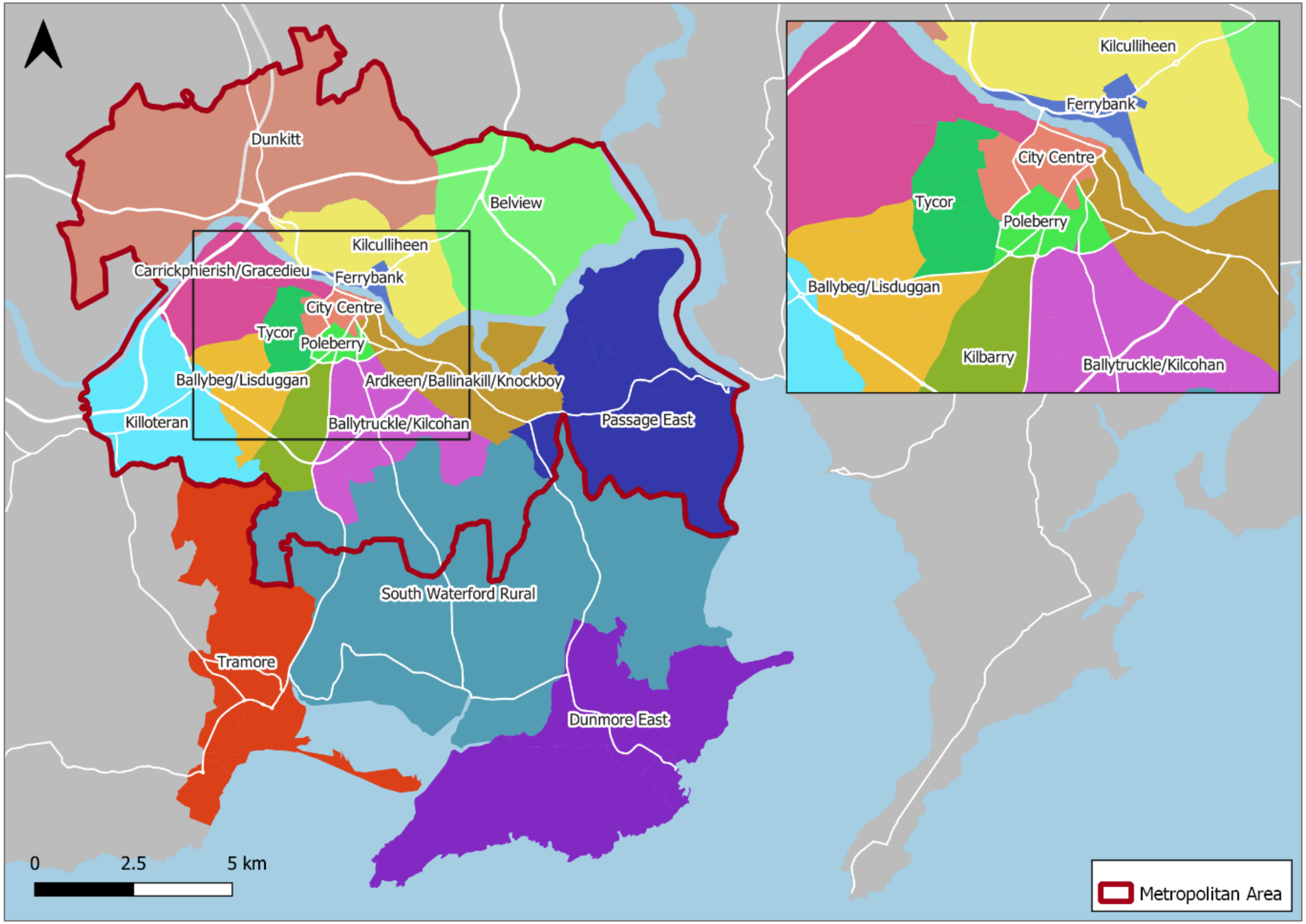
2.3 Settlement Level Comparison

The sections below present population, job and education numbers for the 2040 Baseline Land Use Scenario at a more granular detail, showing the distribution of growth at a settlement level. Comparison between the 2016 base and the 2040 scenario are also made to present the growth between the two scenarios.

2.3.1 Waterford City and County and Kilkenny County Settlements

The population, employment and education data at its most disaggregated form consists of 2,261 Census Small Areas (CSAs) for the SERM. In the interest of simplicity, these CSAs were grouped into specific settlements that allowed for sensible analysis of demographic information. The settlements, illustrated in Figure 2-2, do not match Electoral District boundaries but are defined based on a best match between the South-East Regional Model Zoning System and the planning data at a CSA level.

Figure 2-2: Metro Area Settlements



2.3.2 Population

Table 2-4 provides a comparison between the 2016 and the 2040 Planning Datasheets at a settlement level for population. As shown, the highest levels of absolute growth in population is planned in Kilculliheen (7,186 people), Ardkeen/Ballinakill/Knockboy (5,585 people), Ballytruckle/Kilcohan (5,220 people) and the City Centre (3,683 people). In terms of percentage growth, Kilbarry (170%) and Ferrybank (124%), which includes the North Quays SDZ, experience the highest increases from 2016 levels. The significant planned population growth at Kilculliheen and Ferrybank support the development of a more balanced concentric city.

Table 2-4: Population Comparison at a Settlement Level

Metro Settlements	Population		Population Growth	
	2016	2040	2016 to 2040	2016 to 2040 %
City Centre	6,885	10,568	3,683	53%
Ferrybank	858	1,919	1,061	124%
Tycor	7,026	10,058	3,032	43%
Poleberry	3,262	4,541	1,279	39%
Carrickphierish/Gracedieu	2,464	4,635	2,171	88%
Ballybeg/Lisduggan	3,066	3,920	854	28%
Kilbarry	1,137	3,065	1,928	170%
Ballytruckle/Kilcohan	9,543	14,763	5,220	55%
Ardkeen/Ballinakill/ Knockboy	13,975	19,560	5,585	40%
Passage East	2,152	2,796	644	30%
South Waterford Rural	2,043	2,219	176	9%
Killoteran	574	748	174	30%
Kilculliheen	5,246	12,432	7,186	137%
Tramore	10,768	12,560	1,792	17%
Dunmore East	2,720	3,056	336	12%
Belview	1,095	1,411	316	29%
Dunkitt	1,898	2,474	576	30%
Total	**74,712**	**110,725**	**36,013**	**48%**

The population growth distribution between 2016 and 2040 is shown at the Small Area level in Figure 2-3 below. It indicates the consolidation of existing neighbourhoods and the establishment of new suburban neighbourhoods in areas such as Gracedieu, Kilbarry, Ballytruckle, Ballinakill, Knockboy and Ferrybank.

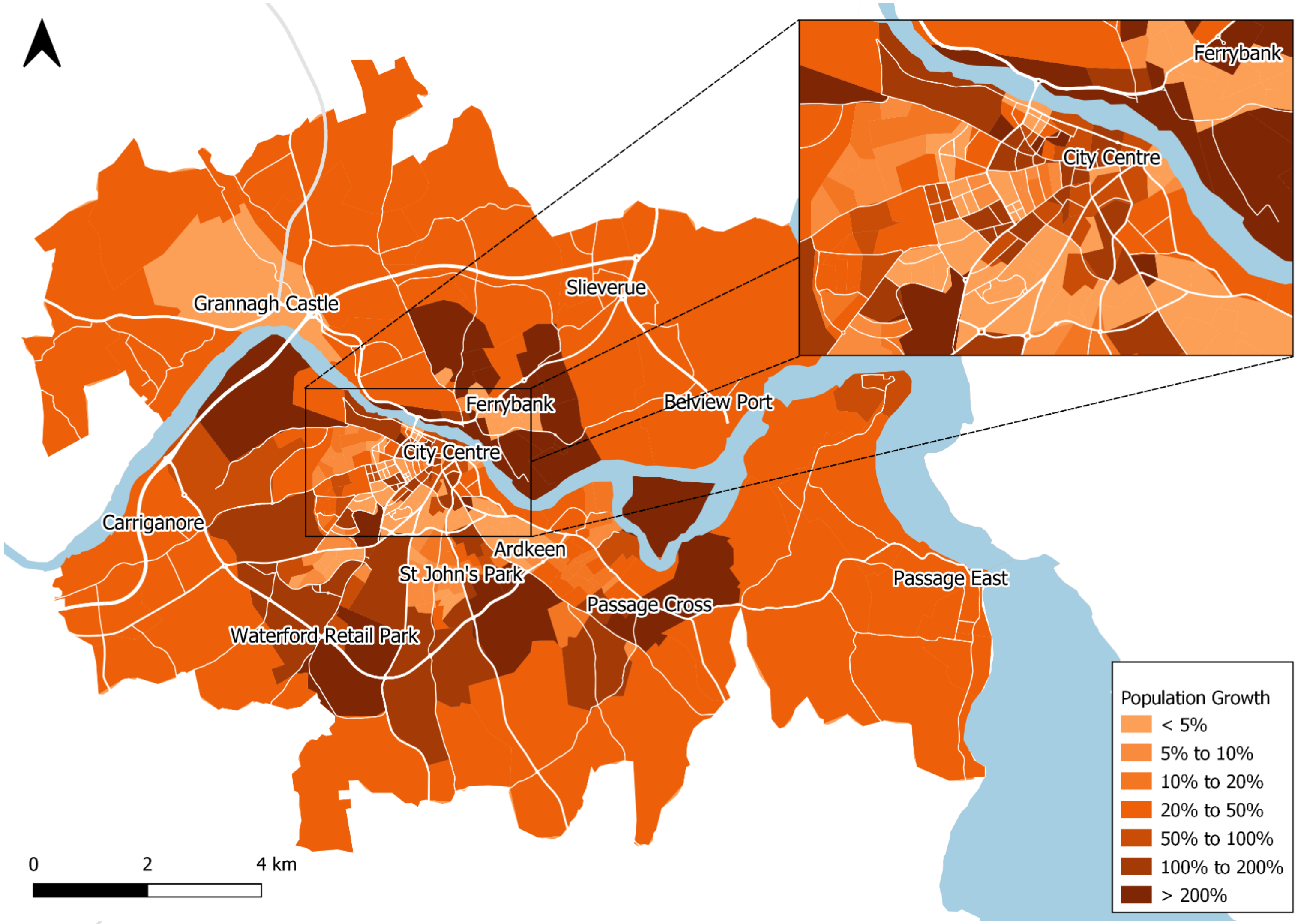


Figure 2-3: Population Growth 2016 to 2040

2.3.3 Employment

Table 2-5 provides a comparison between the 2016 and the 2040 Planning Datasheets at a settlement level for employment. The greatest percentage growth is seen in Ferrybank, where the number of jobs is forecast to grow by 471%, representing an additional 1,789 jobs in 2040. There is also significant employment growth in Belview, Carrickphierish/Gracedieu, Tycor and the city centre.

In terms of absolute employment numbers in 2040, Waterford City Centre remains the largest employer with 7,469 jobs. Existing industrial sites to the southwest of the city, such as the IDA Waterford Industrial Estate, also remain significant employers in 2040.

Table 2-5: Job Comparison at a Settlement Level

Metro Settlements	Employment Numbers		Employment Growth	
	2016	2040	2016 to 2040	2016 to 2040 %
City Centre	5,372	7,469	2,097	39%
Ferrybank	380	2,169	1,789	471%
Tycor	1,731	3,828	2,097	121%
Poleberry	1,360	1,360	0	0%
Carrickphierish/Gracedieu	1,294	3,391	2,097	162%
Ballybeg/Lisduggan	6,592	6,592	0	0%
Kilbarry	253	253	0	0%
Ballytruckle/Kilcohan	961	961	0	0%
Ardkeen/Ballinakill/ Knockboy	4,960	4,960	0	0%
Passage East	188	188	0	0%
South Waterford Rural	424	424	0	0%
Killoteran	876	876	0	0%
Kilculliheen	858	1,512	654	76%
Tramore	1,474	1,656	182	12%
Dunmore East	256	283	27	11%
Belview	762	3,375	2,613	343%
Dunkitt	870	870	0	0%
Total	**28,611**	**40,166**	**11,555**	**40%**

The employment growth distribution between 2016 and 2040 is represented by CSO small area in Figure 2-4 and Figure 2-5, overleaf. As outlined in Table 2-5, the city centre, Gracedieu, Ferrybank and Belview Port are highlighted as the largest employment growth areas.

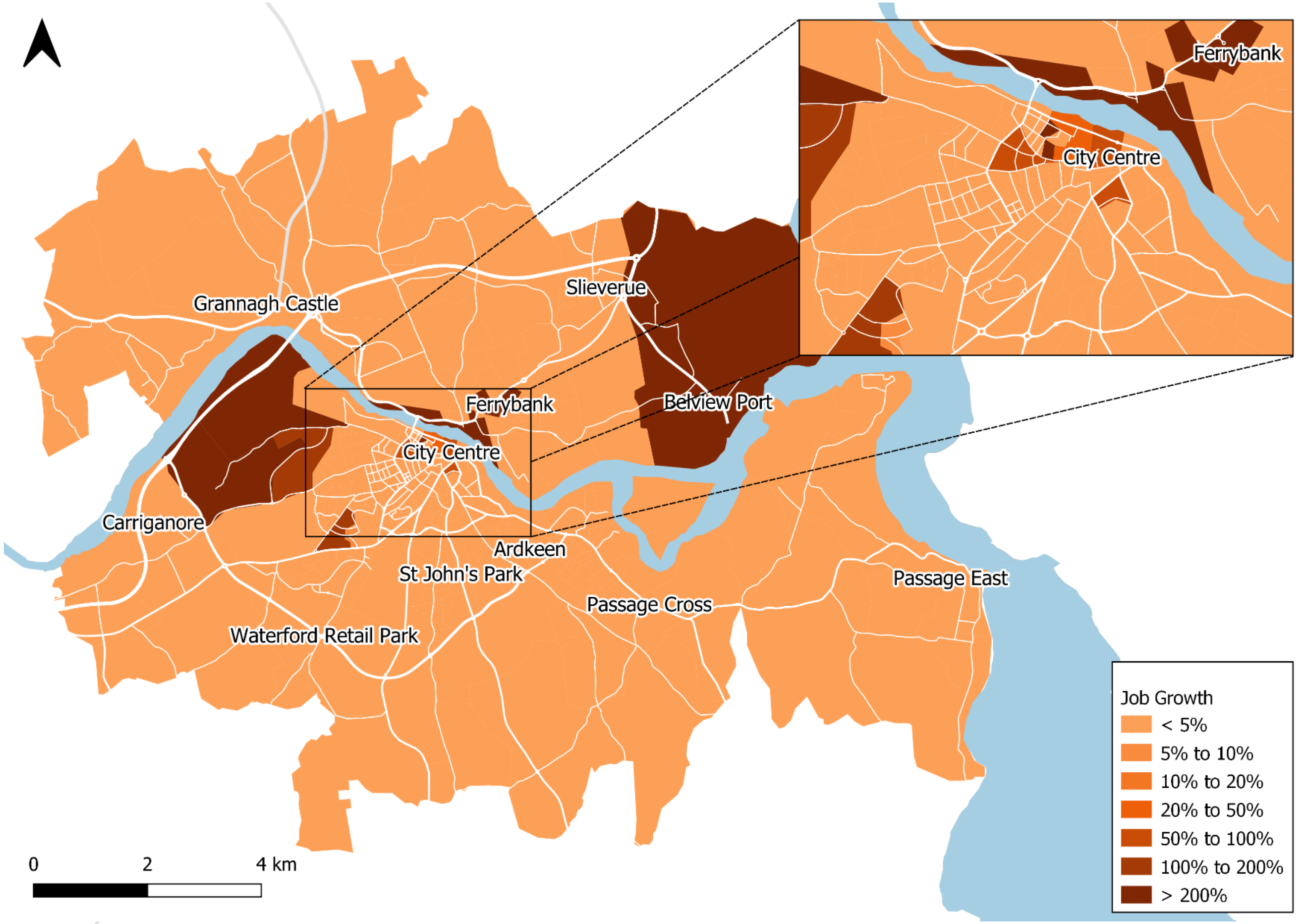


Figure 2-4: Job Growth 2016 to 2040

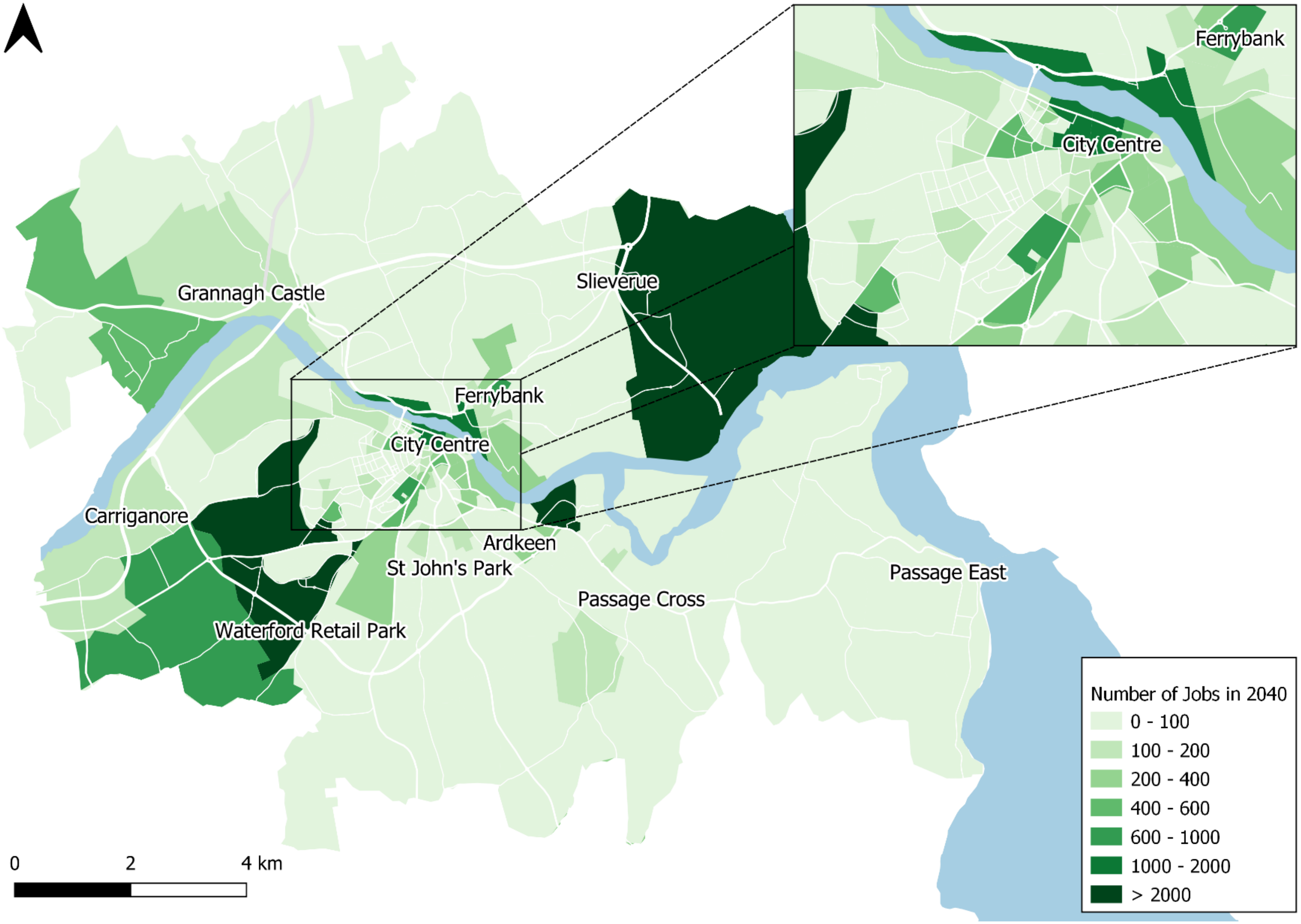


Figure 2-5: Job Growth 2016 to 2040

2.3.4 Education

Table 2-6 provides a comparison between the 2016 and the 2040 Planning Datasheets at a settlement level for education. The highest absolute growth in education places occurs in Tycor, with an increase of 6,176 in 2040, which is primarily driven by the growth of Waterford Institute of Technology (WIT).

Other areas experiencing significant increases in education places are Carrickphierish/Gracedieu, Kilbarry, Kilculliheen and Ballytruckle/Kilcohan. This is primarily driven by the provision of primary and second level schools to support proposed residential development in these areas. The absolute growth in education places rather than percentage growth between 2016 and 2040 is illustrated in Figure 2-6 to clearly represent areas with a lower number of students.

Table 2-6: Education Comparison at a Settlement Level

Metro Settlements	Education Places		Education Growth	
	2016	2040	2016 to 2040	2016 to 2040 %
City Centre	3,204	3,791	587	18%
Ferrybank	351	417	66	19%
Tycor	4,543	10,719	6,176	136%
Poleberry	978	1,228	250	26%
Carrickphierish/Gracedieu	141	1,817	1,676	1189%
Ballybeg/Lisduggan	300	711	411	137%
Kilbarry	8	659	651	8139%
Ballytruckle/Kilcohan	2,371	3,431	1,060	45%
Ardkeen/Ballinakill/ Knockboy	3,051	3,551	500	16%
Passage East	286	493	207	72%
South Waterford Rural	0	0	0	-
Killoteran	6	6	0	0%
Kilculliheen	714	2,641	1,927	270%
Tramore	2,302	2,702	400	17%
Dunmore East	210	250	40	19%
Belview	205	270	65	31%
Dunkitt	324	426	102	32%
Total	**18,994**	**33,111**	**14,117**	**74%**

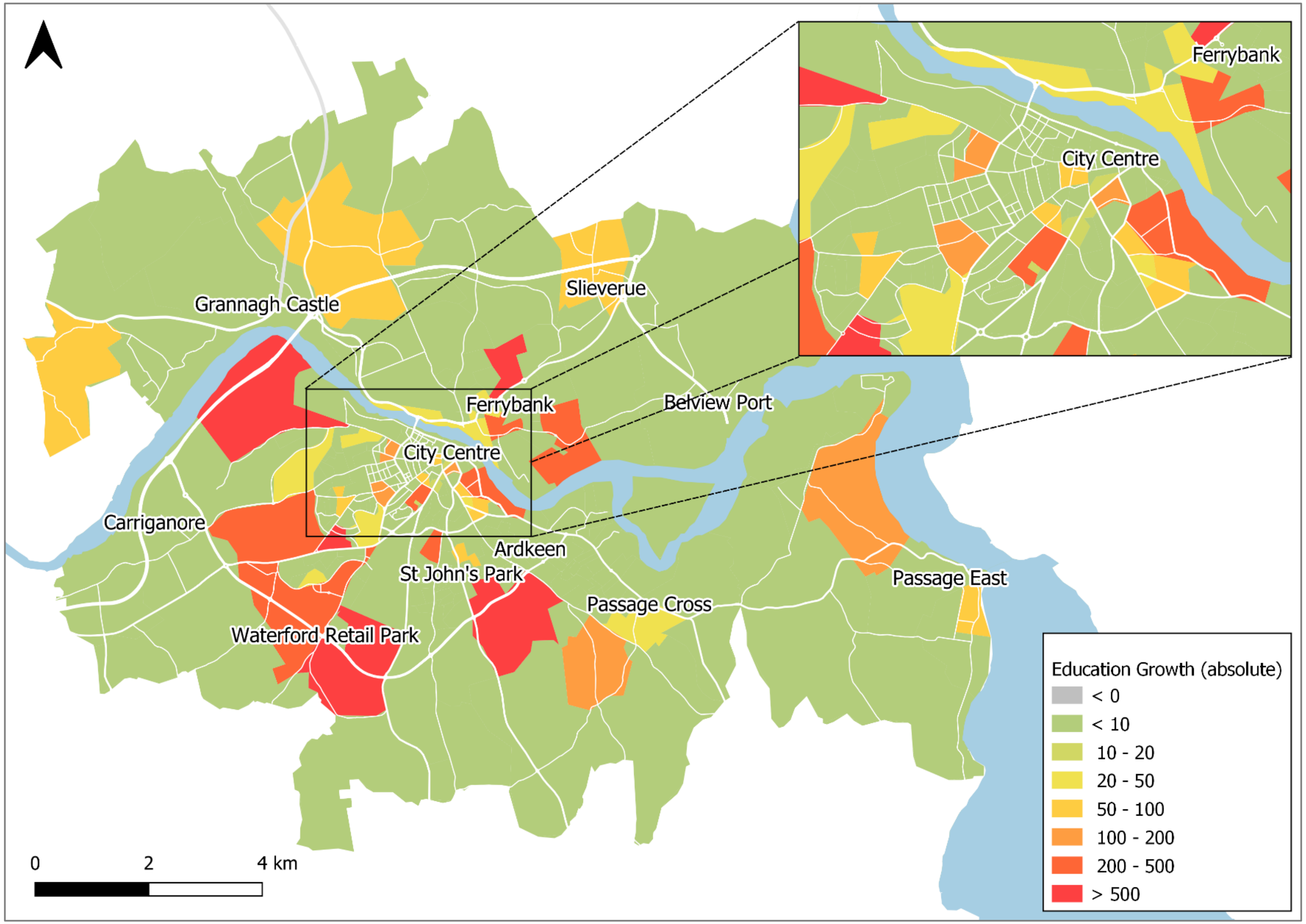


Figure 2-6: Education Growth 2016 to 2040

3 NTA Regional Modelling System

3.1 Introduction

This section describes the NTA Regional Modelling System, outlining its scope, extent, components, functionality and its suitability for use in developing the WMA Transport Strategy. The national remit of the NTA uses a system of regional models to help it deliver on its planning and appraisal needs. The NTA Regional Modelling System comprises five regional transport models covering the Republic of Ireland and centred on the five main cities of Dublin, Cork, Galway, Limerick, and Waterford, summarised in Table 3-1 below.

Table 3-1: Regional Modelling System

Regional Modelling System	Abbreviation	Counties Covered
Eastern Regional Model	ERM	Louth, Monaghan, Cavan, Longford, Westmeath, Meath, Offaly, Laois, Kildare, Dublin, Wicklow, Carlow and Northern Wexford
South East Regional Model	SERM	Wexford, Kilkenny, Waterford and Tipperary South
South West Regional Model	SWRM	Cork and Kerry
Mid-West Regional Model	MWRM	Limerick, Clare and North Tipperary
Western Regional Model	WRM	Galway, Mayo, Roscommon, Sligo, Donegal and Leitrim

Each regional model has the following key attributes:

- Full geographic coverage of the relevant region;
- A detailed representation of the road network, particularly the impact of congestion on on-street public transport services and include modelling of residents' car trips by time period from origin to destination;
- A detailed representation of the public transport network and services, and can predict demand on the different public transport services within the regions;
- A representation of all major transport modes including active modes (walking and cycling) and includes accurate mode-choice modelling of residents;
- A detailed representation of travel demand, e.g. by journey purpose, car ownership/availability, mode of travel, person types, user classes and socio-economic classes, and representation of four-time periods (AM, Inter-Peak, PM and Off-Peak); and
- A prediction of changes in trip destination in response to changing traffic conditions, transport provision and/or policy.

The South-East Regional Model (SERM), which covers Waterford City and County and Kilkenny County, has been used to support the development of the WMA Transport Strategy. Figure 3-1 on the following page illustrates the geographical extent of each of the Regional Models.

Figure 3-1: Modelling System Regional Model Areas

3.2 Regional Modelling System Dimensions

The regional modelling system features or dimensions are defined in terms of:

- Zone system;
- Modes of travel represented;
- Base year;
- Time-periods; and
- Demand segmentation;

3.2.1 Zone System

The zone system definitions for each of the regional models were based on Census Small Area (CSA) boundaries and Electoral Districts (EDs). The 2016 CSAs are the core base layer for each zoning system. CSAs are the smallest geographic unit of data available with which to define the model zone system. Each CSA is a defined geographic area associated with demographic data (e.g. population, age distribution, employment status), and the work / school travel characteristics of the population (via *Place of Work, School or College - Census of Anonymised Records* (POWSCAR)).

CSAs are subsets of EDs. ED boundaries are commonly used as the unit of geographic information in Ireland and as such it was desirable to maintain a transparent relationship between EDs and the model zone system. Regional Model zones can be smaller or larger than either of these units where required.

The criteria used for developing zone boundaries for the SERM and other regional models included:

- Population, Employment and Education – maximum values were specified for zone population, number of jobs and persons in education;
- Activity Levels – limits were applied to zone activity levels ensuring that zones with either very low, or very high, levels of trips were not created;
- Intra-zonal Trips – threshold values were applied to the proportion of intra-zonal trips, within each zone, to avoid an underestimation of flow, congestion and delay on the network;
- Land Use – zones were created with homogeneous land use and socio-economic characteristics where possible;
- Zone Size / Shape – thresholds were applied to zone size, and irregularity of shape, to avoid issues with inaccurate representation of route choice;
- Political Geography – as mentioned above, it is possible to aggregate all zones to ED level i.e. zone boundaries do not intersect ED boundaries;
- Special Generators / Attractors – large generators / attractors of traffic such as Airports, Hospitals, shopping centres etc. were allocated to separate zones.

The SERM zone system includes a total of 654 zones which are illustrated in Figure 3-2 and Figure 3-3, overleaf. This includes two Special Zones covering demand to/from Rosslare and Belview Ports. Further information on the development of the SERM zone system can be found in the SERM Model Development Report.

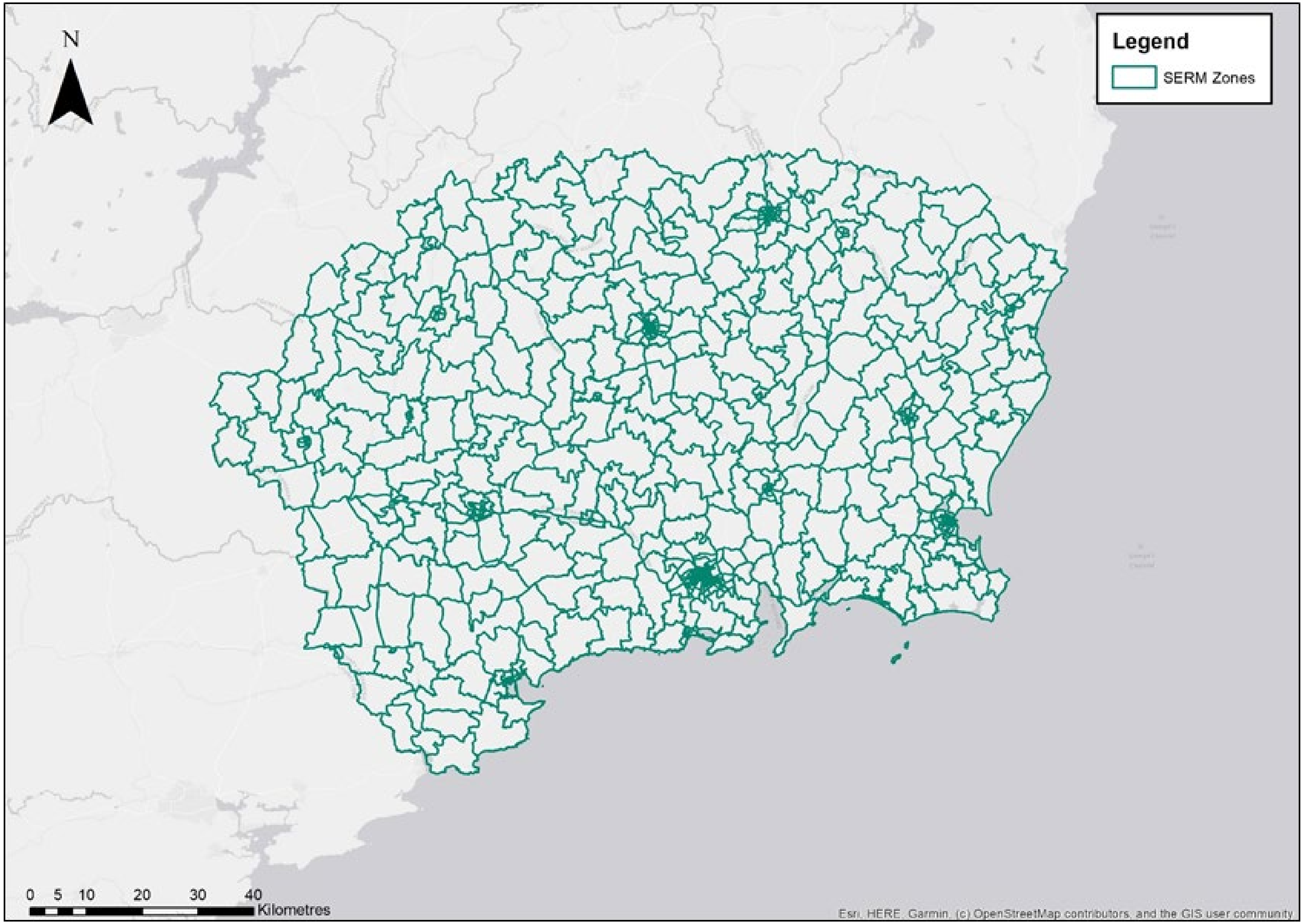


Figure 3-2: SERM Zone System – Full Model Area

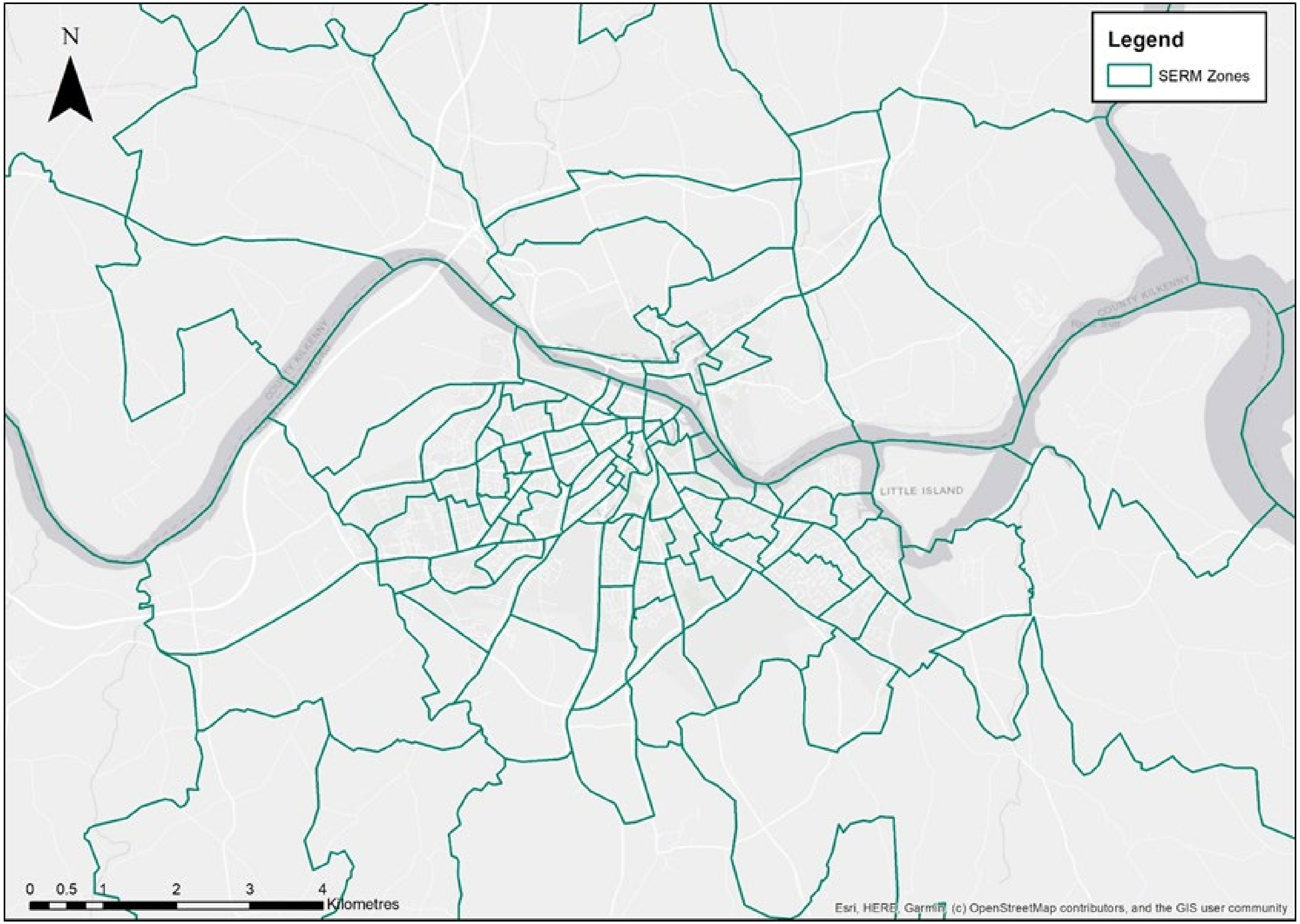


Figure 3-3: SERM Zone System – Waterford City

3.2.2 Modes of Travel

The regional model system covers all surface access modes for personal travel and goods vehicles:

- Private vehicles – taxis and cars;
- Public transport – bus, rail, Luas, BRT, Metro;
- Active modes – walking and cycling; and
- Goods vehicles – light goods vehicles and heavy goods vehicles.

3.2.3 Base Year

The current release version of the SERM has been calibrated to data from the 2017 National Household Travel Survey (NHTS) and 2016 Census, as well as traffic counts and public transport count data. The demand utilises the latest available 2016 census data on population and social demographics at a CSO Small Area level.

3.2.4 Time Periods

The model represents an average weekday. The day is split into five-time periods considered within each of the regional models, detailed in Table 3-2 below. The periods allow the relative difference in travel cost between time periods to be represented. Representative peak hours are used in the assignment models, which are based on period to peak hour factors derived for each time period and mode. The peak hour factors are derived from survey count data for each time period to represent the 'busiest' hour within the full demand period.

Table 3-2: Time Periods

Period	DEMAND MODEL FULL PERIOD	ASSIGNMENT PERIOD
AM Peak	07:00-10:00	Peak hour – based on a Peak Hour factor of 0.471 for cars, 0.539 for walking, 0.515 for cycling and 0.617 for public transport
Morning Inter Peak (IP1)	10:00-13:00	Peak hour – based on a Peak Hour factor of 0.522 for cars, 0.333 for active modes and 0.508 for public transport
Afternoon Inter Peak (IP2)	13:00-16:00	Peak hour – based on a Peak Hour factor of 0.422 for cars, 0.333 for active modes and 0.534 for public transport
PM Peak	16:00-19:00	Peak hour – based on a Peak Hour factor of 0.496 for cars, 0.34 for walking, 0.42 for cycling and 0.491 for public transport
Off Peak	19:00-07:00	Peak hour – based on a Peak Hour factor of 0.212 for cars, 0.083 for active modes and 0.519 for public transport

3.2.5 Demand Segmentation

Groups of people with similar travel behaviours (for example, commuters who own a car) are represented by distinct demand segments in the regional modelling system. This allows those groups to be treated differently in the regional demand model according to their behaviour.

The NDFM demand segments were derived from the National Household Travel Survey (NHTS) data and *Place of Work, School or College - Census of Anonymised Records* (POWSCAR) data sets. They have been segmenting into 33 distinct classifications as noted below in Table 3-3

Table 3-3: Demand Segments

No.	Purpose	Car Availability	Third Level of Segmentation
1	Commute	Available	Blue collar
2	Commute	Available	White collar
3	Commute	Not available	Blue collar
4	Commute	Not available	White collar
5	Education	Available	Primary
6	Education	Available	Secondary
7	Education	Available	Tertiary
8	Education	Not available	Primary
9	Education	Not available	Secondary
10	Education	Not available	Tertiary
11	Escort to education	Available	Primary
12	Escort to education	Available	Secondary
13	Escort to education	Available	Tertiary
14	Escort to education	Not available	Primary
15	Escort to education	Not available	Secondary
16	Escort to education	Not available	Tertiary
17	Other	Available	Employed
18	Other	Available	Non-working
19	Other	Not available	Employed
20	Other	Not available	Non-working
21	Shopping - food	Available	Employed
22	Shopping - food	Available	Non-working
23	Shopping - food	Not available	All
24	Visit friends / relatives	Available	Employed
25	Visit friends / relatives	Available	Non-working
26	Visit friends / relatives	Not available	All
27	Employers Business	All	All
28	All	Available	Retired
29	All	Not Available	Retired
30	One-way business	Available	All
31	One-way business	Not available	All
32	One-way other	Available	All
33	One-way other	Not available	All

3.3 SERM Structure

3.3.1 Overarching RMS Structure

The general structure of the NTA's Regional Modelling System (RMS) is outlined in Figure 3-4: Model Structure. The National Demand Forecasting Model (NDFM) generates travel demand based on planning information on population, employment and education. This travel demand is then fed into the Regional Model (in our case the SERM) where mode and destination choice is undertaken, and it is then assigned to the road, public transport and active (walking and cycling) networks. The model represents a neutral weekday/month in 2016, and the following sections provide a brief overview of the key elements of the RMS.

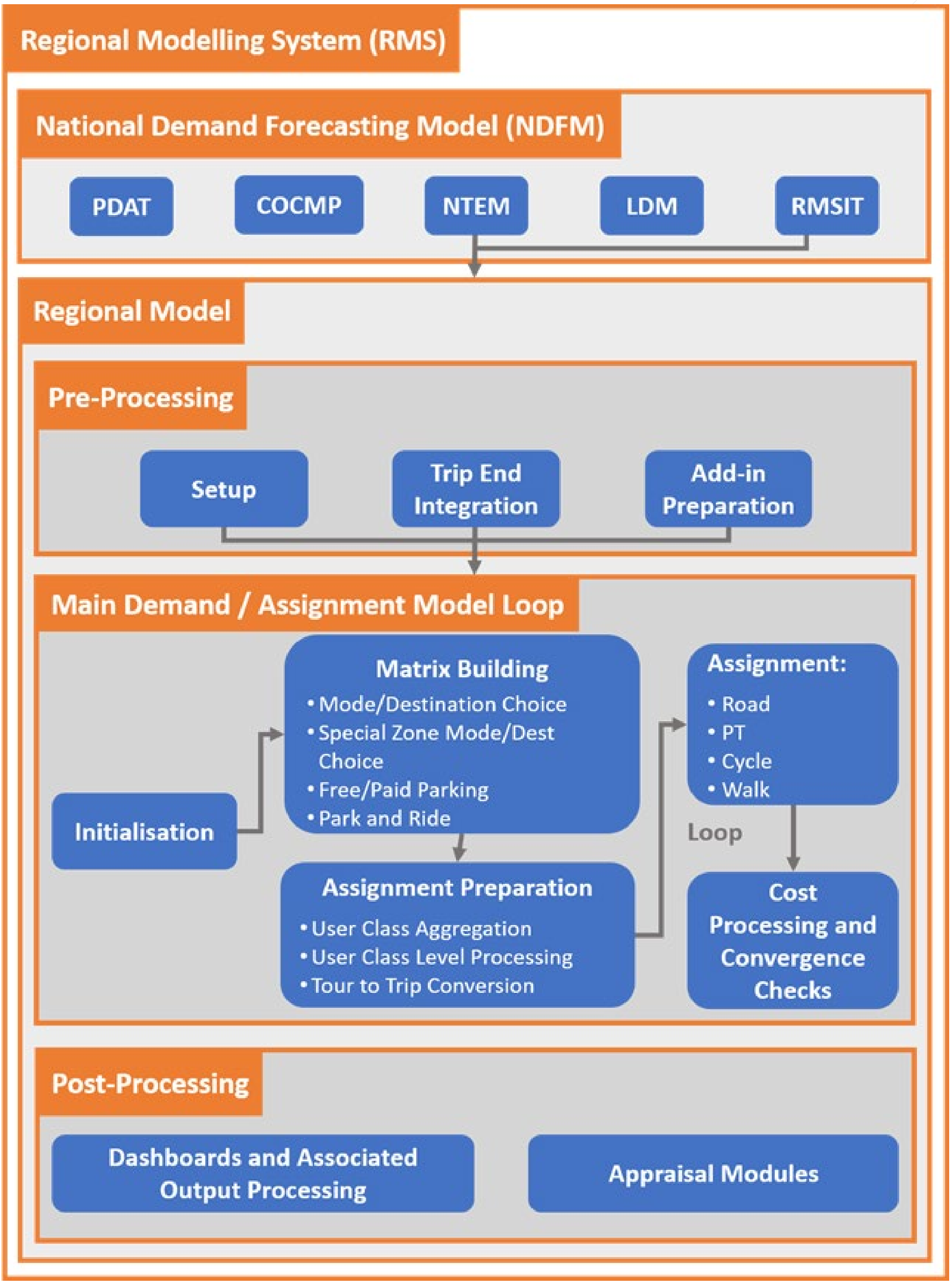


Figure 3-4: Model Structure

3.3.2 Planning Data

The Planning Data referred to above is a national database of 99 demographic and spatial variables for each of the 18,641 CSAs in the state. The main categories of planning data are:

- References and spatial definitions;
- Origin-based person types; e.g. age bands, gender, principal economic status (PES), employment type, and various combinations of categories;
- Destination-based person types; e.g. employment type or education type; and
- Households.

3.3.3 National Demand and Forecasting Model (NDFM)

The ***NDFM*** is a separate modelling system that estimates the total quantity of travel demand generated by and attracted to every Census Small Area (CSA) daily. The level of demand from, and to, each zone (referred to as 'trip ends') is related to characteristics such as population, number of employees and land-use data as outlined in Section 2.

The NDFM comprises the set of models and tools that are used to derive national levels of trip making, for input to each of the regional models. The NDFM outputs the levels of trip making at the smallest available spatial aggregation (CSA).

The key components of the NDFM are as follows:

- The **Planning Data Adjustment Tool (PDAT)** controls the planning data inputs to the core NDFM system. It is used to amend planning data to represent the combination of general changes over time and the relevant land-use planning scenarios;
- The **Car Ownership/Car Competition Model (COCMP)** estimates the level of car ownership in a CSA, (sub-dividing the number of households in each CSA between 'No Car', 'Cars < Adults' and 'Cars >= Adults' households) i.e. the car competition bands;
- The **National Trip-End Model (NTEM)** converts the planning data into person trips, using calibrated trip rates;
- The **Long Distance Model (LDM)** calculates settlement-to-settlement trips across the island of Ireland allowing the number of trips between different regions (and to/from Northern Ireland) to be estimated, as well as providing consistency in the overlap areas; and
- The **Regional Modelling System Integration Tool (RMSIT**) converts the private car, PT and HGV movements produced by the LDM and thus provides consistent flow data to each Regional Model boundary with respect to traffic moving into, through, and out of each region.

3.3.4 SERM Demand Model

The **Demand Model** models travel behaviour and is implemented in Cube Voyager. The demand model processes all-day travel demand from the NDFM through a series of choice models to represent combined mode, time of day, destination and parking decision making. The outputs of the demand model are a set of trip matrices which are assigned to the Road, Public Transport and Active Modes models to determine the route-choice and generalised costs.

3.3.5 SERM Road Assignment Model

The **Road Assignment Model** (RDAM) is implemented in SATURN and includes capacity restraint whereby travel times are recalculated in response to changes in assigned flows. The main purpose of the RDAM is to assign road users to routes between their origin and destination zones. The cost of travel is then calculated by the RDAM for input to the demand model and economic appraisal.

It should be noted that SATURN is a macroscopic model and considers the aggregate behaviour of traffic flows. It does provide detail on junction delay and queueing along links. However, it is a strategic model that is used to look at impacts across a wider area. Whilst suitable for the purposes of this strategic assessment it is not suitable for detailed junction modelling which consider the interaction of individual vehicles which should be undertaken using a microscopic model such as VISSIM or PARAMICs.

The inputs to the Road Assignment model from the demand model are the road assignment matrices from the assignment preparation stage. The outputs from the Road Assignment model for the demand model processes consist of generalised costs skims by time period and assigned road networks in CUBE Voyager format which are passed on to the Public Transport model.

In addition to these requirements for demand model processes, there are a series of standard SATURN outputs that are produced for use in the specific interrogation of the road networks for scheme and/or scenario assessment.

3.3.6 SERM Public Transport Assignment Model

To generate costs to update the choice model processes, a Public Transport assignment must be undertaken to establish new generalised costs. The **Public Transport Assignment Model** (PTAM) is implemented in Voyager and is used to allocate public transport users to services between their origin and destination zones. The model includes a representation of the public transport network and services for existing and planned modes within the modelled area. The model includes:

- Rail;
- DART;
- Luas;
- Metro.
- Urban Bus;
- Inter-Urban Bus; and
- Bus Rapid Transit (BRT).

The outputs of the public transport assignment model fall into two categories, those required by the demand model, and those produced for reporting and analysis purposes.

The outputs from the Public Transport Assignment model for the demand model processes consist of the assigned networks which are passed on to active mode assignment as the starting point for their network build procedure, and generalised cost skim matrices by user class for each of the assigned time periods that feed back into the main Mode and Destination choice demand model loop.

3.3.7 SERM Active Modes Model

The Regional Modelling System represents active modes (i.e. walking and cycling) within the demand model to improve the realism of travel choices. To generate costs to update the choice model processes, an **active modes assignment** must take place to establish new generalised costs. This active mode assignment assumes no crowding or delays.

The inputs for the active assignment model are the output CUBE format Public Transport networks, the demand model produced assignment matrices and separate input pedestrian only links and cycle lanes. The outputs of this process include an assigned network with walk and cycle flows by user class, and a set of generalised cost skims. The active assignment is a CUBE-based lowest cost path assignment model with no junction modelling based purely on distance and a constant speed by mode.

Walk speeds are taken as 5.1km/h, independent of link type, for Employee (EMP), Commuter (COM) and Others (OTH) user classes. In the case of the Education and Retired user classes, this default walk speed is factored (by 0.94 for EDU and by 0.92 for RET). For cycling, a rule-based system was developed during model specification to assign speeds based on link type. Hence, where information on Quality of Service, and/or descriptions of other characteristics (e.g. road type, presence of marked cycle lanes, etc.) is available, speeds of between 14.1km/h and 22.2km/h have been assigned based on the quality of the link. Improvements to cycling mode provision are included through associating improvements to cycling Quality of Service to increases in service user speeds.

3.4 Suitability of South-East Regional Model in Developing the Strategy

3.4.1 Model Calibration and Validation

It is important that a strategic transport model is appropriately calibrated and validated in line with best practice guidelines. The SERM has been subject to a comprehensive calibration and validation process whereby a substantial amount of observed data has been incorporated into both the demand model and the assignment models as presented in Table 3-4.

Table 3-4: Observed data used for model calibration and validation

Demand Model	Assignment Models
Tour proportions	Road traffic volumes
Generalised cost distributions	Road journey times
Travel distance distributions	Road trip length distribution
Modal share	Public transport in-vehicle time factors
Journey time distribution	Public transport fares and ticket types
	Public transport passenger flows
	Public transport boardings and alightings
	Public transport journey times
	Public transport interchange/transfers

The calibration and validation process ensures that the SERM accurately reflects existing conditions and 'costs' associated with travel. This allows changes in the forecasting of transport demand and strategic transport infrastructure schemes and appropriate transport policies to be modelled and tested using the SERM. Further details on the model calibration can be found in the SERM Demand, Road, Public Transport and Active Mode development reports, available from the NTA.

3.4.2 Use of SERM for Strategic Transport Planning

The model has many strengths and features that make it the ideal tool to aid the strategic planning process. The SERM has been developed from first principles making best use of the most recently available data (POWSCAR and NHTS) to replicate travel choices and transport network conditions as accurately as possible.

Several distinct journey purposes and characteristics including car availability, employment status, and education level are considered within the model to evaluate travel choices more accurately. This carries through to forecasting whereby specific person type demand can be forecast to derive appropriate trip distributions and future year travel conditions.

The model utilises a tour-based approach which allows for more accurate mode choice modelling and consideration of travel costs, particularly with respect to the inclusion of parking charges.

Four main modes of travel: private car, public transport, walking, and cycling are included in the model. Each mode has been calibrated individually, for each journey purpose, to replicate observed trip cost distributions.

The use of SATURN software in the road model allows for junction modelling to be included in the model which improves typical network representation in congested areas over an entirely link-based approach. Link speeds and delays are transferred to the public transport model which allows journey times of on-street modes (Bus, BRT) to reflect perceived traffic conditions rather than a strict timetable.

The model covers the WMA region plus surrounding counties, and takes full account of travel within, into and out of the WMA area. As the model is also used as the basis for scheme evaluation, the transport networks represented contain a level of detail beyond that which would be normally required for its use as a strategic transport planning tool.

To account for the availability of parking facilities in Waterford City Centre, both a free workplace parking model and a parking constraint model have been implemented to re-evaluate mode choice based on whether parking was available at the travellers' ultimate destination.

There are however, as with all transport models, limitations to what the model can be used to assess. There are several potential measures which cannot be assessed using the SERM. These include, amongst others;

- Intelligent Transport measures which improve wayfinding, management of parking and route choices;
- Behavioural Change Initiatives which influence choice of mode and time of travel;
- Public Transport measures such as Real Time Information and integrated ticketing;
- Public Ream enhancements – which improve the quality of the environment and likelihood for walking/cycling trips.

SATURN does provide some information on the performance of individual junctions however, junction operation assessments should be undertaken at a more localised level using microscopic modelling. For the purposes of this strategy however, such a level of detail is not required. Any measures identified in the strategy will need to undergo further assessment as part of their future appraisal, which may include further modelling.

3.4.3 Summary

The South East Regional Model (SERM) provides a comprehensive representation of travel patterns across the Waterford Metropolitan Area and is a suitable tool for the testing and appraisal of the Strategy. The limitations of strategic transport models are recognised and fully understood. The SERM is considered the appropriate tool for fulfilling the NTA's requirements in terms of its planning and appraisal needs.

4 Modelled Scenario Comparison

4.1 Introduction

This section of the report outlines a comparison of the characteristics of the demand between the two 2040 modelled scenarios, the Do-Minimum Scenario and the Idealised Network Scenario. An overview of each scenario is provided below.

4.1.1 Do-Minimum Scenario

This scenario represents the committed future transport network, i.e. the base transport network with committed road improvements in place.

4.1.2 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.

4.2 2040 Transport Demand Characteristics

4.2.1 Profile of Demand throughout the Day

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 4-1. 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.

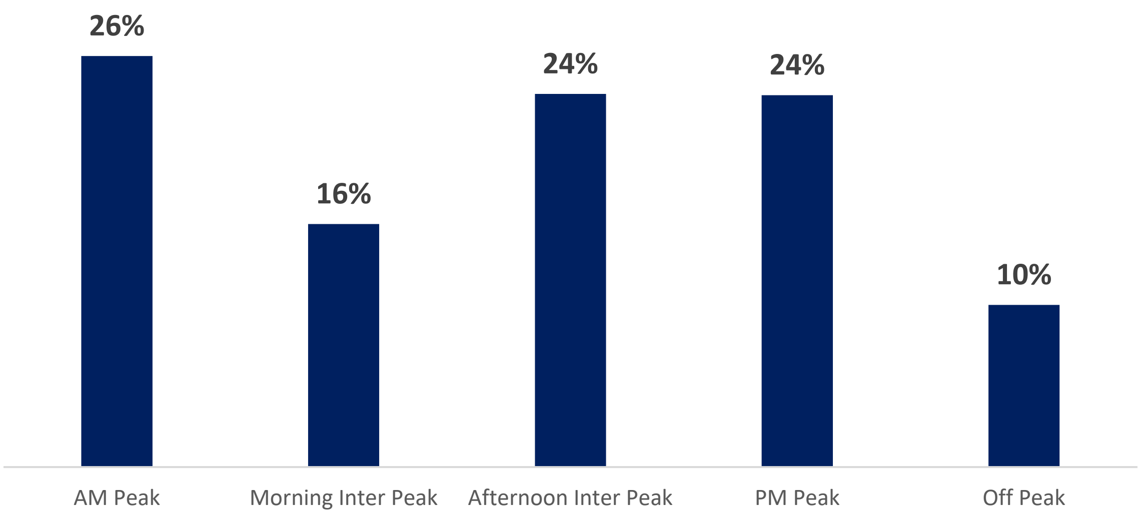


Figure 4-1: Percentage of 2040 Demand by Time Period

4.2.2 Breakdown of Trip Purposes

The breakdown of 2040 demand between trip purposes is shown in Figure 4-2 (by time period) and in Figure 4-3 (for the 24-hour period). As expected, the highest proportions of commuting trips occur during the AM and PM peaks, whilst education trips occur mostly during the AM peak, PM peak, and the afternoon interpeak periods. The 'other' trip purpose is the largest purpose type in the morning inter peak, afternoon inter peak and off-peak time periods, as well as the largest component of trip demand over the whole 24-hour period. This category includes trips made by those in retirement, visiting friends and relatives, food shopping, leisure trips and non-food related shopping trips.

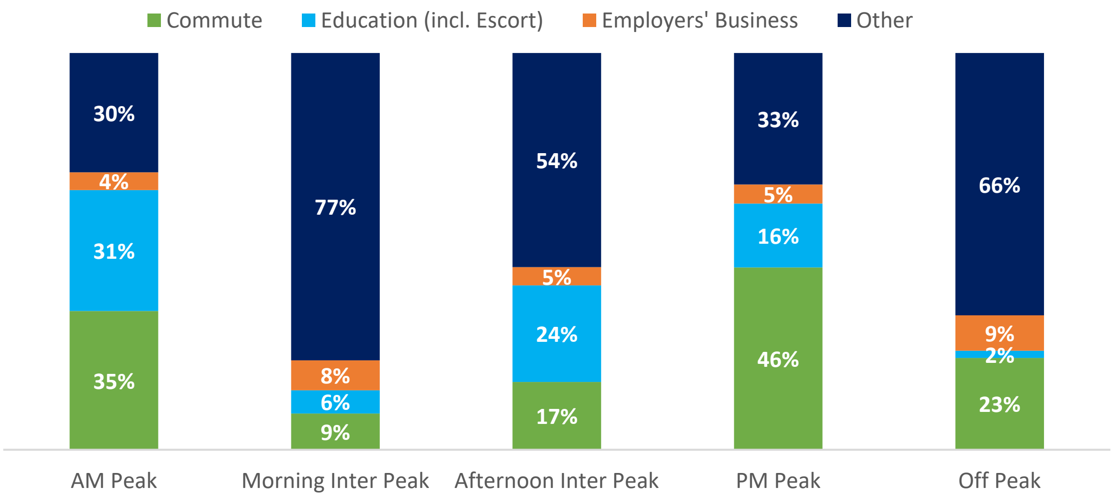


Figure 4-2: Percentage of 2040 Demand by Trip Purpose per Time Period

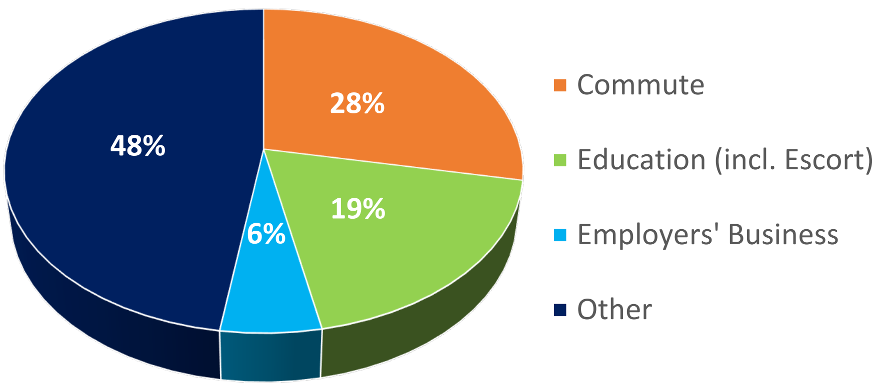


Figure 4-3: Percentage of 2040 24-Hour Demand by Trip Purpose

4.2.3 Overall Mode Share Comparison

The mode shares under each scenario for the 24-hour period are shown below in Figure 4-4. Figure 4-4 indicates 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 4-4 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.

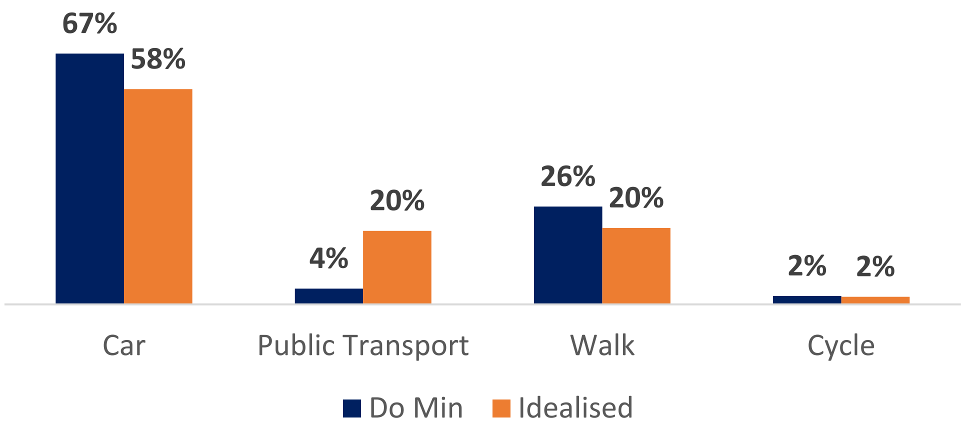


Figure 4-4: Waterford Metropolitan 2040 24-Hour Mode Share Split Comparison

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.

4.2.4 Mode Share by Trip Purpose Comparison

The breakdown of mode share by trip purpose is outlined in Table 4.1 and Table 4.2 for the 2040 Do Minimum and Idealised Network scenarios respectively. The data contained within the tables indicate that the commuting and education car mode shares reduce significantly under the Idealised scenario by 10.9% and 16.6% respectively, with a less significant reduction of 6.6% observed for 'other' car trips compared to the Do Min scenario.

Table 4.1: Waterford Metropolitan Area 2040 Do Min Mode Share by Trip Purpose

Purpose	Car	Public Transport	Walk	Cycle
Commute	78%	5%	15%	3%
Education	47%	9%	42%	2%
All Other Purposes	69%	3%	27%	2%

Table 4.2: Waterford Metropolitan Area 2040 Idealised Mode Share by Trip Purpose

Purpose	Car	Public Transport	Walk	Cycle
Commute	67%	22%	8%	2%
Education	31%	46%	22%	1%
All Other Purposes	62%	9%	26%	2%

4.2.5 Mode Share by Area

A comparison of 24-hour mode share under each scenario for both the Waterford City and Suburbs area and Remaining Metropolitan Area are presented in Figure 4-5. Figure 4-5 shows that there is a significant uplift in the level of public transport use across all areas in the 2040 Idealised scenario, from 4% to 20% in the City and Suburbs area, and from 3% to 19% in the Remaining Metropolitan Area. Along with the expected reductions in the car mode share, walking mode share also drops across all areas as a result of enhanced public transport under the Idealised scenario.

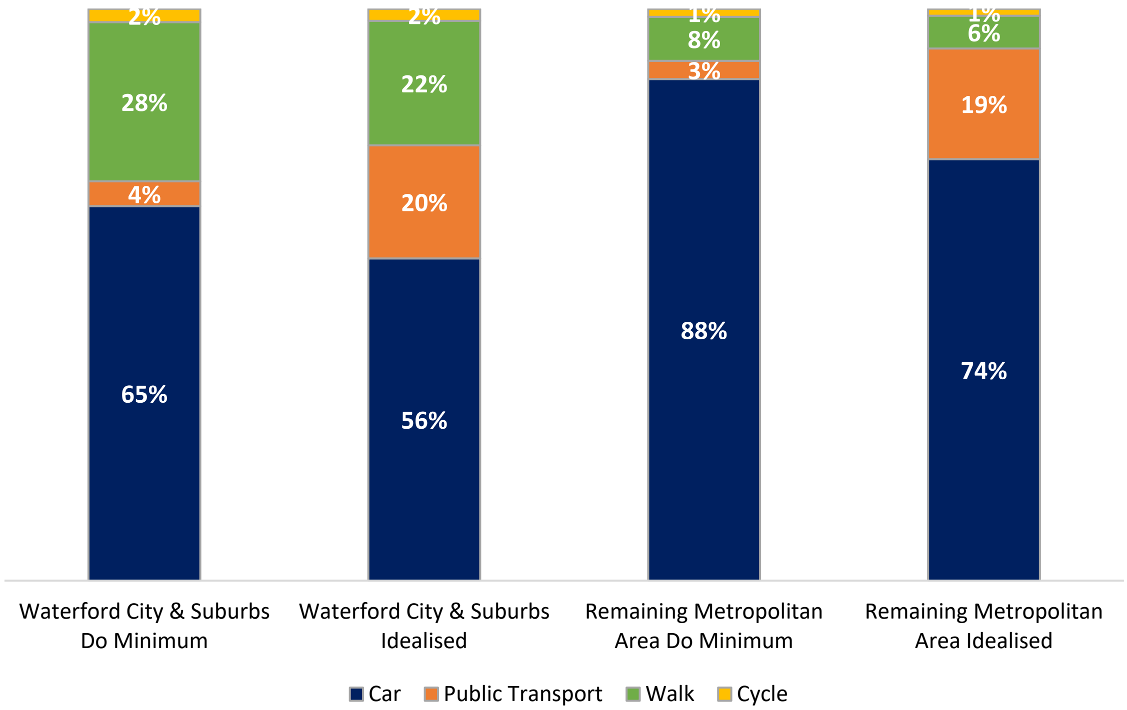


Figure 4-5: Waterford Metropolitan 2040 24-Hour Mode Share Split by Area

Additionally, a detailed breakdown of the car mode share by SERM zone is shown in Figure 4-6 and Figure 4-7 for the Do-Minimum and Idealised Network scenarios. Figures 4-6 and 4-7 show notable decreases in the car mode share throughout the WMA, particularly in the wider suburbs, in the idealised scenario. Both scenarios indicate the benefit of concentrating future land use growth in the city centre with car mode shares consistently less than 50% in these central areas.

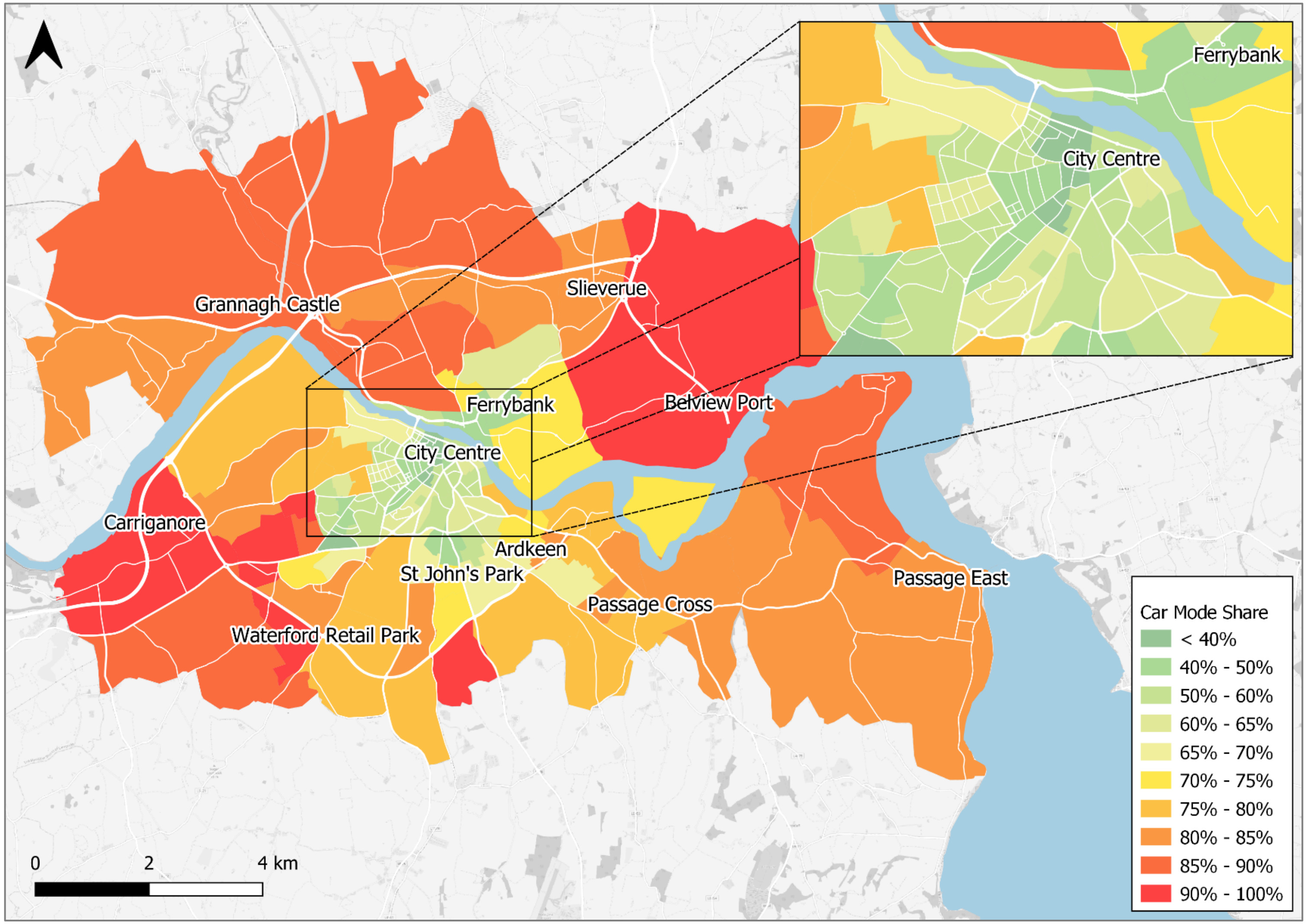


Figure 4-6: Waterford Metropolitan 24-Hour 2040 Do Minimum Scenario: Car Mode Share by SERM Zone

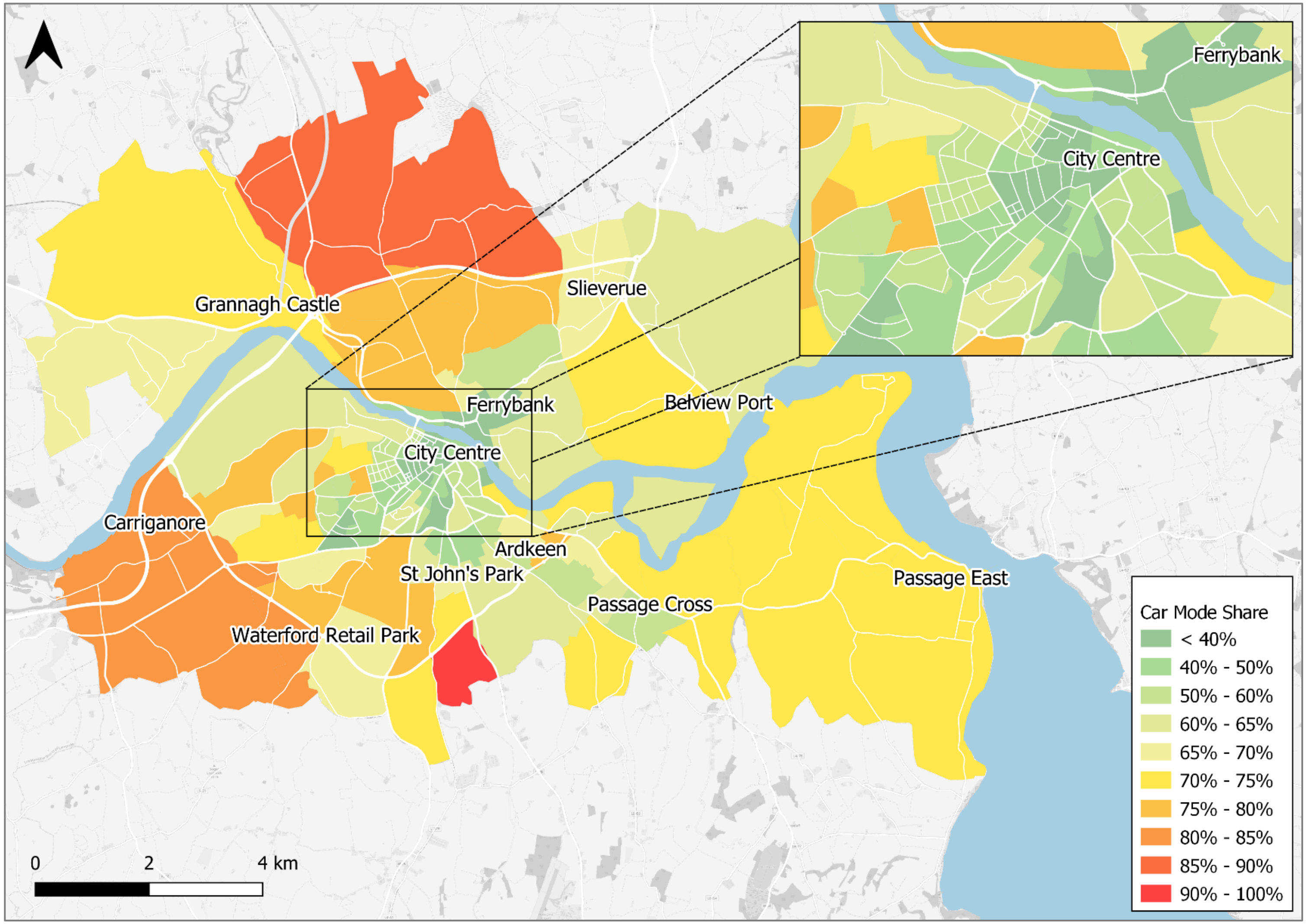


Figure 4-7: Waterford Metropolitan 24-Hour 2040 Idealised Scenario: Car Mode Share by SERM Zone

4.2.6 Mode Share by Time Period

Figure 4-8 and Figure 4-9 show the mode shares in the WMA by time period for the 2040 Do-Minimum and Idealised Network scenarios, respectively. A comparison of Figure 4-8 and Figure 4-9 indicates a significant increase in public transport mode share across all time periods, particularly the AM and PM peaks. This is due to both reductions in the car mode share and walk trips replaced by public transport.

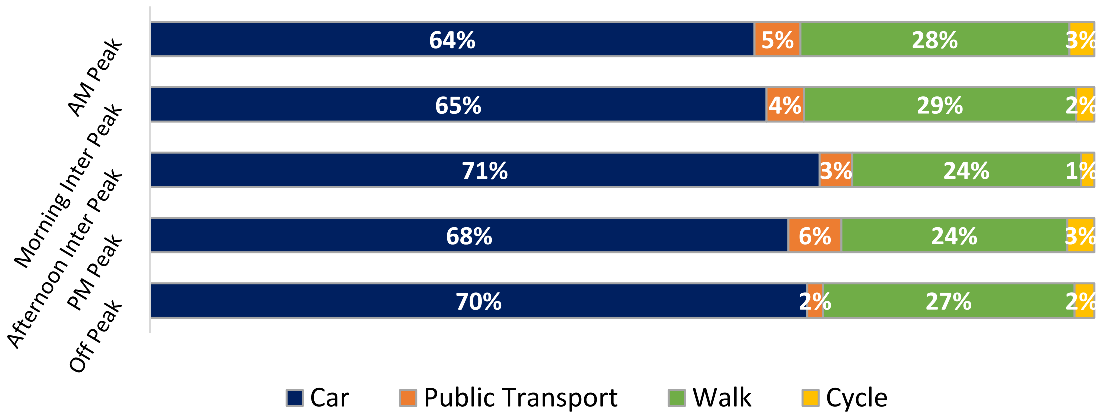


Figure 4-8: 2040 Do-Minimum Scenario Mode Shares by Time Period

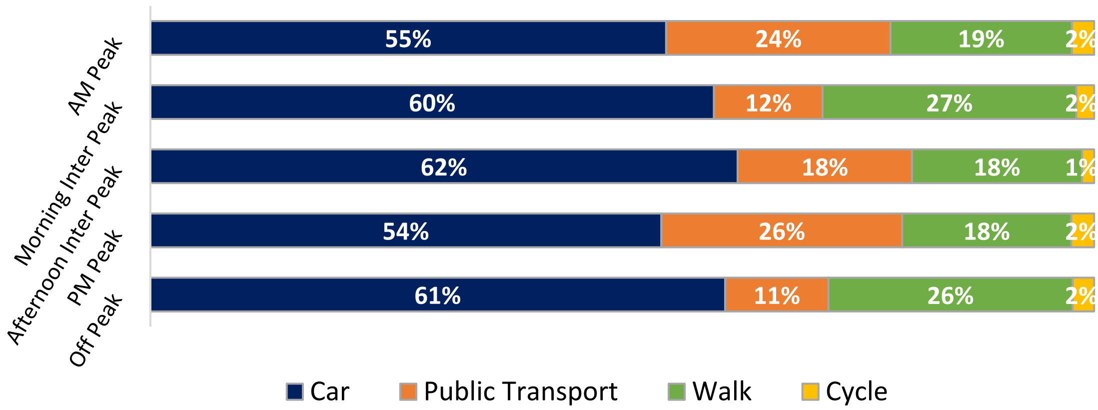


Figure 4-9: 2040 Idealised Network Scenario Mode Shares by Time Period

4.3 Transport Demand Movement Patterns

4.3.1 Sector to Sector Comparison Analysis

The movements between defined sectors (illustrated in Figure 4-10) were also extracted from the SERM for the 24-Hour and AM periods, and the results are presented in Table 4.3 and Table 4.4. As shown, there is strong demand to and from Waterford City Centre, particularly from Tycor and Ardkeen/ Ballinakill/ Knockboy. There is also a strong local demand between Ballytruckle/ Kilcohan and Ardkeen/ Ballinakill/ Knockboy to the south east of the city. This is likely to represent demand between residential estates in the area and local schools and employment such as the University Hospital Waterford.

Outside of the main study area, Carrick-on-Suir is the highest generator of trips travelling to the WMA in the AM peak period (approx. 1,050 trips) followed by Kilkenny city (701 trips), New Ross (613 trips) and Dungarvan (595 trips).

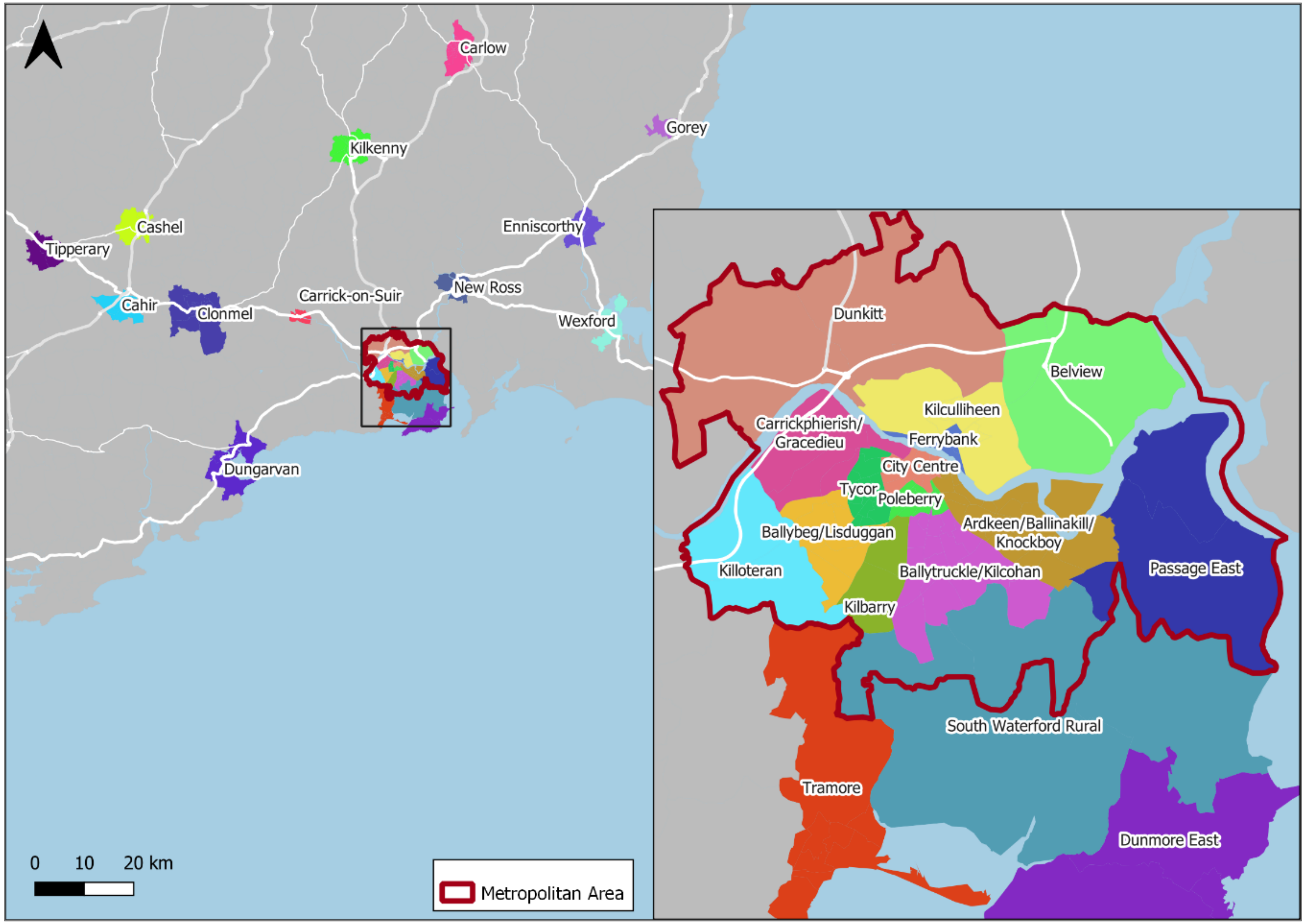


Figure 4-10: Sector System used for Origin-Destination Analysis

Table 4.3 Settlement to Settlement Idealised 24 Hour 2040 Demand

	City Centre	Ferrybank	Tycor	Poleberry	Carrickphierish/ Gracedieu	Ballybeg/ Lisduggan	Kilbarry	Ballytruckle/ Kilcohan	Ardkeen/ Ballinakill/ Knockboy	Passage East	South Waterford Rural	Killoteran	Kilculliheen	Tramore	Dunmore East	Belview	Dunkitt	Cahir	Carlow	Carrick-on-Suir	Cashel	Clonmel	Dungarvan	Enniscorthy	Gorey	Kilkenny	New Ross	Tipperary	Wexford	Total Origin
City Centre	9,376	1,128	4,079	2,010	2,782	1,693	681	3,555	3,967	205	247	270	2,195	1,200	369	284	322	30	99	407	5	107	227	53	19	357	263	13	114	36,055
Ferrybank	1,043	1,040	477	149	416	410	82	379	702	48	36	43	2,119	150	55	401	263	9	35	122	1	45	37	25	8	131	152	5	50	8,435
Tycor	4,469	445	6,682	1,884	2,439	2,330	1,016	3,452	2,890	224	253	258	685	1,814	172	136	130	14	62	212	6	74	302	33	11	249	164	8	61	30,476
Poleberry	1,914	155	1,380	1,235	585	738	315	1,188	1,345	76	84	157	238	432	71	54	37	3	18	54	1	18	83	9	3	52	40	2	19	10,302
Carrickphierish/ Gracedieu	3,120	386	2,277	596	2,529	1,156	347	1,123	1,412	90	105	166	590	417	119	119	140	7	33	125	2	31	81	15	5	115	82	4	28	15,221
Ballybeg/ Lisduggan	1,891	400	2,281	974	1,033	2,235	1,224	2,100	2,749	404	186	235	688	865	126	127	165	16	102	179	2	50	215	30	10	279	131	7	50	18,758
Kilbarry	1,127	57	1,292	476	469	1,090	1,069	709	788	58	54	84	109	299	37	37	30	1	5	18	0	6	20	3	1	31	19	0	6	7,895
Ballytruckle/ Kilcohan	3,123	288	1,929	1,384	1,247	2,469	756	7,853	8,077	384	591	267	564	761	205	153	67	2	16	59	1	24	91	10	2	101	61	1	29	30,518
Ardkeen/ Ballinakill/ Knockboy	4,524	805	2,360	1,188	1,639	3,211	826	7,098	18,673	1,175	752	413	2,109	972	459	434	314	10	53	237	3	63	167	42	7	248	283	5	93	48,165
Passage East	335	52	197	69	137	447	71	315	1,162	1,598	89	45	85	94	115	43	14	0	5	12	0	6	12	4	0	22	29	0	21	4,980
South Waterford Rural	213	27	122	86	94	265	68	626	823	83	338	23	35	245	216	16	7	0	2	7	0	2	7	1	0	9	5	0	3	3,324
Killoteran	211	65	262	111	176	264	142	242	405	55	18	162	249	127	13	27	59	1	8	31	0	6	49	4	1	55	21	1	5	2,770
Kilculliheen	1,896	2,148	719	208	679	605	189	787	1,486	66	100	182	8,223	272	126	1,899	811	6	31	190	2	51	62	51	8	231	467	3	75	21,573
Tramore	1,579	142	1,073	574	426	774	350	658	1,015	115	250	96	271	19,624	362	101	50	2	39	78	1	21	110	7	1	85	32	1	21	27,857
Dunmore East	353	39	139	85	135	248	55	252	537	113	231	15	41	361	1,725	26	8	0	3	9	0	5	8	2	0	17	10	0	9	4,427
Belview	229	387	152	49	140	115	50	214	347	34	21	30	1,873	103	30	897	223	7	30	145	1	30	30	23	6	102	179	4	45	5,497
Dunkitt	235	403	123	27	155	112	29	107	188	7	9	39	1,464	34	14	188	869	6	12	297	1	34	20	5	1	107	36	2	10	4,536
Cahir	32	10	16	4	8	16	1	3	12	0	0	1	7	2	0	8	8		6	40	566	1,539	10	1	0	80	3	236	3	2,613
Carlow	125	39	71	20	36	75	6	22	57	5	2	7	35	16	3	30	13	5		14	9	24	10	113	38	951	31	5	88	1,852
Carrick-on-Suir	349	113	218	44	121	175	25	60	152	8	8	21	161	74	11	143	181	80	18		42	1,559	79	5	1	194	26	18	21	3,905
Cashel	7	2	6	1	2	3	0	2	4	0	0	0	3	1	0	2	3	630	10	18		597	5	1	0	116	3	269	2	1,689
Clonmel	129	46	84	21	38	51	8	30	78	7	3	6	71	20	5	29	71	1,774	24	784	711		188	6	2	324	19	307	19	4,857
Dungarvan	227	40	258	70	89	206	34	89	164	13	5	45	70	98	8	33	17	8	13	88	6	181		8	2	67	22	2	24	1,886
Enniscorthy	44	19	30	7	15	29	3	11	24	2	1	2	32	5	1	19	4	0	85	4	1	4	4		489	77	415	1	1,748	3,078
Gorey	21	9	12	3	5	10	1	2	6	0	0	1	8	1	0	7	1	0	33	1	0	1	1	473		29	40	0	563	1,227
Kilkenny	282	132	269	46	113	220	30	108	184	18	10	27	191	61	16	68	85	62	892	163	82	233	44	65	23		192	64	93	3,773
New Ross	247	122	213	45	125	196	36	154	209	25	20	17	384	42	20	145	52	2	26	41	2	17	17	338	38	217		1	702	3,454
Tipperary	18	4	10	2	4	8	1	2	7	0	0	1	4	1	0	4	3	204	7	20	276	285	1	1	0	99	2		3	968
Wexford	83	52	56	14	31	52	7	32	63	18	3	4	83	14	7	34	10	1	57	15	1	11	11	1,801	511	79	672	1		3,723
Total Destination	37,204	8,554	26,787	11,384	15,668	19,205	7,422	31,173	47,525	4,834	3,415	2,617	22,589	28,104	4,287	5,464	3,958	2,883	1,727	3,371	1,724	5,025	1,893	3,128	1,187	4,425	3,399	959	3,905	313,815

Table 4.4 Settlement to Settlement Idealised 2040 AM Demand

	City Centre	Ferrybank	Tycor	Poleberry	Carrickphierish / Gracedieu	Ballybeg/ Lisduggan	Kilbarry	Ballytruckle/ Kilcohan	Ardkeen/ Ballinakill/ Knockboy	Passage East	South Waterford Rural	Killoteran	Kilculliheen	Tramore	Dunmore East	Belview	Dunkitt	Cahir	Carlow	Carrick-on-Suir	Cashel	Clonmel	Dungarvan	Enniscorthy	Gorey	Kilkenny	New Ross	Tipperary	Wexford	Total Origin
City Centre	1,943	222	700	277	511	365	57	423	752	19	24	19	189	84	18	72	38	1	6	12	0	9	20	9	1	56	36	0	23	5,888
Ferrybank	400	308	203	43	156	268	6	35	149	2	2	18	369	9	2	252	50	0	6	10	0	14	8	3	0	62	24	0	20	2,421
Tycor	2,089	119	1,677	435	1,007	751	108	757	516	17	22	32	85	187	11	45	20	0	4	9	0	6	25	4	1	42	20	0	10	8,001
Poleberry	577	54	528	225	172	206	38	251	296	4	7	17	41	42	4	23	6	0	3	3	0	3	7	1	0	12	7	0	5	2,532
Carrickphierish/ Gracedieu	1,340	129	605	91	978	513	32	158	384	10	9	29	80	22	5	44	31	0	2	7	0	4	11	3	0	23	17	0	6	4,534
Ballybeg/ Lisduggan	728	41	513	155	224	638	280	323	352	18	8	24	64	64	3	31	25	0	5	7	0	3	19	4	1	67	20	0	9	3,628
Kilbarry	591	35	460	124	167	413	335	208	221	6	7	19	42	56	4	22	16	0	1	3	0	2	4	1	0	14	9	0	2	2,765
Ballytruckle/ Kilcohan	1,265	158	629	283	386	1,030	178	2,894	2,447	81	124	65	124	198	34	71	12	0	5	11	0	9	19	3	0	46	14	0	11	10,098
Ardkeen/ Ballinakill/ Knockboy	2,062	316	720	286	485	1,177	123	1,862	5,065	244	124	65	372	150	56	189	69	1	11	21	1	17	27	14	2	69	70	0	39	13,638
Passage East	186	31	76	17	42	143	11	85	385	532	29	8	25	29	34	26	6	0	2	4	0	3	4	2	0	10	19	0	10	1,721
South Waterford Rural	112	17	44	24	38	139	22	300	243	13	65	6	14	83	41	9	4	0	1	4	0	1	2	0	0	4	1	0	1	1,187
Killoteran	63	12	61	17	57	89	32	54	78	5	2	32	21	14	0	7	13	0	1	5	0	1	8	1	0	17	3	0	2	596
Kilculliheen	780	1,164	286	64	296	163	27	319	486	16	4	92	2,510	39	6	1,180	435	1	8	43	1	14	19	11	1	104	124	0	27	8,217
Tramore	569	82	536	178	177	337	121	176	307	17	66	24	39	5,837	59	47	6	0	5	15	0	6	20	2	0	32	8	0	8	8,675
Dunmore East	205	25	64	29	60	150	19	111	229	27	77	4	20	150	485	16	5	0	1	4	0	2	2	1	0	7	4	0	4	1,702
Belview	49	62	29	5	32	19	3	30	49	1	1	8	266	3	1	305	38	0	2	12	0	3	2	3	1	23	30	0	10	987
Dunkitt	116	209	56	10	83	33	5	42	84	1	1	8	375	3	2	110	294	0	2	51	0	7	2	1	0	29	10	0	3	1,537
Cahir	19	7	9	2	5	11	0	1	5	0	0	1	3	0	0	6	4		2	13	163	582	1	0	0	36	1	42	1	914
Carlow	82	23	43	10	24	50	2	6	24	1	0	3	13	3	0	19	5	1		3	2	10	3	33	7	379	9	1	31	789
Carrick-on-Suir	256	83	135	26	79	118	7	18	74	1	1	8	47	14	1	108	74	9	6		6	463	19	2	0	84	10	2	11	1,660
Cashel	3	1	3	0	1	1	0	0	1	0	0	0	1	0	0	1	1	76	3	2		133	0	0	0	40	1	50	1	319
Clonmel	74	20	47	9	20	34	2	5	23	1	0	3	16	3	0	16	24	201	5	91	119		14	2	0	107	5	22	7	868
Dungarvan	100	18	136	19	45	105	11	21	49	2	1	19	21	25	1	16	6	1	4	15	1	45		2	0	22	6	0	8	698
Enniscorthy	20	9	12	3	7	20	1	2	7	0	0	1	11	1	0	8	2	0	20	1	0	1	1		71	32	116	0	608	953
Gorey	14	6	8	1	3	7	0	0	3	0	0	0	4	0	0	4	1	0	15	0	0	1	0	213		15	16	0	334	646
Kilkenny	146	38	153	16	56	123	4	20	49	1	1	9	29	7	1	32	16	5	150	15	13	71	7	11	2		38	4	29	1,045
New Ross	85	55	65	12	39	119	3	21	37	1	1	10	100	4	1	45	15	0	6	8	0	5	3	58	5	67		0	249	1,019
Tipperary	13	3	6	1	3	6	0	0	4	0	0	0	2	0	0	2	1	56	3	9	84	152	0	0	0	53	1		1	403
Wexford	36	18	23	5	14	35	1	3	12	2	0	2	19	2	1	16	3	0	9	2	0	3	2	317	33	25	96	0		681
Total Destination	13,923	3,266	7,828	2,366	5,167	7,063	1,427	8,125	12,331	1,023	576	526	4,901	7,030	772	2,722	1,220	355	289	380	394	1,571	247	703	129	1,478	713	124	1,471	88,120

5 Corridor Analysis

5.1 Overview

To facilitate analysis of 2040 travel demand within the WMA, the area was divided into several corridors based on the national and regional transport networks around a central 'city centre' core. This section of the report provides a comparison of overall demand from each corridor and an analysis of the demand characteristics and distribution for each corridor using outputs from the SERM 2040 idealised network model run. It should be noted that areas outside of the defined metropolitan boundary such as Tramore, Passage East and Dunmore East have also been included in this analysis. This is to reflect the strong linkages between these areas and Waterford City, and ensure that this demand is catered for in the transport strategy.

The defined corridors are as follows:

- Corridor A: Ardkeen/Ballinakill/Knockboy and Passage East
- Corridor B: Poleberry, Ballytruckle/Kilcohan, South Waterford Rural and Dunmore East
- Corridor C: Poleberry, Tycor, Ballybeg/Lisduggan, Kilbarry, Killoteran and Tramore
- Corridor D: City Centre, Tycor, Carrickphierish/Gracedieu, Ballybeg/Lisduggan and Killoteran
- Corridor E: Ferrybank, Kilculliheen and Dunkitt
- Corridor F: Ferrybank, Kilculliheen and Belview

The corridors have been subdivided into smaller segments based on inner and outer sectors, which allows for the greater understanding of movements along the corridor and orbital trips between corridors. The city core, corridors and segments are outlined in Figure 5-1. The segments are named based on their corridor letter and sector number (i.e. Segment B1 lies with corridor B and sector 1).

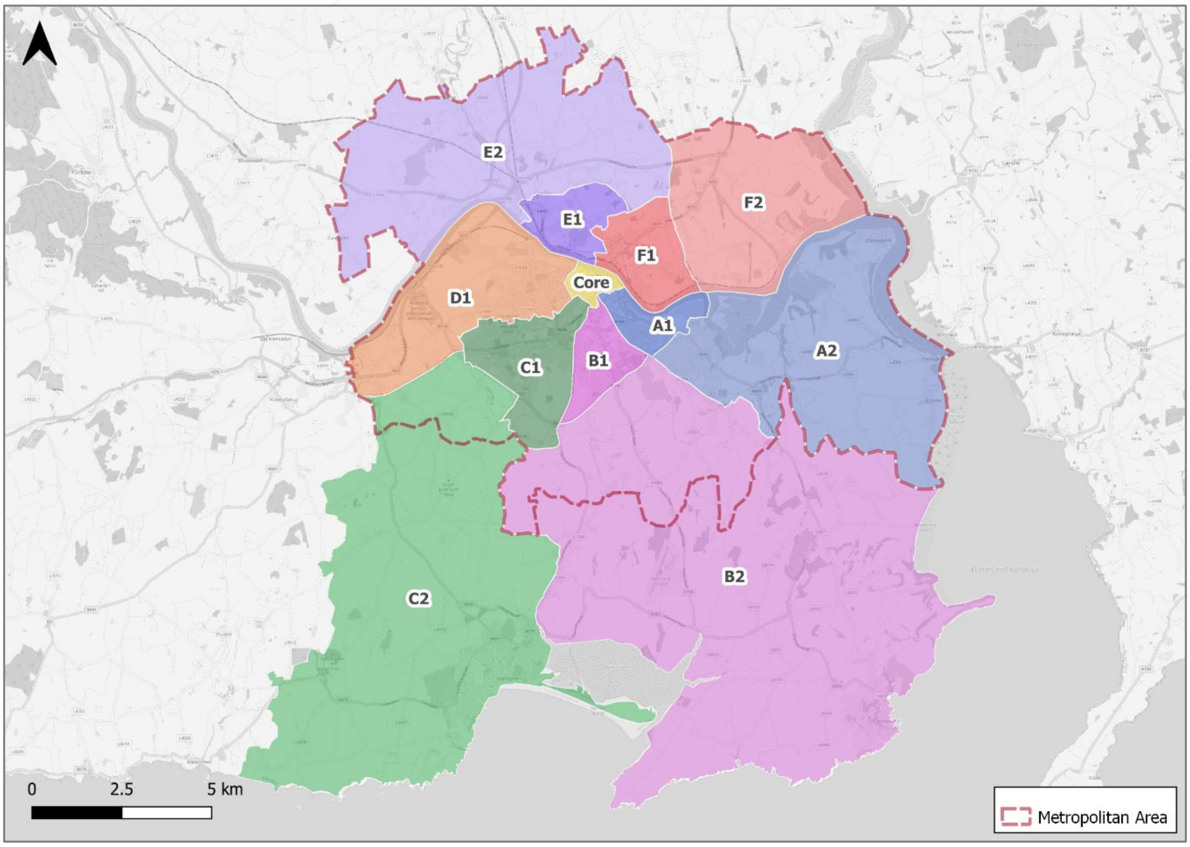


Figure 5-1 WMA Corridors and Segments

5.2 Corridor Comparison

5.2.1 Population and Employment

The total 2040 population, employment and education figures by corridor are shown in Figure 5-2, as derived from the 2040 planning sheet. Figure 5-2 shows that Corridor C has the highest population, followed by Corridor B and Corridor A. Employment is highest within Corridor C, followed by Corridor D and the City Core. Corridor C exhibits significantly higher education figures than other corridors as it includes WIT.

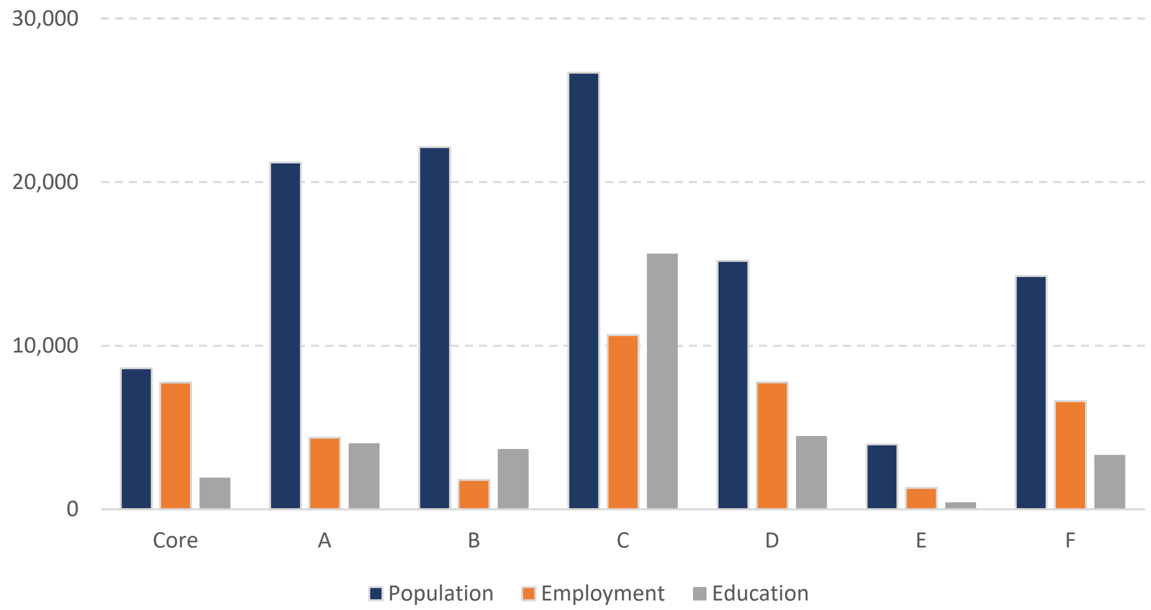


Figure 5-2 2040 Employment and Population by Corridor (2040 Planning Sheet)

5.2.2 Total Demand

The total all-day 2040 demand originating within each corridor has been extracted from the idealised SERM model run and is shown in Figure 5-3 and Figure 5-4 overleaf, which also provide a breakdown of corridor demand by segment. Segments C1 and D1 have the highest trip generation with approx. 48,000 trips generated throughout the 24-hour period (Figure 5-3). These two corridors have a significant level of population and employment, including the IDA Waterford Industrial Estate, as illustrated in Figure 5-2. Segment C1 also includes the Waterford Institute of Technology, which is a large generator/attractor of trips.

Overall, Corridor C generates the largest volume of trips in the 24 hour period. Segment C2 generates approx. 34,500 trips that are primarily based on travel to/from Tramore. Corridor A generates the second highest volume of trips, which is split across Segment A1 and A2. It should be noted that whilst Segment A2 stretches east as far as Passage East, the majority of the 24,656 trips are generated from the residential estates close to R710 ring road, such as Knockboy, Dunmore Road, Ballinakill and others.

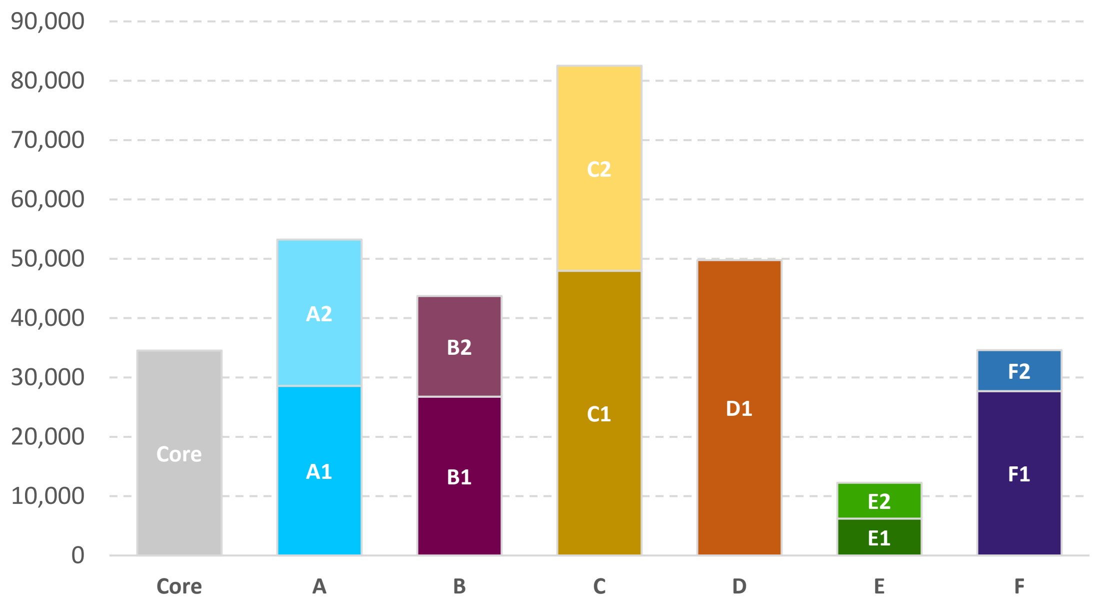


Figure 5-3 2040 All Day Demand Originating within each Corridor

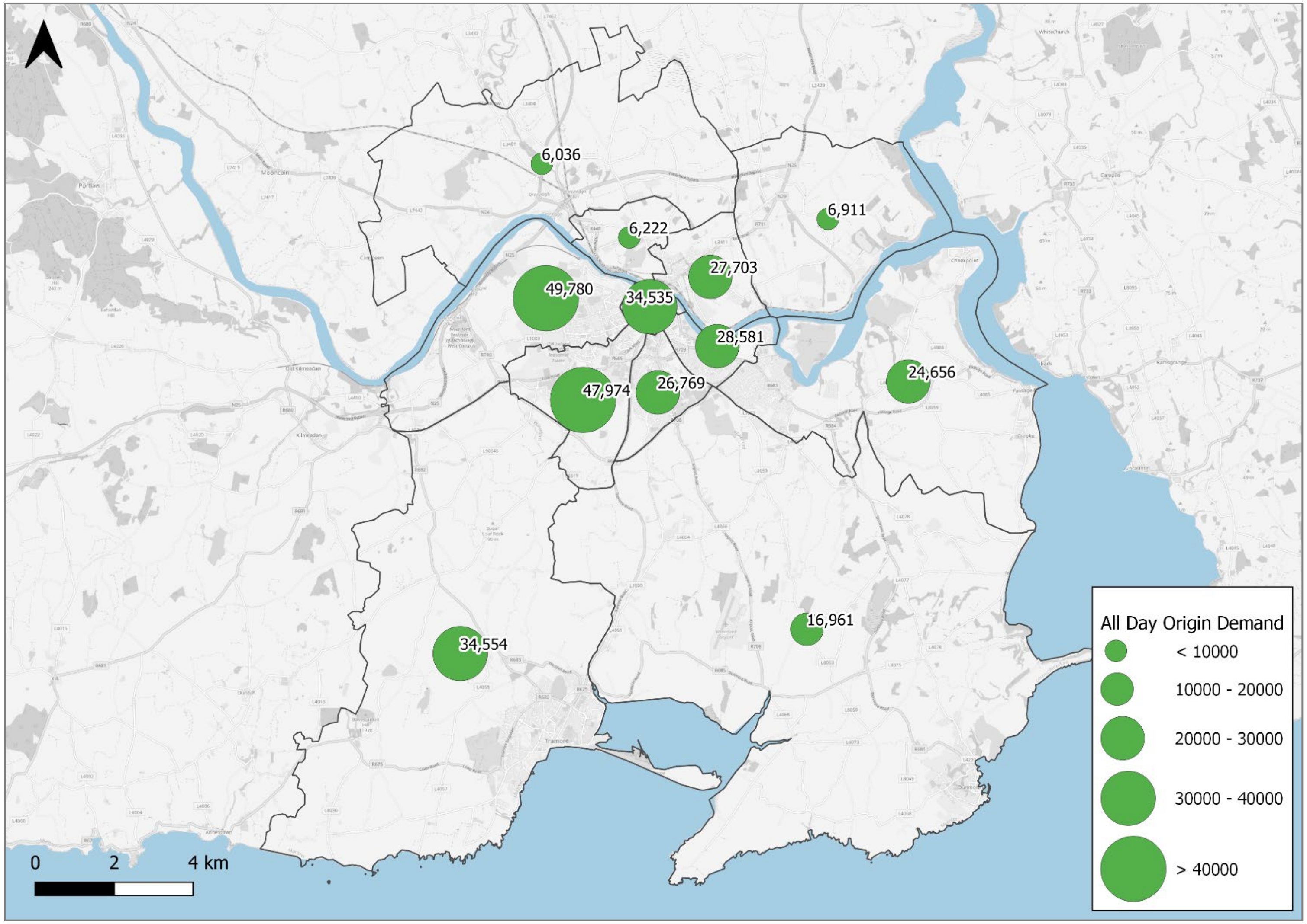


Figure 5-4 2040 All Day Demand Originating within each Segment

5.2.3 Mode Share

The breakdown of mode share for each corridor, including the city centre core, has been extracted from the 2040 idealised scenario and is presented in Figure 5-5 below. Figure 5-5 shows the lowest car mode share of 41% is within the core segment, followed by Corridor F with 54%. The highest walking mode share is also observed in the core city centre, where it is upwards of 30% (compared to around 20% or less in all other corridors). Within the other corridors, the car mode share figures are largely similar, ranging between 60% and 70%

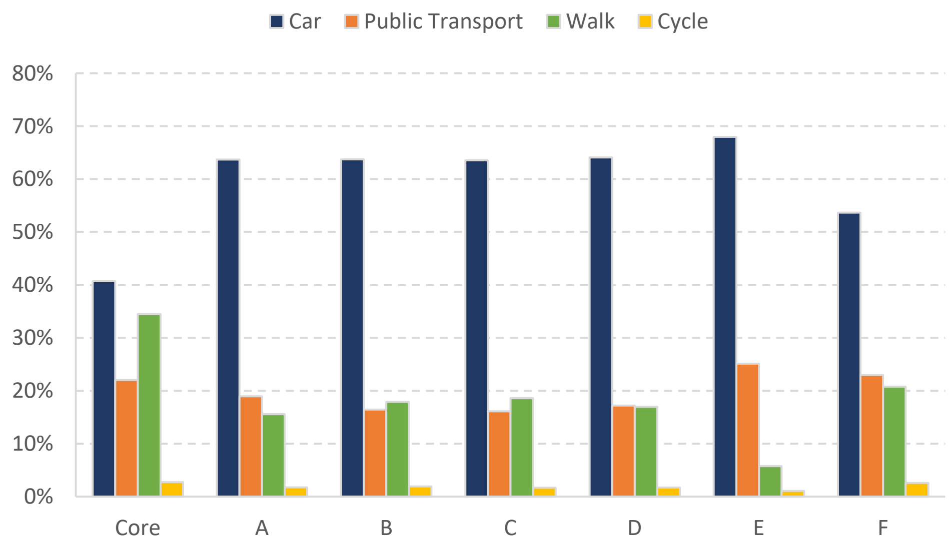


Figure 5-5 2040 Corridor Mode Share-24 hour

The car mode share within each corridor has been further disaggregated by segment, as shown below in Figure 5-6. Notably, car mode share is higher in sector 2 than it is in sector 1 across all relevant corridors, with all but corridor A showing a marked difference (the core and D corridors do not contain segments in sector 2).

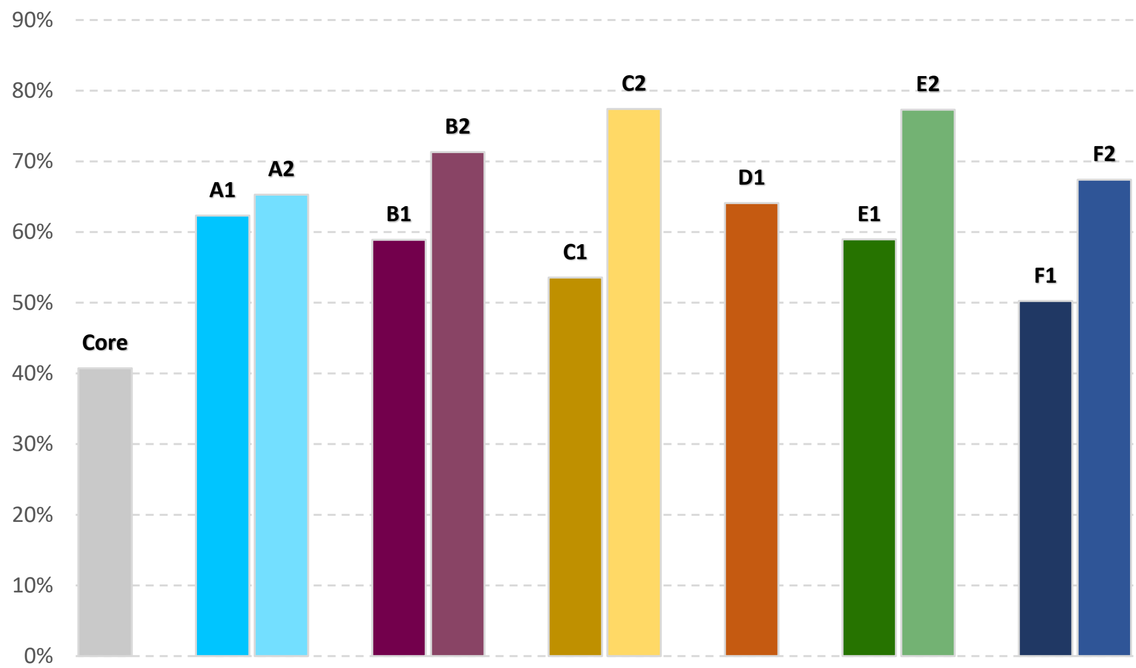


Figure 5-6 2040 Segment Car Mode Share-24 hour

5.2.4 Waterford Metropolitan Origin and Destination Patterns

2040 Origin-Destination (OD) matrices were developed for all trips between each corridor segment for all time periods, modes and trip purposes for the idealised scenario. The matrices for the 24 hour and AM peak for both the total demand, public transport demand and car demand are presented in Table 5.1 to Table 5.6.

The AM peak shows strong radial demand to the city centre core, particularly from Segments A2, B1 and D1. There is also high levels of demand from Segment A2 to A1, and between Segments C1 and D1.

The boundary between Segments A2 and A1 is at the R170, and as such, A2 includes large residential areas around Knockboy, Ballinakill and Dunmore Road. In the AM peak, there is a significant level of demand travelling from these residential areas to schools and employment locations within Segment A1.

Segments C1 and D1 both include high levels of employment, with the IDA Waterford Industrial Estate traversing both segments. In Segment D1 a significant increase in employment and population is planned for the Gracedieu area, whilst Segment C1 includes WIT, which is a large attractor for both tertiary education and employment trips. These segments also include a lot of residential development (e.g. Tycor, Slievekeale, Larchville, Gracedieu), and as such, there is a strong desire for orbital travel between Segments C1 and D1. Even in the Idealised model scenario, the public transport usage for these orbital trips is still quite low. This is due to the relatively short trip lengths, quick journey times and the availability of parking. In general, for short trip lengths it is quite difficult for public transport to compete with other modes due to aspects such as walk time to the bus stop, waiting for the service to arrive and boarding penalties, all of which increase the cost of travel.

At a 24-hour level, the OD matrices again indicate a high demand between Segments C1 and D1, with movements between Segment D1 and the Core, A2 and A1, and B1 and C1 also experiencing strong demand.

Table 5.1 Segment to Segment 24-hour Total 2040 Demand

Segment	Core	A1	A2	B1	B2	C1	C2	D1	E1	E2	F1	F2
Core	7,815	2,162	1,583	3,251	1,048	3,302	990	5,311	644	308	2,566	283
A1	2,162	5,798	4,717	3,320	1,953	2,338	914	2,287	254	207	1,659	211
A2	2,239	4,974	5,616	1,322	2,318	3,021	616	2,163	159	68	604	205
B1	2,841	3,850	1,745	5,044	1,595	4,654	1,004	3,583	166	61	594	143
B2	1,007	2,224	2,280	1,645	5,133	1,475	907	1,117	88	31	261	77
C1	2,946	2,696	3,148	4,661	1,421	12,562	2,643	9,306	515	225	1,132	203
C2	1,334	903	579	937	949	2,898	21,582	2,078	125	71	416	121
D1	5,421	2,010	1,922	4,643	1,487	8,310	2,723	14,273	744	381	1,976	327
E1	566	257	170	206	105	536	131	876	340	295	1,282	324
E2	201	139	46	96	40	200	49	315	289	869	1,578	188
F1	2,069	1,182	541	804	467	1,316	402	1,722	1,050	779	10,859	1,976
F2	200	181	181	198	90	231	125	318	338	223	1,922	897

Table 5.2 Segment to Segment 24-hour 2040 Public Transport Demand

Segment	Core	A1	A2	B1	B2	C1	C2	D1	E1	E2	F1	F2
Core	398	379	617	544	282	561	316	698	389	77	364	84
A1	322	474	1,016	477	347	391	171	332	135	64	419	77
A2	623	977	519	223	308	631	76	484	29	26	314	126
B1	422	504	231	630	188	652	146	637	42	29	310	91
B2	309	366	345	181	209	268	145	270	21	18	174	51
C1	562	454	651	727	265	849	643	882	359	75	414	83
C2	326	214	110	153	105	664	631	357	25	18	148	57
D1	607	351	527	695	240	840	426	1,474	376	78	470	81
E1	292	132	28	36	23	335	22	443	12	38	230	181
E2	68	67	26	30	22	70	13	75	35	24	82	13
F1	345	414	313	336	267	409	168	464	222	70	1,076	207
F2	77	79	122	91	46	85	54	78	178	14	242	26

Table 5.3 Segment to Segment 24-hour 2040 Car Demand

Segment	Core	A1	A2	B1	B2	C1	C2	D1	E1	E2	F1	F2
Core	1,254	963	726	1,743	667	1,417	659	2,749	163	194	992	169
A1	1,033	3,374	2,742	2,146	1,327	1,623	737	1,776	105	136	994	125
A2	1,368	2,977	3,572	975	1,519	2,179	537	1,609	125	41	224	70
B1	1,440	2,641	1,402	1,735	1,252	2,597	849	2,656	112	29	164	44
B2	597	1,581	1,472	1,308	3,853	1,119	755	819	65	13	67	23
C1	1,053	1,912	2,288	2,540	1,069	5,406	1,891	5,999	129	135	466	108
C2	993	683	465	775	839	2,124	16,865	1,695	100	52	264	64
D1	2,959	1,477	1,327	3,663	1,219	5,034	2,270	8,713	329	292	1,220	234
E1	177	111	137	159	80	173	109	392	277	242	954	139
E2	95	65	19	63	17	114	36	229	239	623	1,463	173
F1	474	510	164	346	180	651	230	963	731	677	4,688	1,616
F2	91	92	50	99	42	134	70	230	157	207	1,523	679

Table 5.4 Segment to Segment 2040 AM Peak Total Demand

Segment	Core	A1	A2	B1	B2	C1	C2	D1	E1	E2	F1	F2
Core	1,527	649	126	408	94	707	81	851	101	38	286	75
A1	698	1,383	273	458	275	467	81	380	62	33	189	58
A2	1,349	2,492	1,638	489	972	1,389	176	877	105	31	308	133
B1	1,102	1,430	289	1,524	707	1,797	276	1,015	90	10	161	66
B2	523	844	484	465	1,727	686	315	450	52	12	97	42
C1	788	639	136	696	141	3,369	304	2,529	77	47	194	72
C2	388	357	73	288	225	1,242	6,560	842	77	12	76	55
D1	1,948	693	153	866	159	2,583	221	5,092	219	70	284	106
E1	337	152	14	48	15	351	17	494	123	91	494	228
E2	94	78	5	38	7	72	5	147	133	294	451	110
F1	657	413	38	252	64	350	43	630	471	394	3,263	1,204
F2	40	44	5	27	5	42	6	61	43	38	285	305

Table 5.5 Segment to Segment 2040 AM Peak Public Transport Demand

Segment	Core	A1	A2	B1	B2	C1	C2	D1	E1	E2	F1	F2
Core	131	147	33	96	30	149	29	210	9	14	74	36
A1	123	210	46	99	52	127	22	128	5	6	74	25
A2	464	845	245	176	212	454	46	399	15	17	221	94
B1	225	353	36	294	92	310	63	375	7	10	110	53
B2	160	245	71	79	94	145	110	147	5	11	84	35
C1	228	178	22	212	43	312	84	425	8	11	97	30
C2	186	124	19	67	18	426	314	229	6	6	60	35
D1	212	132	16	128	25	292	42	635	11	11	95	34
E1	245	114	6	22	9	282	11	383	6	30	198	154
E2	39	51	2	16	4	40	2	53	3	12	49	9
F1	187	272	28	185	57	202	38	300	14	27	514	122
F2	17	30	3	17	4	26	2	26	3	1	74	9

Table 5.6 Segment to Segment 2040 AM Peak Car Demand

Segment	Core	A1	A2	B1	B2	C1	C2	D1	E1	E2	F1	F2
Core	432	334	79	235	58	227	51	356	73	22	60	33
A1	370	722	149	249	181	222	57	207	54	26	67	30
A2	748	1,188	996	249	481	796	129	432	87	14	47	32
B1	562	830	230	458	550	821	211	508	77	0	3	8
B2	320	509	302	336	1,368	494	204	288	46	1	3	6
C1	319	395	108	374	93	1,578	209	1,686	65	35	65	40
C2	198	231	54	220	206	768	5,281	603	71	6	15	20
D1	1,266	502	130	695	131	1,481	176	3,228	192	58	113	68
E1	67	34	7	25	6	57	6	102	109	57	260	73
E2	43	24	2	22	2	25	3	90	126	219	388	100
F1	110	56	3	46	5	48	5	229	436	364	1,324	1,008
F2	16	12	1	9	1	13	4	33	40	37	183	242

5.3 Activity Density

5.3.1 Overview

The gross Activity Density (combined population, education and employment density) has significant implications for the economic viability of transport infrastructure, service provision and the potential for greater sustainable transport mode share. To assess the viability of serving demand along each corridor by public transport, the Activity Density has been mapped for the 2040 land-use scenario, where activity density is defined as the total of the number of residents, jobs and school places per square kilometre (places / km^2).

The approximate 2040 Activity Density within the Core Segment is presented in Figure 5-7 and highlights significant density of over 8,000 places/km^2 within the city core as would be expected.

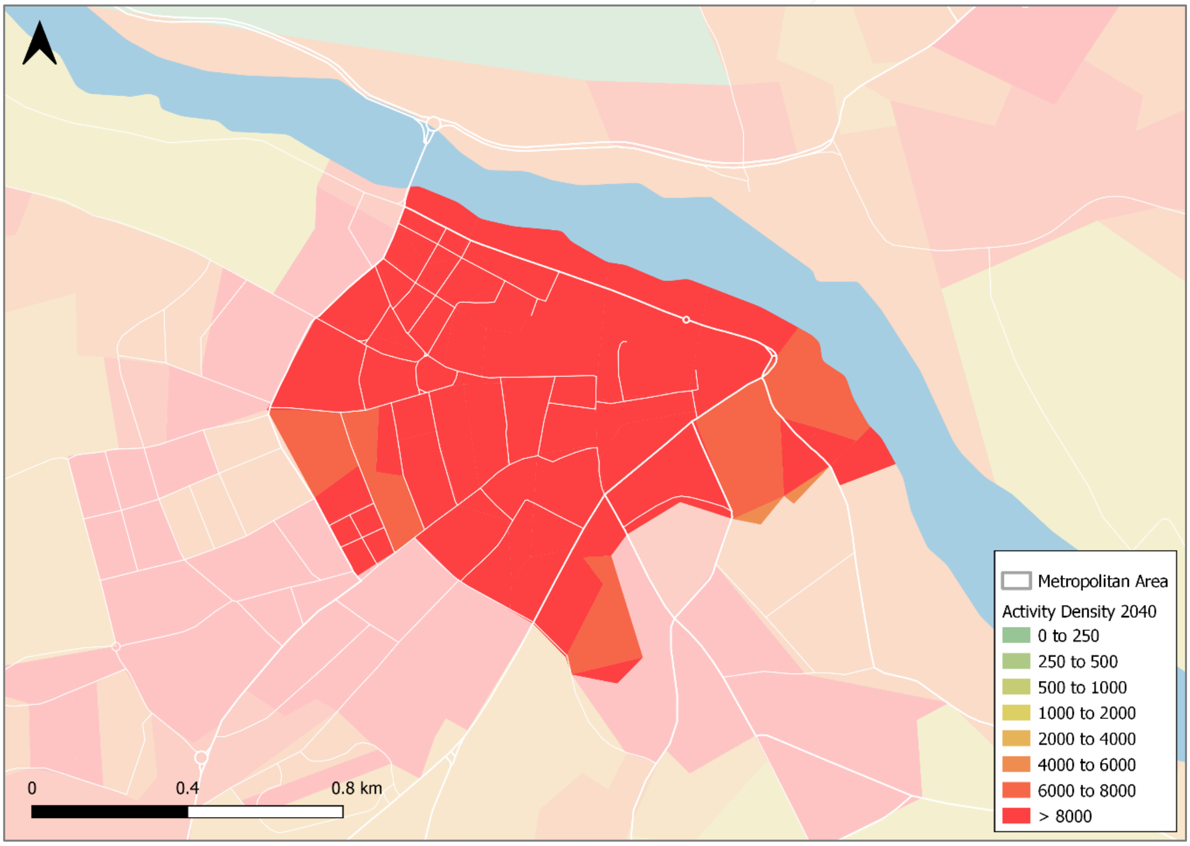


Figure 5-7 City Core 2040 Activity Density

Within Corridor A (Figure 5-8), there is a focus of activity at the hospital and along the R683 Passage Road / Dunmore Road corridor, with densities above 4,000 places/km^2. Activity densities are much lower east of Passage Cross, although there is an area of moderate activity in Passage East.

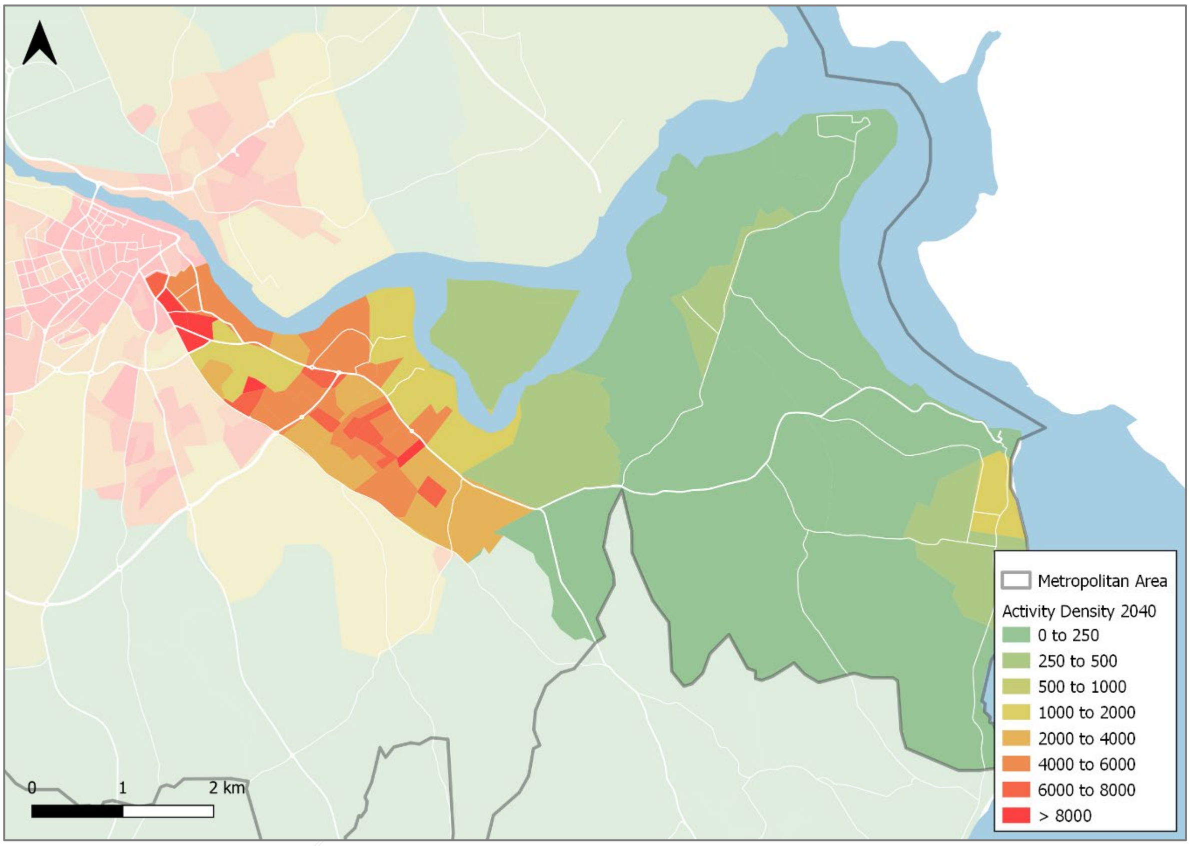


Figure 5-8 Corridor A 2040 Activity Density

As shown in Figure 5-9, Corridor B has high density areas that lie within the ring road, in particular in Kilcohan, with densities above 4,000 places/km^2. Elsewhere there are moderate levels of activity in Dunmore East and out along the Williamstown Road.

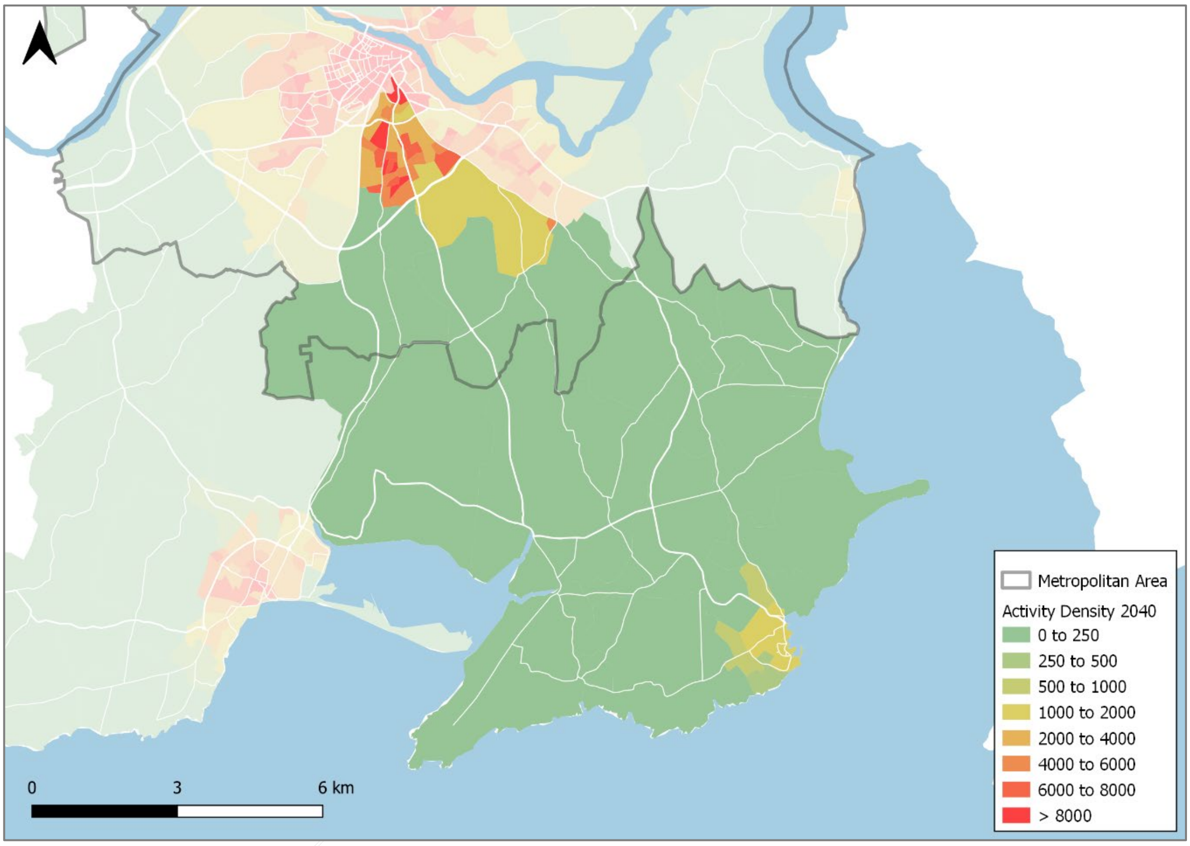


Figure 5-9 Corridor B 2040 Activity Density

Within Corridor C (Figure 5-10) there are areas with very high activity densities of more than 6,000 places / km^2 located at the Waterford Institute of Technology, and in Ballybeg and Tramore. There are also modest levels of activity in areas adjacent to the R710 ring road, and beyond that densities are low.

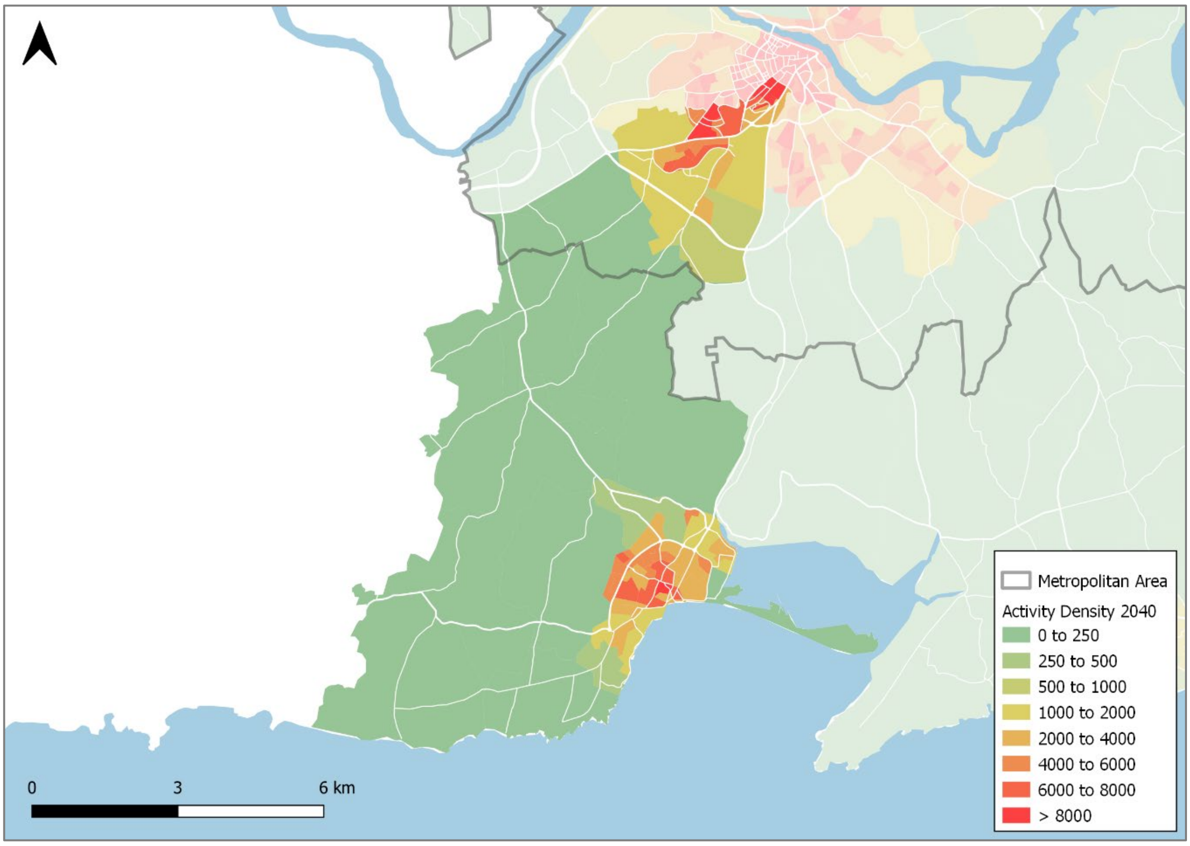


Figure 5-10 Corridor C 2040 Activity Density

Within Corridor D (Figure 5-11) there are very high activity densities of more than 6,000 places / km^2 in the residential areas of Tycor and the town centre, and in the residential and employment areas of Carrickpherish.

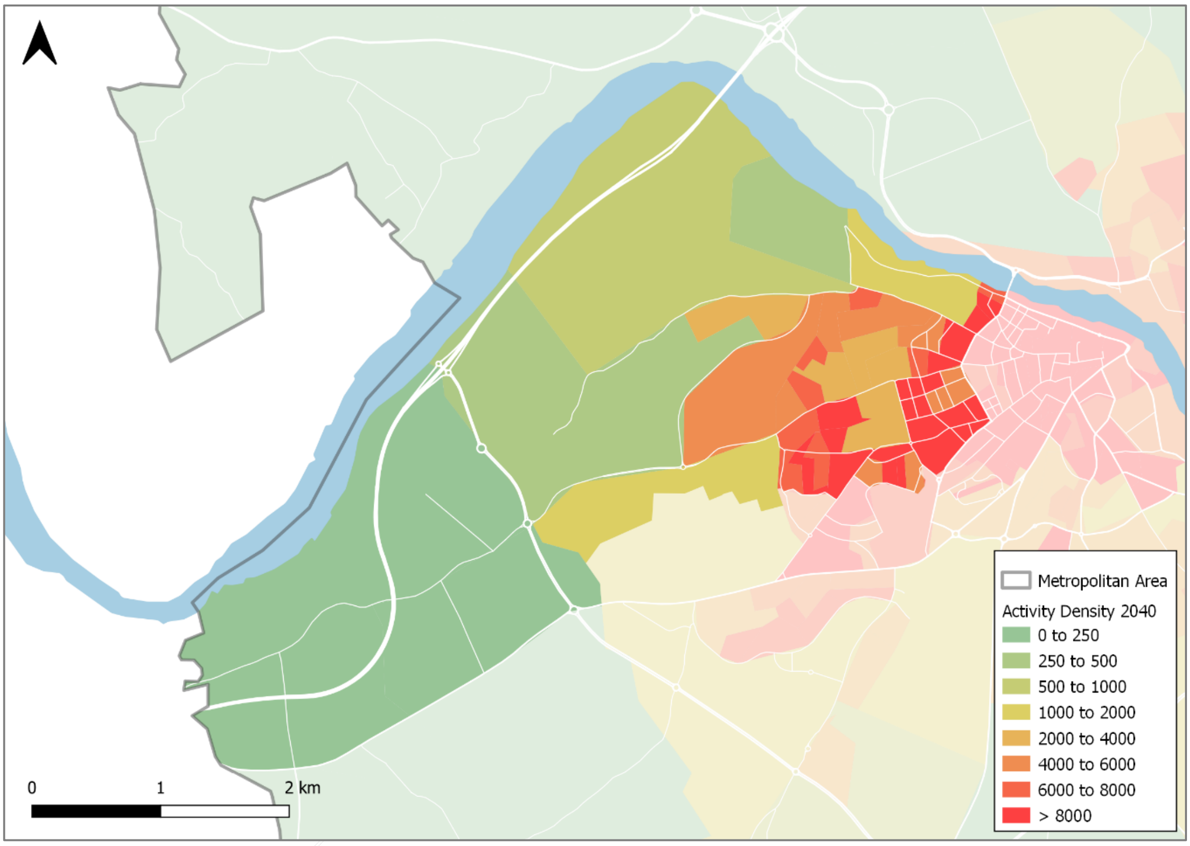


Figure 5-11 Corridor D 2040 Activity Density

Within Corridor E (Figure 5-12) there are mostly low activity densities, with the exception being the area of the North Quay SDZ around Rice Bridge, with densities of over 4,000 places/km^2.

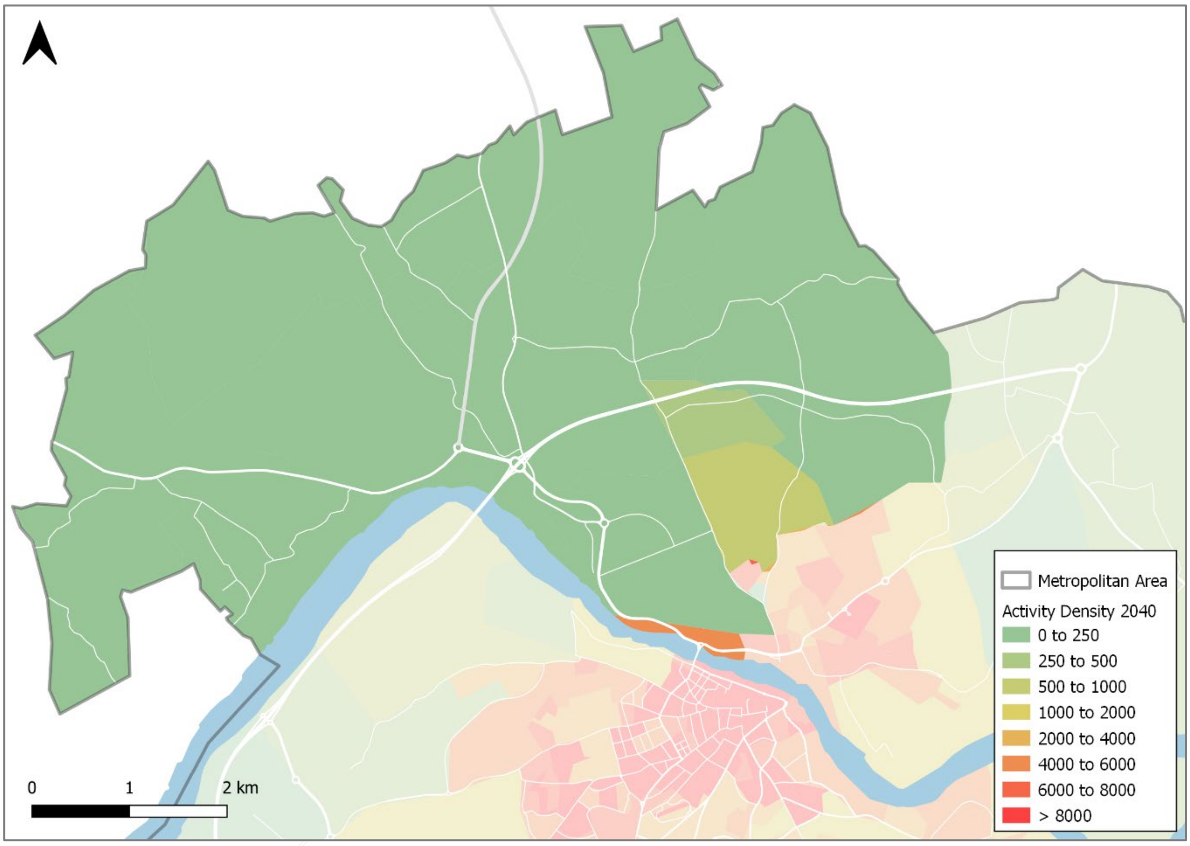


Figure 5-12 Corridor E 2040 Activity Density

Within Corridor F (Figure 5-13) there are very high activity densities of more than 6,000 places / km^2 in Ferrybank and parts of Kilculliheen. It should be noted that the Belview Port is planned for a significant increase in employment by 2040. This location is showing as a low activity density in Figure 5-13 as its Census Small Area is very large in size and covers more rural areas near the N25.

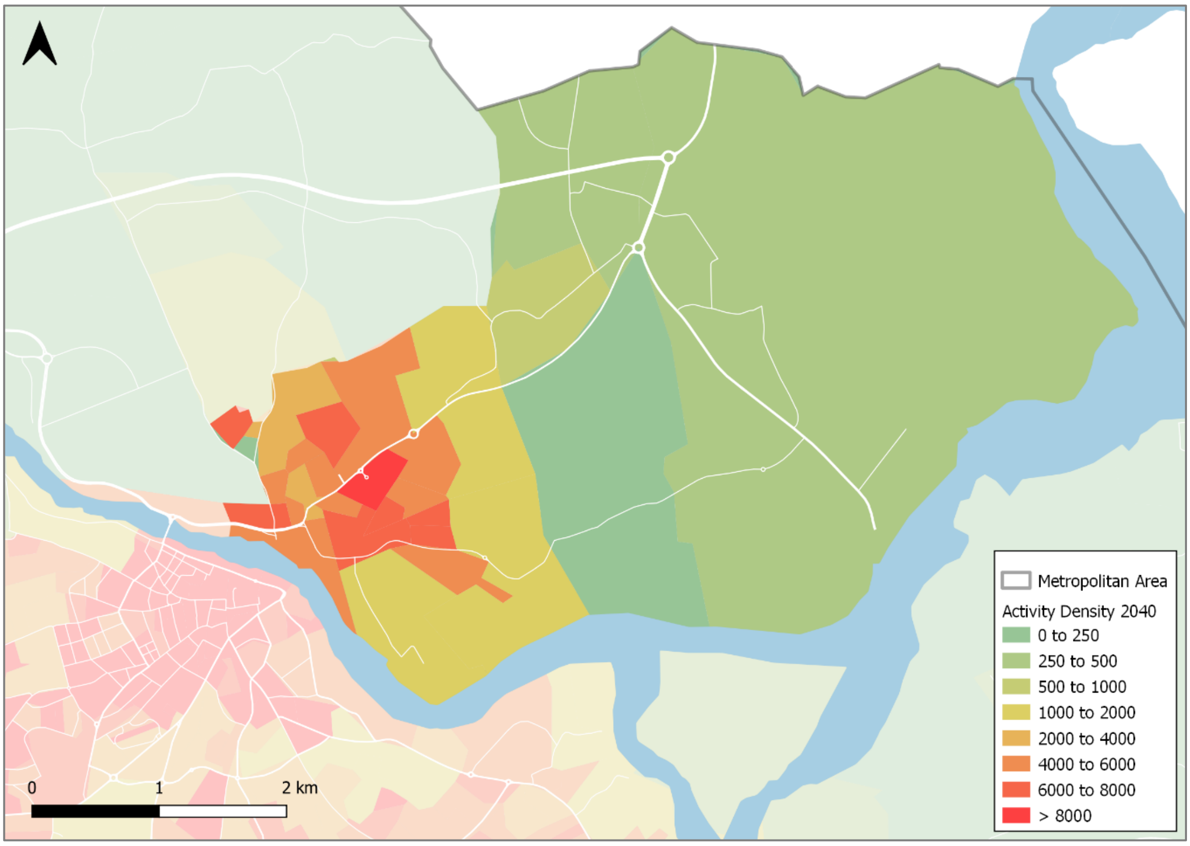


Figure 5-13 Corridor F 2040 Activity Density

Both the activity density and 2040 totals for population, employment and education places will be considered when assessing the viability of serving demand along each corridor by public transport.

6 Combined Demand Analysis

6.1 Desire Line Analysis

To assess the cumulative impact of the 2040 corridor demand outlined in Section 5, desire line maps were produced based on the OD matrices presented in Table 5.1 (24-hour demand), Table 5.5 (AM peak hour public transport demand) and Table 5.6 (AM peak hour car demand).

The desire lines for total 24-hour demand are illustrated in Figure 6-1. The results indicate that there is significant demand for the following movements: between Core and D1; A1 and A2; B1 and C1; B1 and D1; C1 and D1.

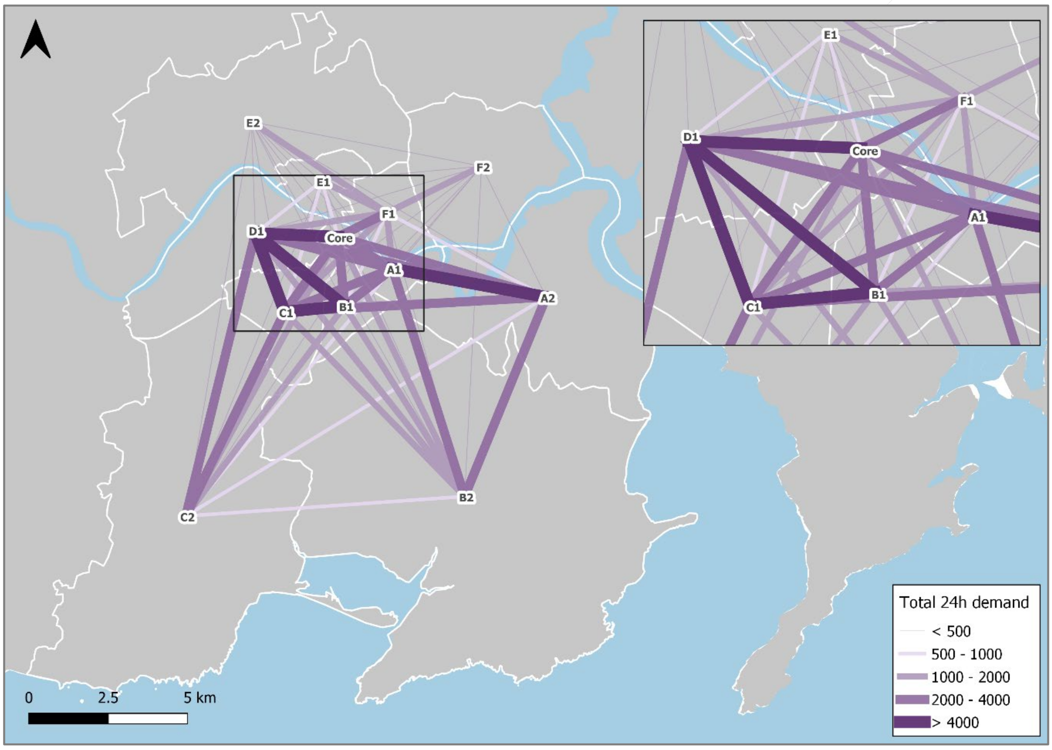


Figure 6-1 24-Hour 2040 Total Demand Desire Lines

To understand the potential demand for an improved public transport network and potential road improvements, the AM public transport and car demand desire lines have also been mapped and are shown in Figure 6-2 and Figure 6-3. The 2040 public transport desire lines indicate a strong demand between the following segments:

- A2 (Knockboy/Dunmore Road/Ballinakill) to the Core (City Centre);
- A2 (Knockboy/Dunmore Road/Ballinakill) to A1 (Ardkeen/Newtown/University Hospital Waterford);
- C2 (Tramore) to C1 (Ballybeg/WIT/Tycor);
- C1 (Ballybeg/WIT/Tycor); to D1 (Waterford Industrial Estate/Gracedieu); and
- the A2-B1-C1 orbital corridor.

The AM car desire lines highlight strong demand from:

- Core (City Centre) to D1 (Waterford Industrial Estate/Gracedieu);
- A2 (Knockboy/Dunmore Road/Ballinakill) to A1 (Ardkeen/Newtown/University Hospital Waterford);
- C1 (Ballybeg/WIT/Tycor) to D1 (Waterford Industrial Estate/Gracedieu); and
- F1 (Ferrybank/Kilculliheen) to F2 (Belview Port).

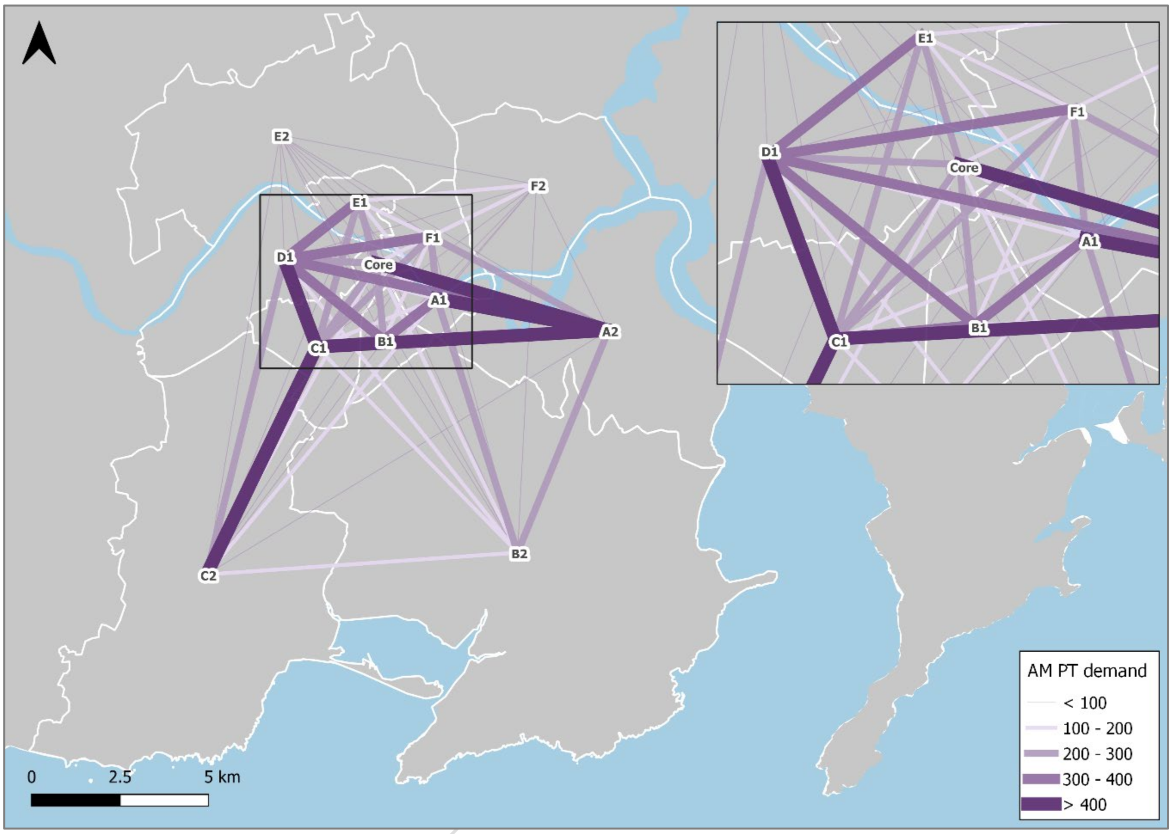


Figure 6-2 2040 AM Public Transport Demand Desire Lines

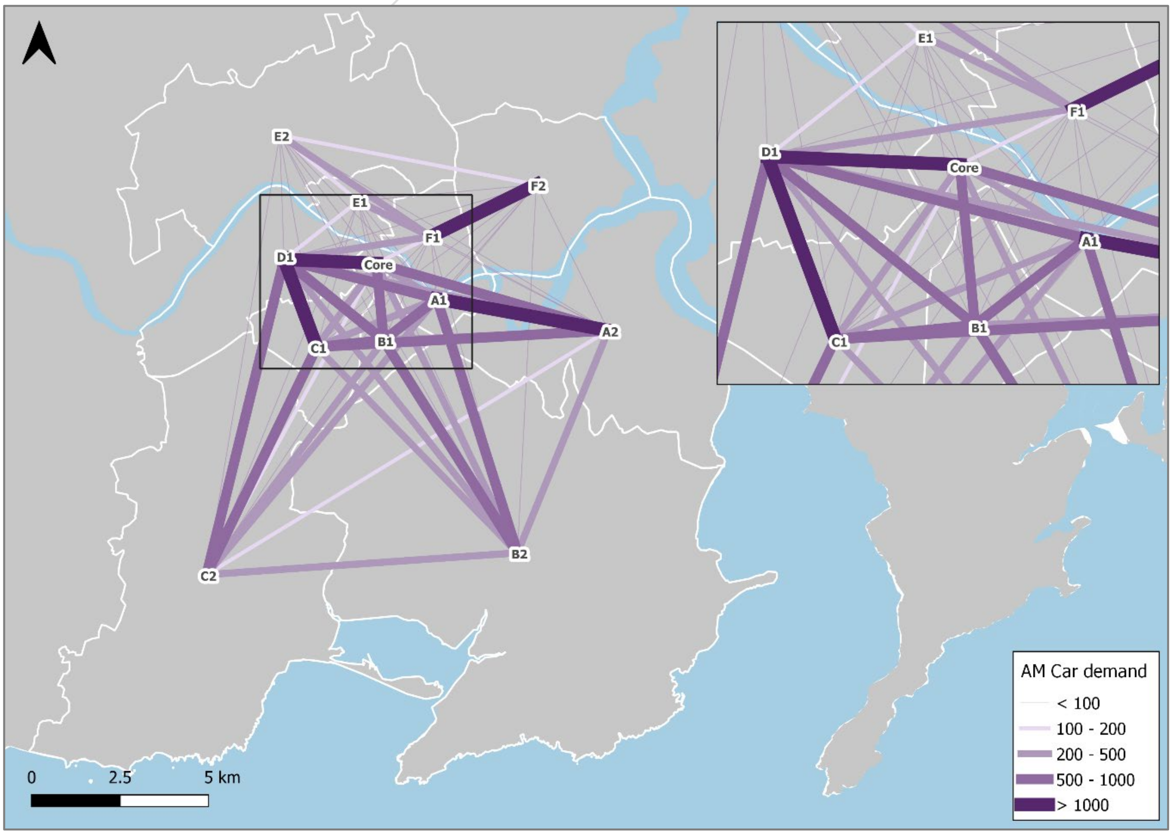


Figure 6-3 2040 AM Car Demand Desire Lines

6.2 Spider Web Analysis

To further refine the 2040 corridor demand shown in the desire line maps 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 all demand, public transport demand and car demand (excluding demand from outside the wider study area) is shown in Figure 6-4 to Figure 6-6.

The results in Figure 6-4 indicate that the highest total demand in the AM peak is travelling from A2 to A1. It should be noted that Segment A2 covers a large area spanning as far as Passage East. However, the majority of demand in this segment is likely to be generated by the residential areas to the immediate east of the R710 ring road. Other high demand movements include travel between the Core and D1, from A1 to the Core and along the southern orbital route between A1-B1-C1-D1.

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 feed into the Option Development stage of the Transport Strategy development process, identifying public transport demand which needs to be served by the future network.

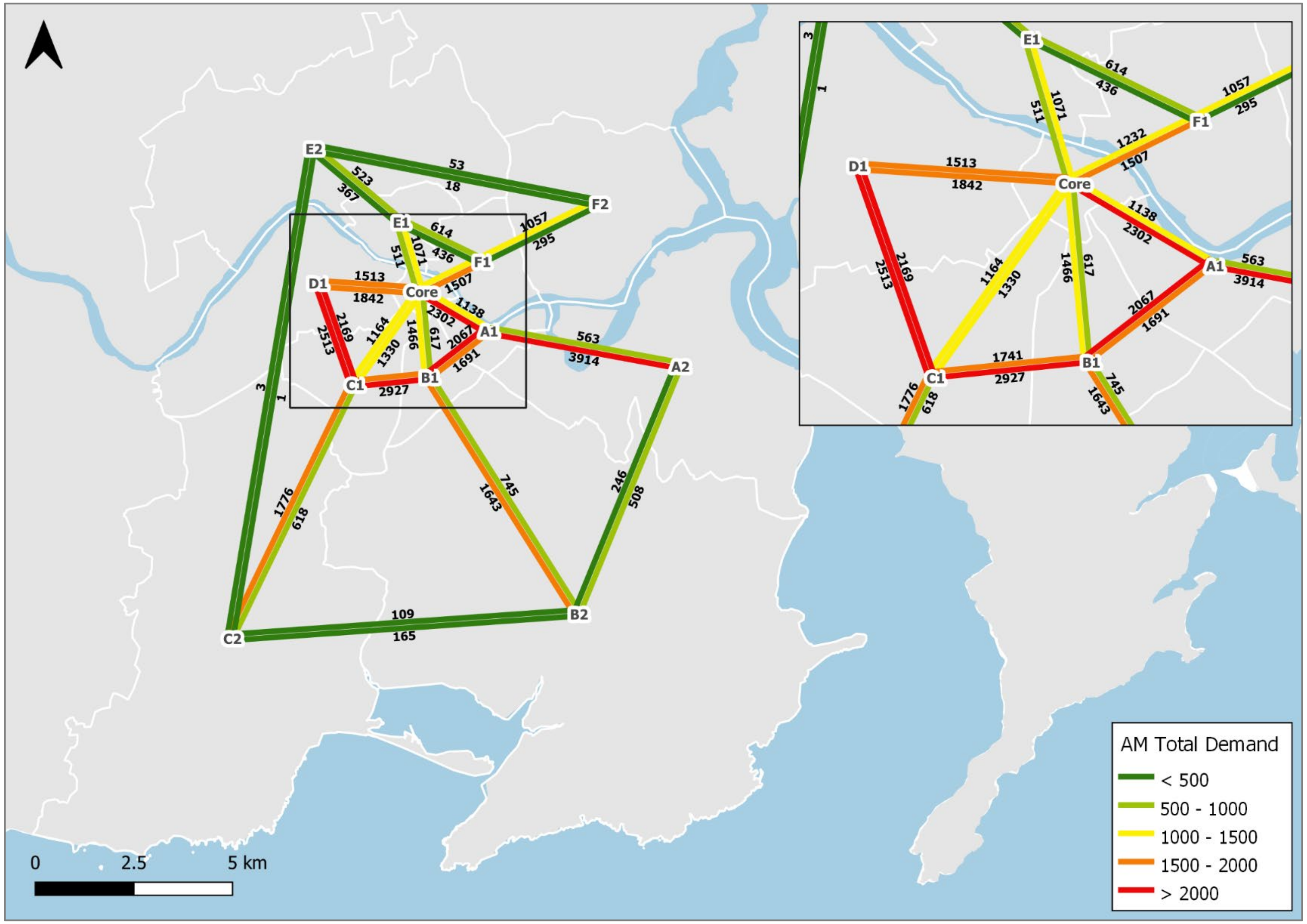


Figure 6-4 2040 AM Peak Hour Total Demand 'Spider's Web Network'

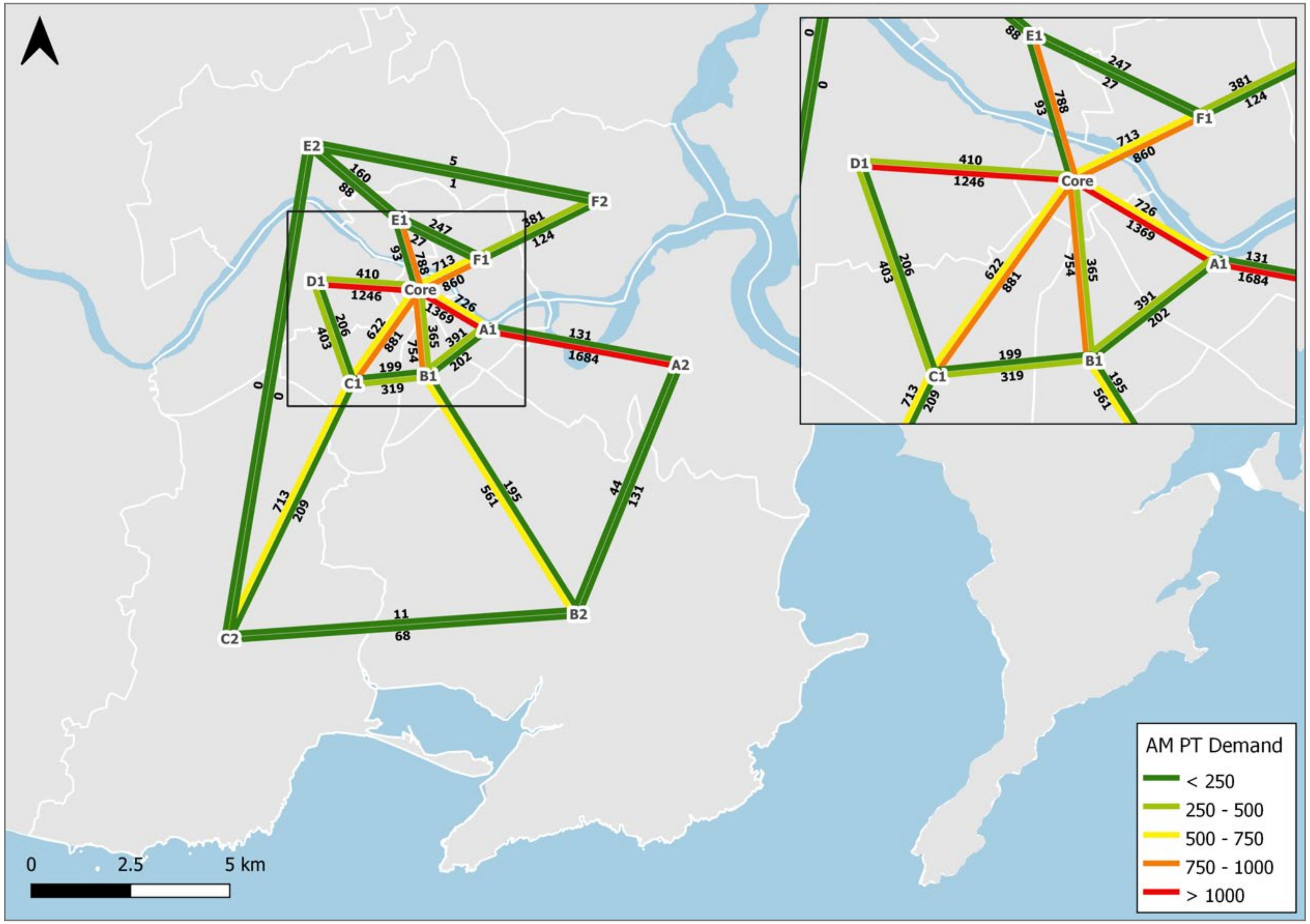


Figure 6-5 2040 AM Peak Hour Public Transport Demand 'Spider's Web Network'

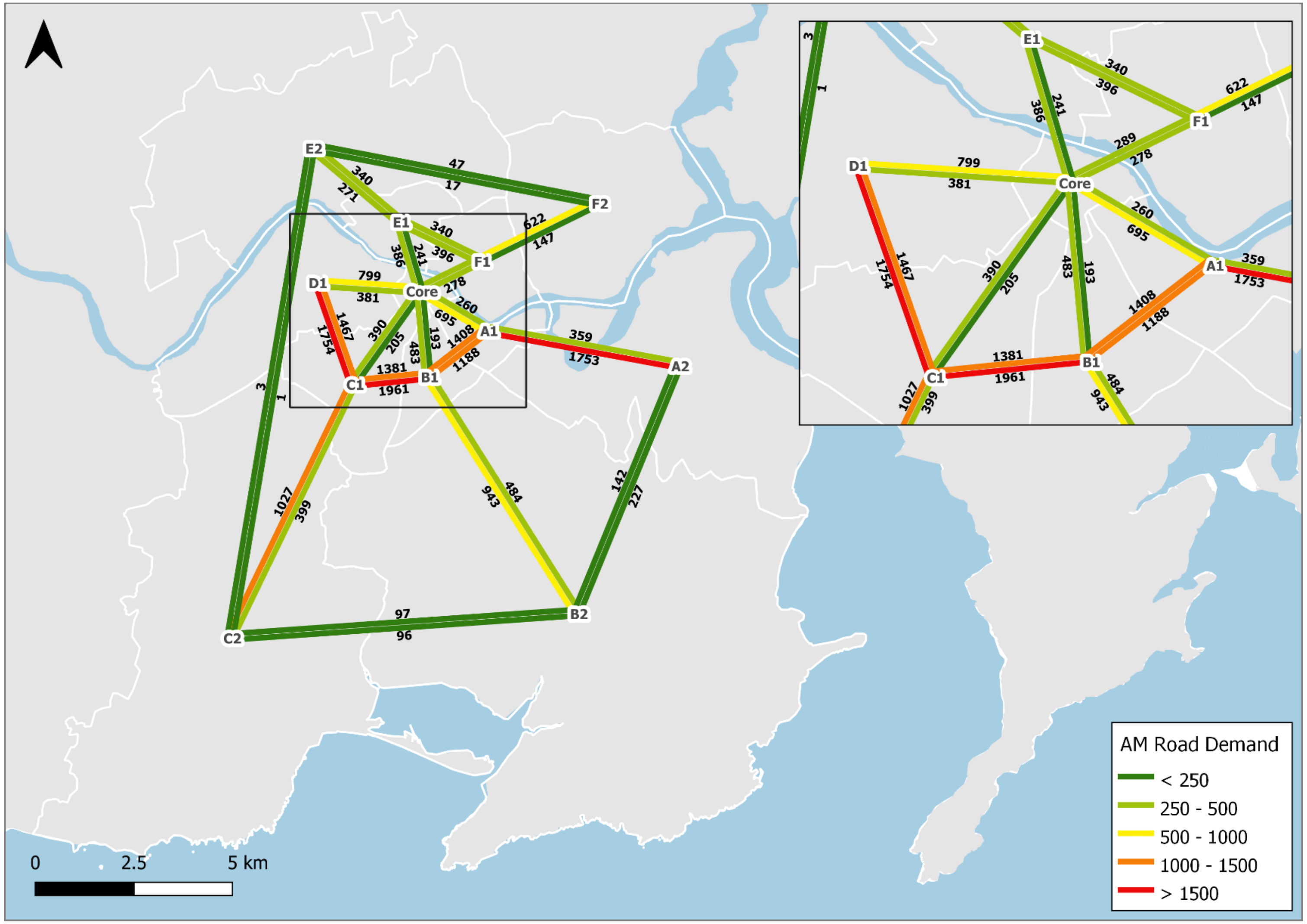


Figure 6-6 2040 AM Peak Hour Car Demand excluding External Demand 'Spider's Web Network'

6.3 Indicative Public Transport Network

6.3.1 Strategic Cross City Demand

To identify potential high capacity strategic public transport corridors, the two-way cross-city AM peak demand was extracted from the OD matrices presented previously and is shown below in Table 6.1. Note that travel by public transport to the adjacent corridor is considered an orbital movement and not included in Table 6.1.

Table 6.1 Two-Cross City 2040 AM Public Transport Peak Demand

Corridor	B	C	D	E	F
A	Orbital	612	416	134	461
B		Orbital	416	51	336
C			Orbital	225	302
D				283	281
E					Orbital

As shown, the highest cross city demand is between Corridors A and C. This includes demand to/from Tramore, which is approx. 13 km from the city centre. Based on the activity density map for corridor C (Figure 5-10), there is little activity located between Tramore and the R710. In this case, public transport demand may be best accommodated with a frequent service to the city centre, which could interchange with higher capacity cross city services from Corridors A and B to Corridor D.

Cross city demand is also high between Corridors A and D, Corridors B and D and Corridors A and F. Corridors A and B could potentially be served by one high-capacity route operating via John's Hill/Upper Grange Road which would serve areas of higher densities along both corridors. There could also be consideration given to combining demand to/from Corridors E and F as most services would operate via Dock Road and Rice Bridge. This could support cross city demand linking Corridors C and D to the North Quays SDZ and other residential developments around the Ferrybank area. More detailed analysis will be undertaken in the next stage of the Transport Strategy development process which identifies the optimal public transport network to support the 2040 future demand.

6.4 HGV Demand Analysis

To assess the level of HGV demand in the 2040 scenario the HGV link flows were extracted from the Idealised Network Scenario for the AM peak hour and are shown below in Figure 6-7. The figure shows high levels of demand across the National and Regional Network, in particular the N24 and N25 around Waterford, the N29 to Belview Port, the R448 into Ferrybank, and the southwestern quadrant of the R710.

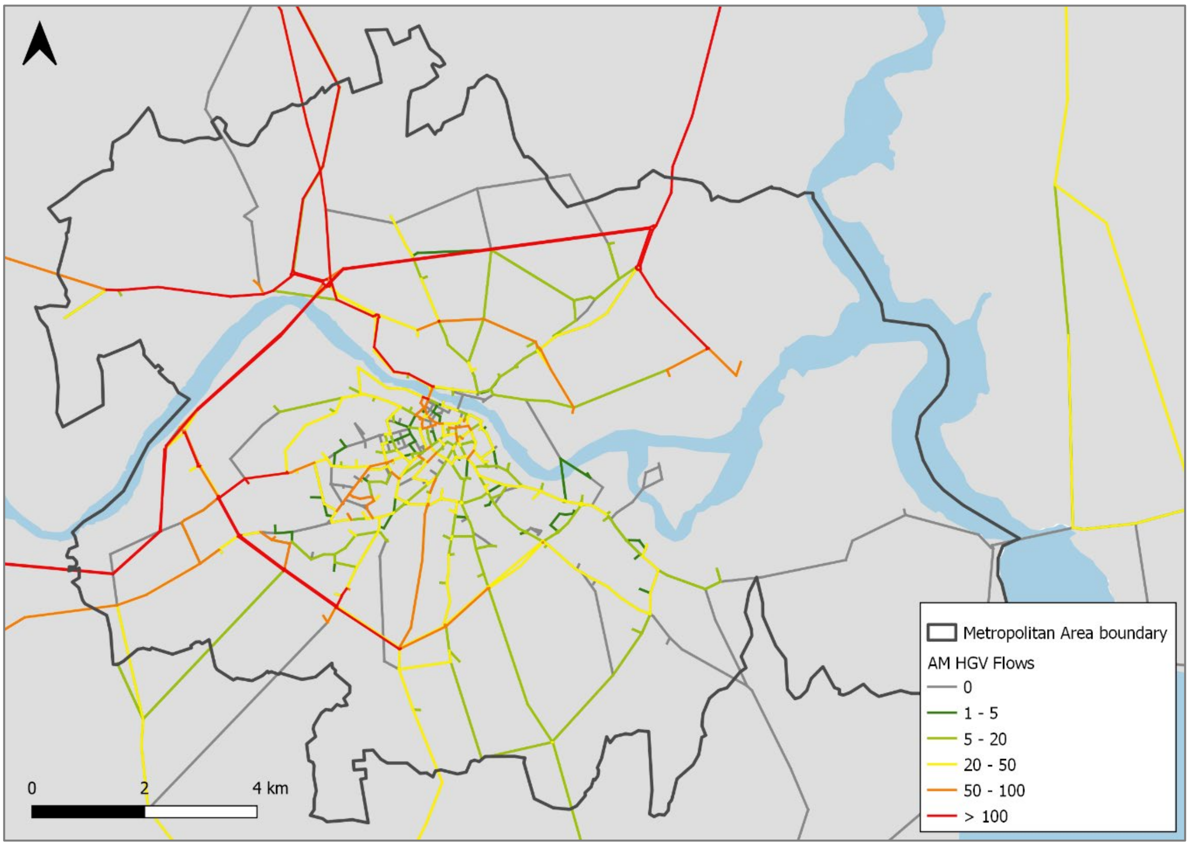


Figure 6-7 2040 AM Peak Hour HGV Link Flows (PCUS)

7 Summary

The aim of this transport strategy is to design a transport network that will accommodate the future demand for trips within the Waterford Metropolitan area by 2040. This report has reviewed the 2040 planning sheet data for the two local authority areas in order to understand where future growth in employment, education and housing will be located. This growth will be the catalyst for additional trips in the years to come.

In order to design a transport network that will support the sustainable growth of the WMA, the NTA's SERM was used to model transport demand in two scenarios; the do minimum scenario and the idealised network scenario, where public transport provision is optimised.

The model outputs have outlined the number of trips forecast to occur in 2040, the origins and destinations of these trips, and the modal split between car, public transport and active modes. In terms of modal split, the idealised scenario leads to public transport having around a 20% modal share within the WMA.

Trip patterns have been summarised across defined geographical segments within the wider metropolitan area. From this analysis, key corridors have been identified 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 presented within this report has provided information on estimated future transport demand, trip patterns across the network and potential mode splits, all of which will inform the subsequent Options Development stage of this Transport Strategy development process.