Appendix B: MetroLink Route Options Multi-Criteria Analysis Summary

This appendix is a summary of the assessment of alternatives report prepared by TII's engineering designer Jacobs/Idom.

As recommended in the Stage 1 CAF Appraisal, a metro scheme was identified as the preferred alternative to meet the scheme objectives. However, identifying the preferred mode alone is not sufficient to determine the preferred option to bring forward for detailed appraisal. An option selection study was carried out to determine the preferred route for the proposed metro scheme. A detailed Route Option Selection Study was carried out in the 2018 'New Metro North Alignment Options Report' to determine the preferred Metro Route option.

The New Metro North Alignment Options Report aim, and purpose was to identify 'feasible and practical' route options for MetroLink by considering transport demand, and potential station locations and alignments to serve this demand. Based on the CAF, the report adopted a Multi-Criteria Assessment approach, whereby each route option was assessed on its ability to meet the economic, integration, accessibility and social inclusion, and environmental objectives of the scheme.

The study considered a number of options with varying station locations, route lengths, costs and passenger demand numbers, which were each assessed on their potential for interchange, potential trip demand, key trip attractors and directness, and potential impacts on the environment. These routes were assessed comparatively identifying any advantages/disadvantages each option has against the others.

Ten end-to-end feasible Metro route options were identified and subjected to the MCA defined in this route option study. Descriptions of the station services of the ten options are provided below, with maps of the preferred options given in the next section.

- Option 1 (A1-B6-C4) serves Charlemont, College Green, O' Connell Street, Mater Hospital, Drumcondra, St. Patrick's College West, DCU at Collins Avenue West, Santry Village, Northwood Central, Dardistown, Dublin Airport, Fosterstown, Swords Central, Seatown and Estuary Park & Ride;
- Option 2 (A1-B6-C11) serves Charlemont, College Green, O'Connell Street, Mater Hospital, Drumcondra, St. Patrick's College West, DCU at Collins Avenue West, Santry Village, Northwood Central, Dardistown, Dublin Airport, Airside Retail Park West, Pavilions Shopping Centre, North Street and Estuary Park & Ride;
- Option 3 (A1-B10-C4) serves Charlemont, College Green, O'Connell Street, Mater Hospital, Drumcondra, Griffith Park East, DCU at Collins Avenue Junction, Ballymun Village, Northwood West, Dardistown, Dublin Airport, Fosterstown, Swords Central, Seatown and Estuary Park & Ride;
- Option 4 (A1-B10-C11) serves Charlemont, College Green, O'Connell Street, Mater Hospital, Drumcondra, Griffith Park East, DCU at Collins Avenue Junction, Ballymun Village, Northwood West, Dardistown, Dublin Airport, Airside Retail Park West, Pavilions Shopping Centre, North Street and Estuary Park & Ride;
- Option 5 (A2-B6-C4) serves Charlemont, St. Stephen's Green East, Tara Street, O'Connell Street, Mater Hospital, Drumcondra, St. Patrick's College West, DCU at Collins Avenue West, Santry Village, Northwood Central, Dardistown, Dublin Airport, Fosterstown, Swords Central, Seatown and Estuary Park & Ride;
- Option 6 (A2-B6-C11) serves Charlemont, St. Stephen's Green East, Tara Street, O'Connell Street, Mater Hospital, Drumcondra, St. Patrick's College West, DCU at Collins Avenue West, Santry Village, Northwood Central, Dardistown, Dublin Airport, Airside Retail Park West, Pavilions Shopping Centre, North Street and Estuary Park & Ride;

- Option 7 (A2-B10-C4) serves Charlemont, St. Stephen's Green East, Tara Street, O'Connell Street, Mater Hospital, Drumcondra, Griffith Park East, DCU at Collins Avenue Junction, Ballymun Village, Northwood West, Dardistown, Dublin Airport, Fosterstown, Swords Central, Seatown and Estuary Park & Ride;
- Option 8 (A2-B10-C11) serves Charlemont, St. Stephen's Green East, Tara Station, O'Connell Street, Mater Hospital, Drumcondra, Griffith Park East, DCU at Collins Avenue Junction, Ballymun Village, Northwood West, Dardistown, Dublin Airport, Airside Retail Park, Pavilions Shopping Centre, North Street and Estuary Park & Ride;
- Option 9 (A4-B12-C4) serves Charlemont, St. Stephen's Green East, Tara Station, O'Connell Street, Mater Hospital (on Eccles St), Whitworth, Griffith Park West, DCU at Collins Avenue Junction, Ballymun Village, Northwood West, Dardistown, Dublin Airport, Fosterstown, Swords Central, Seatown and Estuary Park & Ride; and
- Option 10 (A4-B12-C11) serves Charlemont, St. Stephen's Green East, Tara Street, O'Connell Street, Mater Hospital (on Eccles St), Whitworth, Griffith Park West, DCU at Collins Avenue Junction, Ballymun Village, Northwood West, Dardistown, Dublin Airport, Airside Retail Park West, Pavilions Shopping Centre, North Street and Estuary Park & Ride.

The outcome of this ten-route option assessment is shown in the table below, where a comparative five-point scale was adopted to measure how well each option addressed the project objectives.

Figure 0-1 - Comparative MCA of the Ten Route Options from Arup Metro Route Option Assessment

One component of the economy section of the assessment is to use TUBA to calculate a BCR for all ten options considered. This shows that all ten routes generate a BCR significantly greater than one, with this result being used to help inform Figure 3-1.

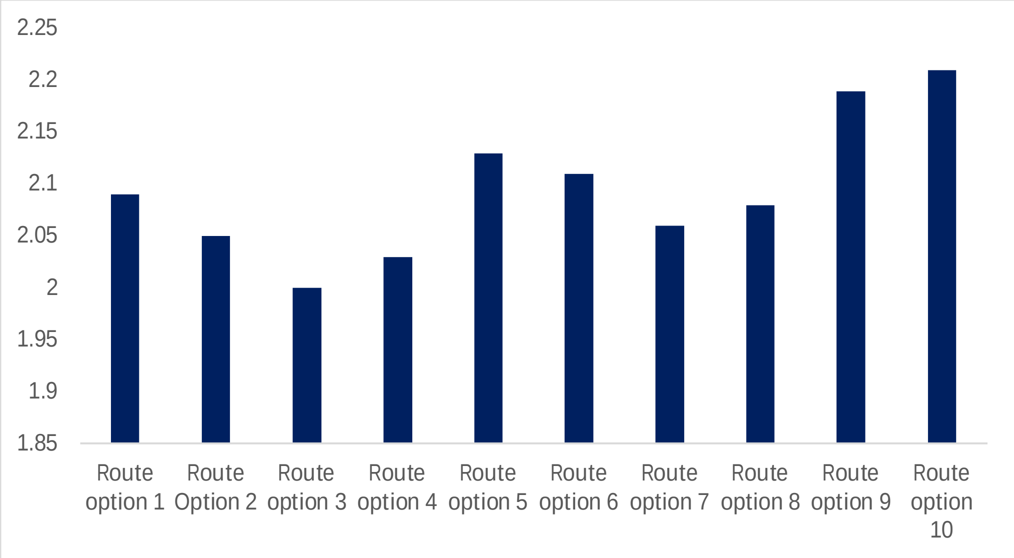

Figure 3-2 – BCRs of the Ten Route Options from Arup Metro Route Option Assessment

From Figure 0-1 and Figure 3-2 above, it is evident that the Metro Route Options 9 and 10 emerge as being the most favourable. This is based on the public transport integration criterion, as well as the economic differences, and impact on land-use policy Integration.

In summary, Option 9 and Option 10 are more consistent with the Transport Strategy for the Greater Dublin Area as they allow for interchange with the Maynooth and Kildare Irish Rail lines at Whitworth Station (now called Glasnevin), facilitating better coverage of the region. It also allows for a larger and more unique geographic area to be included in the catchment areas, that is not served by stations up or downstream.

The number of passenger transfers and direct passengers boarding is also much higher at Whitworth Station than an alternative interchange location at Drumcondra (which was included in some of the other route options above) and therefore is a more relevant station in the context of overall potential transport network integration opportunities. Similarly, as there is an earlier opportunity for interchange and a shorter physical interchange distance at Whitworth Station than at Drumcondra, options including Whitworth Station thus have a shorter journey time.

Identifying the Preferred Route Option

To determine the Preferred Option for the proposed scheme both Option 9 and Option 10 from the Route Option Selection Report was assessed individually on how well each option addresses the scheme's defined objectives set out in the Preliminary Business Case Document.

Like the previous stage 1 assessment, a five-point scale was adopted to assess each option in relation to how well each option addresses the defined project objectives.

Score	Description
	Fully addresses objective
	Addresses objective well
	Addresses project objective
	Addresses objective poorly
	Does not address objective

Figure 0-3 - Scale Used for MCA of Options 9 and 10

Option 9

Option 9 (A4-B12-C4) is shown below.

Figure 0-2 - Map of Route Option 9 ('New Metro North Alignment Options Report' (2018))

Option 10

Option 10 (A4-B12-C11) is shown below.

Figure 0-3 - Map of Route Option 10 (New Metro North Alignment Options Report (2018))

Stage 2 MCA

The outcome of the assessment of Option 9 and Option 10 against the scheme objectives is shown below:

	Objective	Option 9	Option 10
Economy	Cater for the growing travel demand along the corridor		
	Support Economic Development		
	Reduction of urban congestion		
	Segregated from urban congestion		
Safety	Reduction of cars		
Integration	Provision of interchanges and 'Park and Ride' improving transport integration		
Environment	Reduced CO2 emissions		
	Air quality improvement		
	Noise reduction		
Accessibility and social inclusion	Facilitate connection to attractor nodes		
	Attractive and accessible to all users		
TOTAL			

Table 0-1 - Outcome of comparative MCA assessment of Option 9 and 10

Based on this assessment, Option 9 emerges as a preferred route for MetroLink. Both options fully address the objectives to support economic development, reduce and be segregated from urban congestion, reduce the number of cars, and facilitate connections to attractor nodes. Both options address environmental objectives of the project, but not fully, and these can be mitigated through design.

However, the key difference between the two options lies in the Integration criterion. Option 9 integrates better with the wider transport network with better potential for seamless interchange with other modes, particularly heavy rail in the city centre and buses in Swords.

It also integrates better with current Land Use Policy particularly in Ballymun and Swords than Option 10. The Fingal County Development Plan Swords town and its environs is planned to grow significantly in population of and as such will have a significantly increased transport travel demand. In order to accommodate this demand, public transport systems will have to be fully integrated with each other, and with the surrounding land-use. Additionally, Option 10 is significantly more expensive than Option 9, therefore also giving Option 9 an economic advantage.

Appendix C: Strategic Policy Context Review

There is a significant need for a transport solution along the North Dublin transport corridor. In this Appendix, a more detailed overview of Government policies in the areas of transport, sustainability and land use development relevant to the business case for MetroLink, is provided. European and national policies focus on the need for greater sustainability of transport networks and a shift from private car travel to public transport, whilst, regional and local policies specifically set out priorities for public transport development and compatible land use development that is of direct relevance to the proposed MetroLink.

Policy type	Relevant policy (ies) / policy elements	Relevance to proposed MetroLink
European / Sustainability / Transport	The EU Transport White Paper 6 (2011)[52] focussed on the reduction of emissions from transport and a series of target actions have been established for Member States, including supporting increasing demand for mobility whilst meeting the 60% emission reduction target. The White Paper sets out a specific objective that by 2050, all core network airports will be connected to the rail network.	Modal shift to high capacity, electrified light rail solution will contribute to this policy objective: The proposed MetroLink scheme will be an electrified light rail solution, but its biggest contribution to climate change targets is a combination of its ability to attract and achieve modal shift through its operation as a high frequency, fast, efficient and sustainable public transport system and its high carrying capacity. A metro system can carry large numbers of people daily and that's what brings down carbon emissions per person travelling. In addition, passenger movements on high capacity (urban rail systems such as a metro require less than a tenth of the energy needed to move individuals by car.
European / Sustainability / Transport	The European Union Green Deal[53] launched a new growth strategy for the EU that aims to transform the EU improving the quality of life, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050. Transport accounts for a quarter of the Union's greenhouse gas emissions and these continue to grow. To achieve climate neutrality, a 90% reduction in transport emissions is needed by 2050. Reaching this target, includes actions such as: including; investing in environmentally friendly technologies; and the roll out of roll out of cleaner, cheaper and healthier forms of private and public transport	Electrified light rail solution will contribute to this policy objective: MetroLink supports and is aligned to the ambitious objectives set out by the Green Deal. The scheme will be designed and delivered to support new and existing sustainability modes that can reduce congestion and pollution in Dublin, especially in the urban environment. Transport in Dublin is thus on a path to become less polluting and more sustainable. Furthermore, MetroLink will assist Dublin in reaching the stringent air pollutant emissions standards of the EU that are set to be tightened by June 2021.
Sustainability / Social inclusion	The UN Sustainable Development Goals are the centre piece of the 2030 Agenda for Sustainable Development, adopted by UN Member States in 2015. These goals reflect economic, social and environment dimensions of sustainable development, with an ultimate goal of "leave no one behind."	Relating directly to the provision of MetroLink are the SDGs of Sustainable Cities and Communities and Climate Action. However, other goals such as Good Health and Well-Being and Reduced Inequality are also woven into the social inclusion mission of the MetroLink project as it will connect communities, which previously had little to no access, with Dublin City where they can access a

[52] European Commission: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, 2011
[53] Sustainable Mobility: European Union Green Deal, 2019

Policy type	Relevant policy (ies) / policy elements	Relevance to proposed MetroLink
		host of social services unavailable in surrounding areas.
Sustainability	The EU Biodiversity Strategy 2030 is a set of commitments and actions agreed to by EU member states which aim to build the resilience of societies against current and future environment related threats.	As an EU member state funded project, MetroLink will need to keep policies such as the EU Biodiversity Strategy 2030 in mind when delivering this piece of infrastructure. TII will aim to deliver MetroLink in a way which will not do further harm to the Irish ecosystem. Additionally, with MetroLink expected to divert approximately 6.8 million car trips per annum in the early years and growing to 12 million per annum by 2045., GHG emissions will be reduced.
National / Sustainability / Transport / Regional	The Project Ireland 2040 National Planning Framework is Ireland's strategic planning framework and was released in 2018, alongside Ireland's 10-year National Development 2018-2027.	See Chapter 3 for a detailed assessment of the positive alignment that MetroLink has to the national strategic outcomes set out in the Project Ireland 2040 National Planning Framework.
National / Sustainability / Transport	Part of Project Ireland 2040, The National Development Plan 2018-2027 is Ireland's €116bn investment plan over the next decade to contribute towards achieving the ten strategic outcomes under the NPF. Major national infrastructure projects which are specifically called out for investment under "Sustainable Mobility" include MetroLink, BusConnects and the DART Expansion Programme.	The National Development Plan recognises the collective importance of a sustainable integrated transport network and for this reason includes projects such as MetroLink, DART Expansion Programme, BusConnects, delivery of a Park-and-Ride Programme and a comprehensive cycling and walking network. Projects such as the proposed MetroLink are vital to Ireland achieving the national strategic outcomes. The proposed MetroLink system is taking full advantage of the opportunity to integrate with other major transport hubs, such as two major Iarnród Éireann lines – the north-western line from Sligo / Maynooth to Dublin, and the south-western commuter line from Newbridge / Hazelhatch to Grand Canal Dock, as well as Dublin Airport. In addition to this, the proposed MetroLink scheme will also connect with DART and Iarnród Éireann services at Tara Street, as well as providing interchanges with the Luas Green Line at Charlemont, O'Connell Street, and St. Stephen's Green, and the Luas Red line at Abbey Street.
National / Sustainability / Transport	The 2020 Programme for Government provides an overview of the current Government's vision for the country over the coming years. Specifically, MetroLink and other key transport projects are called out under the Government's Mission of "A Better Quality of Life for All," where a focus on improving the wellbeing of the Irish people and society is of critical importance. The current Government has committed to a 2:1 ratio of expenditure between new public transport infrastructure and new roads over its lifetime, highlighting the important role that public transport will play in the Government's policies and budgets.	The Government has pledged to prioritise plans for the delivery of MetroLink during its tenure. MetroLink will build upon Dublin's current integrated public transport network, providing an additional reliable transport option and reducing the nation's reliance on emissions heavy cars for daily transport needs. The inclusion of a park-and-ride facility at the northern terminus of MetroLink is also in direct alignment with the Government's tasking of the NTA with a park and ride implementation plan for each of the country's major cities. This park and ride facility will reduce congestion, journey times and transport related emissions.

Policy type	Relevant policy (ies) / policy elements	Relevance to proposed MetroLink
National / Sustainability	The Climate Action Plan 2019 is the previous Government's commitment / plan for tackling the climate crisis and de-carbonising the Irish economy. Key targets contained within the plan include reducing non-ETS sector greenhouse gas emissions by 30%, relative to 2005, by 2030; and support for an ambition emerging from the European Union of net zero Greenhouse Gas emissions by 2050.	With a huge focus on reducing the number of people who are reliant on cars in their daily lives, sustainable-mobility projects are at the forefront of the Climate Action Plan and are categorised as Critical Infrastructure. The implementation of MetroLink is specifically called out in the Climate Action Plan as a necessary step towards achieving climate related targets for modal shift and will encourage the shift to more sustainable transport usage with its integration with current transport modes such as LUAS, Irish Rail, BusConnects, and cycling and walking paths.
National / Sustainability / Transport	TII's Environmental Strategy outlines the Authority's vision to "ensure that Ireland's national road and light rail infrastructure is safe, sustainable and resilient."	As part of this document, TII outlines its Environmental Sustainability Delivery Framework which ensures that sustainability is at the heart of all stages of infrastructure delivery: planning, construction, implementation and post implementation reviews. TII will use this framework while delivering MetroLink to ensure that
Regional / Transport / Economic Development / Sustainability	Eastern & Midland Regional Assembly Regional Spatial & Economic Strategy 2019-2031: The Eastern and Midland Regional Assembly developed this plan identifying regional assets, opportunities and pressures and recommends relevant policy to better manage spatial planning and economic development. The three key principles include Healthy Placemaking, Climate Action and Economic Opportunity. The strategy will be implemented for the purpose of supporting Project Ireland 2040 and the Government's planning and economic framework for the development of the region.	This RSES specifically discusses MetroLink in the context of expanded residential development, economic development, and enabling infrastructure. As a key sustainable transport project included in Project Ireland 2040, the MetroLink transport corridor will become a hub of residential and subsequent economic development in the area north of Dublin city centre, including Finglas, Swords, and Dublin Airport. Becoming more well-connected with reliable transport options, towns such as Swords will attract a larger set of potential residents, allowing for growth in all aspects of the local economy.
Economic development plans and transport strategies	Fingal County Council Development Plan (2017-2023) Future Swords Dublin City Council Development Plan (2016-2022) Transport Strategy for the Greater Dublin Area (2016-2035) The above development plans for Dublin and its surrounding areas focus on the recognition of the need to integrate land use and transport to facilitate long term growth. All the strategies focus on the expansion of integrated public transport options to allow for greater ease of travel in the region, with a heavy focus on the provision of a Metro.	MetroLink will provide areas in need of economic development with transportation needed to allow passengers to easily travel to and from different areas in the Greater Dublin Area. Many of these development plans specifically rely on the development and provision of a Metro connecting the city centre to areas north of Dublin City. MetroLink would bring footfall to areas such as Swords that would not have previously had such an easy connection to city centre. This would allow for the development of business in the area while also providing an easier commute for those working in the city, and greater access to social services such as hospitals which may have proven more challenging to access in the past.

Policy type	Relevant policy (ies) / policy elements	Relevance to proposed MetroLink
National / Transport / Economic Development / Sustainability	Transport Strategy for the Greater Dublin Area 2016 – 2035: The NTA developed this strategy for the purpose of contributing to the economic, social and cultural progress of the Greater Dublin Area through the provision of efficient, effective and sustainable movement of people and goods. The strategy sets out the goals, current situation, patterns and trends, development of the strategy and anticipated 2035 transport network of the Greater Dublin Area. With a heavy focus on the promotion of public transport and provision of a system that reduces the number of individual car journeys undertaken.	The Transport strategy for the Greater Dublin Area 2016 – 2035 specifically proposes New Metro North, a previous iteration of MetroLink. A metro system connecting Swords, Dublin Airport, city centre, and other areas in North Dublin will directly support the strategy's goals of supporting economic, social, and cultural progress in the Greater Dublin Area in an efficient, effective and sustainable way. Sustainability plays a key role in the development of MetroLink, with both this transport strategy and MetroLink aiming to reduce the share of trips undertaken by car and a proportional increase in the use of public transport and other sustainable means of travel.
Transport	RSA Road Safety Strategy 2013 – 2020: The government has adopted a highly ambitious vision for road safety in Ireland and for the remainder of the decade. The aim is to raise Ireland's road safety performance to that of comparator countries and to continue the progress that TII has made in the past.	Public transport systems, especially mass-fast transport systems such as MetroLink are a safer form of travel than travelling by road24. The introduction of this scheme into Ireland's existing transport system will assist Ireland into reaching future road safety goals by taking cars off the road.
Transport	Smarter Travel: Smarter Travel sets out a broad vision for the future and establishes a national transport vision and objectives. The main objectives focus on reducing the dependency on the private car by increasing public transport mode share and encouraging walking and cycling. The policy contains a target to increase the number of commuters travelling to work to such a level that leads to a drop in the total share of car commuting from 65% to 45%. This policy is under review and expected to be updated during 2021.	The provision of an integrated, reliable public transport option such as MetroLink will directly tie into the Department of Transport's Smarter Travel initiative. The reliance on private cars can often be attributed to a lack of options, reliability or speed regarding public transport options. MetroLink will ensure that travellers have a reliable public transport option which will reduce their journey time, allowing them to reduce their dependence on private cars.

Appendix D: Sustainability Plan

METROLINK

Integrated Transport. Integrated Life.

MetroLink Sustainability Plan

September 2021

Table of Contents

Introduction

In 2019, Dublin was ranked as the 17th most congested city in the world and the 6th most congested in Europe, with each Dublin commuter spending approximately 28 minutes extra stuck in traffic each rush hour[1]. The National Transport Authority (NTA) has been seeking a sustainable solution to this problem since 2014 when it first commissioned the Fingal/ North Dublin Transport Study. This demand for increased capacity has resulted in MetroLink's recognition as a key low-carbon, sustainable transport project in the National Development Plan 2018-2027 and Project Ireland 2040.

At the same time, global awareness of sustainable development, the climate emergency, economic and social equality, and the biodiversity crisis have increased significantly. In 2015, 196 countries, including Ireland, became a signatory of the legally binding Paris Agreement on Climate change and the United Nations developed the Sustainable Development Goals (UN SDGs). These overarching global policy objectives underpin Ireland's sustainable development policy and, in turn, Transport Infrastructure Ireland (TII)'s Sustainability Statement and Sustainability Implementation Plan – Our Future (SIP), endorsed at board level.

Purpose

TII's SIP requires all projects and operations to consider sustainability under six key principles to align with the national and global goals described in the introduction above. This Project Sustainability Plan presents MetroLink's approach to delivering sustainable development during design, construction, and operation of the metro system. Whilst this plan provides an overview of the sustainability benefits that MetroLink will deliver on completion; its primary focus is on how the project meets TII's SIP and how it can deliver sustainable outcomes during construction and operation.

The plan sets out the background and sustainability benefits MetroLink will bring. It then outlines the sustainability vision, key priority areas, targets and objectives MetroLink will set and use to measure progress during the delivery and operation of the new metro system.

[1] Tom Tom. *Dublin Traffic (as of 29th Nov 2020).* Available at: https://www.tomtom.com/en_gb/traffic-index/dublin-traffic/

Irish Sustainability Policy Context

There is a range of international, national, regional and local sustainability policies, strategies and legislation, which have informed the case for pursuing sustainable development in Ireland. This has informed TII's Sustainability Statement and its Sustainability Implementation Plan, as shown in Table 1. The policy context has been summarised in this section to provide some background and context to why MetroLink has produced this sustainability plan.

Table 1: MetroLink - Sustainability Policy Drivers

Strategic Policy			
	**United Nations Sustainable Development Goals (SDGs)** The UN SGDs are a global call for action by all countries – developed and developing – to promote prosperity while protecting the planet. The goals were agreed to by UN member states in 2015 and reflect the economic, social and environmental dimensions of sustainable development. Not only will MetroLink contribute to the environmental goals of development but will also assist in social equity related matters but connecting communities to vital public services who previously have little access to them.		**European Green Deal** This policy launched a new growth strategy for the EU that aims to improve the quality of life in the EU with a modern, resource-efficient, and competitive economy where there are no net emissions of greenhouse gases in 2050. As an electrified rail solution, MetroLink will contribute to the reduction of transport related emissions in Ireland.
	**Project Ireland 2040 National Planning Framework** The NPF is Ireland's strategic planning framework and discusses strategic outcomes relevant to MetroLink, such as Sustainable Mobility, Compact Growth, Enhanced Regional Accessibility, High-Quality International Connectivity, and Transition to a Low-Carbon and Climate Resilient Society.		**The National Development Plan 2018-2027** The NDP is Ireland's €116bn investment plan which was released alongside the NPF. In particular, the NDP recognises the collective importance of a sustainable, integrated transport network, calling out projects such as MetroLink, DART Expansion and BusConnects.
	**Climate Action and Low Carbon Development Bill 2020** This Bill legally commits Ireland to achieving net zero emissions by 2050, with 5-year economy-wide carbon budgets which will place a ceiling on GHG emissions. This affirmation from the Government that sustainable projects will be crucial moving forward confirms the importance of sustainable mobility infrastructure projects such as MetroLink.		**Climate Action Plan 2019** The CAP 2019 is the plan for tackling the climate crisis and de-carbonising the Irish economy. It focusses on reducing the number of people reliant on cars in their daily lives, with sustainable mobility projects such as MetroLink being categorised as Critical Infrastructure.
	**Dublin City Development Plan 2016-2022** This Plan sets out policies and objectives to guide how and where development will take place in the city over the lifetime of the Plan. It provides an integrated, coherent spatial framework to make sure the city is developed in an inclusive way which improves the quality of life for its citizens, whilst also being a more attractive place to visit and work.		**Fingal Development Plan 2017-2023** This Plan sets out the policies and objectives for the development of the County over the Plan period. It seeks to develop and improve, in a sustainable manner, the social, economic, environmental and cultural assets of the County.
TII Internal Policy			
	**TII's Environmental Strategy** This document outlines TII's commitment to sustainability principles in the development and operation of the country's national transport networks. Through its promotion of transport sustainability, it will endeavour to deliver MetroLink in a sustainable fashion.		**TII's Sustainability Implementation Plan** This document outlines TII's commitment to rethink, reimagine and redesign their approaches to make sure sustainability is at the heart of everything they do to be the leading provider of sustainable transport infrastructure. The plan sets out an extensive roadmap that is forward looking and ambitious. It presents a set of actions that will deliver sustained positive impact for years to come.

Project Ireland 2040[2] focuses on a shift away from carbon-intensive individual vehicles through investment in public transport for Dublin. Between 1990 and 2016, road transport increased by 145% in Ireland and transport-related greenhouse gas emissions increased by 139%[3]. MetroLink is key to reducing Ireland's transport emissions by removing millions of car journeys from the road through its ability to carry large numbers of people is a significant factor in reducing the greenhouse gas emissions per person travelling. When operational, MetroLink will be powered by increasingly lower carbon electricity (e.g. sourcing electricity from renewable sources and/ or site level generation).

TII's Environmental Strategy (February 2019[4]) "commits to strive to incorporate sustainability principles into the development and operation of the national road, light rail and metro networks; therefore, contributing to social wellbeing, supporting economic efficiency, and protecting, restoring and enhancing environmental systems for future generations."

TII's Statement of Strategy 2021-2025 (October 2020[5]) sets out the goals TII are aiming for and the strategic objectives that it hopes to achieve over the next five years. These goals include delivering national road, light railway, metro and Active Travel infrastructure, contributing to compact growth, sustainable mobility, enhanced regional accessibility and the transition to a low-carbon future; whose strategic objectives include delivering infrastructure supporting low-carbon transport systems and emission reductions. The goals and strategic objectives are aligned with those of the Department of Transport.

TII's Sustainability Implementation Plan – Our Future (2021)[6] sets out TII's vision to lead in the delivery and operation of sustainable transport, enabling its networks to drive inclusive growth, create job opportunities and enhance wellbeing of all persons, including vulnerable groups, strengthen resilience to climate change, maintain commitment to the environment and continuing to prioritise safety.

As part of the work carried out in developing the Sustainability Implementation Plan, a detailed policy review was undertaken for policies, legislation and governmental aims that are relevant to the provision of sustainable transport solutions.

[2] Government of Ireland. *Project Ireland 2040. National Planning Framework*. Available at: https://www.gov.ie/en/publication/774346-project-ireland-2040-national-planning-framework/
[3] Transport Infrastructure Ireland. MetroLink. Available at: https://www.metrolink.ie/#/ClimateChange
[4] Transport Infrastructure Ireland (2019). Environmental Strategy. February 2019 Available at: https://www.tii.ie/technical-services/environment/strategy/TII-Environmental-Strategy.pdf
[5] Transport Infrastructure Ireland (2020). Statement of Strategy. October 2020. Available at: tii-statement-of-strategy-2021-2025-final.pdf
[6] Transport Infrastructure Ireland (2021). Sustainability Implementation Plan – Our Future. Available at: xxxx

TII's Sustainability Implementation Plan

TII has developed its Sustainability Implementation Plan (SIP), which describes how its sustainability principles will be embedded into all TII activities, including projects like MetroLink. The SIP articulates how TII's sustainability principles will be incorporated into the development and operation of Ireland's road and light rail networks, contributing to social wellbeing, supporting economic efficiency, and protecting, restoring and enhancing environmental systems for future generations.

The SIP is based on six key interlinked sustainability principles, highlighted in Table 2 below, which align with the UN SDG'S and the National Strategic Objectives of the National Planning Framework. These six principles are mandated across all areas of TII's business and projects and set MetroLink's approach to sustainable delivery.

Table 2: TII Sustainability Implementation Plan – Sustainability Principles

TII SIP	Sustainability Principle	Description
1	**Provide effective, efficient and equitable mobility**	Enable compact urban growth and regional accessibility through networks and services that support more efficient journeys, more effective connectivity and increased accessibility.
2	**Enable safe and resilient networks and services**	Enable safe, secure, accessible and inclusive travel through the provision of transport networks, systems and services that are resilient to future change.
3	**Collaborate for a holistic approach**	Develop smart and sustainable assets and services through innovating and improving the planning, design, construction, operation and maintenance of the transport network, increasing collaboration and systems-thinking to seek mutual gains and mitigate negative externalities.
4	**Deliver end-to-end improvements**	Deliver enhanced whole lifecycle value through impact and influence on stakeholders, partners and suppliers.
5	**Transition to net zero**	Reduce the carbon impact of construction, operation and use of the transport network through responsible use of resources, reuse and repurposing, as well as driving the net-zero transition, while enabling customers to make more sustainable choices.
6	**Create total value for society**	Maintain and enhance the balanced delivery of economic, environmental and social value through robust planning, rigorous appraisal and decisions that prioritise sustainability.

About MetroLink

Why is MetroLink Needed?

Dublin city centre has maintained its position as the pre-eminent location for jobs in Ireland. In the second half of 2018, the Central Statistics Office reported employment growth in the previous 24 consecutive quarters[7]. This trend is likely to continue as major technology companies continue to migrate to the area.

As employment opportunities grow, Dublin's population is expected to increase from 1.41 million in 2020 to 1.59 million by 2036[8]. This increases both the challenge and the urgency to move people around the city for jobs, education and leisure in a reliable, affordable and sustainable manner.

Fingal is the predominant area from which workers travel to Dublin city. Nearly 8,000 workers in Swords commute to Dublin city centre and public transport accounts for only 12% of these trips, with the remainder being undertaken by car. The average Dublin commuter, travelling by car, will spend over 213 hours a year stuck in traffic[9]. MetroLink will have the capacity to reduce 72% of these car trips, freeing up the road network, reducing congestion and journey times for everyone.

The Swords, Dublin Airport, Dublin City Centre corridor plays a critical role in the functioning of the national economy. It facilitates the efficient functioning of two major international gateways (Dublin Airport and Dublin Port) and completes the economic link between Dublin and Belfast. The efficiency of economic traffic movements along this corridor has implications for the entire nation.

MetroLink creates integration and connectivity between these transport hubs (Figure 1). Dublin Airport, as Ireland's main international gateway, handled 30.7 million passengers in 2019. Dublin Airport supports 117,300 jobs in the Irish economy, and 19,200 of these are employed directly at the airport and its environs[9]. However, there is no rail connection to get either passengers or employees to Dublin's biggest transport hub.

Figure 1: MetroLink - Integrated Transport

Under BusConnects, the Dublin Airport to Dublin City Centre route, will be upgraded to a high capacity bus system, with a maximum capacity of 4,500 passengers per direction per hour[10]. The Dublin Area Rapid Transit (DART+) Programme will create a full metropolitan area DART network for Dublin with all of the lines linked and connected[11], the aim is to increase peak-hour capacity from 26,000 to 52,000 per hour per direction by 2027/28[12]. However, despite the increased capacity BusConnects and DART+ will provide, passenger demand is not expected to be met, therefore MetroLink is also needed.

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[7] Transport Infrastructure Ireland. MetroLink. Available at: https://www.metrolink.ie/#/WhyDoesDublinNeedAMetro
[8] Central Statistics Office. *Regional Population Projections.* Available at: https://www.cso.ie/en/statistics/population/regionalpopulationprojections/
[9] Tom Tom. *Dublin Traffic (as of 29th Nov 2020).* Available at: https://www.tomtom.com/en_gb/traffic-index/dublin-traffic/
[10] National Transport Authority. *Fingal North Dublin Transport Study 2015*. Available at: https://www.nationaltransport.ie/wp-content/uploads/2014/12/Fingal_North_Dublin_Transport_Study__Final__June_2015.pdf
[11] National Development Plan 2018-2027. Project Ireland 2040. Available at: https://www.gov.ie/pdf/?file=https://assets.gov.ie/37937/12baa8fe0dcb43a78122fb316dc51277.pdf#page=null
[12] DART+ Programme. Project Ireland 2040. Available at: https://www.irishrail.ie/Admin/getmedia/e13a95f4-c0e9-43ee-883f-7181a96f07fe/DART-Plus-Brochure-17-08-2020-REV2-FA.pdf

The National Transport Authority (NTA) published, and consulted upon, the 'Transport Strategy for the Greater Dublin Area 2016-2035'[13]. This strategy sets out a vision of a sustainable international Gateway Region, with strong connectivity across the Greater Dublin area, nationally and worldwide. The strategy sets out the necessary transport provision to achieve the mode share target of a maximum of 45% of car-based work commuting established under "Smarter Travel – A Sustainable Transport Future"[14].

Following the results of TII's landmark report *Travelling in a Woman's Shoes: Understanding Women's Travel Needs in Ireland to Inform the Future of Sustainable Transport Policy and Design*.[15] Metrolink will include design and operating features intended to better meet a broader range of customer travel needs.

Through a series of project appraisals, using the Common Appraisal Framework (covering economy, safety, integration, environment and accessibility) and consultation events, an "emerging preferred route" emerged, which eventually became MetroLink.

[13] National Transport Authority. *Transport Strategy for the Greater Dublin Area 2016-2035.* Available at: https://www.nationaltransport.ie/wp-content/uploads/2016/08/Transport_Strategy_for_the_Greater_Dublin_Area_2016-2035.pdf
[14] Department for Transport. *Smarter Travel – A Sustainable Transport Future. A New Transport Policy for Ireland 2009 – 2020* Available at: http://www.smartertravel.ie/sites/default/files/uploads/2012_12_27_Smarter_Travel_english_PN_WEB%5B1%5D.pdf

[15] Transport Infrastructure Ireland. *Travelling in a Woman's Shoes: Understanding Women's Travel Needs in Ireland to Inform the Future of Sustainable Transport Policy and Design.* Available at: https://www.tii.ie/technical-services/research/TII-Travelling-in-a-Womans-Shoes-Report_Issue.pdf

What is MetroLink?

MetroLink is a high-capacity, high-frequency, modern and efficient metro rail line running from Swords to Charlemont, linking Dublin Airport, Irish Rail, DART, Dublin Bus and Luas services, creating fully integrated public transport system in the Greater Dublin Area.

As well as linking the major transport hubs, MetroLink will connect key destinations including Ballymun, the Mater Hospital, the Rotunda Hospital, Dublin City University and Trinity College Dublin, as shown in Figure 2**.**

MetroLink will transport around 53 million people per year in its initial years, cutting journey times from Swords to the city centre to 25 minutes[9]. The 19.4km route will commence construction in 2023 and will be operational by 2030.

MetroLink differs from DART and InterCity services operated by Iarnród Éireann and Luas services as it provides:

- A higher service frequency.
- Larger carriages designed to increase capacity.
- A fully segregated rail line from other road users including cars and pedestrians, achieved by operating mostly within tunnel under Dublin City, combined with surface or retained cut sections.
- Driverless vehicles automatically controlled from a remote location.

Figure 2: MetroLink route

There are 15 proposed stations, 11 of which will be underground. The other principal project elements include:

- Increased secure cycle at locations along the route
- Better pedestrian access around the new stations and interchanges
- A Park and Ride Facility for 3,000 vehicles next to Estuary Station
- A Maintenance depot at Dardistown, also housing the Operations Control Centre
- The 262m long Balheary viaduct, crossing the Broadmeadow and Ward Rivers
- A 100m long rail bridge crossing the M50

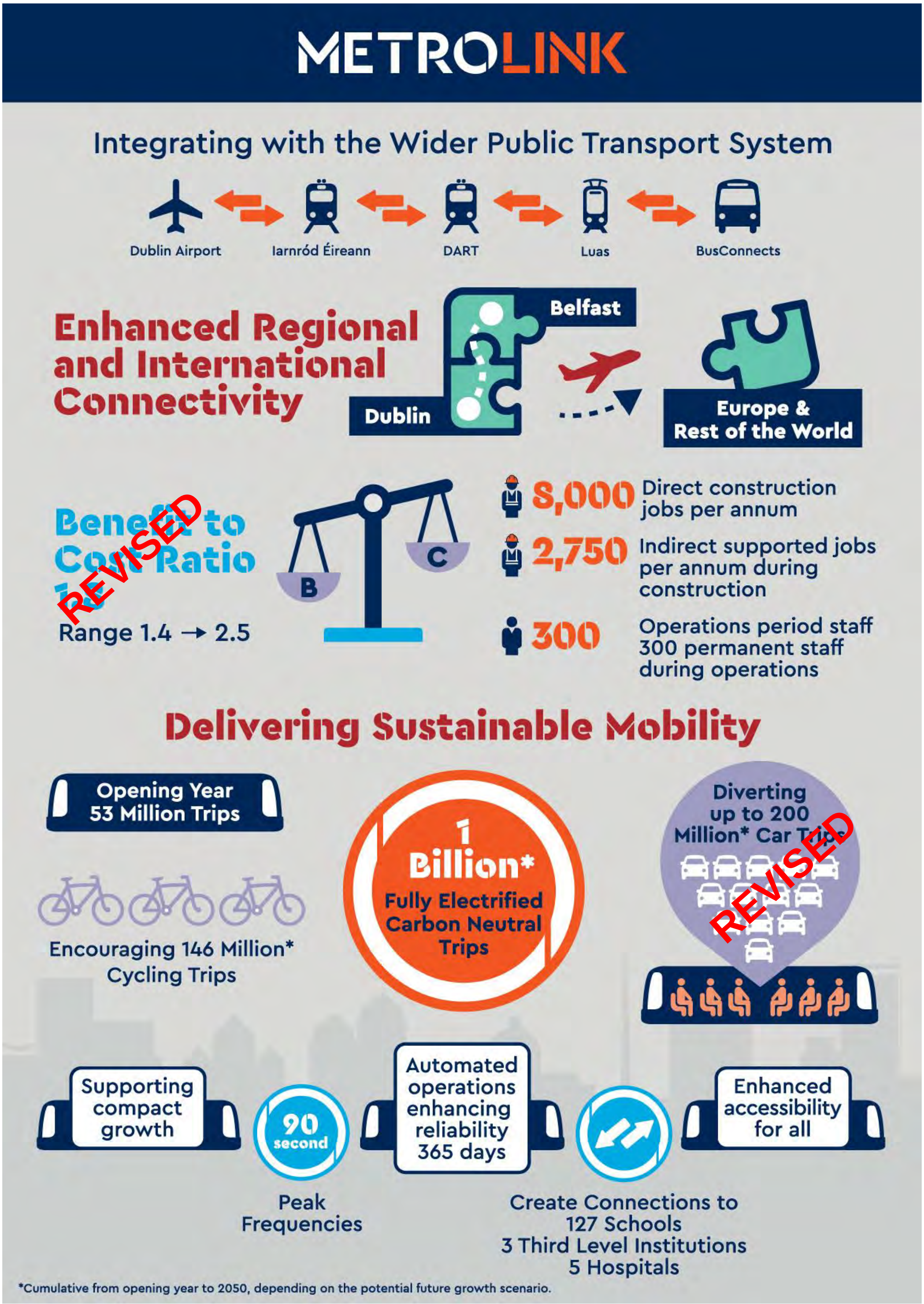
The strategic objectives for the public transport infrastructure intervention along Swords, Dublin Airport, Dublin City Centre Corridor are presented in Figure 3, below.

Figure 3: Objectives for Swords, Dublin Airport, Dublin City Centre Corridor public transport infrastructure intervention

Figure 4

provides some additional key facts on the project relating to route, passenger capacity, journey times and other statistics.

Figure 4: MetroLink Key Facts


METROLINK
Integrating with the Wider Public Transport System
Dublin Airport
Iarnród Éireann
DART
Luas
BusConnects
Enhanced Regional and International Connectivity
Belfast
Dublin
Europe & Rest of the World
Benefit to Cost Ratio
REVISED
Range 1.4 → 2.5
B
C
8,000 Direct construction jobs per annum
2,750 Indirect supported jobs per annum during construction
300 Operations period staff 300 permanent staff during operations
Delivering Sustainable Mobility
Opening Year 53 Million Trips
Encouraging 146 Million* Cycling Trips
1 Billion* Fully Electrified Carbon Neutral Trips
Diverting up to 200 Million* Car Trips
REVISED
Supporting compact growth
90 second
Peak Frequencies
Automated operations enhancing reliability 365 days
Create Connections to 127 Schools 3 Third Level Institutions 5 Hospitals
Enhanced accessibility for all
*Cumulative from opening year to 2050, depending on the potential future growth scenario.

What Sustainability Benefits will MetroLink Bring?

As a sustainable mass transit system, MetroLink intrinsically delivers the following benefits for Dublin and Ireland in line with TII's Statement of Strategy and SIP. A summary of these is presented in Table 3.

Table 3: MetroLink benefits – environment, society and economy

Environment	Society	Economy
• An electrified mass transport option offering a new, operationally carbon neutral, public transport choice for a range of users. This will help Ireland meeting its sustainability and GHG emissions goals. • An effective public transport system creates an opportunity to change the road user mix – which can lead to more efficient and effective use of the road network, reducing current congestion, improving journey times and air quality. • Opportunities for energy and material use efficiency through station and system design. • GHG emission reductions through the displacement of existing car journeys. Metro trips typically emit seven times less CO_2 than the current equivalent car journey[16]. • Opportunities for the protection and enhancement of biodiversity where feasible.	• Promote an improvement in health for a range of users (including carers, children and older citizens) who combine an active travel mode (e.g. walking and cycling to and from stations) with using public transport. • Provide a safe, reliable, comfortable, and faster trips between Fingal and Dublin and within the city. • Greater public transport choice and faster, safer and more reliable journey times providing easier access to jobs and services such as health services and education. • Trains are efficient on space within a city. Underground MetroLink trains will be capable of carrying 500 passengers at the comfortable loading parameter of four people per square metre. • MetroLink is designed to scale up to meet future demand. Additional trains will be added to the fleet over the course of the first 25 years of operation.	• 2,750 people per year are expected to be employed during construction and around 300 permanent staff during operation. • A trainee programme during operation will offer opportunities for upskilling. • MetroLink will offer an affordable alternative to car ownership and use. • MetroLink will improve connectivity between Dublin, Ireland, and the rest of the world, improving competitiveness due to less waste of time by providing regular, reliable and affordable travel to and from Dublin Airport. • New transport connections will give business and property developers the confidence to invest in new areas and delivering regeneration. • As a significant infrastructure project, MetroLink provides supply chain and employment opportunities to local businesses.

MetroLink and Covid-19

During the ongoing COVID-19 pandemic, public health advice concerning social distancing, as well as encouraging more people to work from home if possible, has resulted in a significant decline in the demand for commuter and business-related travel and in turn public transport use. There are differing views on how this will affect cities such as Dublin in the medium to long term. The World

[16] Unife – the European Rail Industry. *Rail: The backbone of Sustainable Transport*. Available at: https://sustainabledevelopment.un.org/content/documents/3761sandor.pdf

Economic Forum for example, suggests that cities may remain as essential hubs for the pooling of human capital, innovation, the arts and other societal structures[17].

Evidence from TII's road network showed that traffic flow on the road network returned to near-normal levels following lockdown events, meaning that the capacity constraints identified in various studies are likely to remain and therefore the sustainability benefits of delivering MetroLink are likely to remain relevant.

[17] Why global cities will flourish in a post-COVID future. Available at: https://www.weforum.org/agenda/2020/08/future-of-citiescovid-19/

How this Plan was Developed

Throughout MetroLink's evolution, delivering outcomes that benefit the environment, people and the Irish economy have been carefully considered during concept, optioneering and now into the reference design. Figure 5, below, shows how this sustainability plan has evolved and the future steps for implementation of the plan.

Figure 5: The Development of the Project Sustainability Plan

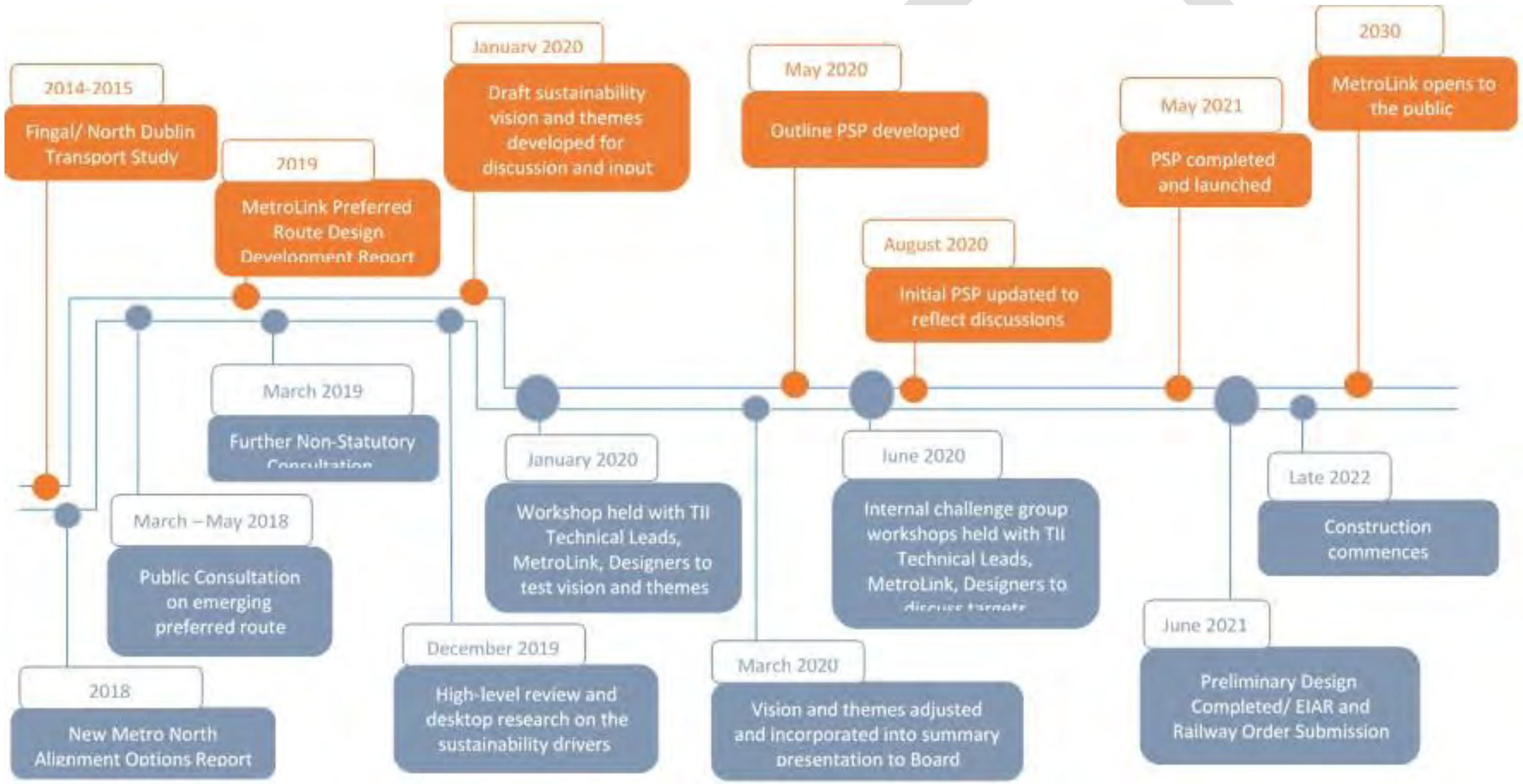


Figure 6, below, summarises how this plan was developed.

Figure 6: How the MetroLink Sustainability Plan has been developed

An initial scoping exercise was conducted to review the sustainability policy (outlined in Table 1) and TII's Statement of Strategy and SIP to understand how the high-level objectives within these documents apply to MetroLink. A collaborative process of engagement involving a wide range of internal stakeholders, followed, to further explore and refine what the findings of the policy review meant for the sustainable delivery of the project.

This resulted in a draft sustainability vision and the identification of key priority areas, shown in the later sections of this plan. The emerging sustainability plan was then subject to a series of 'challenge workshops', which included a diverse cross-section of board and project members, to test how appropriate the vision was and what the key sustainability priority areas are.

For each of the relevant priority areas assessed during the challenge workshops the vision and priority areas were assessed against four ambition levels: 'Compliant', 'Beyond Business as Usual', 'Emerging Leader' and 'World Class'. In setting MetroLink's targets and objectives, a minimum target has been set of going beyond 'Business as Usual' and where economically and technically feasible MetroLink aspires to go beyond this. The thinking behind these levels of ambition are reflected in MetroLink's objectives and targets, described below.

MetroLink Sustainability Vision

Sustainability for MetroLink means delivering and operating an efficient, low carbon and climate-resilient metro system, which better connects passengers as part of an integrated transport system, unlocks regeneration opportunities, drives international connectivity and enables compact growth for present and future generations, while also being designed to be responsive to future demand requirements.

MetroLink Priority Sustainability Areas

In developing the sustainability vision, MetroLink explored what are the priority sustainability areas, which it can directly deliver or reasonably influence in partnership with others throughout the project lifecycle.

Table 4 sets out the MetroLink sustainability priority areas identified during the development of this plan. They are mapped to TII's Sustainability Principles which are aligned to the UN Sustainable Development Goals and the National Strategic Outcomes[18] to make sure that MetroLink will deliver against the key sustainability indicators.

Table 4: MetroLink's Sustainability Priority Areas

MetroLink Priority Areas	TII SIP – Sustainability Principles	MetroLink Sustainability Objective
EN1: Climate Change Mitigation and Adaptation	2 Enable safe and resilient networks and services 5 Transition to net zero	Support Ireland's climate ambitions to achieve net zero by 2050. Improve energy efficiency and increase resilience to future climate change.
EN2: Materials and Resources	3 Collaborate for a holistic approach 4 Deliver end-to-end improvements 5 Transition to net zero	Minimise the use of materials, natural resources and the production of waste.
EN3: Biodiversity	6 Create total value for society	Enhance biodiversity and minimise pollution.
EN4: Heritage	6 Create total value for society	Promote protection of and access to heritage.
CC1: Skills and Learning	3 Collaborate for a holistic approach 6 Create total value for society	Provide opportunities to upskill, learn and develop in the construction and transport sector.

[18] The proposed drivers have been mapped against the National Strategic Outcomes of the Project Ireland 2040 National Planning Framework, with the exception of Access to Quality Childcare, Education and Health Services, as this is not directly related to the delivery of MetroLink.

MetroLink Priority Areas	TII SIP – Sustainability Principles	MetroLink Sustainability Objective
CC2: Community and Engagement	3 Collaborate for a holistic approach 4 Deliver end-to-end improvements	Broad and meaningful engagement and consultation with all stakeholders.
CC3: Safety	2 Enable safe and resilient networks and services	Deliver and operate MetroLink safely, leading by example.
CC4: Health and Wellbeing	4 Deliver end-to-end improvements 6 Create total value for society	Demonstrate and deliver health and wellbeing benefits.
SE1: Connectivity	1 Provide effective, efficient and equitable mobility	Facilitate connectivity between MetroLink and other transport services and modes of transport.
	1 Provide effective, efficient and equitable mobility 2 Enable safe and resilient networks and services	Deliver well designed stations using the principles of universal design, that are accessible to all, safe, comfortable, and attractive.
SE2: Productivity	2 Enable safe and resilient networks and services 3 Collaborate for a holistic approach 4 Deliver end-to-end improvements	Demonstrate increased productivity during construction and associated with the delivery of MetroLink.
SE3: Facilitating growth and planning for the future	2 Enable safe and resilient networks and services 3 Collaborate for a holistic approach	Collaborate with local planning and local and international businesses to deliver sustainable growth. Allow for future trends in growth within the designs and operations.
SE4: SME and Local Spend	6 Create total value for society	Encourage and include local and small and medium-sized companies to engage in tendering opportunities.

Objectives and Targets

This section presents the objectives and targets that have been developed to support the delivery of MetroLink's sustainability vision. They are broadly aligned to the three sustainability pillars of Environment, Society and Economic described in the TII SIP and Corporate Sustainability Strategy.

The objectives and targets apply to the design, construction and operation of MetroLink. An explanation of how they apply during each phase of the project is presented in this section and an indication of the relevant phase the targets are associated with is displayed in the Appendix. Example initiatives have been provided for each theme as an indication of the activities required to meet the targets.

EN1: Climate Change Adaptation and Mitigation

Objective

- Support Ireland's climate ambitions to achieve net zero by 2050 and improve energy efficiency.
- Increase the resilience of MetroLink to future climate change.

Current Status (Design and Planning)

As part of the planning process, a carbon baseline for construction and operation has been established against which progress can be measured. The tool allows carbon hotspots to be identified and focussed on. It also allows differing grid electricity options to be modelled.

Preliminary studies have been conducted to identify the main risk of flooding from climate change and sustainable stormwater management systems have been included in the design.

MetroLink's Ambitions

- Use TII's Carbon Assessment Tool for Road and Light Rail Projects to identify and implement changes in design to reduce energy use in construction and operation and to select materials with lower embodied greenhouse gases.
- Capture the carbon hotspots and minimisation options in a PAS2080 aligned carbon management plan, which will be used by the construction contractor and operator to reduce emissions.
- Explore the purchase of certified low or zero carbon electricity for construction and operations and research the feasibility of offsetting any residual emissions.
- Set an example for Irish infrastructure projects by conducting further assessments of future climate change risks to operations and implement measures to mitigate these.
- Develop operational management plans that focus on further energy reduction and decarbonisation to include targets for the operational partner.

Targets

- Implement a whole-life Carbon Management Plan aligned to PAS2080 to inform the design, build and operation of MetroLink utilising TII's Carbon Assessment Tool.
- Achieve Net Zero for operational energy by opening year (2032), through energy efficiency, innovation, green power purchases and offsetting residual emissions - subject to further assessment of Ireland's decarbonisation of the electricity grid.
- Deliver a 20% reduction in capital and embodied carbon against baseline.
- Achieve direct emission reduction for between 90% and 95% of the energy requirement for MetroLink operations from opening day, through renewable energy sources.
- Utilise certified and validated (assured) carbon offset products to balance the remaining energy usage carbon balance until the national grid achieves net zero.
- Integrate and maintain measures to manage construction and operational surface water and stormwater runoff, providing over 7,500m^3 of attenuation.
- Undertake further Climate Change Risk Assessments during the procurement and detailed design stages for all major assets and implement measures to mitigate identified impacts.
- Maintain measures to support MetroLink's resilience for a 1 in 1000-year flood event +40% for climate change.

Key example initiatives

- Implement efficient energy systems and power supply across all operations.
- 100% renewable energy through a combination of self-generation and procurement.
- Investigate certified offset schemes of residual emissions.
- Develop a route map and carbon plan to transition to Net Zero carbon.
- Conduct a focussed Climate Change Risk Assessment on the project and incorporate findings into further design steps.

EN2: Materials and Resources

Objective

- Minimise the use of materials, natural resources and the production of waste.

Current Status (Design and Planning)

The volumes and types of materials that will be needed to construct and operate MetroLink and have established a baseline for the EIAR. As a significant portion of the route is underground, construction of Metrolink is expected to generate large amounts of excavated material. A preliminary options assessment will be needed to demonstrate how and where materials could be managed to deliver the greatest sustainability benefit by applying circular economy principles.

Through evolving design, assessments of how MetroLink can reduce waste, increase the use of sustainable, lower carbon materials and seeking to follow best practice and use innovative products for this.

MetroLink's Ambitions

To deliver a resource efficient metro system, by:

- Identifying opportunities to reuse or recycle excavated and surplus materials within the project or make the materials available as a product to other projects, in accordance with relevant legislation.
- Requiring contractors to achieve targets for minimising waste, reusing and recycling materials and minimise water through contractual requirements and the construction Environmental Operating Plan.
- Considering environmental impact of materials in further design and procurement by undertaking life cycle assessments and specifying products will lower environmental footprints.
- Requiring operations to achieve high recycling rates with an aspiration to achieve zero waste directly to landfill.

Targets

- Implement a Waste Management Plan for Construction and Demolition Waste to facilitate a maximum of 5% construction and demolition waste (inert and non-hazardous) and operational waste by volume disposed in landfill.
- Undertake lifecycle assessments for major asset components and implement recommendations to influence the procurement of low carbon/ sustainable materials to achieve 40% reduction by volume of virgin materials.
- Procure materials for major asset components that have verified Environmental Product Declarations (EPD).
- Achieve a 20% reduction in mains water use during construction and 20% reduction during operation using rainwater harvesting, water re-use and efficiency systems and devices at all work sites, stations and buildings.
- Zero major pollution incidences during construction and operation and zero accidental or non-consented releases. Implement measures to monitor and report all pollution events and near misses.

Key example initiatives

- Local sourcing of materials (within <80 km), transported through low carbon logistics.
- Local waste management (<80 km) during construction and operation.
- Implement a trading mechanism for reuse of surplus materials.
- Specify >40% of materials by volume/ mass to be from low-carbon or sustainable sources.
- Embed sustainable procurement principles for all contracts that procure goods or service.
- Utilise BIM to develop asset inventory to facilitate end of life redeployment.
- Identify alternative procurement models, which support the circular economy through the lifecycle of MetroLink e.g. leasing or product takeback and remanufacturing.

Case Study – Sustainability at the Luas Broombridge Depot.

- Rainwater collection at the depot buildings will be used for irrigation.
- 80% of the water used for the train cleaning will be reused.
- Solar panels will be integrated either in the building's roof or in the parking canopies.

EN3: Biodiversity

Objective

- Protect and enhance biodiversity, achieve no net loss and minimise pollution.

Current Status (Design and Planning)

MetroLink has assessed, and is working towards, achieving a minimum of no net loss of biodiversity. To facilitate this, best practice and mitigation measures to protect areas of valuable and threatened species habitats have been identified through the environmental assessment process. Mitigation measures include further designing elements of MetroLink to avoid and minimise impacts and including biodiversity sensitive practices in the operational management plan. This will consider the long-term management of the metro to sustain plants and animals and contribute to biodiversity during its operation.

MetroLink's Ambitions

MetroLink will explore and implement the following measures to promote the delivery of a biodiverse metro system:

- Design to reduce impacts on biodiverse habitats and develop suitable planting and mitigation measures to promote biodiversity.
- Implement habitat improvements where feasible.
- Require contractors to manage their sites and activities to support biodiversity and no major pollution instances. All mitigation measures detailed in the Railway Order will be implemented.
- Re-establish biodiversity through native species planting and prevent the spread of invasive alien plant species.
- Monitoring the success of the measures implemented in the short and medium term.

Targets

- Achieve a minimum of no net loss of biodiversity.
- Protect areas of wildlife reserves/ protected habitats/ trees/ species and encourage recolonisation by implementing biodiversity sensitive design, and landscape management in the operational management plan and operations contracts.
- [Targets to be inserted from EIAR ecology chapter mitigations when complete].
- Protect areas of valuable and threatened species habitats designated within the Natura 2000 protected areas network.
- [Target when EIAR complete] to be included in operations contracts, which also include monitoring and reporting for biodiversity.

Key example initiatives

- No net loss – ecology impacts sufficiently mitigated or compensated.
- Green infrastructure is incorporated into design (e.g. green walls in stations).
- Implement biodiversity sensitive management practices in the operational management plan to maintain the no net loss target during operation.

EN4: Heritage

Objective

- Protect and improve access to heritage and cultural heritage along the MetroLink route.

Current Status (Design and Planning)

MetroLink has the potential to affect areas of heritage because of extensive excavation works, demolition of buildings, and construction of stations. Heritage conservation has been a key consideration throughout the design and construction of MetroLink and the potential impact of the project has been assessed. Ongoing measures are being considered to protect and restore historic and archaeological assets in situ.

MetroLink's Ambitions

MetroLink will deliver a metro system that is sympathetic to the local heritage setting, leaving archaeological effects in situ wherever possible. This will be achieved by:

- Identifying opportunities such as tree planting to minimise visual impact on heritage features such as Lissenhall Bridge.
- Restoring heritage features to prolong their lifespan e.g. the cast iron railings around Mater Park, housing the memorial for the Four Masters.
- Relocating the Wolfe Tone monument further into St Stephen's Green to retain its historic setting to allow greater and safer appreciation of the monument as a sculpture.
- Incorporating elements of culture and heritage in station and precinct design through plaques or murals.
- Establishing a heritage trail, like the audiobook telling the story of the archaeology discovered during construction of the Luas line.

Targets

- Develop and implement an ongoing heritage monitoring strategy.
- Implement and maintain measures to retain historic setting of heritage features.
- Maintain measures to minimise visual impact on heritage features through detailed landscape design and the operational management plan.
- Station and/ or train designs to incorporate elements of local and national art, culture and heritage.

Key example initiatives

- Enhance areas of local heritage and historic assets through sustainable restoration.
- Promote awareness and enable interaction with areas of local heritage and historic assets to service users/ surrounding community.

Case Study – Heritage

Construction of the station in St Stephen's Green will require the Wolfe Tone monument to be relocated further into the park. This will retain the monument's historic setting and allow greater and safer appreciation of the monument as a sculpture. The existing railings and footpath floor finishes will be preserved, and the station box will be deep enough to guarantee the relocation of trees above, integrating the station with the park setting.

CC1: Skills and Learning

Objective

- Provide opportunities to upskill, learn and develop in the construction and transport sector through the delivery of MetroLink.

Current Status (Design and Planning)

MetroLink is seeking to develop a skills and learning programme that reflects industry skills requirements, local demographics, the need for a balanced (e.g. gender, culture, age, race) workforce across all fields, regulatory drivers and wider government priorities around skills, employment, diversity and business growth in the construction and transportation sector. This is best achieved by collaboration and MetroLink is identifying partners to help deliver this.

These will be translated into contractual requirements across MetroLink, encouraging contractors to participate in programmes relevant to their activities.

MetroLink's Ambitions

MetroLink will develop the following opportunities to provide skills and learning to the construction workforce and the supply chain by:

- Increasing capability and capacity of the workforce, supporting project delivery through collaboration to address skills shortages and lower productivity in the construction sector.
- Mitigating skills shortages and gaps through training.
- Developing intellectual capital through upskilling local workers.
- Increasing collaboration and innovation with industry partners.
- Developing and supporting a diverse and inclusive workforce.

Targets

- Fund, develop and implement an Apprenticeship and Trainee Programme, incorporating outreach programme with local schools, colleges and universities.
- Apprentices to account for 5% of workforce across design, construction, and operation.
- Incorporate skills and learning targets into MetroLink's construction contracts and measure and report progress monthly.
- Provide an inclusive approach to recruitment, staff training and rotas to build community relationships and foster a sense of safety (including staff training on gender-sensitive approaches to dealing with sexual harassment and assault at work and on the network).
- Develop and implement a programme of community engagement to raise awareness of sustainability topics linked to the design, construction and operation of MetroLink.
- Encourage collaboration and co-creation to identify challenges and design solutions.

Key example initiatives

- Facilitate multidisciplinary workshops (including client, designers, technical, specialists, transport users with different needs and contractor), encouraging collaboration and co-creation to identify challenges and design solutions in delivering MetroLink.
- Explore the merits of establishing a skills academy for rail and light rail.
- Deliver Apprenticeship and Trainee Programme covering a wide range of technical disciplines.
- Defined career pathways delivered and supported by the project in construction and operation.

CC2: Community and Engagement

Objective

- MetroLink will engage with all stakeholders throughout each stage of the project lifecycle to keep them informed of progress.

Current Status (Design and Planning)

The emerging design has been informed by ongoing public consultation with engagement of a wide range of user groups. A stakeholder and community engagement plan have been developed which has guided the frequency and means of communication.

Extensive non statutory public consultation has taken place on the Emerging Preferred Route which ran from 22nd March to 11th May 2018, and the Preferred Route which ran from 26th March to 21st May 2019, with over 8,000 submissions received from members of the public and other interested stakeholders.

MetroLink's Ambitions

Metrolink will achieve progress in this priority area by:

- Regularly reviewing and updating MetroLink's stakeholder and community engagement plans throughout construction and operation, ensuring we seek out a range of voices and experiences.
- Actively maintaining partnerships and design focus groups established with the community.
- Communicating in a timely and open manner, using various channels including social media, during construction and operation to make our community aware of future changes that may affect them.
- Reporting MetroLink's sustainability performance annual online to promote transparency and demonstrate MetroLink's progress.

Targets

- Develop and maintain a stakeholder and community engagement plan, including centralised complaint reporting line, minimum standards for resolution and a programme of virtual and face to face events during design, construction and operation.
- Provide a dedicated helpline and social media channels (e.g. Twitter, LinkedIn, Facebook and emerging platforms) for the community before construction starts.
- Develop and implement a programme of community engagement to raise awareness of sustainability topics linked to the design, construction and operation of MetroLink.
- Minimise the probability of impacts due to flooding and power outages through back-up systems and controls.
- Work with partners to improve user perceptions of safety getting to and using MetroLink.

Key example initiatives

- Public information boards displaying key design features.
- Ongoing communication with affected stakeholders through a range of media.
- Delivery of virtual consultations with use of virtual /augmented reality to present visualisations of build.
- Implement mechanism for users to provide feedback on operational service.
- Continue programme of school visits/ talks covering topics including respect for each other and ways to support women and girls to feel safe on public transport, design features of Metrolink specifically for kids, range of jobs in transport.
- Maintain long-term partnerships with local communities and key stakeholders such as universities, schools, hospitals along the route, women's safety organisations. Public information boards displaying key environmental information regarding the operation of the scheme.
- Communications hubs at key strategic locations (e.g. main station sites) across Dublin.
- Dedicated phone and social media channels for the project to facilitate engagement and ongoing dialogue with the local community.
- Ongoing engagement and contingency planning with other transport agencies to maintain level of service during disruptive events e.g. mass power outage and flooding.

CC3: Safety

Objective

- Deliver and operate MetroLink safely, leading by example and innovative practices.

Current Status (Design and Planning)

MetroLink is a significant infrastructure project in Ireland and involves complex engineering and construction techniques. MetroLink can build on the safe delivery of infrastructure projects by TII and lead by example, considering safety in design and through the procurement of MetroLink's contractors.

How society engages with its public transport systems depends on how pleasant and safe they feel when using MetroLink including getting to and from Metrolink. Safety is central to our universal design approach with measures to prevent anti-social behaviour and clear lines of sight in stations with fewer corners, so people can see who is coming towards them. MetroLink knows that perceptions of safety apply to the entire journey including access to park and ride facilities, connecting services and the walk or ride home, making strong partnerships with local government, surrounding businesses and services important in tackling safety concerns about safety.

MetroLink's Ambitions

MetroLink's commitment to safely deliver includes:

- Embedding a culture that makes sure that everyone on the project returns home safely at the end of their shift.
- Using safety in design to deliver a metro system that is safe to construct and offers safety benefits to everyone that uses it.
- Incentivise contractors to deliver safety benefits to construction workers.
- Develop and publish safety metrics and key learnings for MetroLink during construction and operation.

Targets

- Facilitate ongoing engagement with key stakeholders (e.g. DFB/ Gardai) to deliver a metro system that is safe for all.
- Use a universal design approach to design out safety issues in the construction and operational phases of MetroLink.
- Establish a culture of everyone home safe at the end of their shift.
- Develop and include targets for the safe construction of MetroLink.
- Implement and maintain an inclusive operational emergency response action plan.
- Implement and maintain measures to reduce antisocial behaviour, including provision of real time CCTV and appropriate lighting.

Key example initiatives

- Conduct gender safety audits (including for Park and Ride Facilities).
- Universal design to consider how different users perceive a safe travel environment.
- Learnings incorporated from other infrastructure projects delivered around the world.
- Conduct gender safety audits (including for Park and Ride Facilities).
- Design for children and elderly people on the network.
- Contractors to focus on lowering leading safety metrics (e.g. near misses) rather than actual incidents.
- Focus on delivering toolbox talks and awareness raising.
- Regular publication of case studies and innovation on safer construction activities
- Promotion of a no blame culture where near misses are raised, and improvements made.

CC4: Health and Wellbeing

Objective

- MetroLink will demonstrate and deliver health and wellbeing benefits through construction and operation.

Current Status (Design and Planning)

MetroLink can deliver health and wellbeing benefits by providing active travel options for a wide range of people in the broader Fingal and Dublin areas. Using public transport will enable users to include walking and cycling in their commute and reduce commuting times and associated stress. Modal shift has the potential to reduce air pollution health risks.

However, the construction of MetroLink needs to be sensitive to the impacts on the communities that may be affected by the works, recognising the potential effects of land purchase, construction and disruption of MetroLink's sites on the health and wellbeing of the surrounding neighbours. MetroLink has undertaken extensive assessments as part of the EIAR process to understand the potential impacts of noise, air quality and traffic on the communities involved and mitigation measures are in development, which will be implemented through a Construction Environmental Management Plan.

MetroLink's Ambitions

To deliver the health and wellbeing benefits of MetroLink and prevent unwanted effects during construction will:

- Collaborate with other agencies to provide sources of help and assistance to those directly affected by the MetroLink route.
- Require contractors to consider the impacts on the community through the careful management of noise, dust and emissions from construction, including monitoring where necessary.
- Minimise construction traffic using approved routes, consolidating deliveries and using consolidation centres where practicable.
- Encourage contractors to implement programmes to monitor and educate the workforce on long term health and wellbeing issues.
- Use tools such as the Eastern Regional Transport Model Health Appraisal Tool to calculate the benefits of changes in physical activity levels and absenteeism resulting from more walking and cycling.
- Promote a strong health and wellbeing culture within the project, with buy in from construction partners.

Targets

- Design for children and elderly people on the network.
- Establish noise and vibration baseline and implement and monitor mitigation measures in the noise and vibration management plan to reduce impacts during construction and operation.
- Establish an air quality baseline and dust management plan for construction in consultation with others.
- Appraise and implement a programme, in partnership with other transport agencies, to help and support those directly affected by the construction of MetroLink.
- Deliver a Scheme Traffic Management Plan that mitigates the impacts of construction traffic on the communities MetroLink works in.
- Include initiatives for worker health and wellbeing in contracts.

Key example initiatives

- Initiatives promoting the wellbeing of the workforce and operational staff.
- Public information boards and sources of displaying wellbeing benefits and links to public health services (e.g. mental health).
- Provide a responsive and sympathetic construction helpline for the works.
- Partner with other public health bodies in the areas MetroLink works in to promote health and wellbeing.
- Develop a culture of respect and care of the local community, especially in sensitive areas (e.g. hospitals and residential care centres).
- Active monitoring of noise impacts during the operational phase to pick up where wear and team becomes an issue before it impacts our neighbours.
- Consider where MetroLink can provide additional benefits through universal design.

Case Study – Air Quality

Demand modelling suggests that MetroLink will divert 6.8 million car trips per annum in the early years and growing to 12 million per annum by 2045. This offers an opportunity for a reduction in congestion and harmful emissions, improving Dublin's air quality.

SE1: Connectivity

Objectives

- Facilitate connectivity between MetroLink and other transport services and modes of transport.
- Deliver well designed stations using the principles of universal design, that are accessible to all, safe, comfortable, and attractive.

Current Status (Design and Planning)

MetroLink will promote public transport usage by leveraging connectivity and interchange capabilities through:

- Route alignment creates a fully integrated public transport system in the Greater Dublin Area by connecting with two major Iarnród Éireann commuter lines, buses, DART, Intercity and Luas services. Park and ride helps car users to access public transport.
- Links to major transport hubs, such as Dublin Airport, connect key destinations including Ballymun, the Mater Hospital, the Rotunda Hospital, Dublin City University and Trinity College Dublin.
- Providing access to all the attractions and social opportunities of Dublin, reducing the need to use cars.
- Universal Design to allow greater mobility for people with disabilities and carers with prams and therefore better access for underrepresented groups of users.

MetroLink's Ambitions

By linking Swords to the city centre and increasing the frequency of services, the Project is expected to facilitate a greater modal shift to rail from car.

Future infrastructure needs are incorporated into design, including for station/bus access and car parking areas to support changing transport mode options and technology (i.e. electric vehicles, autonomous vehicles, e-scooters and / or car-sharing modes).

The following actions will be investigated to implement and monitor connectivity improvements:

- The immediate public realm at stations will be designed and constructed to be safe and attractive to users.
- Contribute to active travel through creating improved pedestrian and cycle networks.
- Ongoing collaboration with other transport agencies to maintain level of service during construction.

Targets

- Design for ease of interchangeability at integrated stations with Dart/ IE etc.
- Maintain a minimum of 700 or 23% EV charging points at park and ride and maintain provision to increase this during operation.
- Implement and maintain a minimum of 1700 cycle parking stands (for approximately 3400 cycles) at stations along the MetroLink route.
- Implement and maintain provision of electronic and connectivity services on all trains and at stations (including charging points and free high-speed Wi-Fi).

Key example initiatives

- Integrate timetables and ticketing across transport operators to allow seamless interchange between transport modes.
- Undertake travel surveys for first 5 years of operation to estimate actual modal shift.
- Commitment to a passenger panel with regular satisfaction surveys and published results.
- Deliver carriage loading technology to measure crowding and display carriage loading data to passengers.

SE2: Productivity

Objective

- Demonstrate high productivity during delivery and operation of MetroLink.

Current Status (Design and Planning)

MetroLink will provide a substantial increase in capacity for Dublin's public transport network. Users will experience reduced journey times and improved reliability. MetroLink differs from the DART and Luas services by running a higher level of service frequency. There will also be larger carriages designed to increase capacity. These factors are expected to deliver productivity gains once MetroLink is running.

As a significant infrastructure project, MetroLink has an opportunity to demonstrate productivity gains in construction through robust project and programme management.

MetroLink's Ambitions

MetroLink anticipates increasing productivity throughout the project lifecycle by:

- Adopting a robust project and programme management and governance approach that careful monitors costs and delivery dates.
- Benchmarking and measuring MetroLink against other infrastructure projects in Ireland and comparable metro projects around the world.
- Using socio-economic data and analysis methods to assess and report on the productively benefits of MetroLink to Fingal and Dublin once operational.
- Promote technological innovation by adopting emerging technology and data to provide productivity gains.

Targets

- Research and develop a methodology for assessing and reporting productivity gains associated with the delivery of MetroLink.
- Establish a construction productivity benchmark for MetroLink and demonstrate gains against this benchmark monthly.
- Identify innovative technologies and practices that provide value for money and additional benefits to MetroLink users.

Key example initiatives

- Monitor and report productivity of Dublin transport network.
- Maintain partnerships with planning authorities, local businesses and international businesses to drive productivity within Dublin and nationally.
- Demonstrate matching of capacity to flexibility delivers required productivity levels.

Case Study – Reduced Journey times / Dublin Airport

In 2019 Dublin airport had 30.7 million passengers. Outbound passengers experience significant unreliability in their journey time to the airport, over 40% spent longer than 1 hour. MetroLink will reduce the time from the airport to Dublin city centre to 20 minutes, allowing passengers efficient access to the rail network and allowing them to be confident in the time their journey will take.

SE3: Facilitating shared growth and planning for the future

Objective

- Collaborate with local planning and local, national and international businesses to deliver growth.
- Allow for future trends in growth within the designs and operations

Current Status (Design and Planning)

Partnerships with local planning authorities make sure MetroLink's design complements local area plan requirements, facilitating local growth. Future changes to Dublin's demographics have been incorporated into design through passenger and growth modelling. To support this, Fingal County Council has rezoned 390 hectares of land as the "Metro Economic Corridor". Metrolink notes the importance of understanding who directly benefits from new public infrastructure and services, ensuring resources and benefits are distributed.

The MetroLink project is designed to provide capacity for the projected demand out to 2060, the automated nature of the system will allow for increases in demand by reducing headways and increasing the frequency of service. The vehicles are required to be a minimum length of 64m. All station elements including platforms, vertical transport, passenger areas, technical accommodation and plant sizing is space-proofed to accommodate additional demand on the system over time.

MetroLink's Ambitions

MetroLink will work closely with local planning authorities to integrate and align the metro with future growth predictions and deliver Compact Growth, this includes:

- Integrating flexibility into the design and operation of MetroLink so that future expansion and demand can be cost effectively and sustainably delivered e.g. future connections to the Green Line.
- Working flexibility with other developers and projects to integrate access to MetroLink into the public realm of other developments.
- Integrating flexibility into the infrastructure to cater for changes in technology and usage patterns e.g. the forecasted uptake in electrical vehicles.
- Safeguard public space for best practice local placemaking.

Targets

- Investigate and incorporate future growth trends into MetroLink's design and operations to facilitate future expansion based on quantified data from equivalent metro systems.
- Space proofing during design to allow for expansion of the metro system.
- Collaborate with local planning authorities and developers to fully recognise the socio-economic benefits of MetroLink.

Key example initiatives

- Maintain partnerships with local planning authorities, local businesses and international businesses and community organisation to facilitate shared growth.
- Provision of adaptive rolling stock to reflect demand (e.g. flexible service to cater for periodic increases in user demand).
- Monitoring potential risks and opportunities for MetroLink beyond its opening.
- Urban regeneration for local businesses.
- Ongoing collaborative management of surrounding areas to maximise accessibility during operation.

Case Study – Train Automation

MetroLink will be fully automated. This means starting and stopping, operation of doors and handling of emergencies will be automatically controlled without any on-train staff. Trains will be able to travel at shorter intervals of one another, 90 second peak frequencies are possible.
To save energy, the automatic system will optimise acceleration, traction and braking. Temporarily parked trains will be able to switch off non-essential systems and equipment.

SE4: SME and Local Spend

Objective

- Encourage and include local and small and medium-sized (SME) and local businesses to engage in tendering opportunities.

Current Status (Design and Planning)

Increased employment during the construction of MetroLink will have a direct positive impact on the local and regional economy. MetroLink will create opportunities for local and SME businesses during construction and operation.

MetroLink's Ambitions

A significant project like MetroLink can deliver economic benefits to SMEs and local businesses, which will in turn benefit residents and the Irish economy. MetroLink will facilitate these benefits by:

- Developing a sustainable procurement strategy to include local and SME businesses in procurement of services and materials where possible.
- Encouraging contractors to source staff locally and consider and include underrepresented groups in the workforce.
- Investing in local business and innovation where appropriate.

Targets

- Implement and review on an annual basis a sustainable procurement strategy aligned with TII procurement policies and incorporates the national policy *Social Considerations in Public Procurement*.
- Incorporate sustainability requirements into all tenders to consider local and SME businesses and local employment.
- Develop sustainable practice evaluation criteria within tender requirements (e.g. renewable energy generation and sourcing materials to support the circular economy).
- Use meet the buyer events to promote opportunities to supply MetroLink.
- Identify opportunities to engage with local and SME businesses in station facilities and in the public realm areas surrounding stations.

Key example initiatives

- Local and SME involvement is a key factor in procurement of services, employment, and products/ materials where possible.
- Engage with local and SME companies through meet the buyer events and other initiatives.
- Collaboration with local business support groups to help local and SME businesses overcome barriers to participating in tenders.
- Identifying innovation and investment opportunities that benefit MetroLink.

Delivery

Implementation

This sustainability plan will be supported by various implementation measures, specific sustainability topic strategies and procurement requirements for contractors and operators. This is necessary as the responsibility for ensuring sustainability outcomes extends beyond TII and the MetroLink design team.

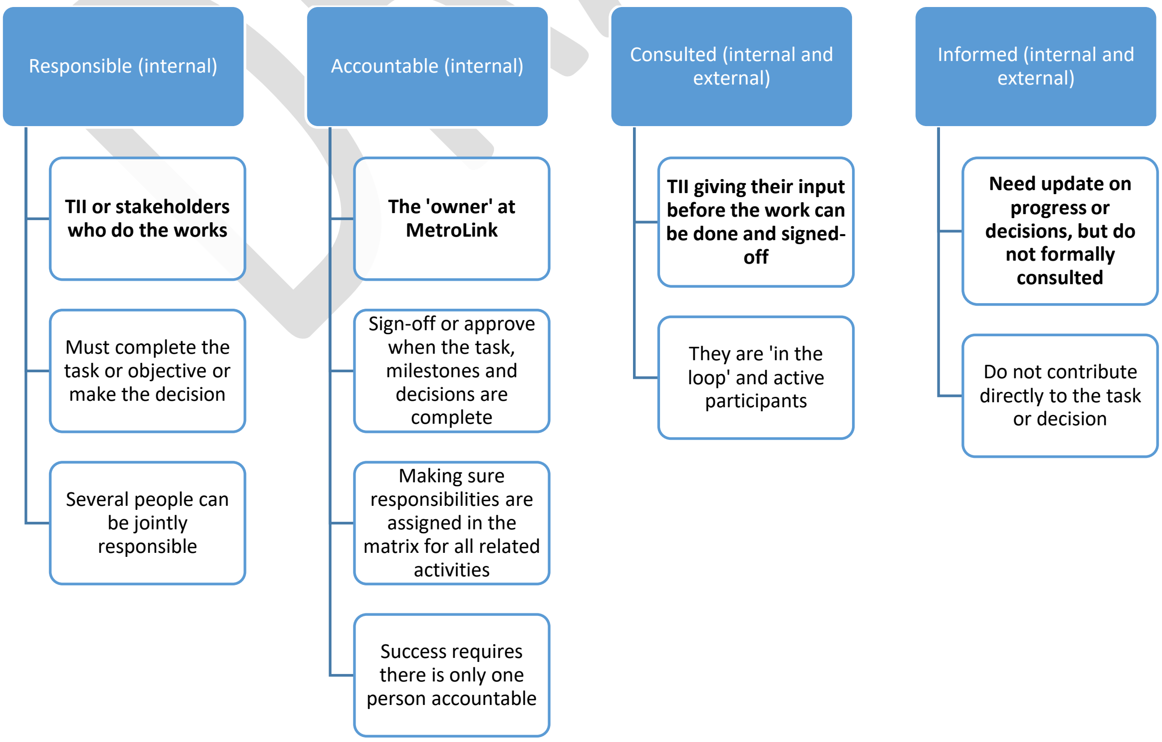
Sustainability commitments and minimum standards will be picked up in a series of requirements documents that will be instructed during contractor and operator procurement. This will ensure that sustainability is integrated across the team and becomes a shared responsibility, whether it relates to the ownership of targets, or promotion of MetroLink benefits and outcomes. In addition, MetroLink will assess whether infrastructure sustainability frameworks and rating systems such as CEEQUAL or LEED will provide value for delivery of this plan.

Monitoring

For this plan to be successful, with sustainability fully integrated into the design, build and operation of MetroLink, a framework to monitor the implementation of the priority areas, objectives and targets will be developed.

MetroLink will adopt a RACI matrix (Figure 7), providing a simple, effective means for defining and documenting project roles and responsibilities, whether these sit with TII, designers, contractors or operators individually or in collaboration between various parties. Having clear visibility of who is Responsible, who is Accountable, who needs to be Consulted, and who must be kept Informed will support implementation of this sustainability plan.

Figure 7: Project Sustainability Plan RACI matrix



The RACI matrix will be used to map the tasks, milestones and decision-making processes underpinning the design, build and operation of MetroLink.

Delivering compliance

This sustainability plan will be integrated into the MetroLink Environmental Operation plan and associated management system, which is illustrated in Figure 8. This sustainability plan will have clear intervention points into the E&SMS, which will include the sustainability targets.

Figure 8: MetroLink Environmental and Sustainability Management System

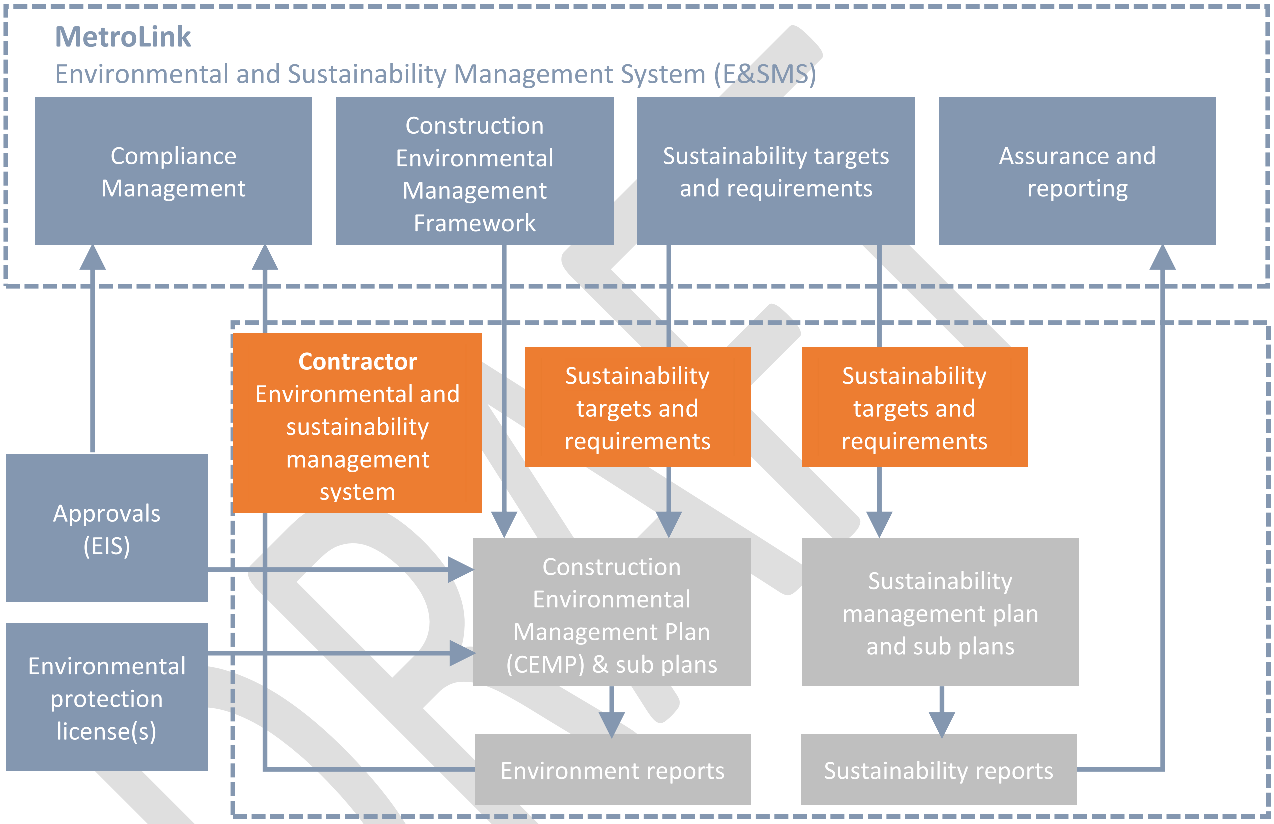


Figure 8 illustrates the relationship between the MetroLink E&SMS framework and Contractor's E&SMS, which includes the cascading of sustainability targets through procurement in employer's sustainability requirements, which in turn the Contractor will cascade to their supply chain. The supply chain will be required to report progress against the sustainability targets detailed in this sustainability plan to the Contractor, who will combine this with their own progress as part of the overall sustainability reporting to MetroLink.

The Construction Environment Operating Plan will capture the construction environmental requirements emerging from the EIAR, the Railway Order (including details of planning conditions) and this sustainability plan.

In addition, employer's sustainability requirements will capture governance and design requirements as well as social sustainability initiatives required by this sustainability plan and contract requirements.

Governance

MetroLink is committed to embedding good governance in all processes of the project and providing the resources required to ensure effective implementation of those practices.

Governance will be undertaken by a panel of representatives selected from NTA, TII, the MetroLink Project Board, internal MetroLink Staff and selected external stakeholders where appropriate.

Review

This sustainability plan is a 'live' document, implemented throughout the design, build and into the operation of MetroLink. The sustainability plan will be 'owned' by the MetroLink project team and reviewed and refreshed at appropriate points during the project lifecycle, for example project milestones or completion of lifecycle stages or significant events e.g. changes to external policy or performance issues/ improvements.

Communication and Reporting

To support this sustainability plan, a Target Delivery Tracker (TDT) will be developed as a framework mechanism to track sustainability performance throughout the evolving design process (i.e. from reference design through detailed design to the 'as built' designs), build and operation and support evidencing of progress towards to fulfilling the MetroLink sustainability targets.

As part of the commitment to deliver the MetroLink sustainability targets, designers, contractors and operators will be required to raise awareness of this sustainability plan to their staff and supply chains, and provide role-specific training to them, so they are understand how delivering their role on MetroLink will support achieving the sustainability targets.

Appendix: MetroLink Sustainability Targets

MetroLink Theme	Priority Areas	Targets	Design	Build	Operation
Environment	Climate Change Mitigation and Adaptation	• Implement a whole-life Carbon Management Plan aligned to PAS2080 to inform the design, build and operation of MetroLink utilising TII's Carbon Assessment Tool.	●	●	●
		• Achieve Net Zero for operational energy by opening year (2032), through energy efficiency, innovation, green power purchase and offsetting residual emissions – subject to further assessment of Ireland's decarbonisation of the electricity grid.	●	●	●
		• Deliver a 20% reduction in capital and embodied carbon against baseline.	●	●	
		• Achieve direct emission reduction for between 90% and 95% of the energy requirement for MetroLink operations from opening day, through renewable energy sources.	●	●	●
		• Utilise certified and validated (assured) carbon offset products to balance the remaining energy usage carbon balance until the national grid achieves net zero.	●		●
		• Integrate and maintain measures to manage construction and operational surface water and stormwater runoff, providing over 7,500m^3 of attenuation.	●	●	●
		• Undertake further Climate Change Risk Assessments during the procurement and detailed design stages for all major assets and implement measures to mitigate identified impacts.	●	●	●
		• Maintain measures to support MetroLink's resilience for a 1 in 1000-year flood event +40% for climate change.	●	●	●
	Materials and Resources	• Implement a Waste Management Plan for Construction and Demolition Waste to facilitate a maximum of 5% construction and demolition waste (inert and non-hazardous) and operational waste by volume disposed in landfill.	●	●	●
		• Undertake lifecycle assessments for major asset components and implement recommendations to influence the procurement of low carbon/ sustainable materials to achieve 40% reduction by volume of virgin materials.	●	●	●
		• Procure materials for major asset components that have verified Environmental Product Declarations (EPD).	●	●	●
		• Achieve a 20% reduction in mains water use during construction and 20% during operation using rainwater harvesting, water re-use and efficiency systems and devices at all work sites, stations and buildings.	●	●	●
		• Zero major pollution incidences during construction and operation and zero accidental or non-consented releases. Implement measures to monitor and report all pollution events and near misses.		●	●
		• Achieve a minimum of no net loss of biodiversity.	●	●	●
		• Protect areas of wildlife reserves/ protected habitats/ trees/ species and encourage recolonisation by implementing biodiversity sensitive design, and landscape management in the operational management plan and	●	●	●

	Biodiversity	operations contracts.			
		• [Target to be inserted from EIAR ecology chapter mitigations when complete].			
		• Protect areas of valuable and threatened species habitats designated within the Natura 2000 protected areas network.	●	●	●
		• [Target when EIAR complete] to be included in operations contracts, which also include monitoring and reporting for biodiversity.			●
	Heritage	• Develop and implement an ongoing heritage monitoring strategy.	●	●	●
		• Implement and maintain measures to retain historic setting of heritage features.	●	●	●
		• Maintain measures to minimise visual impact on heritage features through detailed landscape design and the operational management plan.	●	●	●
		• Station and/ or train designs to incorporate elements of local and national art, culture and heritage.	●	●	●
Community Commitment	Skills and Learning	• Fund, develop and implement an Apprenticeship and Trainee Programme, incorporating outreach programme with local schools, colleges and universities.		●	●
		• Apprentices to account for 5% of workforce across design, construction, and operation.	●	●	●
		• Incorporate skills and learning targets into MetroLink's construction contracts and measure and report progress monthly.		●	
		• Provide an inclusive approach to recruitment, staff training and rotas to build community relationships and foster a sense of safety (including staff training on gender-sensitive approaches to dealing with sexual harassment and assault at work and on the network).		●	●
		• Develop and implement a programme of community engagement to raise awareness of sustainability topics linked to the design, construction and operation of MetroLink.	●	●	●
		• Encourage collaboration and co-creation to identify challenges and design solutions.	●	●	
	Community and Engagement	• Develop and maintain stakeholder and community engagement plan, including centralised complaint reporting line, minimum standards for resolution and a programme of virtual and face to face events during design and operation.	●	●	●
		• Provide a dedicated helpline and social media channels (e.g. Twitter, LinkedIn, Facebook and emerging platforms) for the community before construction starts.		●	●
		• Develop and implement a programme of community engagement to raise awareness of sustainability topics linked to the design, construction and operation of MetroLink.	●	●	●
		• Minimise the probability of impacts due to flooding and power outages through back-up systems and controls.	●	●	●

		Work with partners to improve user perceptions pf safety getting to and using MetroLink.	●	●	●
	Safety	Facilitate ongoing engagement with key stakeholders (e.g. DFB/ Gardai) to deliver a metro system that is safe for all.	●	●	●
	Safety	Use a universal design approach to design out safety issues in the construction and operational phases of MetroLink.	●	●	●
	Safety	Establish a culture of everyone home safe at the end of their shift.		●	●
	Safety	Develop and include targets for the safe construction of MetroLink.		●	
	Safety	Implement and maintain an inclusive operational emergency response action plan.		●	●
	Safety	Implement and maintain measures to reduce antisocial behaviour, including provision of real time CCTV and appropriate lighting.	●		●
	Health and Wellbeing	Design for children and elderly people on the network.	●		●
	Health and Wellbeing	Establish noise and vibration baseline and implement and monitor mitigation measures in the noise and vibration management plan to reduce impacts during construction and operation.		●	●
	Health and Wellbeing	Establish an air quality baseline and dust management plan for construction in consultation with others.		●	
	Health and Wellbeing	Appraise and implement a programme, in partnership with other transport agencies, to help and support those directly affected by the construction of MetroLink.	●	●	
	Health and Wellbeing	Deliver a Scheme Traffic Management Plan that mitigates the impacts of construction traffic on the communities MetroLink works in.	●	●	
	Health and Wellbeing	Include initiatives for worker and community health and wellbeing in contracts.	●	●	●
Socio-Economic	Connectivity	Design for ease of interchangeability at integrated stations with Dart/ IE etc.	●	●	●
Socio-Economic	Connectivity	Maintain a minimum of 700 or 23% EV charging points at park and ride and maintain provision to increase this during operation.	●	●	●
Socio-Economic	Connectivity	Implement and maintain a minimum of 1700 cycle parking stands (for approximately 3400 cycles) at stations along the MetroLink route.	●	●	●
Socio-Economic	Connectivity	Implement and maintain provision of electronic and connectivity services on all trains and at stations (including charging points and free high-speed Wi-Fi).	●		●
Socio-Economic		Research and develop a methodology for assessing and reporting productivity gains associated with the delivery of MetroLink.	●		●
Socio-Economic		Establish a construction productivity benchmark for MetroLink and demonstrate gains against this benchmark monthly.	●		●

Productivity	• Identify innovative technologies and practices that provide value for money and additional benefits to MetroLink users.	●	●	●
Facilitating growth/ planning for the future	• Investigate and incorporate future growth trends into MetroLink's design and operations to facilitate future expansion based on quantified data from equivalent metro systems.	●		●
	• Space proofing during design to allow for expansion of the metro system.	●	●	●
	• Collaborate with local planning authorities and developers to fully recognise the socio-economic benefits of MetroLink.	●		●
SME and Local spend	• Implement and review on an annual basis a sustainable procurement strategy aligned with TII's procurement policies and incorporates the national policy Social Considerations in Public Procurement.	●	●	●
	• Incorporate sustainability requirements into all tenders to consider local and SME businesses and local employment.	●	●	●
	• Develop sustainable practice evaluation criteria within tender requirements (e.g. renewable energy generation and sourcing materials to support the circular economy).	●	●	●
	• Use meet the buyer events to promote opportunities to supply MetroLink.		●	●
	• Identify opportunities to engage with local and SME businesses in station facilities and in the public realm areas surrounding stations.			●

Appendix E: Project Level Quantified Risk Assessment Summary

This appendix is a summary assessment of the project risk register and the quantified risk assessment developed and undertaken by TII's engineering designer Jacobs/Idom.

MetroLink will be a transformative project for Dublin and Ireland. Delivering this project will be a significant undertaking and managing project risks effectively will be essential to success.

To this end, the project team has created a live risk register for MetroLink. Currently the register has identified 345 identified risk events related to the pre-procurement, procurement, design and construction stages of MetroLink, and associated uncertainties and assumptions. These risks have been identified and assessed for their potential impact to the project budget and schedule, using metro development experience from other jurisdiction, other Irish project experience and the experiences of the project team and technical advisors.

Risk management is a continuous activity for the MetroLink project team, and the risk assessment must continue to be refined, enhanced and updated as the project progresses. Specifically, at the time of submission of the preliminary business case, detailed risk identification and analysis for the operations and maintenance period is required. This required assessment will be influenced strongly by the finalisation of the contracting and procurement strategy. For example, the current anticipated procurement strategy, subject to detailed value for money analysis, is to include a PPP Service Delivery Partner. Accordingly, the risk assessment will need to consider how the PPP responsibility may influence and impact the risks of the operations and maintenance period.

Furthermore, the risk assessment presented herein has not fully considered the current contracting and procurement strategy as presented in Chapter 6, with risks related to the splitting of scope across contracts, or the inclusion of the PPP Service Delivery Partner, having yet to be considered in detail. This work and analysis will form a critical part of the detailed value for money analysis that will be necessary to confirm and finalise the contract and procurement strategy.

For now, the risk assessment includes several additional risks that have not been integrated into the full risk register but are captured in the cost uplift.

Risk register function

The risk register has two primary functions. The first is it allows for the quantification of the specific risk event allowance. This allowance is currently estimated to be €1.67 billion which is based upon a set of Monte Carlo simulations that further break down into cost impacts (€0.57 billion) and delay impacts (€1.1 billion).

The second function of a risk register is to facilitate effective risk management, monitoring and mitigation. By identifying and understanding their likelihood and potential impacts, TII can deploy resources, and risk management strategies to better manage and mitigate the specific risk events insofar as may be possible.

What is critical to appreciate is that the risk register, and therefore the associated manageable allowance, is not static. It is in a continuous review and update cycle. As the project progresses, certain risks will expire (as the risk event will have passed for example or no longer be relevant). In other instances, new risks may be identified, perhaps by a bidder during the tender process, or due to a new technical standard or world event, or generally new information. This may occur through the procurement, design, or construction stages.

Accordingly, the approach to risk management as an active and ongoing function is critical to overall programme budget management and effective execution of contracting strategy. Furthermore, it has a significant and direct link to achieving overall value for money goals.

Risk assessment process

A robust approach including qualitative and quantitative analysis has been implemented to assess project risks. This risk assessment process includes:

1. Qualitative assessment: Qualitative risk assessments are used to calculate a risk score which enables the project to determine the significance of specific known risks. The determination of risk significance feeds into risk quantification when assumptions around the probabilities and cost / delay impacts of specific risk events are developed.
2. Quantification through a Quantitative Risk Assessment ("QRA") consisting of two elements:
   a. Quantitative schedule risk analysis ("QSRA") to analyse the impact of known risk events and uncertainties to the project duration and completion date.
   b. Quantitative cost risk analysis ("QCRA") including consideration of prolongation (cost impacts caused by schedule delays identified in the QSRA).

   Both the QSRA and QCRA utilised a three-point estimate of schedule / cost impact (low, medium, high) for a probable risk event. Monte Carlo simulation was then utilised to generate a risk schedule distribution (for the QSRA) and risk cost distribution (for the QCRA). This approach relied on the use of probabilistic assumptions. Where mitigation strategies which have been implemented to reduce the cost / delay impact and / or probability of the risk occurring, this is considered.
3. Review and refinement: Risk information (such as risk registers, risk reports and subsequent risk analysis) are reviewed on an on-going basis, as the project proceeds through its lifecycle. The aim of these efforts is to recognise project progress, and to facilitate risk-based decision making using the most up to date and accurate information and methods available.

Summary of Delivery Risks

Over 345 risks relating to the delivery of MetroLink have been identified and have been grouped in 12 categories, as set out in Table E - 1 below.

INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER NOTE

Category	% of total	# specific risks	Risk category summary
Design, Construction and Contractual	42.0%	195	Design risks mainly contemplate changes in requirements during the design, construction and operations stages resulting in a change to the scope; design integration risks such as overlaps, omissions, misalignments; and requirements for redesign due to legal challenges / stakeholder (DCC, FCC, sports clubs, etc.) requirements. Construction risks include: the scheduling / sequencing of construction tasks and their interdependencies (one of key risks), rates of progression (with the TBM), construction / engineering challenges during the construction (e.g. water inflows, alignment of tunnels); and ground conditions not being as anticipated. One of the most significant construction risks is that advance and enabling works cannot commence until a railway order is made. Contractual risks relating to contractual arrangements and the inability of contractors to deliver. Key contract related risks include oversights in contractual terms (due to the complexity of the project) creating unforeseen integration clashes and delays; the risk of a principal contractor going out of business or underperforming; and risk of delays due to failure to accept stations and railway system assets.
Procurement	22.4%	19	Procurement related risks contemplate risks such as: delays in awarding contracts due to delays in obtaining Government approval; risks that bids will be rejected as they don't provide value for money; risks of challenges by unsuccessful bidders; and risk that the railway order application does not take place as planned in Q2 2022.
Environment	11.1%	42	Environment risks mainly relate to the issues and potential challenges to carrying out the required Environmental Impact Assessment Report and related activities, e.g. basement impact assessments. Other environment risks relate to achieving planning, finding agreement with key stakeholders and issues relating to the acceptance of the proposed blasting approach by an Bord Pleanála.
Traffic Management	7.0%	13	Traffic management risks are mostly concerned with: the risk that programme extensions or overruns may require a change to existing traffic management plans; potential stakeholder objections to specific traffic junctions causing delay to approval of the railway order; and the risk that train or bus routes change during the design and construction stages.
Stakeholder Consultation	5.6%	17	Risks which relate to stakeholder consultation consider: the risk that works restrictions are introduced into the programme to facilitate special events taking place in Dublin; the risk of protests causing delay to the construction programme; risk that objections are raised or extreme restrictions are placed on tunnelling activities; and risk of not reaching agreement with key stakeholders (e.g. DCC, FCC and DAA).
Heritage	3.7%	9	Heritage related risks are mostly concerned with the listed building status of properties in the vicinity of the MetroLink; potentially damaging monuments during the construction; and obtaining the required approvals and permissions to commence construction.
Programme	2.9%	4	Programme risks cover risks such as the risk that programme timelines are excessive, underestimation / overestimation of key timelines such as the time to receive planning approval from An Bord Pleanála (12 months); and the risk that testing could take longer than currently assumed.
Property	3.0%	10	This risks considers all property and land related risks, namely: the risk of not identifying / underestimating the cost of acquiring / renting the lands required to complete MetroLink; the lack of detailed design which makes identifying all lands impacted by MetroLink difficult; and the risk that lands required are not available when works are scheduled to take place.
Utility	1.2%	14	Utility risks include: the risk that utilities works and approvals take longer than anticipated; the risk that MetroLink preliminary design may become incompatible with other strategic transport projects undertaken by NTA, Local Authorities, Irish Rail; and the risk that storm design requirements provided to manage flooding solution may not be accepted by FCC and DCC.
Resources	0.5%	9	This risk relates to the resourcing of the project. The lack of / scarcity of / tight availability of required specialised skills / resources in areas such as system integration; project delivery and civil works (due to a tight market for very specialised skills) poses a risk for the project as it could lead to delays in decision making and project delivery. Furthermore, with all projects of this nature, there is the risk that resources will seek new projects when the MetroLink approaches its conclusion.

Legal	0.3%	9	Legal risks include risks relating to the appointment of the independent safety assessor; risk of fraud and cybersecurity breaches; the impact of Brexit on the supply of labour for the project; and changes in regulatory standards.
Archaeology	0.2%	4	This risk primarily relates to the risk of finding archaeologically significant finds during the works that may be provided national monument status.
	100.0%	345	

Table E - 1: Summary of Delivery Risks. Source: MetroLink Risk Register

The above table provides some insights to the type of risks which may impact on the MetroLink final cost. Managing these risks is a key focus of the MetroLink project team, and comprehensive mitigation strategies are being developed and to be put in place to limit their cost impact.

Risk event and delay costs

While specific risks will have a cost impact to rectify, manage, alleviate etc., they also can trigger a delay cost. Whether or not a particular risk event could trigger a delay cost is a function of more than just the risk event itself. When the risk occurs, if other risks have occurred already, or if the risk event is the result of cumulative impacts of other risks, will all play a part in determining the scale and impact of a risk event potentially generating delay costs.

Accordingly, the risk simulation modelling for delay costs is more complex than the Monte Carlo Simulation for specific risk event cost impacts – being driven by all risks at the same time occurring at different points in the construction programme. Such complexity is overcome by developing a logically linked and integrity error-free schedule, along with activity duration ranges attributable to risk and uncertainty impacts, and their likelihood of occurrence. Through a randomisation and iterative simulation (based on Monte Carlo methods), the level of confidence in completing the project in line with the deterministic schedule with uncertainty and risk events considered can be determined.

The current analysis has assessed the potential for risk event-related delay costs in the range of €1.1 billion.

To assist in appropriate risk management and mitigation activity, various project activities have been identified as having critical impacts on the project schedule and therefore have the greatest potential to generate delay costs. Risk events that impact these tasks must be managed effectively to reduce the delay cost risk implications on the project budget.

Table E – 2 sets out the top 10 activities that have the most potential to drive the MetroLink schedule based on their duration sensitivity. Duration sensitivity of a task / activity is a measure of the correlation between its duration and the duration of the project as a whole.

Activity	Duration Sensitivity (%)
1. Launch Shaft / Northwood Station	84%
2. Deliver, Assemble and Commission TBM	84%
3. Dublin Airport Station: Drill to temporary prop level 1 (11,934m^3 @ 75m^3 / day)	26%
4. Dublin Airport Station: Drill underside of 2nd prop (4,774m^3 @ 75m^3 / day)	26%
5. Dublin Airport Station: Drill underside of concourse slab (4,774m^3)	25%
6. Dublin Airport Station: Drill (Excavate) to tunnel axis in 10m sections	23%
7. Integrated Test & Commissioning - Signalling, Power, Comms, System Wide	20%
8. Dublin Airport Station: Drill (Excavate) sump (527m^3 @75m^3 / day)	20%
9. Carry Out Dynamic Testing / Trial Runs - Phase 2 South	19%
10. Collins Avenue Station: Drill (Excavate) LHS & RHS of tunnel 527m^3	16%

Table E – 2: Top 10 drivers of MetroLink Schedule.

These top 10 drivers of the schedule can be grouped further as:

- the assembly and commissioning of the tunnel boring machine, which logically is highly

correlated with the launch of the Northwood shaft (commencement of the Southern tunnel);
- tunnel boring at Dublin Airport Station; and
- testing and commission of Line-wide systems.

Risk exposure windows

As noted earlier, the risk assessment is not static. At certain times, the project will encounter less or more risks. Currently, the risk register includes a large proportion of risks related to procurement for example.

Broadly speaking, over 50% of the exposure is expected to be carried between now and the end of year four of construction. The remaining 50% exposure is associated with the subsequent years of the construction, testing and commissioning programme.

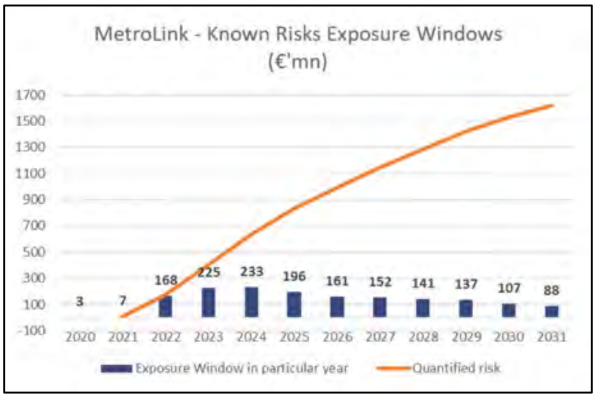


Figure E - 3: Risk exposure windows.

Figure E - 3 Explained: The blue bars represent the exposure windows associated with identified risk events, uncertainties and the main quantifiable assumptions for each year of MetroLink delivery and the orange bar represents the total cumulative known / quantified risks.

INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER NOTE

Appendix F: Scheme Costs

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JACOBS IDOM

MetroLink

Scheme Costs

ML1-JAI-LSI-ROUT_XX-RP-Y-00003 | P01

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P01	07/12/20	Preliminary Business Case for Issue	ML	BD	JS	NC

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JACOBS

IDOM

Contents

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1. Scheme Costs

1.1 Introduction

The costs presented cover the required capital, operations and maintenance (O&M) and whole life cycle costs and costs associated with land ownership and purchase, utilities and excavation. A robust approach to the estimation of capital expenditure has been developed by the cost surveyors (London Bridge Associates Limited) and is based on benchmarked values and professional experience within the industry. Further detail is provided in "D574-LBA-REFD-ROUT_XX-TN-Z-A06-2017 Cost Estimate - Yearly Spend" and "Dublin Metro 60 year Forecast of OM and Life Cycle Costs".

1.2 Do Minimum Costs

At this stage, it is assumed that there are no Do Minimum costs.

1.3 Scheme costs

The scheme costs are categorised under capital and O&M expenditures. Under each category are sub-elements. Some elements will be delivered via a Service Delivery Partner under a PPP arrangement. A PPP opens the opportunity to transfer risks to the private sector that would otherwise rest with TII. Further, under a PPP scheme there are reduced upfront exchequer funding requirements as payments are deferred until the start of operations. This is discussed further in the procurement strategy (ML1-JAI-PRC-OTHE_XX-ST-Y-00003).

The main cost elements are detailed below:

- Construction Costs
    - Advanced Enabling Works (AEW) – These consist of various works conducted prior to the main works required to de-risk the programme. This includes, for example, environmental baseline monitoring, traffic works, demolition and removal or remediation of any contaminants etc.;
    - Main Works Contractors (MWC) - The MWCs will construct all major civil engineering works. This includes; station structures, station 'boxes', retaining walls,

portals, embankments and cuttings, viaducts, drainage, access shafts, bored and cut & cover tunnels;

- Public Private Partnership (PPP) – A delivery partner will deliver the train systems, signals and line side wiring, along with mechanical and electrical elements of the stations. These costs will be borne by the delivery partner and will be reimbursed through the public purse at a later date.

- Client Costs
  - Indirect Costs – The fees associated with setting up the project, design costs and other legal fees.
  - Land & Property Costs- This cost element covers the land required for MetroLink itself and during construction stage, as well as for any necessary worker accommodation.

O&M costs comprise of the following cost elements:

- Operation and Maintenance Costs: This consists of labour costs, propulsion, utilities, materials, casualty and liability and services and miscellaneous costs.
- Asset Renewals: This is split by fleet and infrastructure renewals such as station facility works.

1.3.1 Base Capital Costs (Excluding Nominal Inflation and VAT)

Scheme cost for the MetroLink programme were estimated by London Bridge Associates (LBA) Limited. These base costs incorporate capital costs, contractor preliminary costs and contingency risk, based on a Quantitative Cost Risk Analysis (QCRA) or Quantitative Schedule Risk Analysis (QSRA), dependent on the cost item. These costs are expected to be incurred over a period of 2016 – 2031. Client costs prior 2020 were provided by TII.

As stated above, the overall scheme cost includes contributions made by the private sector to the project. The delivery partner will provide monies to help deliver the construction of the scheme through the years 2022-2031.

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The base cost (2019 prices, undiscounted) to the public purse by cost item (excluding inflation and VAT) is presented in Table 1–1. This is the cost of the scheme if it could all be paid for now.

Table 1–1: Base Capital Cost Summary Excluding Inflation and VAT (2019 Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
AEW	190
MWC	2,935
Construction Costs Total	3,125
Indirect Costs	605
Land & Property Costs	415
Client Costs Total	1,020
Delivery Partner Costs Total	1,323
Total	5,468

Source: LBA Costs

Risk has been summarised separately in Table 1–2. These totals incorporate the risk for all costs, including the delivery partner costs, in Table 1–1.

Table 1–2: Base Risk Cost Summary Excluding Inflation and VAT (2019 Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
QCRA in line with Exposure Windows	518
QSRA Prolongation / Adjustments	1,101
Unknown Unknowns	1,094
Estimating Uncertainty	269
Additional Assumptions	49
Total Risk (2019 Prices)	3,030

Source: Jacobs' Analysis of LBA Costs

The totals in Table 1–2 include risk assumed to be attributable to already incurred costs of years 2016 – 2019. This has been apportioned and excluded in further analysis, as presented Table 1–3. The total costs from hereon therefore may appear to be different to the totals as seen in source document "D574-LBA-REFD-ROUT_XX-TN-Z-A06-2017 Cost Estimate - Yearly Spend" due to this adjustment.

Table 1–3: Adjusted Base Risk Cost Summary Excluding Inflation and VAT (2019 Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
QCRA in line with Exposure Windows	517
QSRA Prolongation / Adjustments	1,100
Unknown Unknowns	1,091
Estimating Uncertainty	268
Additional Assumptions	49
Total Risk (2019 Prices)	3,025

Source: Jacobs' Analysis of LBA Costs

The overall cost of the scheme has been summarised in Table 1–4 below.

Table 1–4: Total Capital & Risk Cost Summary Excluding Inflation and VAT (2019 Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
Construction Costs	3,125
Client Costs	1,020
Delivery Partner Costs	1,323
Risk	3,025
Capital & Risk Total Costs	8,494

Source: Jacobs' Analysis of LBA Costs

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1.3.2 Capital Costs (Including Nominal Inflation, Excluding VAT)

Annual inflation has been applied to all the cost components, with the inflation indices used varying by scheme component where available. For client costs, a sector-specific inflation rate was not provided by LBA Ltd, however the inflated totals in this section were provided. For these cost items, the inflation rate was derived for each year by Jacobs.

Table 1–5 gives the cost of the scheme as it will be once inflation over the construction period is taken into account.

Table 1–5: Capital Cost Summary Including Inflation, Excluding VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
AEW	219
MWC	3,567
Construction Costs	3,786
Indirect Costs	719
Land & Property Costs	499
Client Costs	1,218
Delivery Partner Costs	1,696
Total Capital Costs	6,700

Source: Jacobs' Analysis of LBA Costs

Risk is also subject to inflation during the life of the project. This is shown in Table 1–6.

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Table 1–6: Risk Cost Summary Including Inflation, Excluding VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
QCRA in line with Exposure Windows	636
QSRA Prolongation / Adjustments	1,353
Unknown Unknowns	1,356
Estimating Uncertainty	330
Additional Assumptions	60
Total Risk Costs	3,736

Source: Jacobs' Analysis of LBA Costs

With inflation applied, the summation of the capital construction costs with the risk costs is detailed in Table 1–7.

Table 1–7: Total Capital & Risk Cost Summary Including Inflation, Excluding VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
Construction Costs	3,786
Client Costs	1,218
Delivery Partner Costs	1,696
Risk Costs	3,736
Capital & Risk Total Costs	10,436

Source: Jacobs' Analysis of LBA Costs

1.3.3 Capital Costs (Including Nominal Inflation and VAT)

Table 1–8 shows total outturn costs including VAT. Respective VAT rates were applied for construction costs (13.5%), land and property costs (13.5%) and indirect client costs (23%).

Table 1–8: Unadjusted Capital Cost Summary Including Inflation and VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
AEW	249
MWC	4,048
Construction Costs	4,297
Indirect Costs	884
Land & Property Costs	567
Client Costs	1,450

	Cost Estimate (€m, Undiscounted)
AEW	249
Delivery Partner Costs	1,925
Total Capital Costs	7,673

Source: LBA Costs

It should be noted that for costs incurred in 2016-2018, TII were previously not liable to pay VAT on public transport projects. This ruling was changed in May 2019; hence VAT has been applied from thereon. This results in a minor reduction in client costs totals, as seen in Table 1–9, noting that all client costs from hereon will be marginally lower than the unadjusted figure in Table 1–8.

Table 1–9: Adjusted Capital Cost Summary Including Inflation and VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
AEW	249
MWC	4,048
Construction Costs	4,297
Indirect Costs	883
Land & Property Costs	567
Client Costs	1,450
Delivery Partner Costs	1,925
Total Capital Costs	7,672

Source: Jacobs' Analysis of LBA Costs

The risk total has been estimated against construction costs therefore the same VAT rate has been applied (13.5%), as seen in Table 1–10.

Table 1–10: Risk Cost Summary Including Inflation and VAT (Nominal Prices, Undiscounted)

Element (Inc. Nominal Inflation and VAT)	Cost Estimate (€m, Undiscounted)
QCRA in line with Exposure Windows	722
QSRA Prolongation / Adjustments	1,536
Unknown Unknowns	1,539
Estimating Uncertainty	375
Additional Assumptions	69
Total Risk Costs	4,241

Source: Jacobs' Analysis of LBA Costs

With both inflation and VAT applied, the summation of the capital construction costs with the risk costs is detailed in Table 1–11.

Table 1–11: Total Capital & Risk Cost Summary Including Inflation and VAT (Nominal Prices, Undiscounted)

Element (Inc. Nominal Inflation and VAT)	Cost Estimate (€m, Undiscounted)
Construction Costs	4,297
Client Costs	1,450
Delivery Partner Costs	1,925
Risk Costs	4,241
Capital & Risk Total Costs	11,912

Source: Jacobs' Analysis of LBA Costs

1.4 Operating, Maintenance and Renewals Costs

1.4.1 Base Operating and Maintenance Costs (Excluding Nominal Inflation and VAT)

Operating, maintenance and lifecycle costs have been calculated using a bespoke forecasting model. The model has built in contingency allowances for each category of operating, maintenance and renewal expenditures. The model also provides a framework to project the impact of inflation on future expenditures. Detailed derivation of these costs can be found in "Dublin Metro 60 Year Forecast of OM and Life Cycle Costs V3 November 6, 2020". Only the first 30 years of the base costs (2019 prices, undiscounted) are relevant for financial appraisal. Subsequent years up to 2090 are used to inform economic analysis. All operating, maintenance and lifecycle costs within this report cover a 62-year period (2029 – 2090).

Table 1–12: Base Operating and Maintenance Cost Summary Excluding Inflation and VAT (2019 Prices, Undiscounted)

	Cost Estimate (2019 prices, €m, Undiscounted)

Wages, Salaries, Payroll Taxes and Benefits	1,704
Propulsion	295
Utilities	142
Materials	227
Casualty and Liability	268
Services and Miscellaneous	342
O&M Total	2,977

Source: Jacobs' Analysis

As well as ongoing operation and maintenance costs, there are period costs associated with expanding the fleet, and renewing infrastructure and rolling stock. Costs associated with this are shown in Table 1–13.

Table 1–13: Base Asset Renewals Cost Summary Excluding Inflation and VAT (2019 Prices, Undiscounted)

	Cost Estimate (2019 prices, €m, Undiscounted)
Infrastructure Renewal	587
Fleet Expansion, Renewal and Replacement	1,014
Asset Renewals Total	1,601

Source: Jacobs' Analysis

Table 1–14 shows a summary of the total O&M and renewal costs for MetroLink over the appraisal period.

Table 1–14: Total Base O&M and Asset Renewals Cost Summary Excluding Inflation and VAT (2019 Prices, Undiscounted)

Element (2019 Prices)	Cost Estimate (2019 prices, €m, Undiscounted)
O&M	2,977
Asset Renewals	1,601
O&M and Asset Renewal Total Costs	4,578

Source: Jacobs' Analysis

1.4.2 O&M Costs (Including Inflation, Excluding VAT)

The application of inflation has been applied to the base costs. Cost elements relating to fleet expansion, renewal and replacement were assumed to subject to the 'rolling stock' inflation rate (2% per annum) as sourced by LBA Ltd for the capital costs. As the inflation rate profile provided only spanned across 2020 – 2031, the inflation rate was assumed to be constant from 2032 onwards in the absence of more specific information.

The 'infrastructure renewal' cost basket encompasses an extensive number of construction elements; therefore, an average inflation rate has been assumed across the following categories as sourced by LBA Ltd: civil engineering, stations, M&E and railway systems. Similarly, to the above, the inflation rate was assumed to be constant from 2032 onwards in the absence of more specific information.

The National Development Finance Agency (NDFA) advises the application of an inflation rate to be equal to the Harmonised Index of Consumer Prices (HICP, 2%) + 1% for services with a labour component in excess of 50%. The O&M costs fall under this category; hence an inflation rate of 3% has been adopted.

Table 1–15 gives the O&M costs with inflation included.

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Table 1–15: O&M Cost Summary Including Inflation, Excluding VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
Wages, Salaries, Payroll Taxes and Benefits	6,604
Propulsion	1,246
Utilities	599
Materials	895
Casualty and Liability	1,185
Services and Miscellaneous	1,369
O&M Total	11,897

Source: Jacobs' Analysis

Table 1–16 gives the renewal costs with the inflation included

Table 1–16: Asset Renewals Cost Summary Including Inflation, Excluding VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
Infrastructure Renewal	1,927
Fleet Expansion, Renewal and Replacement	2,674
Asset Renewals Total	4,600

Source: Jacobs' Analysis

Table 1–17 gives a summary of the total O&M and renewal costs with inflation included.

Table 1–17: Total O&M Cost Summary Including Inflation, Excluding VAT (Nominal Prices, Undiscounted)

	Cost Estimate (2019 prices, €m, Undiscounted)
O&M	11,897
Asset Renewals	4,600
Total O&M & Asset Renewals Costs	16,497

Source: Jacobs' Analysis

1.4.3 O&M Costs (Including Nominal Inflation and VAT)

The impact of VAT on the nominal O&M costs has been calculated. The VAT rate employed for O&M and fleet expansion costs was 23%, whilst infrastructure renewal used 13.5%. Table 1–18 gives the O&M costs inclusive of inflation and VAT.

Table 1–18: O&M Cost Summary Including Inflation and VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
Wages, Salaries, Payroll Taxes and Benefits	8,122
Propulsion	1,532
Utilities	737
Materials	1,101
Casualty and Liability	1,458
Services and Miscellaneous	1,684
O&M Total	14,633

Source: Jacobs' Analysis

Table 1–19 gives the asset renewal costs inclusive of inflation and VAT.

Table 1–19: Asset Renewal Cost Summary Including Inflation and VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
Infrastructure Renewal	2,187
Fleet Expansion, Renewal and Replacement	3,289
Asset Renewals Total	5,475

Source: Jacobs' Analysis

Table 1–20 shows gives the combined total for operations and maintenance and renewal costs for MetroLink, over the appraisal period, including inflation and VAT.

Table 1–20: Total O&M Cost Summary Including Inflation and VAT (Nominal Prices, Undiscounted)

	Cost Estimate (€m, Undiscounted)
O&M	14,633
Asset Renewals	5,475
O&M & Asset Renewals Total	20,109

Source: Jacobs' Analysis

1.5 Spend Profile

Figure 1-1 shows the yearly non-operating spend profile, incorporating the PPP and non-PPP elements of the scheme (including inflation and excluding VAT). Please note that this reflects the project spend profile and not the public sector spend profile which is presented in the financial case.

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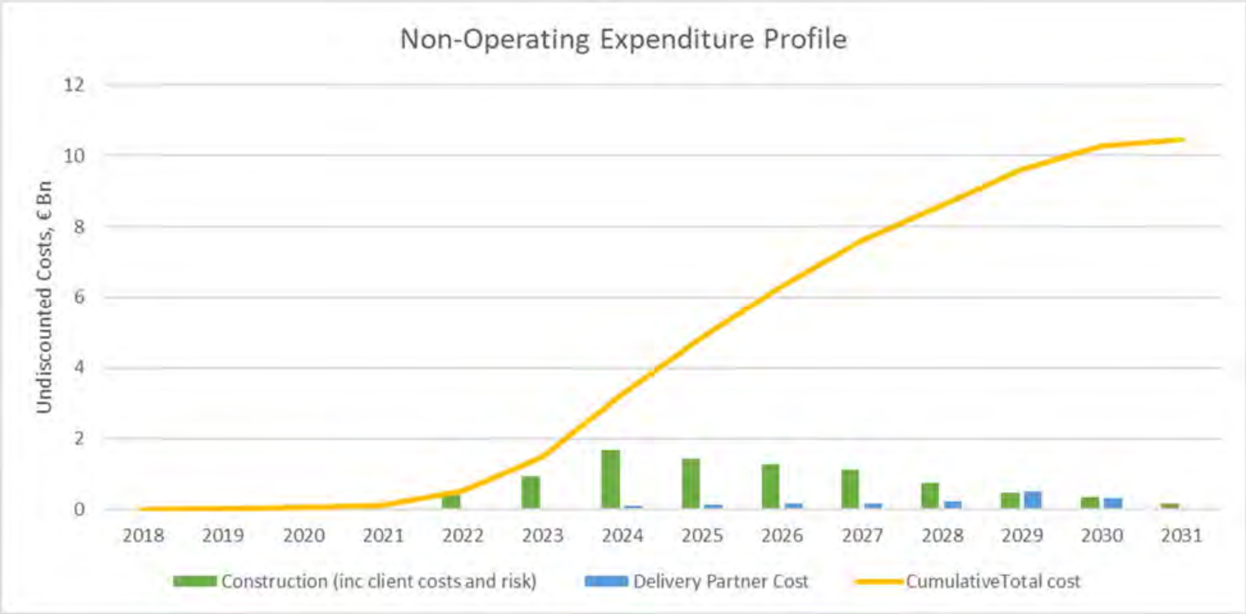
Figure 1-1 Non-operating costs, year by year profile



Source: Jacobs' Analysis

Appendix G: Benefits of Automation

TII210 MetroLink Operations Advisor

The Benefits of Automation

Transport Infrastructure Ireland

12th November 2020

Introduction

The MetroLink project is being designed to make full use of automation in the operation of trains (fully unattended operation i.e. Grade of Automation Level 4), at the control centre and in the operation of stations. TII requested that the Operations Advisor produce a report that illustrates the benefits (compared to a conventional metro system) that this level of automation brings to the operation of the MetroLink system.

This paper explains the benefits of automation through:

- An illustration of a typical "day in the life" of an automated metro;
- An explanation of the benefits of automation;
- An explanation of the components of automation.

Contents

1. A Day in the Life of an Automated Metro

It's 3am in the MetroLink Service Control Centre. The Service Plan for the coming day (a Friday) is being automatically reviewed by the control centre computer systems. In the past, railways had timetables; even frequent, metro-style railways, which were so frequent that customers would simply arrive on the platform safe in the knowledge that they'd never have to wait more than a few minutes, had timetables. These timetables weren't for the benefit of the customers, but rather were to ensure that there was a driver available for every train, developed to fit into the starting and finishing times of shifts, meal breaks and breaks required for safety after a certain number of driving hours. With trains that no longer require a human driver on-board, these restrictions have disappeared and so has the need for a timetable. Instead, a service plan guarantees customers a minimum service level during operating hours that can flex to manage the actual demand experienced each day. Today, there is a rugby match at the Aviva stadium; Ireland are playing Wales and a crowd of 50,000 is expected. Kick-off is at 7pm, and based on previous customer flow measurements, the control centre systems are able to modify the service plan, to ensure adequate capacity will be provided between the airport, Dublin City Centre and connections to the rugby ground at the southern end of the MetroLink route.

At 05:00 the system starts up; all maintenance staff have reported themselves clear of the track and that they have left their work sites safe for trains to operate so the traction power can be switched on. The automated systems perform their integrity and safety checks, and report all systems are healthy and ready for service. The intelligent CCTV system that covers every part of the track performs an automated check that the track is free from obstructions. Trains within the depot and at sidings at the south end of the line are remotely awoken and perform an automated self-test. As the trains each report themselves healthy, the control centre system allocates them to timed departures to start the day's service plan. As it is a cold morning, each train has automatically switched on its saloon heating in advance, ready to welcome the first passengers with a comfortable journey. The Customer Service Agents (CSAs) who have just booked on for their shift are directed to board the trains before they leave the depot. As well as being an efficient way to spread CSAs around the system, ready to interact with customers, the CSAs take this opportunity to perform a further inspection of the track and tunnels to identify anything out of the ordinary that might require further investigation. The control centre system then instructs further trains to join the service, calculating when they should leave the depot to avoid conflicting with the trains already in operation and creating an even headway service for passengers.

The automated systems are constantly on the watch, monitoring system performance and passenger trends, and frequently making almost imperceptible changes to optimise system performance. By 07:30, the control centre systems notice a trend in the open data, reported from sensors on the road network, and MetroLink's own sensors on the vehicle entrance to Estuary Park and Ride, which is filling up more quickly than usual; possibly people want to start work earlier and finish work earlier so they can meet friends before the rugby match this evening. The automated systems rapidly plan and action their service adjustments to match this earlier peak. A tighter headway will be needed to maintain passenger comfort levels, and an additional train is released into service earlier than previously planned.

At 08.30, the control centre staff receive a call from a customer help point on a southbound train travelling towards O'Connell Street station; a young lady has fainted on the train. The control room assistant speaks directly with the alerting passenger and assess the situation via the on-train CCTV. The nearest CSA is immediately located, through the tracking technology on their smart device, on a northbound train entering O'Connell Street station. They are immediately sent a message to disembark and cross to the opposite platform, so they are ready and waiting on the southbound platform when the incident train arrives. Meanwhile the control room assistant requests an ambulance to the station through a hotline to the emergency services control centre. The control room assistant instructs the control system to hold the southbound train at O'Connell Street station whilst the CSA investigates. The CSA's first aid training is supplemented by real-time advice from paramedic-trained support staff who can see whatever the CSA can see through the CSA's head-worn camera. The fainted lady comes around and appears unharmed and is able to stand and walk. The CSA assists the lady onto the platform and helps her to a seat in a private station area to rest and await the paramedics. All told, this incident has resulted in a 4-minute delay to the incident train, and also affected several trains behind, but the control centre systems started mitigating this delay as soon as the train with the casualty was held; they identified, evaluated and proposed a range of plans to the control room supervisor based upon the location and estimated duration of this type of incident. The supervisor selected a plan that reversed one train behind the incident train, from southbound to northbound at the Glasnevin crossover to ease congestion and launched a spare train northbound from Charlemont sidings to fill the gap in service in front on the incident train. As the trains delayed by the incident travel southbound to Charlemont, one of them is taken out of service to replace the spare train, ready for any further disruption. Within ten minutes, the service is back to normal, and customers at the north end of the line remain unaware of any prior disruption. The control centre staff take a moment to reflect on how such an incident would have played out prior to Communications Based Train Control (CBTC) and manually driven trains. Using the old technology with fixed block signalling, the service disruption would have been seen for the rest of the morning peak, because of the need to transport spare drivers to the right places, and to make gradual manual adjustments to uneven headways. Instead, the fully automated system takes everything in its stride with the minimum of fuss.

At 13:15, an alarm on the Remote Condition Monitoring (RCM) system at the control centre indicates that a crucial set of points at the turnback sidings beyond Estuary Park and Ride station has started to operate more slowly than usual. The points are still working, but the automated system is always on the lookout for early signs of failure, so that issues can be fixed before a failure occurs. The control room supervisor immediately responds by accepting the automated system recommendation to minimise train movements over that set of points. The data generated by the RCM is automatically routed to the maintenance technician at the depot, who reviews the data and rapidly confirms that although the points are operating more slowly than usual, they are still safe and reliable and can stay in commission, but will be prioritised for maintenance that night.

At 15:00, the control centre systems determine from an open data feed that a large number of flights are being delayed due to fog over the Irish Sea; this means that a lot of the Welsh rugby fans will be delayed, changing the previously planned MetroLink service patterns. Now, there will be a later but more intense peak of traffic between the airport and the rugby ground. To match this demand, the control room supervisor agrees with the maintenance staff that vehicles currently scheduled for maintenance can be returned to service over the next hour, enabling an increase in capacity. Between 16:00 and 16:30, the additional trains are injected into the service from Dardistown Depot. The control centre systems have calculated how these can join the train service without causing disruption. By 16:30, the train service operating is more intense than MetroLink's usual peak service, making use of the additional capacity that was built into the system ready for future increases in customer demand.

By 17:00, rugby fans are arriving in droves. For most of them it is the first time that they have travelled on MetroLink, but they are able to find their way around due to the electronic wayfinding signage, which is also displaying messages welcoming the Welsh fans. This signage begins within the airport itself, ensuring that visitors are aware that there is a faster and more reliable route to the city centre than joining the long queues for buses and taxis. The fans are in good spirits, but as they board the trains they tend to hold the doors for their friends, causing very slight delays to each train. Fortunately, the Automatic Train Regulation subsystem can manage this by constantly calculating and implementing imperceptibly small changes to the train departure times and train speed profile between stations; this keeps the train service regularly spaced and prevents small perturbations leading to larger delays. The flexibility of CSA deployment, afforded by automating the trains and stations, means that they can be concentrated at the Airport station, where the Welsh fans are getting onto MetroLink, and at St. Stephen's Green and Charlemont stations, where all fans are arriving close to the stadium.

When the rugby kicks off at 19:00, everyone has got to the ground in time. While the rugby fans across both nations follow a closely-fought game, the MetroLink control system is also following the game through open data – this is just as well, as a rare tied score pushes the game into extra time, delaying the exit crowd by half an hour, and resulting in another update to the service plan. With the Irish team eventually emerging victorious, the fans start to pour out of the stadium and back to Charlemont station. Again, MetroLink CSAs are ready at the station to direct and assist the fans, and the customer information systems display essential wayfinding information and real-time next train and journey-time data. The service plan has ensured that the sidings beyond Charlemont station are full of trains before the fans arrive, so that a very intense northbound service can be run by combining these spare trains with the trains reversing at the station. The train loadings are high as fans spill out onto the platforms, and whilst the regular MetroLink users are aware of the station signage indicating individual car loadings on the next arriving train, the visiting fans have to be encouraged by the CSAs to move down the platform to ensure everyone can board.

As the evening draws on, the fans celebrate and commiserate throughout the centre of Dublin. At 22:30, a report is received that someone has been rather ill over part of a northbound train. The control room supervisor is able to observe the situation via the on-board CCTV, and immediately instructs the control system to undertake a train changeover. As the train reaches Estuary Park and Ride station, it is taken out of service for cleaning and a spare train from the sidings replaces it; the issue has been swiftly resolved with no service impact.

As the returning revellers reach their destination MetroLink stations, they are pleased to see taxis waiting outside. This is more than good fortune; a simple app powered by the MetroLink open data feed has helped local taxi businesses position their vehicles according to the number of customers forecast to be exiting at each station. This is good business for the taxi company and a happy outcome for the fans since it has just started to rain.

By 00:45, the service has been gradually reduced and closed down as planned, and the stations are secured remotely after CCTV has been used to check that they are clear of customers. While cleaners start to clean the stations, maintenance on the wayside infrastructure can begin. Top priority is given to investigating the points at Estuary sidings that were reported as operating slowly. Using the diagnostic process shown on his smart device, the maintenance technician quickly identifies that the issue is a worn motor brush, and the entire motor module is quickly replaced so that the brush replacement and testing can happen in MetroLink's workshops. It is estimated that the point motor would have carried on operating for at least another week before it would have caused a failure, but through the Remote Condition Monitoring system, that future point failure will never be realised. The amount of wear on the motor brush, and the number of point operations since that brush was last replaced, are logged in the asset management system to improve the accuracy of the predictive maintenance regime.

Meanwhile, the control centre systems have recorded the customer flows reported by station and train-based sensors, and the open data feeds showing air travel, road usage, the progress of the rugby game, and even the weather through the day, and have processed this to improve the prediction quality of demand patterns for future events.

The MetroLink system is prepped and ready for another unique day that will no doubt present the automated control systems with a new set of challenges to test their never-ending patience.

2. Real World Benefits of Automated Metros

Part 1 of this paper, whilst presenting a light-hearted look at the day in the life of an automated metro system like MetroLink, does serve to illustrate the many benefits of a fully automated and driverless system. Many of these benefits are achieved by utilising autonomous systems and computer power to concentrate on what these systems are good at – fast, reliable, consistent and untiring reaction to monotonous and routine events that require a calculated and deterministic response. This technology relieves humans to concentrate upon the things that we are good at – dealing with people and making decisions that require more than a comparison of calculated results.

The benefits of a fully automated railway include increased capacity, reduced costs, better environmental performance and increased customer and employee satisfaction. This section analyses those benefits from a variety of viewpoints, and briefly looks at the technologies that make this happen.

Some of the key benefits of an automated metro system are shown in Figure 1 and are discussed in the following sections:

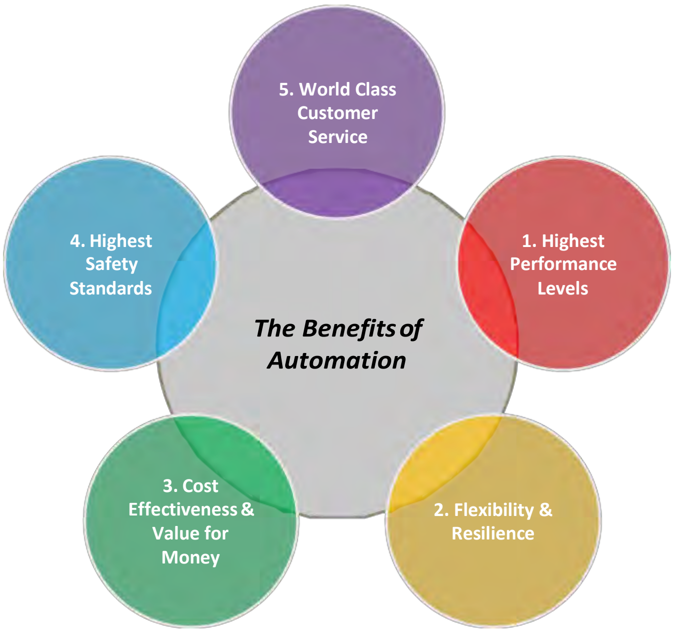


Figure 1: The Benefits of Automation

2.1. Highest Performance Levels

Computers are better at driving trains than humans. This is because automated systems are always attentive, do not take breaks, can manage huge amounts of information, and can react immediately with incremental small (or large) changes to ensure performance is always optimised. This reality has led to increasing levels of automation being introduced as computing has become more capable.

The control of railway systems has evolved greatly over the last two centuries. Railway control serves two purposes; firstly, to ensure the safety of trains on the network, and secondly, to enable efficient train movements and operations. In the early days of railways, train control was based upon little more than working to a timetable. Quickly the concept of visual signals controlling fixed blocks of line were introduced. Signalling systems evolved to become more capable, but still leaving the control of the train entirely to the traincrew. Next, a greater degree of integration allowed control systems to take over responsibility for managing key train functions. Lastly, train control systems evolved to enable full control of all train driving functions, with or without crew members present. The different stages of train control functionality are commonly termed Grades of Automation (GoA) and are described on a 5-point scale as shown in Figure 2.

	GoA0	GoA1	GoA2	GoA3	GoA4
Description	*Line of sight; no ATP*	*Manual driving with ATP*	*ATO; driver in the cab*	*ATO with a train attendant*	*ATO with no on-board staff*
Starting Train	Driver	Driver	Automated	Automated	Automated
Stopping Train	Driver	Driver	Automated	Automated	Automated
Door Operation	Driver	Driver	Driver	Train attendant	Automated
Degraded mode operation	Driver	Driver	Driver	Train attendant	Automated
Examples	*Trams*	*Mainline trains*	*LU Victoria line*	*Docklands Light Railway*	*Airport People Movers, Paris Lines 1/4/14, Barcelona Lines 9/10*

Figure 2: Simplified Grades of Automation

Achieving higher Grades of Automation requires a holistic approach, with the train control system supported by other systems in the wider railway environment (including the provision of walking routes and lineside fencing) and appropriate operational procedures.

The benefits of moving from each Grade of Automation to the following Grade of Automation are described in Figure 3.

Increment	Benefits
GoA 0➔1	Safety – protection from human error Capacity – signalling allows closer running
GoA 1➔2	Capacity – more consistent operation enables denser sustainable service Journey time – optimised driving at line speed reduces runtimes Efficiency – power/wear-efficient operation, coasting, eco-driving, comfort
GoA 2➔3	Staff visibility – train staff now visible to passengers to assist, reassure & check tickets Staff reduction – no need for separate revenue control team Capacity – no need for dedicated driving cabs Simpler termini – fewer berths required to reverse a given service level
GoA 3➔4	Flexibility – no need for a timetable – run a service plan (variable in real time) instead Resilience – recover service without worrying about staff location or driving hours Staff reduction – integrate train and station teams Reduced wayside staff facilities (mess rooms, toilets etc)

Figure 3: Incremental benefits of Increasing Grades of Automation

By providing signalling and train protection (GoA0→1), the railway becomes safer through the elimination of human error. The use of technology to communicate movement authorities and set routes also adds significant capacity to the railway.

By providing automated train operation with a driver still in the cab (GoA1→2), the automated control of train speed enables each train to follow the optimum speed profile more accurately than a human driver would achieve, thus reducing journey time, ensuring consistent operation, which avoids service instability, and allowing the most efficient speed profile to be selected to maximise energy efficiency.

If the onboard member of staff is enabled to move from the cab (GoA2→3), they are more visible to customers in the saloon, and can provide assistance and reassurance, while checking tickets. This means that there is no longer the need to employ a separate revenue protection team, leading to staff cost savings. As there is no longer a requirement for a dedicated cab, this space can be reused for additional customer seating/standing, adding approximately 5-10% capacity to each train; dependent upon the train configuration. Should the train need to be driven manually (e.g. due to a system failure) this can be achieved using a driving panel at the front of the train. As the driver need no longer "change ends" to be at the front of the train in the time between moving into a reversing berth and moving out in the opposite direction, the train can reverse more quickly, and this leads to a potential reduction in the number of reversing berths required to reverse a given service frequency at each terminus.

If the staff member needs to no longer be on the train (GoA3→4), then it is possible to move from a timetable-driven system to a service demand-driven system, as once the system is at a turn-up-and-go frequency from the customer's point of view (typically 6 trains per hour (tph) or more) the primary benefit of the timetable is for crew management. Once the timetable has been dispensed with, service regulation is simpler; it is possible to optimise customer service without having to consider driving hours or overtime management; and it becomes possible to vary the service level to respond to real-time demand. It is possible to use data sources including traffic flow detectors on the approach to the Estuary Park and Ride; data on airport arrivals/departures; data on delays on the wider road network; data on planned sporting and cultural events; and even weather forecasts to predict the customer flow every day in advance, and implement a service to meet that demand, generating the greatest benefits and the lowest operating cost.

To operate the 30tph service that Dublin will need, automatic operation (GoA2+) is required. With good discipline, manual driving can be used up to 28tph, but beyond that, delays in response times and lack of driving consistency will cause service instability and chronic delays. The reduction in variability from automatic operation allows a stable service to operate with a reduced recovery margin (the difference between the theoretical and practical capacity) enabling a more intensive customer service to operate on the same underlying signalling capacity.

GoA3 and GoA4 increase capacity further by reducing the time taken to reverse trains in a siding as there is no longer a requirement for a human driver to walk from one end of the train to the other for it to change direction. This means that an intensive service can be reversed off fewer sidings, reducing the cost and disruption of operating at high service frequencies, while enhancing reliability (fewer point machines and a less complex track layout) and sustainability (less embodied carbon and smaller construction sites).

GoA4 means that no additional platforms are required at termini stations to allow crew changes, comfort breaks and cope with the variability that humans introduce to a system (staff being 30s late for a shift can have significant consequences on the capacity of a high intensity service). A GoA4 system does not require these extra platforms as there are no on-train staff to consider.

2.2. Flexibility & Resilience

Fully automated driving enables MetroLink to operate a demand-based rather than a timetable-based service (as traincrew management is no longer a constraint) and enables service levels to be dynamically adjusted to meet the real-time (or predicted) demand.

While railways are often considered to be a system composed of many subsystems, they are themselves subsystems of the bustling cities that they serve. They should be able to interface with other subsystems of that city in real-time to deliver the best possible customer experience.

Many other parts of the city generate real-time data that indicates how the customer demand might change. These include:

- Airports, which generate real-time data on flight arrivals and departures, including delays;
- Road systems, which generate real-time information of traffic flow and incidents;
- Sports facilities, which generate real-time data on upcoming events, anticipated attendances and the progress of those events;
- Weather forecasts, which are a good indication of the proportion of people who will choose to walk, drive or take the train;
- Other transport modes (e.g. Irish Rail) that will deliver information on train arrival/departure times, delays and incidents.

Increasingly, these data sources are "open data" – readily available real-time data in a standardised format. Information from publicly available websites can be used, and private data feeds can be agreed with other parties.

MetroLink will also generate its own data; for example, traffic flow measurement on the vehicle entrance to Estuary Park and Ride station will give a good indication of the customer demand that will appear on the platform in 5-10 minutes' time, once the arriving customers have parked their vehicles and walked to the platform. Customer counting technology can also be integrated to count the number of customers entering a station from each entrance, and to monitor movements towards North & South platforms.

This wealth of information allows the control system to build a model of customer demand tailored to every individual day, and to keep refining it throughout the day in response to real-time changes in inputs. It will be used to develop and implement the most appropriate service plan, considering the need to maintain the trains and wayside equipment. Fully automated train operation means that this can happen without the need to review staff availability or duty hours.

With this technology, not only can unusual crowds for sporting events be catered for efficiently, without the cost and energy wastage of over-provision, but if that event runs into extra time or there is external disruption, it allows the plan to evolve and be re-optimised in real-time. It moves from a railway that can handle pre-planned events to a railway that is pre-enabled to handle real-time scenarios.

With every day of service, the system can review the actual customer demand against the predicted customer demand and use machine-learning techniques to refine its models so that the next prediction will be more accurate. This enables this constant optimisation to occur with minimal human effort.

2.3. Cost Effectiveness & Value for Money

Automated systems bring several advantages that contribute to Cost Effectiveness & Value for Money:

- More capacity & performance from fewer assets;
- Reduced staff costs;
- Ease of change & upgrade.

2.3.1. More Capacity & Performance from Fewer Assets

Automation enables precise optimisation of railway operations, whether in the operation of an individual train, the optimisation of a train service, or the ability to minimise the amount of infrastructure to meet a required level of capacity.

Automatic driving will make most efficient use of coasting while maintaining journey time and capacity requirements, and therefore reduce the use of traction power. Automated driving can also co-ordinate train movements to make the most effective use of traction power savings through regenerative braking. The smoother operation and reduced use of braking will reduce wear on system components, reducing the embodied carbon in replacement parts and maintenance activities.

As fully automated trains do not require human drivers, train moves to locate drivers (e.g. bringing them back to a depot for the end of a shift or a meal relief) are eliminated, and the ability to change the service pattern to reflect actual demand eliminates energy wastage due to over-provision of train services. Facilities for drivers at stations can be reduced, removing the embodied carbon associated with their construction and the ongoing energy use of associated station facilities (lighting, heating, kettles etc.).

Station automation promotes energy efficiency through the switching of station facilities (e.g. lighting, heating, escalators) in response to measured light levels, temperatures and customer demand, rather than to a fixed schedule, or when a station supervisor notices that action is required. Stations and the depot may include microgeneration (solar and wind power) where possible, and this will be monitored by the same automation system to ensure peak performance is maintained, and to synchronise the use of energy while it is most abundant.

MetroLink forms only one part of many customer journeys but is designed to optimise sustainability for the entire journey. For example, the installation of electric car charging facilities within the carpark at Estuary Park and Ride and open data that enables taxi services to position vehicles proactively at stations, will accelerate the adoption of more sustainable modes of transport for onward journeys. The provision of real-time information for modes including mainline, LUAS and bus services within MetroLink premises, will assist customers to make informed decisions about how to continue their journey after alighting from MetroLink services. Where there is disruption on these other transport modes, announcements will be made on board MetroLink trains so customers can make alternative travelling arrangements, minimising their own disruption while avoiding further compounding of the disruption on the other transport modes.

By running a high-quality, reliable metro service, MetroLink will attract customers away from other more polluting forms of transport. Automation is key to delivering a service quality and capacity that will attract customers from other modes of transport.

2.3.1.1. Automated Station Systems

MetroLink stations will be fully automated and require no on-site staff in normal operation, although roving CSAs will be available to assist customers where required and to resolve any issues.

The SCADA (Supervisory Control and Data Acquisition) systems will monitor all station systems for any faults or alarms while controlling lighting, ventilation and lift/escalator systems to maximise energy efficiency. Stations facilities will include:

- Full CCTV coverage monitored from the control centre;
- Help point systems allowing immediate assistance from staff at the control centre;
- Real-time customer information though platform and ticket-hall displays and the public address (PA) systems.

An advantage of this remote-control philosophy is that if a station needs to be evacuated in an emergency, the same level of station control can be maintained without leaving a member of staff in an unsafe situation in a station control room.

2.3.1.2. Automated Control Systems

The MetroLink control centre will have full visibility of the MetroLink operation, covering the train service, station services, maintenance activities and utilities. The control centre technologies will include:

- Automatic Train Supervision to monitor and control train movements, including operating the service plan in real-time;
- Automatic Service Planning to analyse real-time data sources and propose the most efficient service plan to meet the projected demand;
- Automatic Train Regulation to automatically identify small service perturbations and make imperceptible changes to train departure time and speed profiles to maintain a stable service;
- Station SCADA to monitor and control the station environment, including customer information systems, CCTV, help points, lighting, heating/ventilation, fire systems, and lifts/escalators;
- Tunnel SCADA to monitor and control the tunnel environment including trackside CCTV, fire detection, ventilation, lighting, access control systems, intrusion detection systems and pumps;
- Decision Support to support control centre staff in identifying, developing and deploying the most appropriate response to operational incidents. This includes communicating with other members of MetroLink staff (e.g. CSAs) via their smart devices;
- Video Analytics to constantly analyse all incoming video feeds and identify scenarios of interest, including unattended items, loitering, movements in non-customer areas (including the trackside environment) and overcrowding. This will ensure more effective supervision of activities on a reduced number of screens compared to traditional control facilities that require vast banks of screens.

These technologies will all be holistically presented to the control centre staff through a unified interface that maximises cross-system automation. This will reduce the operator workload, allowing the human controlling these systems to think strategically and communicate with wider stakeholders.

2.3.1.3. Automated Asset Management

MetroLink will be provided with a modern, intelligent asset management system to record the “single source of truth” configuration and history of each asset, to manage reported faults, and to schedule maintenance (based on time, usage and reported condition) to maximise reliability but minimise costs.

Remote condition monitoring systems on both rolling stock and wayside assets will communicate data back to a data warehouse; this will be analysed in real time to give the earliest possibly indication of failing assets (in some cases recommending and prioritising an operational or maintenance intervention) and building MetroLink's knowledge of long-term asset performance trends, so that future investments may be targeted efficiently to eliminate sources of unreliability.

The system will also enable the digital storage of asset data (including circuit diagrams, manuals etc.) to ensure fully up-to-date information is available wherever it is required, including at the trackside through first-line maintenance technicians' smart devices.

This system will also be used for scheduling track access so that the most efficient use can be made of the time during which customer services are not running.

The asset management system will hold sufficient data to enable Building Information Management (BIM) functionality, with the ability to export data to create a "digital twin" of the railway that shall enable simulations of both railway operations (e.g. to plan future services or explore the benefits of proposed enhancements) and to plan (and communicate the plan) for maintenance activities, such as track replacement, where a sequence of activities must occur in a compressed timescale and a constrained physical environment.

Both operational costs and reliability will be optimised through a modern approach to asset management and maintenance:

- Remote condition monitoring will identify failures before they impact service, providing rich diagnostic information in the event of an unexpected fault. This enables a proactive rather than reactive approach to maintenance, reducing repeat failures and the costs associated with replacing components unnecessarily due to misdiagnosis.
- The provision of backup ("redundant") systems enables the service to continue in the event of a failure and for that failure to be investigated and rectified within a longer timescale than would traditionally have been the case. As well as reducing customer disruption, this reduces the need for on-call maintenance technicians throughout the operating day, as failure resolution can now be time-shifted to when technicians are available.
- A new approach can be taken to scheduling preventative maintenance, reducing the costs from over-maintaining. Some assets will retain time-based maintenance to comply with legislation whereas others will be maintained based upon measured usage or condition. Some assets may even be allowed to run to failure on the basis that there is a backup system that will ensure that this does not impact railway operations.
- A modern asset management system will be deployed so that the asset history is fully known, preventative and reactive maintenance activities are captured accurately and all relevant information (manuals, diagrams, fault history) is in the palm of the front-line maintenance technician, who is also supported by a colleague through their smart device (camera/earpiece) when required.
- The use of multiskilled operations and maintenance staff enhances efficiency and reduces the time taken to get the right skills to the right location; the telemetry enables staff to undertake a broader range of activities, as colleagues with specialist knowledge will be available to support them as they carry out activities.
- The ability of the CBTC to support bidirectional working will allow services to continue around maintenance and fault resolution where appropriate; this reduces the need for system closures and hence customer disruption. This can also reduce the costs of some maintenance activities as it enlarges the available working window every night, improving productivity. Control centre systems will allow for this type of work to be planned around customer demand, implemented safely, and for changes to the platforms at which trains will call to be communicated to customers via station audio-visual information systems.

2.3.2. Reduced Staff Costs

The impact of increasing levels of automation on staff headcount is illustrated in the Figure 4:

	GoA2	GoA3	GoA4
Drivers / train attendants	One per train	One per train	None required; replaced by roaming CSAs
Spare drivers / train attendants	Yes Physical Needs Relief (PNR) & spare	Yes PNR & spare	No Run unmanned trains
Revenue control staff	Yes	No Use train attendants	No Use train attendants
Roving station assistants	Yes	Yes	No Use train attendants
Anticipated headcount saving (vs GoA2 on roles stated above)	**-**	**15-20%**	**35-45%**

Figure 4: Indicative headcount savings through increasing Grades of Automation

Figure 4 demonstrates how GoA4 offers an indicative 35-45% saving in staff headcount when compared against an equivalent GoA2 operation; noting that staffing costs are one of the greatest components of operational expenditure for a railway. This is achieved while improving customer service compared to that which would be delivered on a traditional railway.

Operational costs are also reduced due to the automated control of driving; this reduces the rate of wear on both the train (e.g. reducing the frequency at which brake pads need to be replaced) and the infrastructure (e.g. reducing rail wear.) It also reduces the railway's energy consumption through the intelligent use of coasting rather than motoring towards a point where a heavy brake application will be required.

2.3.3. Ease of Change & Upgrade

Railway infrastructure has a very long design life, and to ensure that the full life is achieved, it must stay maintainable and upgradable as the needs of the railway evolve. The use of digital technologies such as CBTC enable changes to be made in software as they are less dependent upon hard-wired physical assets such as signal heads and track circuits. By choosing technologies carefully (including commercial off-the-shelf technologies) and defining clear interfaces between subsystems, the future cost and disruption associated with the upgrade of these systems can be minimised.

2.4. The Highest Safety Standards

Public mass transit systems absolutely must deliver safe transport environments for their users and staff. Witness the media and public outcry when any public transport system fails and causes injuries. The opportunity for failures must be designed out, and significant investments are made in eradicating safety risks that arise either through system design or operational procedure.

Fortunately, rail accidents are vanishingly rare, and when they do occur rigorous investigations are mounted. In nearly all cases, accidents arise because humans are unpredictable, have lapses of concentration, may be slow to act, get tired, distressed or distracted, and make mistakes. These human shortcomings do not apply to computer-based automated systems, which characteristically excel at dealing almost instantaneously with monotonous tasks in a repetitive, predictable and unwavering way. Automated systems do not arrive late for work, do not stop to answer the phone, do not need toilet breaks, and never fall asleep on the job.

However, whilst great advances are constantly being made with automated systems, they continue to lack several critical human qualities, meaning that humans can be expected to remain a critical component of the overall safety system. These unique human qualities include situational awareness, perception, making decisions using incomplete and unexpected information, self-learning, and intuition. The key benefit of automated systems is that automated systems can be left to reliably make routine and deterministic control decisions, avoiding human error making, and freeing humans up to deal with the unexpected and non-routine. By making this resource allocation, safety can be significantly improved.

2.4.1. Normal Operation

During normal operation, automated systems will be undertaking the basic functions of routing trains and supervising the service to identify the first signs of an anomaly; these systems can do this faster and with a lower error rate than a human operator, and without the risk of distraction. This significantly reduces the risk of incidents being initiated by staff error, and gives the control centre staff the ability to take a wider view of the service and the infrastructure, potentially identifying issues that an automated system would be less likely to detect, and being able to intervene before they threaten the safety of the railway.

Modern automated systems allow a degree of data and control interoperability as a result of the speed and processing power of automated systems that has been impossible in the past using manual systems. Automated systems can monitor a much wider range and quantity of inputs, make comparisons with significant amounts of historical data, and identify input sensor trends that a human may miss, resulting in failures being predicted long before a device fails potentially causing a safety hazard.

The greater flexibility of a fully automated system (e.g. allowing trains to quickly reverse away from an incident without waiting for a human driver to “change ends” and use a manual process to gain authority to drive in a direction that traditional signalling would not allow) brings additional safety benefits.

2.4.2. Degraded Mode Operation

System events that occur outside of MetroLink control and system failures may result in the need to operate in a degraded mode. Examples of external events may include localised power supply outages, critical passenger illness, public demonstrations and the like. System failures may include localised mechanical or electrical breakdowns. Both classes of issue result in a situation of asset denial. When asset denial occurs, automated systems offer multiple safety benefits.

Firstly, the computational power of automated systems means that the feasibility and expected performance of alternative degraded mode strategies can rapidly be assessed and presented to a human operator for informed selection. Automated systems can make these assessments very quickly and with outcome certainty that a human operator could never replicate.

Secondly, automated systems allow transition to a degraded mode to occur much more quickly and smoothly than a manual controlled system would allow. Automated systems enable a much more controlled changeover of service patterns, whilst the lack of train drivers removes entirely the time-consuming issue of driver location and reassignment (which introduces additional safety risks).

The automated control systems can enable the control centre staff to focus on understanding the nature of an incident, setting the strategy to manage that incident, and communicating with customers and external agencies, rather than having to concentrate on authorising individual train movements, as is the case with less automated railways.

2.4.3. Emergency Situations

By their very nature, emergency situations are individually unexpected and unpredictable – otherwise they would not occur. An emergency situation represents a risk to human safety or asset condition and must be detected and dealt with as quickly and effectively as possible, whilst avoiding the unnecessary injection of new hazards and risks. Examples may include smoke and fire, accidents, or potential accidents such as the detection of a trespasser. Dealing with an emergency situation may allow a degraded mode of operation to be put in place, either as a form of emergency risk mitigation, or following resolution of an emergency situation because of asset denial. Often emergency situations will result in temporary full or partial system closure and controlled evacuation.

Automated systems incorporating multiple sensors can detect and react to a wide range of emergency situations much faster and more reliably than a human operator manually monitoring sensor outputs and displays. This reliability and speed of response represents a major increase in safety performance.

In addition, automated systems can action remedial measures faster and with more accuracy than human operators can achieve. In the case of smoke and fire, smoke extraction fans can be automatically turned on to draw smoke away from passengers. The correct automated messages and signage can be initiated and synchronised with the emergency mitigation measures put in place, and passenger communications can be localised at individual stations; an unachievable workload for human operatives.

The control systems will automatically identify where trains need to be held in stations or reversed away from an incident; appropriate audio-visual customer information will automatically be sent to each train to ensure that customers are aware of the actions being taken; this is essential to avoid confusion resulting from unexpected movements, and the potential operation of customer emergency alarms.

Remote supervision can safely be used to evacuate a train stranded between stations. After ensuring that train movements in the area have been inhibited and power has been turned off, the detrainment ramp at the appropriate end of the train can be remotely deployed to allow customers to access the track slab, and on-train audio-visual announcements will guide customers to use the ramp. The progress of customers can be monitored using both the on-train and wayside CCTV, and specific advice given to any customers experiencing difficulties.

To co-ordinate responses to emergency conditions, a highly resilient communications network is required; this ensures that the control centre can continue to view on-train CCTV and disseminate customer information, even after a significant system failure or infrastructure damage. This technology is becoming standard for new high-capacity railways, particularly through tunnels, and therefore the additional resilience measures required to make it fit for a fully automated railway represent a minor additional cost.

All operational staff (including CSAs, maintenance technicians and their supervisors) will be trained in manual driving. In the case of failure of automated driving systems, operational staff will either already be on-board the train or can rapidly make their way from an adjacent station and will manually drive the train to the nearest station to allow customers to alight.

The constant oversight of trains and wayside infrastructure by remote condition monitoring systems ensures that conditions that could lead to an unsafe situation are detected at the earliest possible opportunity and investigated; this means that the majority of unsafe situations or reliability issues are corrected prior to customers being exposed to risk. In many cases there are redundant backup systems so if there is any concern about the integrity of a primary system, the backup system can be deployed with no loss of service, allowing the primary system to be investigated.

2.5. World Class Customer Experience

A world class customer experience is founded upon multiple pillars that underpin the transport service. To be counted as world class, each of these customer service expectations must be met:

- Smooth, efficient & trouble-free journeys;
- Comprehensive information & communications;
- Complete journey connectivity;
- Efficient remedies when things go wrong.

2.5.1. Smooth, Efficient & Trouble-Free Journeys

Railway systems are complex, and like all complex systems, do suffer from performance degradations and breakdowns that have a direct impact on passengers. These failures may be the result of an equipment suffering a breakdown, perhaps from a failed component; or may be due to external factors such as a grid power outage or a flooding event. Frequently however, failures are a result of human error, a lack of human responsiveness, or staff unavailability.

By taking humans out of the loop as much as possible, automated systems can largely avoid failures resulting from human errors and shortcomings. They also remove the variability of human response times and personal preferences, leading to a higher capacity, more consistent railway operation, using analysed and agreed best-practice for every decision.

Automated systems are also better able to deal with equipment failures, and some forms of external influences, through automatically switching to redundant systems with instant service reconfiguration. This enables component failures to be dealt with at times when the customer service will not be disrupted (e.g. overnight) and with less time pressure on the maintenance technician, leading to more in-depth diagnostics and higher-quality corrective work, significantly reducing the risk of a future repeat failure.

By utilising the highest levels of automation on monitoring, detection and control, the passenger benefits from the very highest levels of performance, resilience and responsiveness. In addition, passengers benefit from the additional flexibility to be gained from releasing train services from staff shift patterns, and safety-related working time limits, that result from the need for train crew. If staff are late, it delays the train service, and the human operators (whether driving a preceding train or using a train to get into position for their next duty) will also be delayed; clearly this can form a vicious circle that causes minor delays to propagate into major disruption.

Automated driving will be smoother than traditional manual train operation as hard brake applications will be reduced by the intelligent use of coasting; this will generate customer perception of improved ride quality. The train service reliability will be improved by removing the delays and the vicious cycle of service degradation caused by human operators not being in position.

The automated train regulation system will ensure that small service perturbations are managed before they can grow into larger service disruptions; customers will perceive that trains will reliably arrive at regular intervals, and customer load will be evenly spaced between trains.

2.5.2. Comprehensive Information & Communications

People have two characteristics that really matter in terms of customer service. Firstly, we can be approachable, warm and helpful and customers value human interactions in many situations. Equally, people can be late, inattentive, misinformed or overloaded. Automated systems struggle to provide that human touch when passengers really need it. However, for many simple passenger needs, such as simple information provision, passengers often prefer the accuracy, efficiency and immediacy that an automated system can provide. This is particularly true of recent generations, who have very few reservations about gaining information and communicating via their mobile phone or other smart devices.

The key to comprehensive communication is to combine the very best characteristics of automated systems and humans to match the needs and demands across all passenger demographics and all operational scenarios.

By using automation to move staff from driving cabs and station control rooms to customer-facing roles, the customer perception of staff presence is increased despite the actual number of staff decreasing compared to a traditional railway. This ensures that customers regularly see operational staff around the system and can have queries needing human interaction efficiently resolved.

Staff presence also contributes to the perception that MetroLink is a safe environment. By discouraging vandalism and anti-social behaviour, staff presence also reduces the gradual degradation of the physical MetroLink environment. The availability of staff to perform revenue control duties (and visibility of staff even when they are not performing revenue control duties) will be a major deterrent to ticketless travel, hence boosting farebox revenue.

The customer-facing public address and electronic display boards on trains, platforms and around stations will work together to create an audio-visual customer information system. This coherent source of information will ensure that customers with hearing or visual impairments still receive a full range of relevant information. This information can be made available in multiple languages where required, and will be made available via an open data feed so that customers can also receive information on their smartphones; this enables customers to use specific assistive technologies or translation software to read the information to meet their individual needs, and to plan their journey from before they leave their front door. The open data feed also allows real-time service information to be shared across multiple applications, allowing intermodal data-sharing, journey planning and facilitating multi-modal fare collection.

2.5.3. Complete Journey Connectivity

Automated systems enable a move towards door-to-door journey planning and mitigating the customer impact of disruption on other modes of transport involved in a journey by publishing and importing data from these systems. Customers can check the service on MetroLink from anywhere using their smartphones; the same published data can drive cheap, easy-to-configure customer-facing displays on other modes of transport (including at Dublin Airport) in in cafes and shops close to MetroLink premises. Similarly, MetroLink can provide information on other modes of transport through displays on their infrastructure (and in the case of significant disruption, via on-train displays) so that customers can make informed decisions to vary their intended route to reflect disruption on other transport modes. This may include providing information on road conditions to customers as they arrive at Estuary Park and Rise station. Third party apps will be able to draw upon this published data to suggest the most efficient routes across Dublin in real time under all service conditions in the same way that the satnav in a car responds to real-time traffic conditions when selecting and updating a route.

Common ticketing is a great customer attraction, allowing passengers to take the greatest advantage of a switch to public transport journeys. This attraction is enhanced further when integrated fare policies offer further incentives, such as automated maximum daily fare caps, and automated off-peak usage reductions.

2.5.4. Efficient Remedies When Things Go Wrong

However reliable a railway is, it needs to be able to deal efficiently with variability from sources beyond its control, such as customer action and external events, or just equipment failure. CBTC has a significant advantage over traditional signalling technologies as it provides minimum train separation and highest capacity under all operational conditions; while the traditional technologies are typically optimised for normal and close-to-normal operation. This enables recovery of normal service conditions in the minimum possible time. Automated decision support systems rapidly provide control centre staff with multiple service recovery options evaluated for their relative benefits, ensuring that the best strategy can be selected to regain normal service.

Appendix H: Transport Modelling Plan

MetroLink

Traffic Modelling Plan

ML1-JAI-TRA-ROUT_XX-PL-Y-00001 | P05.2

2021/09/15

MetroLink

Project No: 32108600
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P02	02/07/19		SM	MF	MF	WK
P01	13/03/19		GH	JPF	JPF	NC

Contents

1. Introduction

1.1 Background

On 22 March 2018, the National Transport Authority (NTA) and Transport Infrastructure Ireland (TII) launched the Dublin MetroLink Project. The launch included the release of an Emerging Preferred Route (EPR) and the start of a public consultation period on the EPR.

TII are managing MetroLink on behalf of the NTA. In January 2018 a Jacobs Idom Consortium (J/I) was appointed by TII to develop a preliminary design for MetroLink, to undertake an Environmental Impact Assessment, Appropriate Assessment and prepare all required materials for the submission of a Railway Order Application under Section 37 of the Transport (Railway Order) Act 2001 amended.

The overall MetroLink objective, as established by the NTA and TII, and as informed by planning policy context is:

"to provide a safe, high frequency, high capacity, fast, efficient and sustainable public transport service connecting Swords, Dublin Airport, Irish Rail, DART, Luas, Dublin Bus and the city centre".

In delivering this overall objective MetroLink will:

- Cater for existing and future public transport travel demand along the defined corridor;
- Be modern, attractive and accessible to all users;
- Be designed to integrate appropriately into the existing public realm;
- Be segregated from other transport modes to facilitate future trends in mobility;
- Contribute to a reduction in urban congestion and the enhancement of the environmental sustainability of the region;
- Support the continued economic development of the Dublin area and wider area;
- Be planned, constructed and operated in an environmentally sustainable manner;
- Support public transport network integration by providing high quality passenger interchange points, which facilitate convenient transfer between public transport modes at key locations in the study area;
- Facilitate connection to key trip attractors; and
- Facilitate the provision of a 'strategic Park and Ride' for the M1 Motorway corridor.

The preferred route will be approximately 19km in length, running from Estuary, north of Swords, southwards towards Dublin City via Dublin Airport. The route starts above ground from Estuary through Swords, going underground through Dublin Airport, before emerging again to cross over the M50. From

Northwood, through the city to its terminus at Charlemont in the south of the city, the route will run through a single bore tunnel. The route will include 16 new stations, a Park and Ride facility at Estuary Station, a depot (not operating as a station) at Dardistown, and ancillary infrastructure.

Figure 1-1: Preferred MetroLink Route

1.2 Purpose of Traffic Modelling Plan

As part of MetroLink, Jacobs/Idom (JI) is required to undertake the Transport Assessment, Scheme Appraisal, and Preliminary and Detailed Business Cases. The Transport Assessment is required to assess the potential benefits and/or impacts of the scheme during the operational phase and also during the construction phase, as well as providing technical input to the design, EIAR and Business Cases. The transport assessment requires strategic modelling of operations, strategic modelling of construction impacts, local/micro modelling of operations and local/micro modelling of construction impacts.

This Traffic Modelling Plan outlines the JI proposal in terms of inputs, modelling approach, outputs and deliverables. It is envisaged that this is a “live” document that will evolve over time in collaboration with TII to respond to the requirements of different stages of the assessment and appraisal phases of MetroLink.

2. Proposed Methodology

2.1 Overarching Approach

The following chart outlines the proposed assessment methodology outlining the high-level inputs, the strategic multi-modal modelling assessment, the interaction with local / micro modelling, and the outputs and deliverables. The strategic multi-modal modelling will underpin the assessment and comprise the main assessment of benefits and impacts, feeding into local / micro models where potentially significant impacts are identified. The local / micro modelling will be used to assess in greater detail the potential site-specific impacts and to develop appropriate mitigation for same. The local /micro modelling will also feedback detailed operational outputs to the strategic model to further improve the strategic assessment of the scheme.

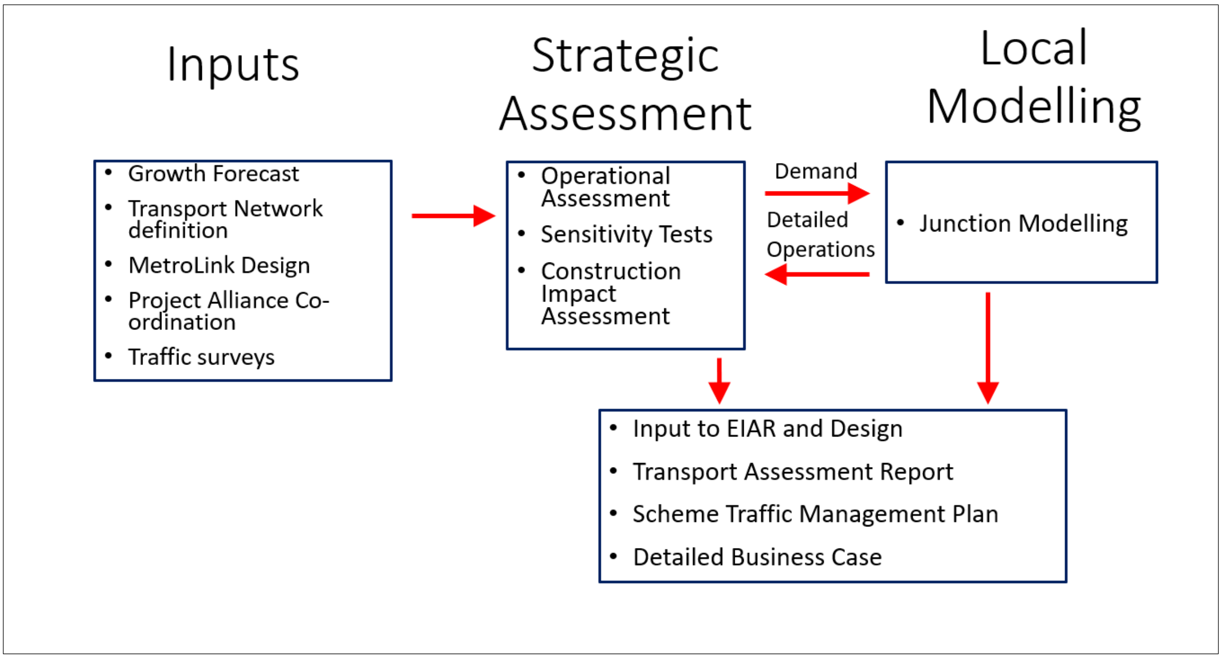

Figure 2.1: Transport Assessment Approach

3. Proposed Strategic Modelling Approach

As outlined in the overarching approach the strategic multi-modal modelling comprises the main element of the transport assessment. The following outlines our proposal in relation to the strategic transport modelling to be undertaken to carry out the scheme assessment and business case for MetroLink.

3.1 NTA Eastern Regional Model

3.1.1 Use of Eastern Regional Model

The strategic model to be used for the MetroLink Scheme Appraisal is the Eastern Regional Model (ERM) developed by the NTA. The ERM is a multi-modal, network based transport model that includes all main surface modes of travel, including: full geographic coverage of the Eastern Region, a detailed representation of the road network, a detailed representation of the public transport network & services, a detailed representation of all major transport modes including active modes, accurate mode choice modelling of residents, a detailed representation of travel demand of four time periods (AM, LT, SR and PM) and a prediction of changes in trip destination in response to changing traffic conditions, transport provision and/or policy.

The ERM captures all day travel demand, thus enabling more accurate modelling of mode choice behaviour and increasingly complex travel patterns, especially in urban areas where traditional nine-to-five working is decreasing. Best practice, innovative approaches were applied to the ERM demand modelling modules including car ownership; parking constraint; demand pricing; and mode and destination choice. The ERM is therefore significantly more responsive to future changes in demographics, economic activity and planning interventions than traditional models. This ERM has a base year of 2016 and is calibrated to 2016 Census, 2017 National Household Travel Survey and localised multi-modal surveys.

The TII Project Appraisal Guidelines (PAG), while not specifically developed for the assessment of public transport schemes, outline the following in support of the use of the ERM as the Variable Demand Model for the assessment of the MetroLink scheme:

- **Nature of Scheme:** Major scheme, traffic management in urban areas, public transport schemes, intermodal impacts;
- **Likely Impacts of Scheme:** Major urban areas where congestion will exist, schemes which lead to large reductions in journey time, schemes which will increase competition with public transport, mode choice is likely to be a significant issue.

3.1.2 Model Extents and Detail

Figure 3.1 outlines the extent of the ERM, covering most of Leinster, excluding Kilkenny. The ERM is centered on Dublin City, within increased network and zonal detail in the metropolitan area surrounding Dublin City. The ERM has 1,953 zones, including 1,907 geographic zones, 39 road route zones, 7 rail route zones and 3 special zones (including Dublin Airport, Dublin Port and Dun Laoghaire Port special zones).

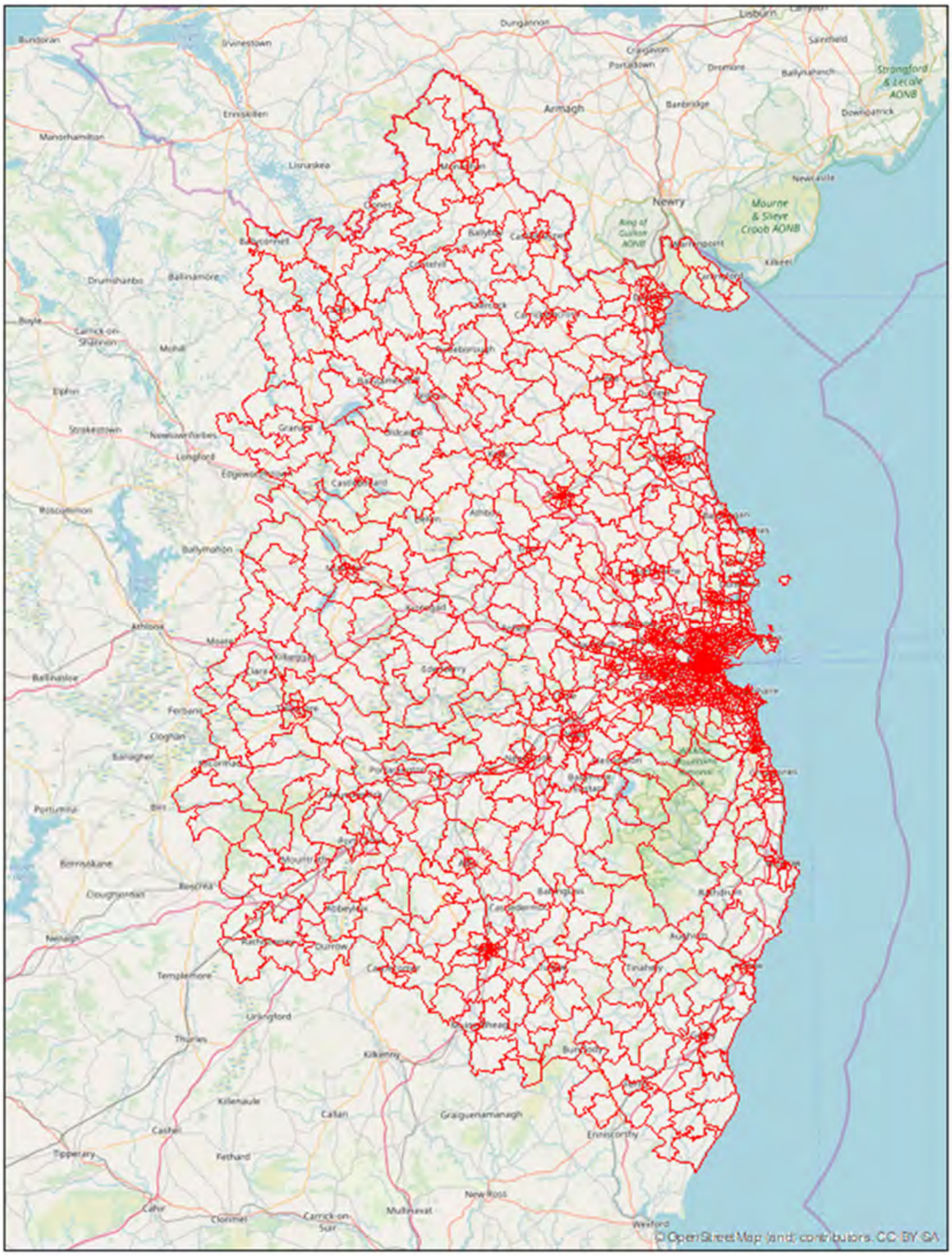

Figure 3.1: Extent of Eastern Regional Model

3.1.3 Area of Influence

To identify the area of influence, a 2018 Baseline Model was compared against a 2018 Do Scheme Model and the public transport outputs, and highway outputs from the model were reviewed to determine an area of influence for MetroLink.

The area of influence for the MetroLink scheme can be seen in Figure 3.2. As expected, the main area of influence is to the North of Dublin directly adjacent to the MetroLink scheme. The area of influence also extends to the West and South of Dublin along major radial corridors, and the M50 due to opportunities to combine Luas Green Line trips with MetroLink, and to access the Park and Ride Station.

The impacts of the MetroLink scheme can and do extend beyond this area of influence, however this area of influence has been used to identify an area where any future network schemes would be included within the future forecast models.

Figure 3.2: Area of Influence

3.2 Scenario Years

The following outlines the proposed scenario years to be considered for the MetroLink scheme modelling runs:

- Opening Year: 2030 (to be used as the construction impact year also);
- Design Year: 2045;
- Forecast Year: 2060; and
- The Business Case runs will utilise a Do Committed Schemes base, while the EIAR will utilise different Do Minimum networks for the 2030, 2045 and 2060 years.

3.3 Forecast Growth Scenarios

To ensure that MetroLink can operate efficiently and deliver benefits into the future, forecasts are required to determine the likely future levels of demand on Dublin’s transport system. The TII PAG states that *“Unbiased future demand projections are a critical input in ensuring that capacity for transport infrastructure is neither too large nor too small to meet the future demand. Furthermore, travel demand projections inform the economic and environmental appraisal of transport schemes and therefore play a fundamental role in deciding whether a scheme is to progress”.*

The NTA have developed a planning datasheet forecast that aligns with the National Planning Framework (NPF) growth levels for the year 2040, and for the latest CSO forecast year of 2051.

The NTA will provide the project team with planning datasheets for the years of 2030, 2045 and 2060 and will provide information on how these years have been forecast including growth trajectories.

In addition to the forecast growth associated with the typical land use patterns, Dublin Airport is a key growth driver in the corridor and has a different growth associated with flight travel demand. Within the ERM, growth in landside demand is determined for passengers, staff and freight, applied to the Dublin Airport Special Zone. Freight and staff numbers are forecasted on a scaling factor, which will be aligned with passenger growth forecasts. DTTAS report "Review of Capacity Needs at Ireland's State Airports - August 2018" outlines forecast passenger growth to 2050 for Low, Central and High growth scenarios. There is a working group with NTA, TII, FCC and DAA where use of this aspect of the model is to be discussed to ensure consistent application of this tool.

The NTA have provided trip end forecasts for Dublin Airport and all other special zones. These are being used within the model.

3.4 Scheme Scenarios

The following describes the scenarios to be considered in the assessment:

- Do Committed;
- Do Minimum;
- Do Scheme; and
- Sensitivity Tests.

3.4.1 Do Nothing Network

Table 3-4 outlines the transport infrastructure and schemes that have been introduced in the intervening years between 2016 and 2019. The schemes listed in Table 3-4 will be added to the baseline 2016 ERM to create a present year ERM model.

3.4.2 Do Committed Scenario

The PAG also makes a clear distinction between Committed and Planned Schemes:

"(a) "Planned" improvements that are included in the fiscally constrained long-range plan for which the need, commitment, financing, and public and political support are identified and may be reasonably expected to be implemented; and

(b) "Committed" improvements that have been progressed through planning and are either under construction or are programmed into the capital expenditure budget.

The Do Minimum option should consider "committed" schemes alone as the inclusion of "planned" improvements may lead to a set of scheme options that incorporate projects that may not happen."

The PAG also outlines that *"the inclusion of planned projects will suggest the reliance of the subject scheme on those projects"*.

As outlined above, ensuring an appropriate Do Minimum scenario is essential to the robust appraisal of the MetroLink Scheme. Schemes such as the DART Expansion, the DART Underground and BusConnects, etc. were they to be included as part of the Do Minimum scenario, could suggest a reliance of the MetroLink scheme, in particular where the proposed alignment and station locations would likely benefit from increased interchange between these schemes. However, there are improvements in DART services above current levels which will be delivered before 2030 and so would be included in the committed train service patterns.

In the case of the Do Committed scenario for the MetroLink Scheme the transport schemes/initiatives outlined in Table 3-4 are included.

3.4.3 Do Minimum Scenario

TII have instructed J/I to utilise the same Do Minimum scenario as BusConnects EIAR. Within the BusConnects EIAR, MetroLink is included within Do Minimum scheme, but within MetroLink, BusConnects is included as a Do Minimum scheme.

The details of the reasoning of case definition are contained within the report “BusConnects TIA - Definition of Do Minimum Schemes Scoping Note”.

3.4.3.1 Do Minimum Scheme Definition

Table 3-4 outlines the schemes to be included as part of the Do Minimum scenario for the opening year (2030) and the Design Year (2045). The Design Year (2045) is based on the implementation of the Transport Strategy for the Greater Dublin Area (GDA) measures.

The scheme opening year (2030) is based on the investment priorities contained within the National Development Plan (NDP).

3.4.3.2 Interchange and Boarding Penalties

It is proposed to maintain the calibrated boarding and interchange penalties within the model for both the Do Minimum and Do Scheme models. The default transfer penalties are presented in Table 3-1.

Table 3-1 ERM V3 Model Default Transfer Penalties between PT Sub-Modes (minutes)

	DART	Irish Rail	Luas	Urban Bus	Other Bus	BRT	Metro
DART	15	15	15	15	15	15	15
Irish Rail	15	15	15	15	15	15	15
Luas	15	15	5	5	5	5	5
Urban Bus	15	15	5	15	5	5	5
Other Bus	15	15	5	5	5	5	5
BRT	15	15	5	5	5	5	5
Metro	15	15	5	5	5	5	5

3.4.4 Do Scheme Scenarios

To appraise the MetroLink scheme, Scenario based analysis will be utilised. The main scenario will be called the Central Case, and in addition Scenario Sensitivity testing will be undertaken as per the Project Appraisal Plan.

Each Scenario will test a Do Minimum (without MetroLink) and Do Scheme (with MetroLink) to understand the impact of the MetroLink scheme under each scenario.

For each model run the following parameters, for example, will be included: MetroLink service pattern, journey time (speed profiles), vehicle capacities, station wait times, interchange penalties and associated local connections providing access to the stations from the street network and interchanging services.

The Scenario Sensitivity testing will include an agreed number of sensitivity tests utilising combinations of parameters that may impact on the passenger demand on the MetroLink scheme, in comparison to the Central Case.

3.4.5 Scenario Analysis / Sensitivity Test 1: Growth Projections

The slower growth scenario assumes that growth in population and jobs follows the same pattern as the core runs but happens at a slow pace, such that the difference increases as the forecast years get closer to 2060. The forecasts have been developed by utilising a planning datasheet from an earlier year, to represent a potential slow growth in the relevant forecast year, as summarized within Table 3-2.

Table 3-2: Slow Growth Forecast

Forecast Year	Planning Datasheet Year used for Slow Growth
2030	2028
2045	2040
2060	2053

3.4.6 Scenario Analysis / Sensitivity Test 2: Service Patterns

In this sensitivity test the core population and job forecasts and travel patterns have been assumed to remain in place, but the frequency of trains on the MetroLink have been reduced. This sensitivity test has been undertaken to understand how the MetroLink may perform if it operated with a lower frequency, i.e. with less trains.

The following table details the lower frequencies assessed in comparison with the core runs.

Table 3-3: Comparison of frequencies included in Core Runs and Sensitivity Test

Forecast Year	Core Run Frequencies	Low Frequency
2030	All Periods: 2mins	All Periods: 5mins
2045	All Periods: 2mins	All Periods: 3.5mins
2060	All Periods: 1.5mins	All Periods: 3mins

3.4.7 Scenario Analysis / Sensitivity Test 3: Complementary Measures

Complementary measures are outlined as a sensitivity test for the MetroLink scheme. Over the lifetime of the MetroLink scheme, additional transport infrastructure and measures are proposed that would likely supplement the operation of the MetroLink scheme. The National Development Plan (NDP), which includes MetroLink, sets out the transport proposals to be delivered in the State by 2027. The Transport Strategy for the Greater Dublin Area (GDA) sets out the transport proposals to be delivered in the GDA by 2035. It is proposed that both the NDP and GDA Transport Strategy are considered as sensitivities to the Do Scheme scenario. It is proposed that for these sensitivities, the NDP is included in the 2030 Opening Year scenario, and that the GDA Transport Strategy is included in the 2045 Design Year and 2060 Forecast Year.

3.4.8 Scenario Analysis / Sensitivity Test 4: Alternative Demand

An alternative demand scenario has been developed by the NTA to represent travel in the post COVID world, this includes increases in working from home, increases in home-based shopping and reductions in business related travel from Dublin Airport.

3.4.9 Scenario Analysis/Sensitivity Test 5: Complementary Measures: National Development Plan + Alternative Demand

An alternative demand scenario has been developed to represent the build out of infrastructure projects included in the National Development Plan, in conjunction with the alternative demand scenario, detailed in section 3.4.8, to represent travel in the post COVID world. This was developed by the NTA, https://www.nationaltransport.ie/wp-content/uploads/2021/03/Alternative-Scenario-Development-Note-v-6.1_Final.pdf.

3.4.10 Construction Scenario

It is proposed to utilise a 2024 Do Minimum scenario as the basis for the construction impact assessment, as this will represent a worst-case scenario for travel demand levels during the construction period.

In this phase the impact of the different traffic management stages on the local transport network will be outlined. The road and street impacts will be coded into the 2024 Do Minimum scenario along with any identified mitigation to determine the potential local impacts, and any wider strategic impacts and diversions. This will provide input to the local junction modelling.

Further details of the traffic management will be contained within the Scheme Traffic Management Plan.

3.5 MetroLink Proposed Scheme List

The following table outlines the schemes to be included as part of the Do Minimum scenario for the opening year (2030) and the Design Year (2045). The Design Year (2045) is based on the implementation of the GDA Strategy measures.

The scheme opening year (2030) is based on the investment priorities contained within the National Development Plan (NDP).

Table 3-4: Proposed Scheme List

Proposed Scheme List		2019/ 2020	2030			2045 & 2060		
Scheme ID	Description	Do Nothing	Do Committed	Do Minimum	Do Scheme	Do Committed	Do Minimum	Do Scheme
Rail Timetabling								
TT1	Revised Irish Rail timetable	✗	✓	✓	✓	✓	✓	✓
Heavy Rail Infrastructure								
HR1	Interim DART Expansion Programme (non-tunnel elements) including additional stations at Kishogue, Cabra, Pelletstown, Woodbrook, Kylemore and Glasnevin	✗	Pelletstown & Kishogue only	✓	✓	Pelletstown & Kishogue only	✓	✓
HR2	DART Tunnel Element (Kildare Line to Northern Line)	✗	✗	✗	✗	✗	✓	✓
Light Rail Infrastructure								
	LUAS Cross City	✓	✓	✓	✓	✓	✓	✓
LR1	MetroLink (to Charlemont)	✗	✗	✗	✓	✗	✗	✓
LR2a	LUAS Cross City incorporating LUAS Green Line Capacity Enhancement - Phase 1	✗	✓	✓	✓	✓	✗	✗
LR3	LUAS Green Line Capacity Enhancement - Phase 2	✗	✗	✗	✗	✗	✓	✓
LR4	Finglas LUAS (Green Line extension Broombridge to Finglas)	✗	✗	✗	✗	✗	✓	✓
LR5	Extension of LUAS Green Line to Bray	✗	✗	✗	✗	✗	✓	✓
LR6	Lucan LUAS	✗	✗	✗	✗	✗	✓	✓

LR7	Poolbeg LUAS	✗	✗	✗	✗	✗	✗	✗
LR8	Metro South (MetroLink extension Charlemont to Sandyford on LUAS Green Line alignment)	✗	✗	✗	✗	✗	✗	✗
BusConnects								
BC1	Radial Core Bus Corridors	✗	✗	✓	✓	✗	✓	✓
BC2	BusConnects Fares / Ticketing	✗	✓	✓	✓	✓	✓	✓
BC3	BusConnects Routes and Services	✗	✗	✓	✓	✗	✓	✓
BC4	Orbital Bus Corridors	✗	✗	✗	✗	✗	✗	✗
Park and Ride								
PR1	Rail and Bus based P&R provision (partial implementation by 2028)	✗	✗	✓	✓	✗	✓	✓
Cycling								
CY1	Greater Dublin Area Cycle Network Plan (excluding Radial Core Bus Corridor elements)	✗	✗	✓	✓	✗	✓	✓
CY2	Greater Dublin Area Cycle Network Plan (including Radial Core Bus Corridor elements)	✗	✗	✗	✓	✗	✗	✓
National Roads								
NR1	Reconfiguration of the N7 from its junction with the M50 to Naas, to rationalise junctions and accesses to provide a higher level of service for strategic traffic travelling on the mainline	✗	✗	✗	✗	✗	✓	✓

NR2	Junction upgrades and other capacity improvements on the M1 motorway, including additional lanes south of Drogheda, where required	✗	✗	✗	✗	✗	✓	✓
NR3	Widening of the M7 between Junction 9 (Naas North) and Junction 11 (M7/M9) to provide an additional lane in each direction	✗	✓	✓	✓	✓	✓	✓
NR4	Widening of the M50 to three lanes in each direction between Junction 14 (Sandyford) and Junction 17 (M11) plus related junction and other changes	✗	✗	✗	✗	✗	✓	✓
NR5	Reconfiguration of the N4 from its junction with the M50 to Leixlip to rationalise accesses and to provide additional capacity at the Quarryvale junction	✗	✗	✗	✗	✗	✓	✓
NR6	Capacity enhancement and reconfiguration of the M11/N11 from Junction 4 (M50) to Junction 14 (Ashford) inclusive of ancillary and associated road schemes, to provide additional lanes and upgraded junctions, plus service roads and linkages to cater for local traffic movements	✗	✗	✓	✓	✗	✓	✓
NR7	Enhancements of the N2/M2 national route inclusive of a bypass of Slane, to provide for additional capacity on the non-motorway sections of this route, and to address safety issues in Slane village associated with, in particular, heavy goods vehicles	✗	✗	✗	✗	✗	✓	✓

NR8	Widening of the N3 between Junction 1 (M50) and Junction 4 (Clonee), plus related junction and necessary changes to the existing national road network	✗	✗	✗	✗	✗	✓	✓
NR9	Development of a road link connecting from the southern end of the Dublin Port Tunnel to the South Port area, which will serve the South Port and adjoining development areas	✗	✗	✗	✗	✗	✓	✓
Regional and Local Roads								
RR1	N3 Castaheany Interchange Upgrade	✗	✗	✓	✓	✗	✓	✓
RR2	N3–N4: Barnhill to Leixlip Interchange	✗	✗	✓	✓	✗	✓	✓
RR3	North-South Road – west of Adamstown SDZ linking N7 to N4 and on to Fingal	✗	✓	✓	✓	✓	✓	✓
RR4	Glenamuck District Distributor Road	✗	✓	✓	✓	✓	✓	✓
RR5	Leopardstown Link Road Phase 2	✓	✓	✓	✓	✓	✓	✓
RR6	Porterstown Distributor Link Road	✗	✓	✓	✓	✓	✓	✓
RR7	R126 Donabate Relief Road: R132 to Portrane Demesne	✗	✓	✓	✓	✓	✓	✓
RR8	Oldtown-Mooretown Western Distributor Link Road	✗	✗	✓	✓	✗	✓	✓
RR9	Swords Relief Road at Lord Mayors	✗	✗	✓	✓	✗	✓	✓
RR10	Poolbeg development roads	✗	✓	✓	✓	✓	✓	✓
RR11	Cherrywood development roads	✗	✓	✓	✓	✓	✓	✓

RR12	Clonburris development roads	✗	✓	✓	✓	✓	✓	✓
RR13	R132 Reconfiguration in Swords	✗	✓	✓	✓	✓	✓	✓
Demand Management								
DM1	Dublin City Centre Parking Constraint	✗	✗	✓	✓	✗	✓	✓
DM2a	M50 Demand Management Measures - Variable Speed Limits	✗	✗	✗	✗	✗	✗	✗
DM2b	M50 Demand Management Measures - Multi-point tolling	✗	✗	✗	✗	✗	✓	✓
DM3	Implement demand management measures to address congestion issues on the radial national routes approaching the M50 motorway	✗	✗	✗	✗	✗	✓	✓
DM4	Further demand management measures that ensure that all future growth in travel demand is facilitated by sustainable modes / max. 45% car commuter mode share.	✗	✗	✗	✗	✗	✓	✓

3.5.1.1 Do Minimum Network Scheme Assumptions

The following section outlines the assumption on service patterns, capacities and frequencies that will be modelled for each of the schemes outlined in Table 3-4.

3.5.1.1.1 Heavy Rail Schemes

HR1: DART Expansion programme

The DART Expansion programme is a comprehensive scheme for the upgrade of all heavy rail commuter lines in the Greater Dublin Area, including electrifications to Drogheda, Maynooth and Hazelhatch. The DART Expansion Programme will not be fully delivered in 2030 with the programme focussed on the exiting network upgrade up to that point i.e. No DART Underground tunnel up to 2030.

For the purpose of modelling, the assumptions for the Heavy Rail network up to 2030 will be based on the NTA's ***DART Expansion Programme Options Assessment – Addendum Report*** with the network and service plans coded shown in Figure 3-4 below. A map of the proposed measures is shown in Figure 3-3 below.

Additional Stations by 2030

As part of the DART Expansion programme and based on further studies undertaken by the NTA since the publication of the GDA Strategy, several rail stations have been proposed at the following locations:

- **Kishogue**
  - An additional rail station has already been built between Clondalkin / Fonthill and Adamstown on the Dublin-Cork line. This will become a stopping station as part of the Do Committed scenario.
- **Pelletstown**
  - An additional rail station will be introduced between Ashtown and Broomsbridge on the Dublin-Sligo line. A footbridge will be provided to access from the North side of the canal. Walk links added for access to the station from both sides of the canal. All services Maynooth-Dublin and M3 Parkway - Dublin to stop at Pelletstown. Journey times increased by 1min to reflect dwell time. This station is included in the Do Committed scenario.

- **Woodbrook**
  - Introduction of a new rail station between Bray and Shankill on the Dublin-Rosslare line. All DART services to/from Bray/Greystones to stop at Woodbrook. Access to the station through the Woodbrook Golf course road. Journey times increased by 1min to reflect dwell time.

- **Kylemore**
  - Introduction of a new rail station between Park West and Heuston on the Kildare line. All DART services on the DART line to stop at Kylemore. Access to the station through from Kylemore road. Journey times increased by 1min to reflect dwell time.

- **Cabra**
  - Introduction of a new rail station on the Phoenix Park tunnel link on the Kildare line between Heuston and Drumcondra. All DART services on the line to stop at the station. Access to the station provided from Cabra Road and Old Cabra Road. Journey times increased by 1min to reflect dwell time.

- **Glasnevin**
  - Introduction of a new rail station at the junction between the Maynooth line and Phoenix Park tunnel line. All DART services on both the Maynooth line and Phoenix Park tunnel line to stop at the station. Transfer link provided to the Glasnevin MetroLink station. Access to the station provided from Phibsborough Road. Journey times increased by 1min to reflect dwell time.

The DART Expansion Programme also includes for the closure of level crossings on the Maynooth line. Location of road links that will be closed is to be clarified by the NTA.

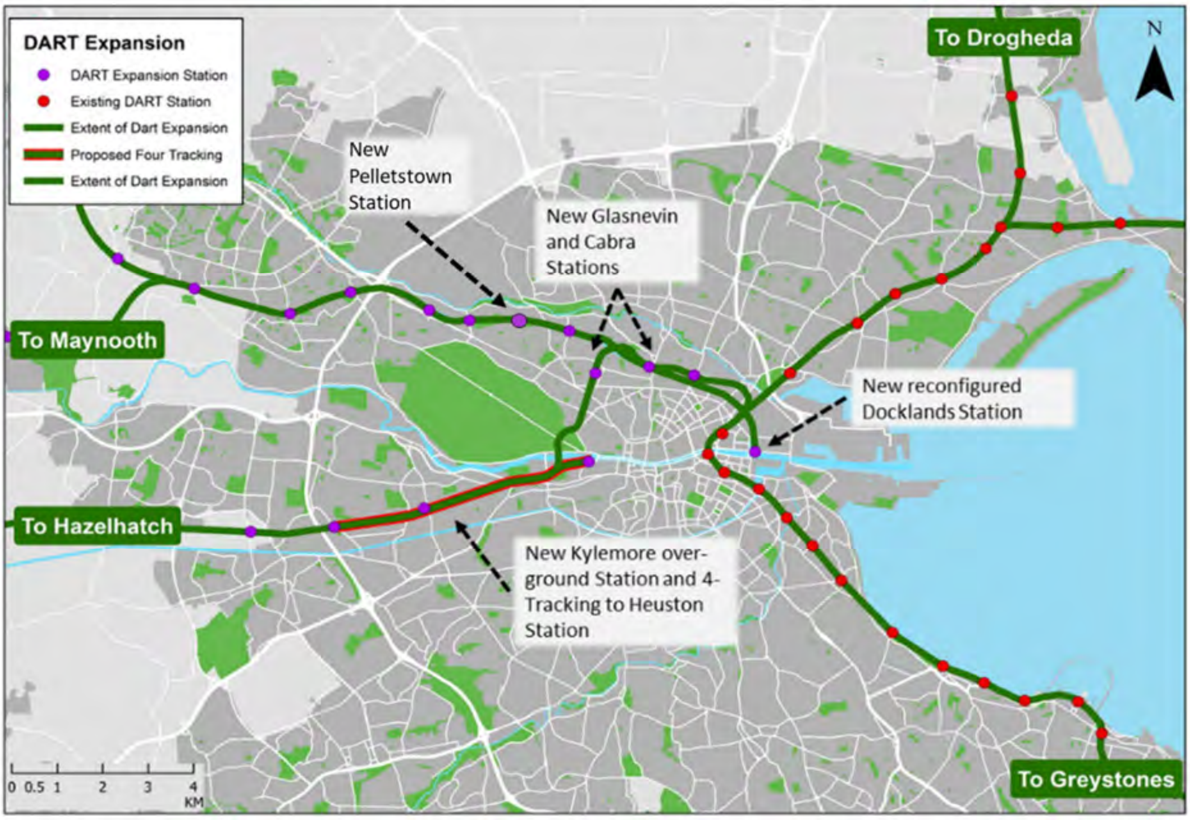

Figure 3-3: Interim DART Expansion Network

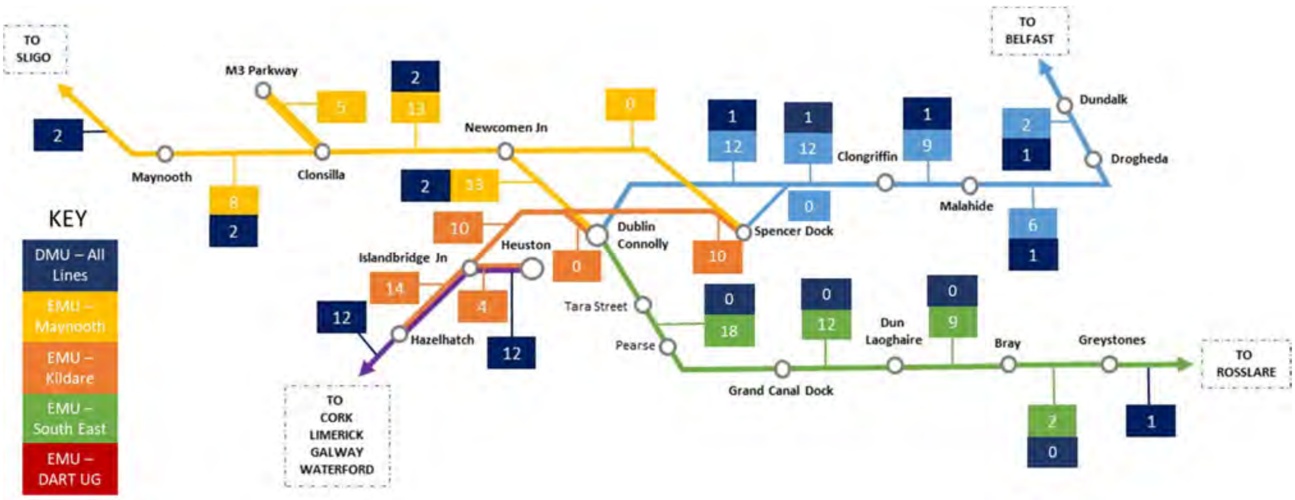

Figure 3-4: Interim DART Expansion – Service Provision

HR2: DART Expansion Programme including DART Tunnel Element

HR2 includes for the full implementation of the DART Underground tunnel component between Kylemore and Docklands stations connecting the Kildare Line with the Northern Line. It is proposed to reallocate the two ‘Hazelhatch to Heuston’ services via the Phoenix Park tunnel to maintain access to Cabra Station as this scenario assumes that HR2 follows the full implementation of HR1.

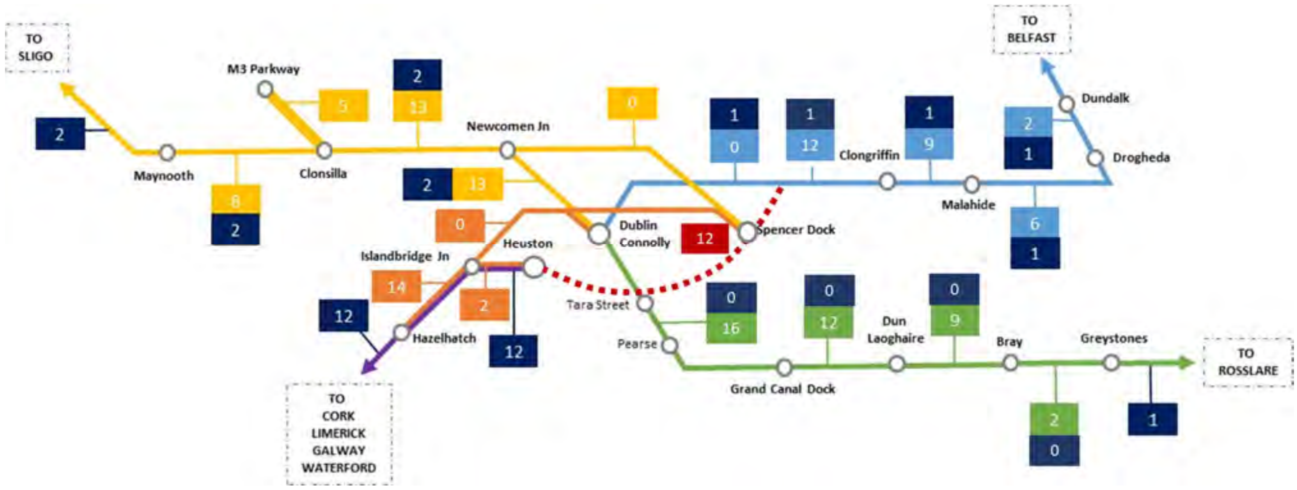

Figure 3-5: DART Expansion including DART Underground – Service Provision

Table 3-5 below outlines the service provision for both HR1 and HR2.

Table 3-5 Heavy Rail Peak Hour Service Provision

Route	HR1 DART Expansion (non-tunnel elements)	HR2 DART Expansion Including DART Underground
Northern Line		
Belfast to Connolly (Enterprise)	1	1
Connolly to Rosslare Europort (Diesel)		1
Greystones to Rosslare Europort (Diesel)	1	
Dundalk to Bray	2	
Drogheda to Docklands	2	
Drogheda to GCD	2	
Malahide to Bray	3	
Clongriffin to Dún Laoghaire	3	
Howth to Howth Jn [Shuttle]	6	6
Connolly to Bray		
Clongriffin to Bray	0	
Kildare / Northern Lines		

Route	HR1 DART Expansion (non-tunnel elements)	HR2 DART Expansion Including DART Underground
Drogheda to Hazelhatch		4
Dundalk to Hazelhatch		2
Clongriffin to Hazelhatch		3
Malahide to Hazelhatch		3
Maynooth & M3 Parkway		
Sligo to Connolly (Diesel)	2	2
Maynooth to GCD	4	
Maynooth to Dún Laoghaire		3
Maynooth to Bray	2	3
Maynooth to Greystones	2	2
M3 Parkway to Clonsilla [Shuttle]		4
M3 Parkway to Docklands	5	
M3 Parkway to GCD		2
M3 Parkway to Bray		3
Kildare Line		
Mainline to Heuston (DMU)	12	12
Hazelhatch to Heuston	4	
Hazelhatch to Docklands	5	2
Hazelhatch to Connolly	5	

Capacities on the routes will be as follows, interpeak frequencies will be assumed as half the peak frequencies:

- DART Services
  - Capacities: 512 seating / 1,382 crush
- Shuttle service Howth – Howth Junction
  - Capacities: 256 seating / 691 crush
- Shuttle service M3 Parkway – Clonsilla
  - Capacities: 185 seating / 660 crush

3.5.1.1.2 Light Rail Schemes

LR3: LUAS Cross City incorporating LUAS Green Line Capacity Enhancement – Phase 1

LUAS capacity increased on the Green Line from the current 43.6m trams (68 seating /312 crush capacity) to 55m tram sets (96 seating / 408 crush).

- 2 trams per hour (tph) Brides Glen to Parnell;

- 10 tph Brides Glen to Broombridge;
- 8 tph Sandyford to Parnell; and
- 4tph Sandyford to Stephen's Green.

LR3: LUAS Green Line Capacity Enhancement - Phase 2

Phase 2 of the LUAS Green Line Capacity Enhancement with 55m tram sets (96 seating / 408 crush) and increased frequency levels

- 10 trams per hour (tph) Bray to Finglas;
- 10 tph Brides Glen to Broombridge;
- 6 tph Sandyford to Charlemont; and
- 4tph Sandyford to Stephen's Green.

LR4: LUAS Extension to Finglas

Extension of the existing LUAS Green line north to Charlestown. Service pattern affected by LR3 (Metro South) as Charlemont-Sandyford section used for Metro services Swords-Sandyford.

- Charlemont – Charlestown services
- 38min end-to-end journey times
- 3min (AM & PM) / 6min (LT & SR)
- Capacity (per LUAS): 96 seating / 408 crush

LR6: Lucan LUAS

Newly constructed LUAS line between Lucan and College Green. The main characteristics are:

- Journey times to reflect similar per km LUAS Red line times;
- Line to join with LUAS Red line services at Blackhorse;
- Limit of 4min frequency for all time periods for the combined routes from Blackhorse to city centre.
- Capacity (as per LUAS Red Line): 72 seating / 308 crush

3.5.1.1.3 BusConnects

BC1: Radial Core Bus Corridors (CBCs)

Each of the BusConnects schemes (based on the available ED schemes) will be coded into the Do Minimum network. The designs will be based on the scheme layouts that were recently issued for public consultation, circa April 2020.

BC2: BusConnects Fares / Ticketing

Integrated ticketing has been included within the Do Minimum and Do Scheme runs for all scenarios. Details on the Integrated ticketing has been provided by the NTA.

BC3: BusConnects Routes and Services

The latest available BusConnects services will be coded into the ERM. The routes will be provided to the project team in GTFS format and converted into model files using a bespoke process.

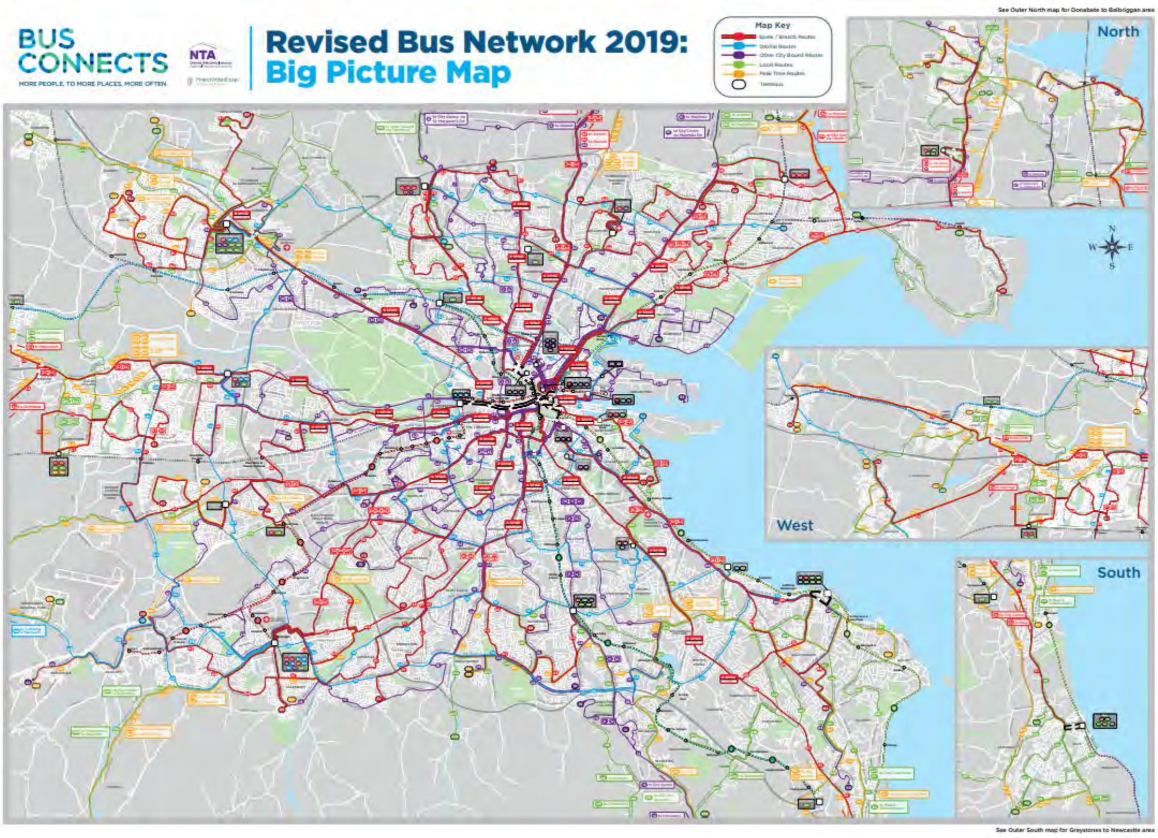

Figure 3-6: Bus Connects Network

Service frequencies will be initially coded based on the frequencies published as part of the 2019 consultation.

BC4: BusConnects Orbital Bus Corridors

These have not been included within the modelling runs to ensure consistency with BusConnects project.

3.5.1.1.4 Park and Ride

As proposed in the GDA Strategy a number of potential Rail based park and ride sites are envisaged. These facilities are, or would be, located at Swords, Finglas, Dunboyne, Liffey Valley, Naas Road, Carrickmines, Woodbrook and Greystones.

3.5.1.1.5 Cycling

The Greater Dublin Area Cycle Network plan will form the basis of the cycling network as part of the Do Minimum scenario (excluding the Radial Core Bus Corridor elements) (CY1).

The Do Scheme scenarios (CY2) will additionally include the cycling improvement proposals that form part of the Radial Core Bus Corridors. The network will be coded into the ERM with improved travel speeds to reflect the upgrade to the routes.

3.5.1.1.6 National Road Schemes

The following National Road improvement schemes will be coded within the Do Minimum scenarios.

- NR1: Widening of the N7 to 3 lanes between junction with the M50 and the M7. (Completed).
- NR 2: Widening of the 2-lane section of the M1 to 3 lanes between Drogheda and Junction 4 with the M50, in both directions.
- NR 3: Widening of the M7 between Junction 9 (Naas North) and Junction 11 (M7/M9) (Recently completed)
- NR 4: Widening of the M50 to three lanes in each direction between Junction 14 (Sandyford) and Junction 17 (M11).
- NR 5: Reconfiguration of the N4 from its junction with the M50 to Leixlip to rationalise accesses and to provide additional capacity at the Quarryvale junction
- NR 6: Capacity enhancement and reconfiguration of the M11/N11 from M50 junction to Junction 14 (Ashford) inclusive of ancillary and associated road schemes, to provide additional lanes and upgraded junctions, plus service roads and linkages to cater for local vehicular traffic movements.
- NR 7: Enhancements of the N2/M2 national route inclusive of a bypass of Slane, to provide for additional capacity on the non-motorway sections of this route, and to address safety issues in Slane village associated with heavy goods vehicles
- NR 8: Widening of the N3 between Junction1 (M50) and Junction 4 (Clonee), plus related junction and necessary changes to the existing national road network
- NR 9: Development of a road link connecting from the southern end of the Dublin Port Tunnel to the South Port area, which will serve the South Port and adjoining development areas, intended primarily for goods access and remove goods vehicle from East-Link (Thomas Clarke) bridge.

3.5.1.1.7 Regional Road Schemes

The following Regional Road improvement schemes will be coded within the Do Minimum scenarios. All of these schemes will be included in both the 2030 and 2045 models.

- RR 1: N3 Castaheany Interchange
- RR 2: N3-N4: Barnhill to Leixlip Interchange
- RR 3: North-South Road – west of Adamstown SDZ linking N7 to N4 and on to Fingal
- RR 4: Glenamuck Distributor Road
- RR 5: Leopardstown Link Road Phase 2
- RR 6: Porterstown Distributor Link Road
- RR 7: R126 Donabate Relief Road: R132 to Portrane Demesne

- RR 8: Oldtown – Mooretown Western Distributor Link Road
- RR 9: Swords Relief Road at Lord Mayors
- RR10: Poolbeg development network modifications
- RR11: Cherrywood development network modifications
- RR12: Clonburris development network modifications

3.5.1.1.8 Demand Management

The following assumptions on demand management proposals will be applied:

- DM1: Dublin City Centre Parking Constraint.
  - No increase in the quantum of Dublin city centre (inside canal boundaries) parking spaces in future years
- DM 1a: M50 Demand Management Measures - Variable Speed Limits
  - Implemented as an adjustment to Speed Flow Curves on M50 links within the model. Methodology to be agreed with the NTA
- DM 1b: Multi point tolling on the M50. Same values to be coded as in previous 2035 Strategy coding as outlined in Figure 3-7 below (in cents).
- DM 2: Implement demand management measures to address congestion issues on the radial national routes approaching the M50 motorway. Same values coded as in previous 2035 Strategy coding as outlined in Figure 3-7 below (in cents).
- DM3: Implement demand management measures to address congestion issues on the radial national routes approaching the M50 motorway.
- DM4: Further demand management measures that ensure that all future growth in travel demand is facilitated by sustainable modes / maximum 45% car commuter mode share.

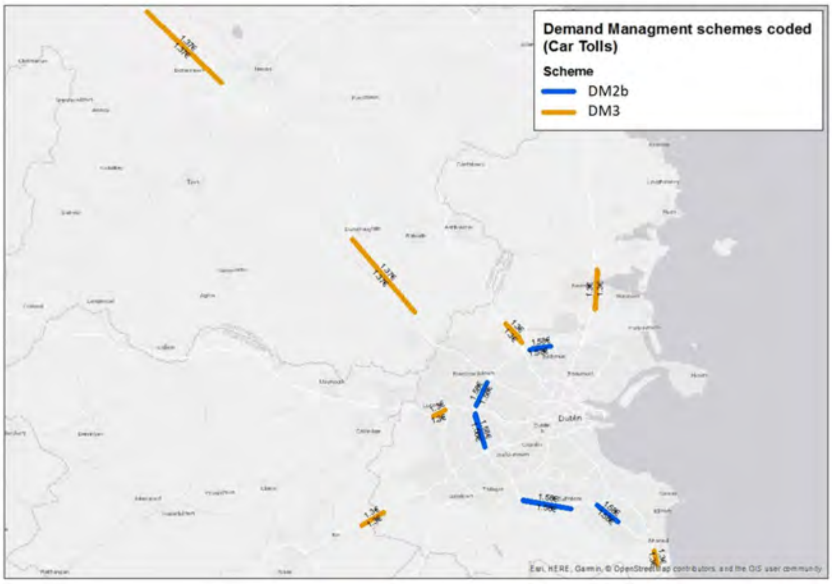

Figure 3-7: Potential Do Minimum Demand Management Schemes

3.6 Modelling Parameters for MetroLink

Assumptions for the strategic modelling are detailed in Table 3-6. It is assumed that the same rolling stock will be used for each model run and the level of service will also be kept the same, to ensure a fair comparison between model runs.

Table 3-6: Modelling Assumptions Table

Assumptions	2028	2045	2060
Service Pattern	Estuary-Charlemont	Estuary-Charlemont	Estuary-Charlemont
Headways	2min	2min	90sec (could reduce to 2 mins if 90 sec appropriate for a high frequency test)
Fares	Integrated ticketing (as used for BusConnects).	Same	same
Capacity (/Vehicle)	125seat/500 crush	Same	Same
Crowding Curve	As ERM standard crowding curve for Luas	Same	Same
Waiting Curve / Boarding Penalties / Transfer Penalties	As standard RMS/ERM curve & penalties	same	same

	These are: • 10min board penalty all modes • 15min transfer penalty to/from rail • 15min transfer penalty Dublin Bus to Dublin Bus • Otherwise, 5min transfer penalty.		

4. Junction and Microsimulation Modelling

If significant local impacts are identified at operational stage of MetroLink by the strategic ERM analysis, additional local modelling will be undertaken to further assess the impacts. The local modelling will likely incorporate LinSig modelling of signalised junctions, PICADY modelling of priority junctions and ARCADY modelling of roundabouts.

Typically, the following modelling packages are anticipated to be used:

- ARCADY – Roundabouts;
- PICADY – Priority Junctions;
- LinSig – Signalised Junctions;
- Vissim / Paramics – Vehicular microsimulation; and
- VisWalk – Pedestrian microsimulation.

5. Deliverables

5.1 Proposed Deliverables

The proposed deliverables are listed below:

- Transport Modelling Plan (this document);
- Traffic and Transport Assessment Report(s) – Operational Phase;
- Scheme Traffic Management Plan
- Transport Modelling Report.

INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER

Appendix I: Economic Appraisal

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MetroLink

Economic Appraisal of the Preferred Option

ML1-JAI-LSI-ROUT_XX-RP-Y-00004 | P03

2021/02/22

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MetroLink

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Document Title:	Economic Appraisal of the Preferred Option
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Document history and status

Revision	Date	Description	Author	Checker	Reviewer	Approver
P01	23/11/20	Preliminary Business Case for Issue	BD	JS	GC	NC
P02	22/02/21	Preliminary Business Case for Issue (NTA amends)	BD	GC	JS	NC
P03	13/09/21	Preliminary Business Case for Issue (TII amends)	ML	GC	GC	

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Contents

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1. Economic Appraisal of the Preferred Option

1.1 Introduction

In line with the Public Spending Code (PSC) a systematic economic appraisal of the preferred option has been undertaken. This includes providing details of the net present value (NPV) of the scheme and its Benefit Cost Ratio (BCR) via a Cost Benefit Analysis (CBA). The following analysis follows the approach set out in the PSC document "Overview of Appraisal Methods and Techniques".

Where possible, and proportional to do so at this stage, scheme impacts are monetised in accordance with the PSC and Common Appraisal Framework (CAF). Where this is not possible a qualitative assessment has been undertaken instead. All monetised costs and benefits are discounted to present values, to account for time valuation, that is, users and providers perceive costs and benefits that occur in the near term as more important than costs and benefits which occur in the long term. Monetised benefits are compared alongside (discounted) costs to provide a BCR for the scheme.

Furthermore, a rigorous assessment is undertaken to assess the qualitative and quantitative impacts and a scaling assessment to determine its rank according to a seven-point scale. This is presented in the Project Appraisal Balance Sheet covered in Section 1.14.

The scheme is appraised in line with the CAF, using the standard appraisal criteria which are as follows:

1. Economy;
2. Safety;
3. Environment;
4. Accessibility and Social Inclusion; and
5. Integration.

These have also been used to align with the Strategic Objectives of the scheme. Economic impacts appraised within this section are given in Figure 1-1.

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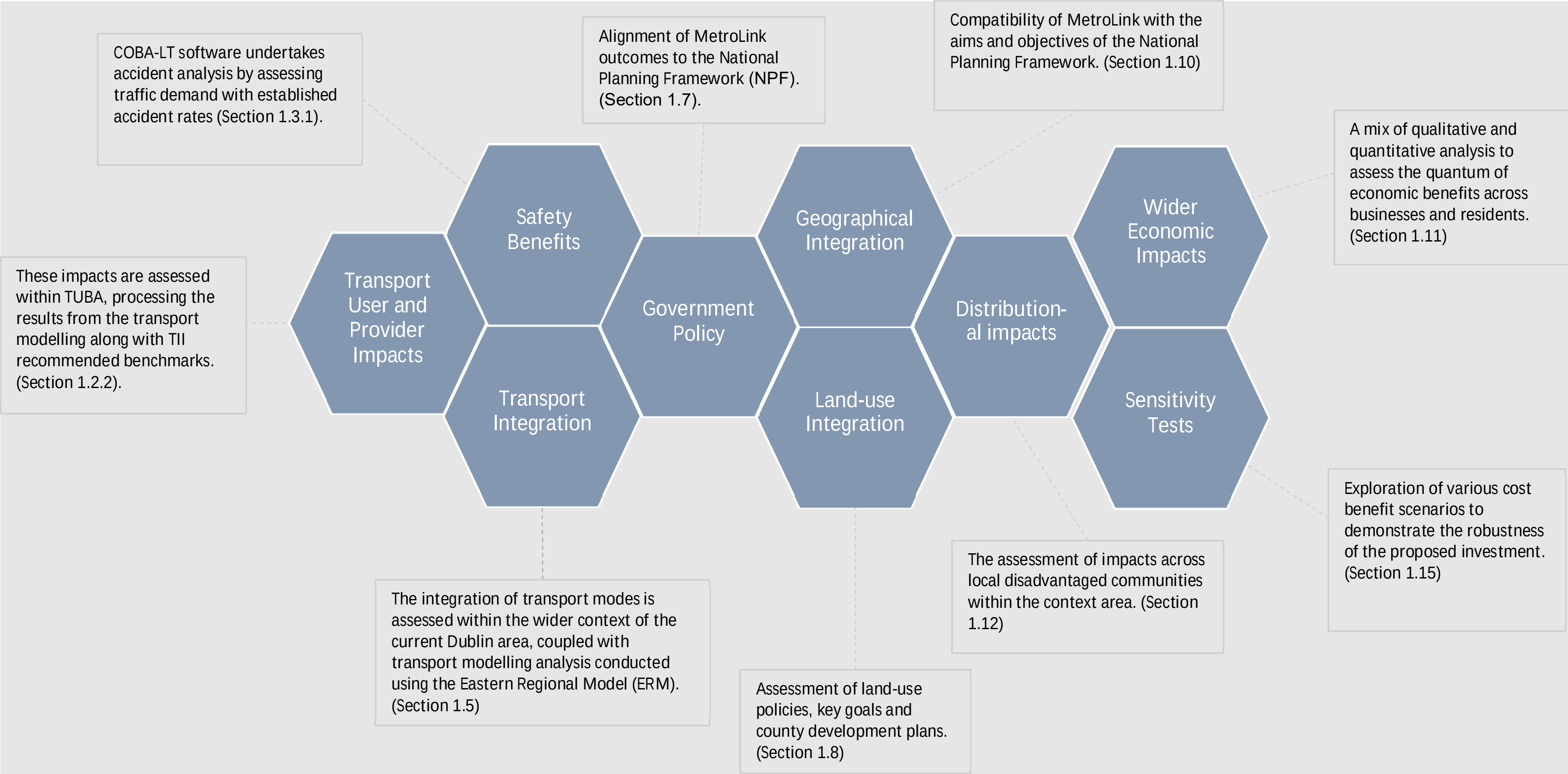
Figure 1-1: Appraised Economic Impacts



Source: Jacobs

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1.2 Direct Transport User and Provider Impacts

1.2.1 Journey Time Savings

The introduction of MetroLink will provide significant journey time savings for users. The transport modelling analysis conducted indicates that there are significant journey time improvements to and from key zones as shown in the following examples:

- Swords Pavilion to St. Stephen's Green, in the morning peak, reduces from 55 minutes (without MetroLink) to 37 minutes;
- Ballymun to St. Stephen's Green, in the morning peak, reduces from an average of 46 to 32 minutes; and
- St. Stephen's Green to Dublin Airport, in the morning peak, reduces from an average of 45 to 31 minutes.

These represent a 30-33% improvement in journey times. Additional to the journey time savings are other additional key benefits of MetroLink, such as the consistency and reliability of service, which cannot be guaranteed by other modes.

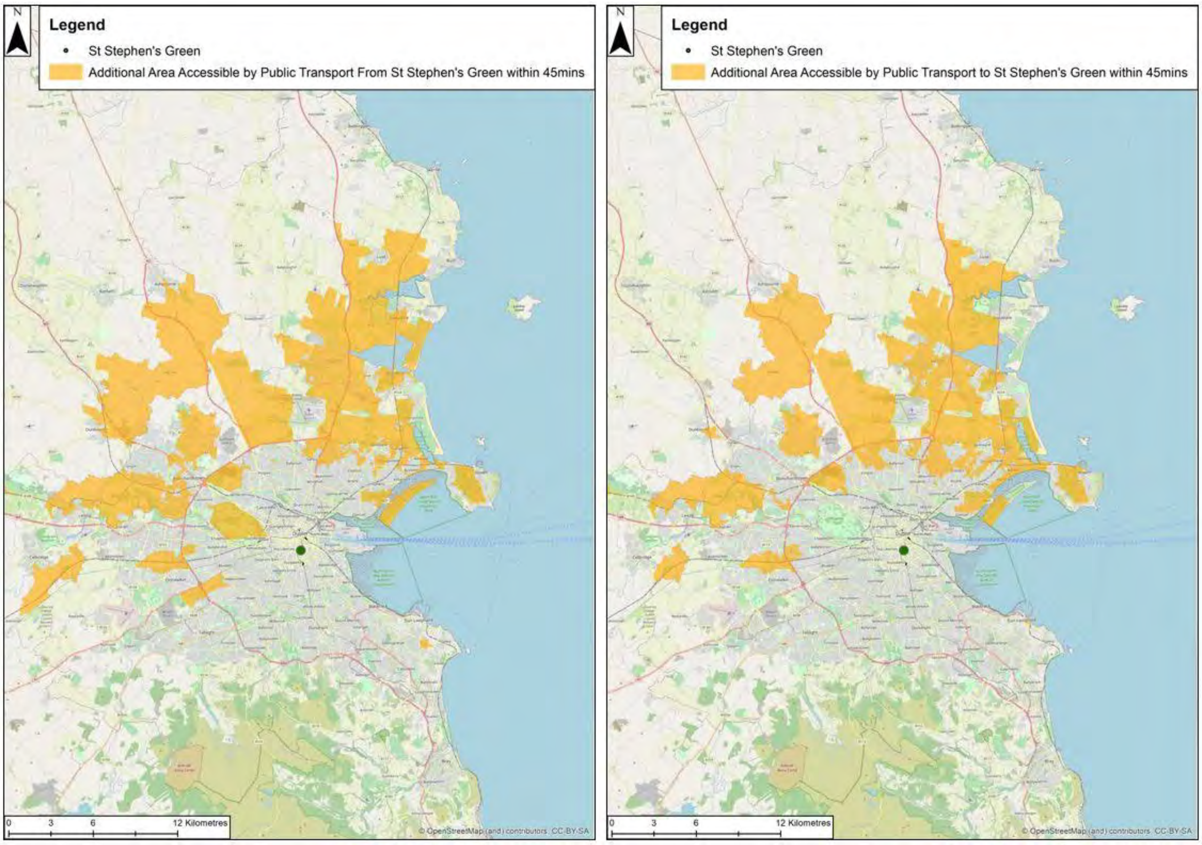
Figure 1-2 illustrates the areas with enhanced accessibility to and from Castle Park in Swords. With MetroLink in place it shows the areas that are now accessible within 45 minutes in the morning peak that previously were not. Areas now accessible from swords includes not only new employment opportunities within parts of the city centre but also along some key radial routes to the north-west and west of the city.

Figure 1-2: Change in accessibility at Swords by origin (left) and by destination (right) in the morning peak by public transport

Source: Jacobs' Analysis

Similar analysis for St Stephen's Green illustrates the areas which are now within 45 minutes travel time when MetroLink is in place, Figure 1-3. Approximately an additional 81,900 people will be able to access St Stephen's Green in less than 45 minutes in the morning peak, when MetroLink is in place.

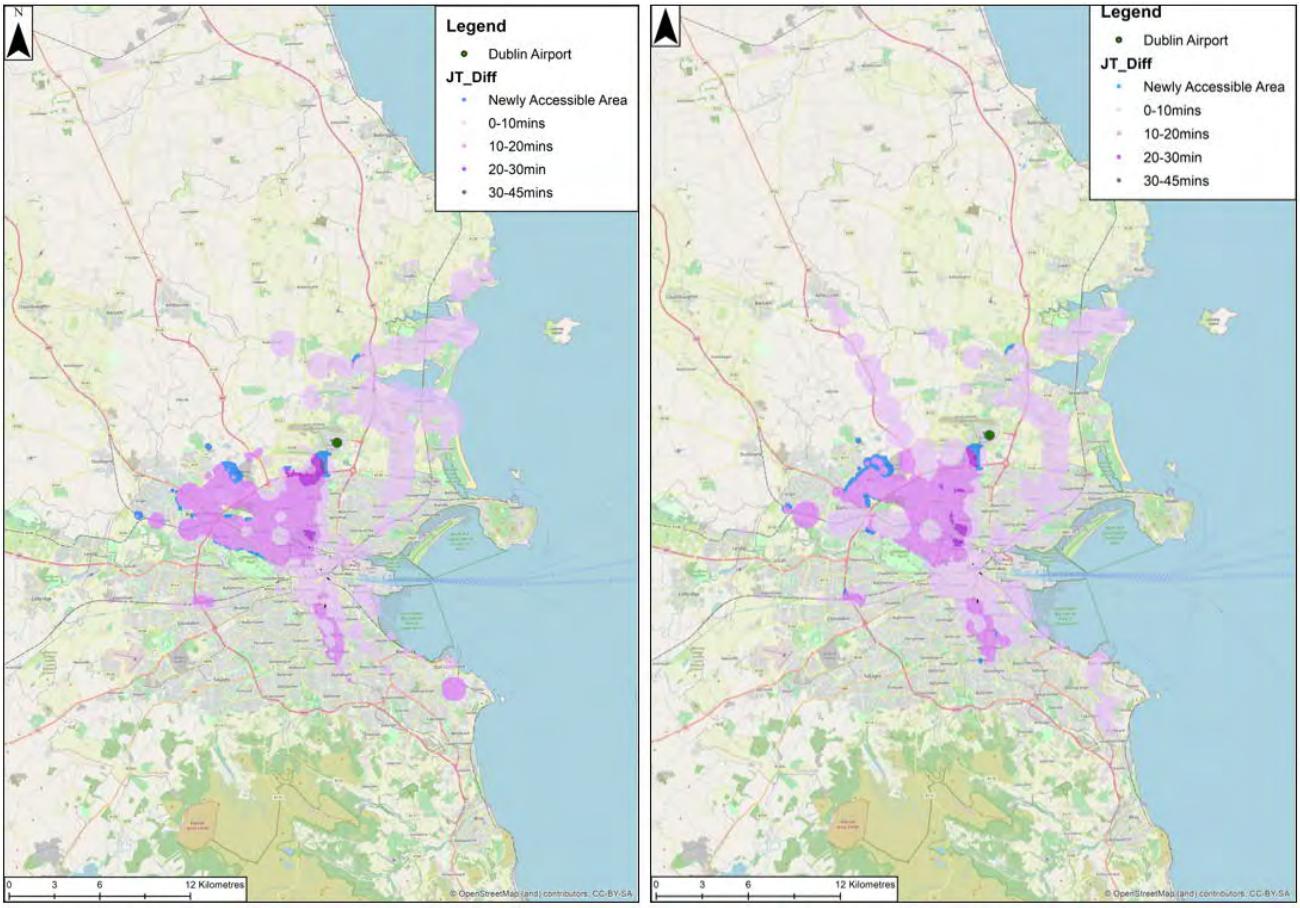
Figure 1-3: Change in accessibility at St Stephen's Green by origin (left) and by destination (right) in the morning peak by public transport



Source: Jacobs' Analysis

Figure 1-4: illustrates morning peak differences in public transport journey time catchments to and from Dublin Airport when MetroLink is in place. To the west of Dublin Airport, several new areas are now accessible within 45 minutes transit time, which are not currently accessible. Along the M2 accessibility times reduce by up to 10 minutes when using public transport to travel from Dublin Airport. Accessibility time savings up of to 20 minutes can also be seen when travelling from Dublin Airport to south of the city centre when MetroLink is in place.

Figure 1-4: Differences in public transport accessibility catchments by time band to Dublin airport in the morning peak by origin (left) and by destination (right)



Source: Jacobs' Analysis

A new segregated rail-based link between the Airport and the city centre is a key benefit of the scheme, and MetroLink delivers this to a much greater extent than a bus-based or light rail scheme. As shown in Table 1-1, there is a 7% reduction in highway users travelling to the airport in peak hours, and a significant increase in the number of public transport trips to and from the airport in all time periods, with up to a 14% increase in the School Run period.

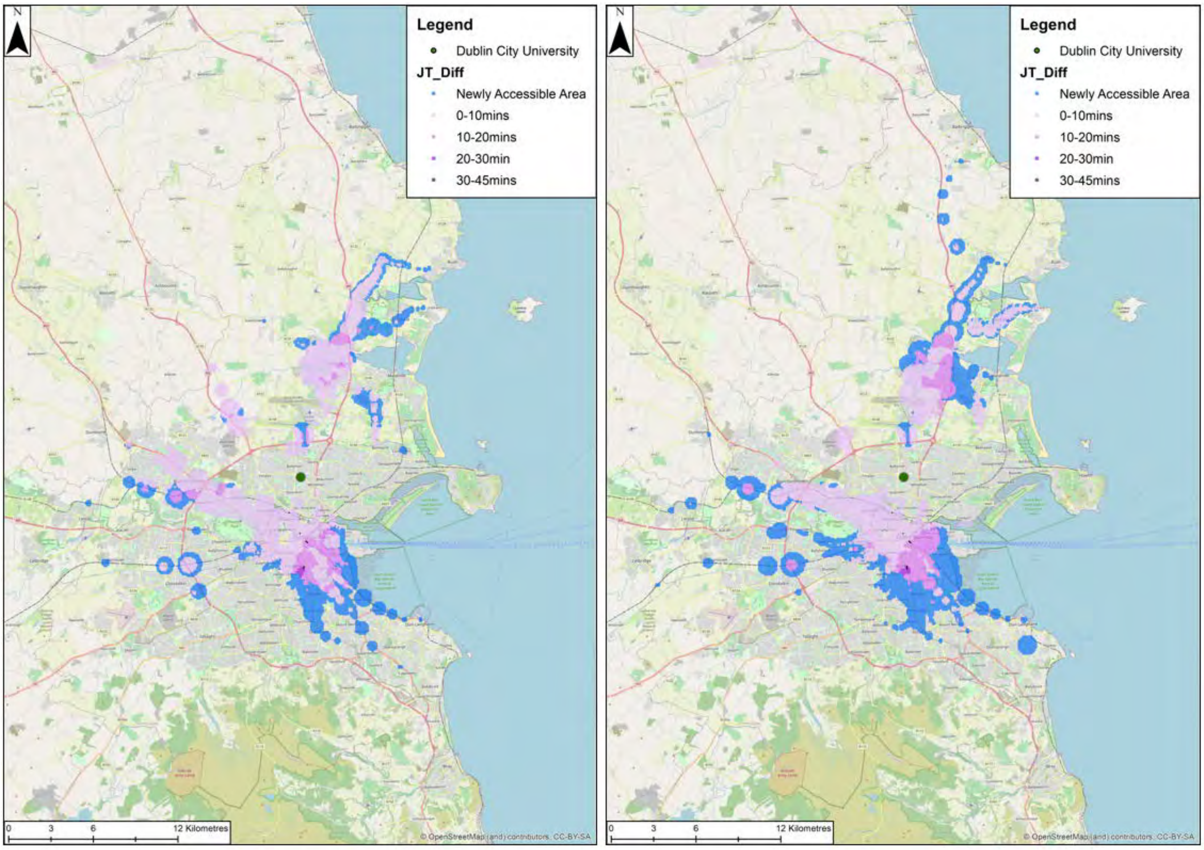
Table 1-1 Mode share splits with and without the scheme for trips to and from the airport

Time Period	Mode	Do Minimum				Do Something				Difference			
		Total From	Total To	Total From	Total To %	Total From	Total To	Total From	Total To %	Total From	Total To	Total From	Total To %
AM	PT	5,114	8,475	40.1%	37.1%	5,453	10,263	45.2%	45.5%	339	1,788	5.1%	8.4%
	Road	7,575	13,614	59.5%	59.6%	6,573	11,949	54.5%	53.0%	-1,002	-1,665	-4.9%	-6.6%
LT	PT	9,246	6,411	44.8%	31.4%	9,891	8,647	49.4%	41.4%	645	2,236	4.6%	10.0%
	Road	11,356	13,931	55.0%	68.2%	10,096	12,179	50.4%	58.3%	-1,260	-1,752	-4.6%	-9.9%
SR	PT	10,123	4,638	47.0%	27.6%	11,055	7,101	52.7%	41.1%	932	2,462	5.8%	13.4%
	Road	11,283	12,092	52.3%	72.0%	9,841	10,149	46.9%	58.7%	-1,442	-1,943	-5.4%	-13.3%
PM	PT	8,497	3,678	40.5%	25.2%	9,081	5,313	44.5%	36.7%	584	1,636	4.0%	11.5%
	Road	11,840	10,876	56.4%	74.5%	11,033	9,138	54.1%	63.1%	-807	-1,738	-2.3%	-11.4%

Source: Jacobs' Analysis

Dublin City University (DCU) is located in close proximity to the proposed Collins Avenue station. Due to the nature of student travel, public transport is the primary mode of transport. Figure 1-5 illustrates the difference in public transport journey catchments to and from DCU in the morning peak comparing scenarios with and without MetroLink in place. It shows that with MetroLink in place, the 45minute catchment extends further south, to areas currently inaccessible in that time. Similarly, newly accessible areas within 45minutes (transit times) of DCU can be seen to the north east towards Balbriggan. Access time savings of between 10 and 20 minutes can be seen to the south east.

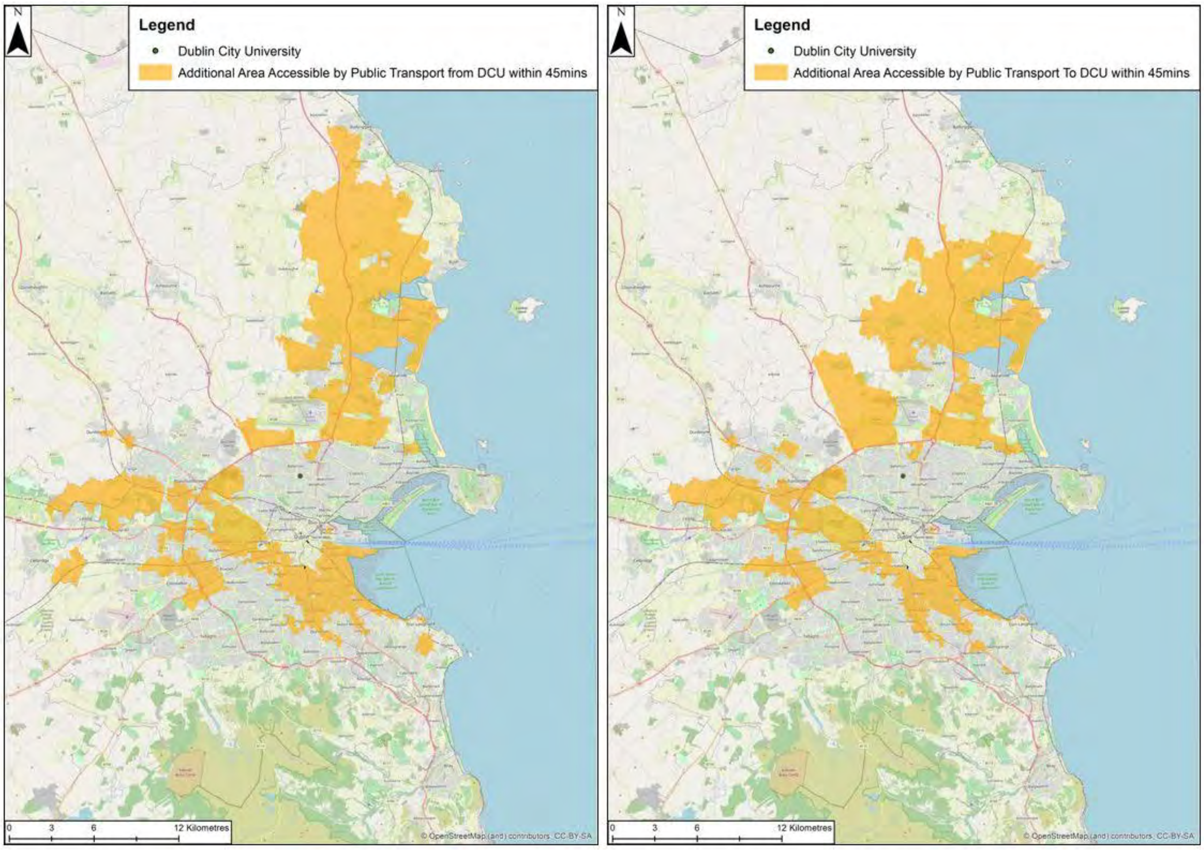
Figure 1-5: Public transport journey time catchments to DCU in the morning peak before (left) and after (right) MetroLink.



Source: Jacobs' Analysis

Figure 1-6 illustrates the areas where more people can travel to and from DCU within 45 minutes with MetroLink in place. In total, 145,000 people now live within 45 minutes of DCU by public transport.

Figure 1-6: Change in accessibility at DCU by origin (left) and by destination (right) in the morning peak by public transport



Source: Jacobs' Analysis

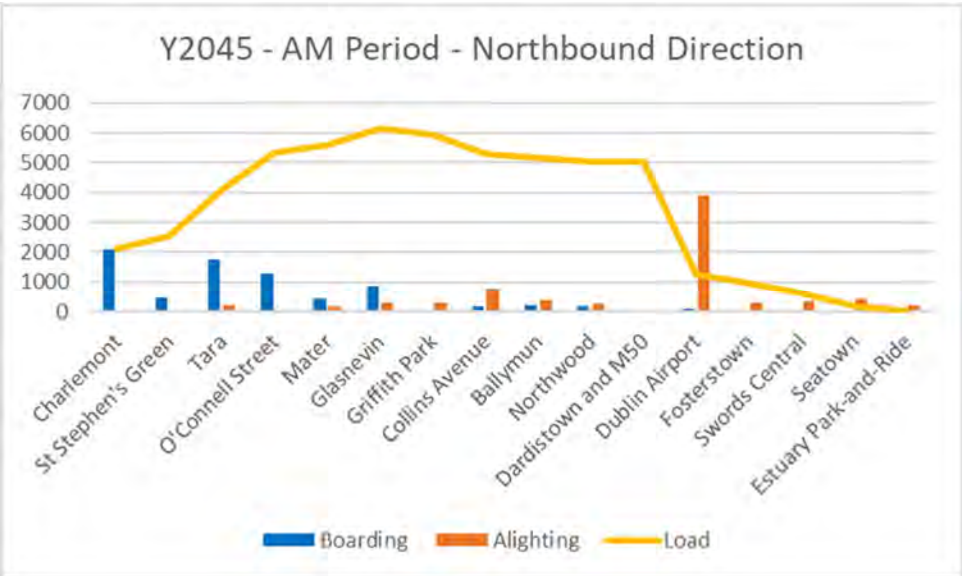
Further details, comparing change in a range of zone to zone journey times with and without MetroLink, can be found in Appendix A.

There are minor differences in travel patterns within the modelled years, but the broad impact of MetroLink is similar across the appraisal period. The discussion below focuses on 2045, the modelled year in which MetroLink has the largest patronage. It is clear that MetroLink has sufficient capacity to cope with the level of demand forecast. Travel patterns in the earlier modelled year, 2030, align with those in 2045.

By 2045, in the morning peak, over 29,000 passengers an hour are projected to use the line. This is roughly the equivalent of 800 buses or 24,000 cars an hour which would otherwise be needed to move this many people. During the day, nearly 16,000 passengers an hour are projected to use the line. With Dublin Airport being a key employment centre, as well as the city centre, demand is well balanced between north and southbound directions as seen in

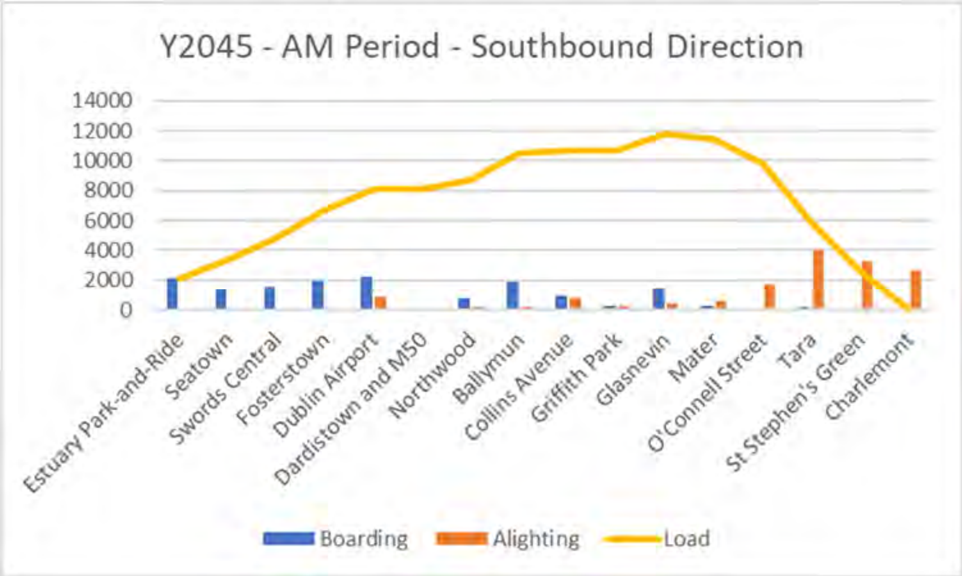
Figure 1-7: and Figure 1-8:

Figure 1-7: Boardings and alightings northbound morning peak hour 2045



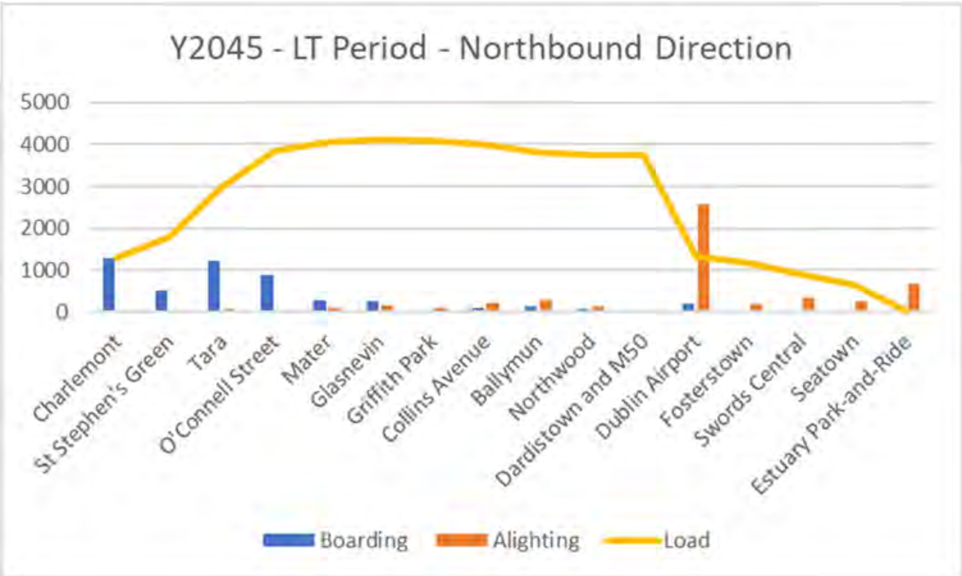
Source: Jacobs' Analysis

Figure 1-8: Boardings and alightings southbound morning peak hour 2045



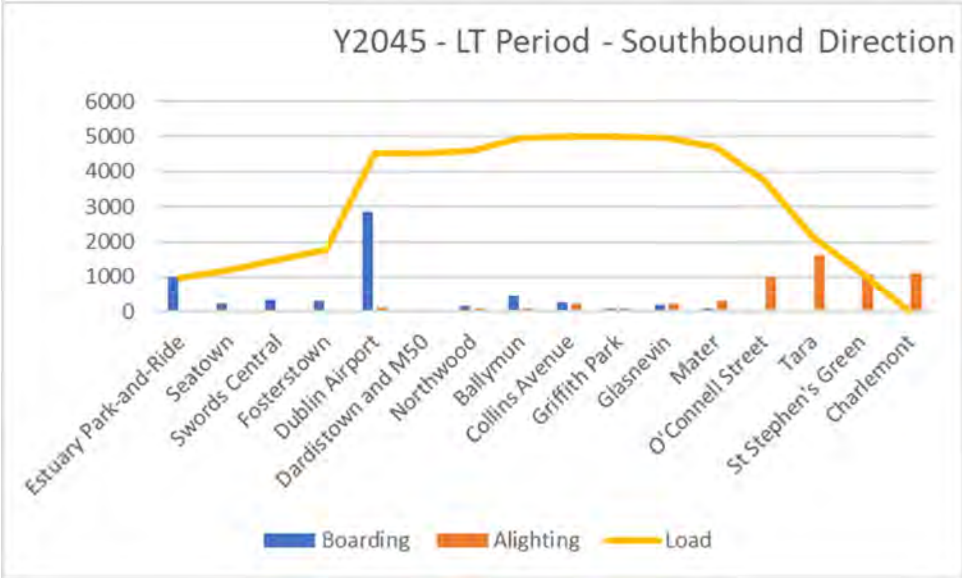
Source: Jacobs' Analysis

Figure 1-9: Boardings and alightings northbound mid-morning hour 2045



Source: Jacobs' Analysis

Figure 1-10: Boardings and alightings southbound mid-morning hour 2045

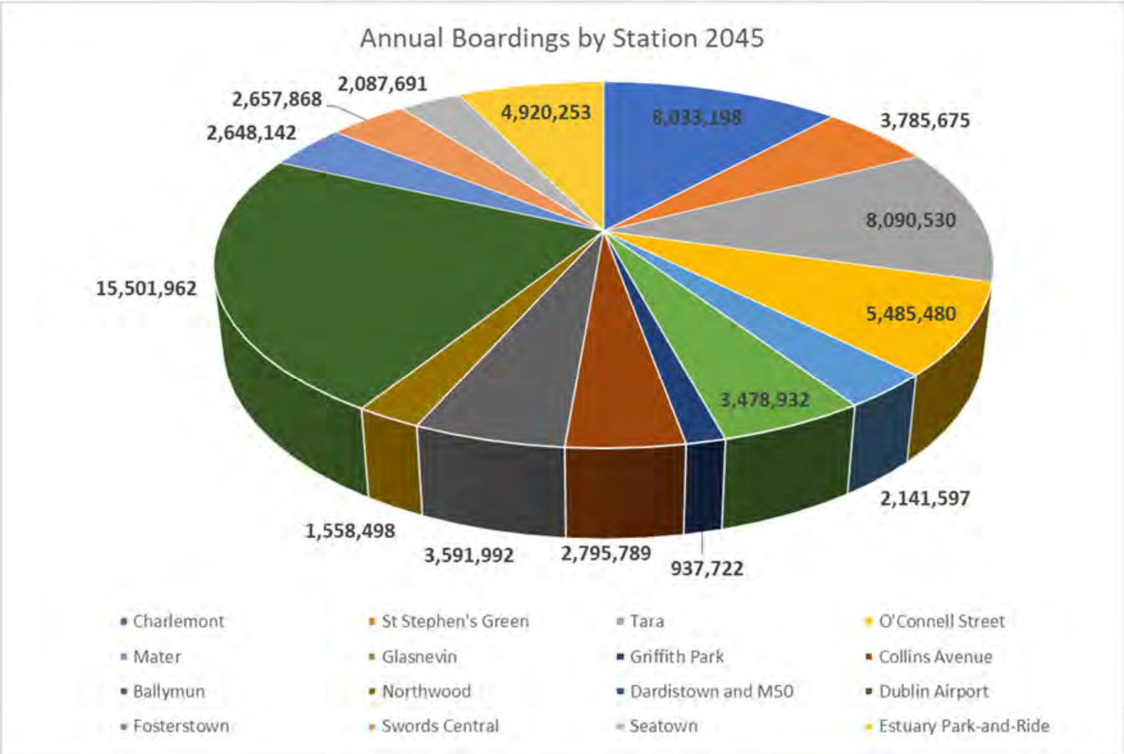


Source: Jacobs' Analysis

By 2045 it is projected that the system will be carrying around 68m people a year, or nearly 186,000 a day. At present DART is used by around 80,000 passengers a day and the whole of Iarnród Éireann's network by around 50m a year. The busiest stations are projected to be Dublin Airport with 28m boardings and alightings a year, Tara Street 17m, Charlemont 14m and O'Connell Street with 10m.

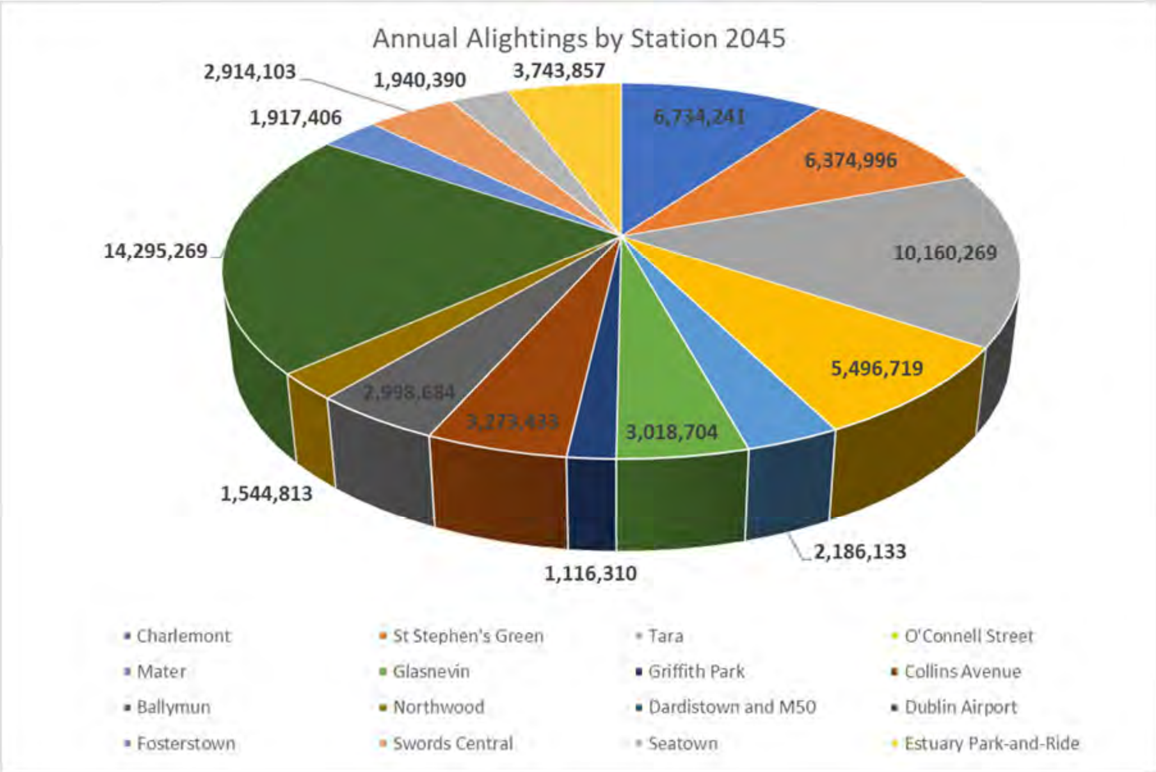
INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER NOTE

Figure 1-11: Annual boardings by station 2045



Source: Jacobs' Analysis

Figure 1-12: Annual alightings by station 2045



Source: Jacobs' Analysis

1.2.2 Transport User Benefits Appraisal (TUBA) Impacts

MetroLink will induce a mode-shift as the improved level of public transport provision will reduce the generalised cost of a trip compared to other modes of transport. This mode-shift will mean a reduction in trips on other modes, potentially easing congestion and providing time savings elsewhere on the transport network. This will translate into benefits for other transport mode users. The transport model captures this impact in terms of the changes in journey times for all transport users (highway and public transport) between the with and without the scheme scenarios. It is possible to monetise this impact using TUBA software.

TUBA is the industry-standard software which considers Transport User Impacts, the Private Sector Provider Impacts (revenues and costs), as well as the impact on government revenues through changes in Indirect Tax receipts. TUBA takes demand, journey time and distance travelled information from the traffic forecast model for each future year, vehicle type and journey purpose; for each time period; and calculates travel time saving benefits. It does this by comparing the travel times in the 'Do-Minimum' scenario with those in the 'Do-Something' scenario. It then applies monetary values (known as Values of Time - VoT) to derive the monetary benefits of those time savings. These monetary values are standard for appraisals within Ireland and are provided by PAG.

TUBA also calculates Vehicle Operating Cost (VOC) changes which occur due to changes in costs associated with such items as fuel, maintenance, and vehicle wear and tear. These occur due to changes in speed and distance when the scheme is implemented and can include both positive and negative values depending upon the scheme's impact upon traffic flows and routeing.

For the public transport element of the assessment, TUBA takes travel times which are the same as those calculated within the Eastern Regional Model (v3) model assignment process[1]. The assignment cost calculations used within the ERM are based on stated preference surveys undertaken during the model development and are different to the cost calculations suggested as default within TUBA (which is based on UK, as opposed to Irish, standards). To ensure a standardised approach between assignment and appraisal the impact of MetroLink is assessed using the assignment cost calculations. Further details of this, and the impact of using the assignment cost calculations versus using 'standard' appraisal cost calculation is given in "Technical Note - Appraisal Travel Cost Assessment".

Valuations provided by TUBA rely on the model outputs for accuracy. The results in this Appendix should be read in conjunction with the technical modelling documentation to understand the level of confidence which can be placed in each of the tests undertaken.

Due to the lifespan of this Project, a 30-year appraisal is not an appropriate length of time to assess the overall impacts of the scheme and to determine the overall benefits. Therefore, a 60-year appraisal, comprised of 30-year appraisal plus 30-year residual value, has been defined for this scheme.

TUBA version 1.9.13 has been used for this assessment, and the economic parameter file has been updated in accordance with the latest PAG guidance[2]. This is to ensure the assessment is using the latest version of the software with adjusted Irish guidance to incorporate Ireland specific operating costs and other TUBA elements.

[1] Excluding additive mode constants.
[2] Including the October 2020 DoT circular – SRA 01/2020

To align the appraisal with the modelling work undertaken, two additional modelled journey purposes (beyond the core model and appraisal purposes - Business, Commute, Other[3]) have been included within the economic parameter file. These are Education and Retired, which are included within the transport model. For the purposes of this assessment, it is assumed that these two purposes have the same parameter characteristics as 'Other'.

The modelling of any time period is an average traffic flow for the respective time period, and so an annualisation factor is applied to convert this into an overall annual traffic flow. The annualisation factors that are used for this assessment have been provided by the NTA as a package with the ERM and are shown in Table 1-2. These annualisation factors are used for both the highway and public transport elements of the appraisal.

Table 1-2: Annualisation Factors

Modelled Time Period	Time	Appraisal Representative Period	Annualisation Factors
AM	0700-1000	AM	616
LT (Lunch Time)	1000-1300	LT, Evening Off-Peak, Weekend	3,044
SR (School Run)	1300-1600	SR	688
PM	1600-1900	PM	688

Source: NTA

The NTA consider the LT period to be representative of the evening, off-peak and weekend periods in terms of traffic levels and provision of public transport services, and so it is used as a proxy for the impact of MetroLink in these periods. To achieve this the lunchtime annualisation factor is increased to incorporate the evening, off-peak, weekend and bank holiday periods. The other time periods (AM, LT and PM) only represent weekday movements, and so have much lower annualisation factors. Table 1-3 shows the purpose splits within each time period. The LT period has the least number of Commuters and significantly more Other purpose users than in other time periods, and so is the modelled period most representative of off-peak and weekend time periods.

[3] 'Other' trips include all trips not captured in the four specified categories. The bulk of 'Other' trips will be journeys for leisure purposes.

Table 1-3: Model Purpose Splits in 2045 with MetroLink in place

Time Period	Purpose		
	Business	Commute	Other
AM	6.1%	39.1%	54.8%
LT	9.8%	8.2%	82.0%
SR	5.8%	11.5%	82.8%
PM	6.3%	41.7%	51.9%

Source: Jacobs' Analysis

As shown in Table 1-4 the LT period has more airport trips, including highway trips, within this time period compared to other modelled time periods – again making it more suitable for use as a proxy for off-peak and weekend trips than the other modelled time periods.

Table 1-4: Modelled hour airport demand trips within each time period in 2045 with MetroLink in place

Time Period	Public Transport	Highway	Total
AM	7,691	8,631	16,322
LT	9,269	10,491	19,760
SR	9,078	9,176	18,253
PM	7,197	8,888	16,085

Source: Jacobs' Analysis

TUBA checks and warnings

Whilst undertaking the benefit calculations, TUBA produces a detailed list of warnings, flagging any potentially unusual changes between the Do Minimum (DM) and Do Something (DS) inputs. Warnings are provided based on the ratio of DM to DS travel times and distances, and the modelled speeds, as well as flagging exceptionally long (both in distance and time) trips.

The warning messages were reviewed to highlight any potential issues with the model outputs. Warnings affecting a very small demand (less than 5 trips) were not investigated as they are unlikely to have a material impact on the results. Overall, there were very few warnings relating to movements greater than 5 trips, and therefore, requiring further investigation. For those movements that did require investigation a further detailed review was undertaken. It is not considered that the underlying causes of the remaining warnings have a material impact on the appraisal of the scheme.

1.2.3 User and Provider Impacts

The impacts of MetroLink can be considered in two parts – public and private sector impacts. Public sector impacts include any costs borne or revenue received by the public sector and private sector impacts include costs borne by, revenue received by and journey time impacts for the private sector.

In terms of appraisal revenue returns to the public sector are considered as negative costs within the BCR and private sector costs are considered as negative benefits within the BCR. This section considers on the private sector impacts of MetroLink. Public sector costs are discussed in greater detail in in "ML1-JAI-LSI-ROUT_XX-RP-y-00001_V21 Technical Appendix - Scheme Costs" and also in the Public Accounts table given in Section 1.13

The total private sector impacts as a result of the scheme are shown in Table 1-5. The benefits presented include the monetisation of journey time savings, VOC, and private sector provider impacts, taken over the 60-year appraisal period of the scheme. These are based on standard time valuations and operating cost assumptions as set out in PAG. In total, there are €15.6 billion direct benefits as a result of the scheme.

Table 1-5: Summary of scheme benefits (€M's, 2011 prices and values)

Description	Public Transport Benefit (€M's)	Highway Benefit (€M's)	Investment (€M's)	Total Benefit (€M's)
Economic Efficiency: Consumer Users (Commuting)	1,848	596	-	2,444
Economic Efficiency: Consumer Users (Other)	4,241	1,685	-	5,926
Economic Efficiency: Business Users	3,076	3,174	-	6,250
Economic Efficiency: Business Providers	205		814	1,018
Wider Public Finances (Indirect Taxation Revenues)	-35	-8	-	-43
Present Value of Benefits (PVB)	9,334	5,446	814	15,594

Source: Jacobs' Analysis

The economic evaluation of transport projects seeks to identify and account for all the impacts and transfers between sectors in the economy e.g. transfers from public sector to private sector (for instance in the case of a fare that is both a cost to the user and a source of revenue for the public sector). All private sector impacts (positive or negative) are accounted for as a benefit in order to isolate the impacts to the public sector and analyse them as costs.

The Investment column in Table 1-5 reflects the economic treatment of the role of the Service Delivery Partner (explained in more detail in the Scheme Costs Technical Appendix and Procurement Technical Appendix). The Delivery Partner will finance a part of the scheme prior to the opening of MetroLink. This initial cashflow has been included as a negative impact to the private sector. However, when MetroLink opens the Delivery Partner will recover its investment through a unitary charge paid for by the government over 25-years. The later phase of cashflow has been included as a positive impact to the private sector. The net effect is captured as a positive cashflow in the Investment column.

The transport modelling captures the benefits for any user that changes transport mode as a result of the scheme in place. This includes the journey time saving as a result of the change in mode of transport, as well as any positive impact this has on the previous transport mode to other users, for example, a reduction in highway trips meaning less congestion on the road network. Analysis of the travel time benefits by time period is shown in Table 1-6. These are the monetised journey time benefits, not including VOC, fares or other benefits.

Table 1-6: Profile of Time Benefits in 2011 Prices Discounted to 2011 (€M's, 2011 prices and values)

Mode	Time Period	60-Year Benefit (€M's)	Percentage
Public Transport	AM	1,574	18%
	LT, Evening Off-Peak, Weekend	4,642	53%
	SR	1,255	14%
	PM	1,339	15%
Highway	AM	822	17%
	LT, Evening Off-Peak, Weekend	2,604	52%
	SR	775	16%
	PM	778	16%
All Modes	AM	2,397	17%
	LT, Evening Off-Peak, Weekend	7,246	53%
	SR	2,030	15%
	PM	2,117	15%

Source: Jacobs' Analysis

In total, 17% of the benefits are associated with morning peak trips, 53% with Lunch Time, Evening, Off-Peak and Weekend trips, 15% with school run trips, and 15% with evening peak trips. The actual lunchtime period equates to around 25% of the benefits attributed to the LT, Evening, Off-Peak and Weekend Appraisal Period. That is, 28% of benefits arise in the evenings, off-peak and weekends.

Table 1-7 shows the total benefits by the size of time saving for Public Transport Trips over the 60-year appraisal period. The majority of benefits arise from journey savings greater than 5 minutes, highlighting the transformational impact of MetroLink.

Table 1-7: Public Transport total benefits (€m) by size of time saving

Purpose	Public Transport Trip Benefits by size of Time Saving (€M's)						
	< -5 mins	-5 to - 2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	> 5 mins	Total
Business	-21	-32	-42	36	47	3,126	3,115
Commuting	-37	-33	-45	42	41	1,894	1,862
Other	-22	-35	-39	37	57	3,867	3,864
Education	-17	-15	-26	24	16	395	378
Retired	0	-1	-2	1	1	43	42
Total	-97	-117	-153	140	161	9,326	9,261

Source: Jacobs' Analysis

Table 1-8 shows the total benefits by time savings for Highway Trips. The majority of benefits arise from savings of less than 5 minutes, suggesting that most benefits accrue from local congestion relief. Disbenefits accrue to some users, particularly commuting and business trips. This is likely to be due to increased traffic in the peak periods as a result of people driving to the Park and Ride site to then use MetroLink to travel to the city centre. The resultant congestion, to the north of Swords affects Commuters more than Business and Other users, as it occurs in the peak periods when the number of commuting trips is highest.

Table 1-8: Highway total benefits (€Ms) by size of time saving

Purpose	Highway Trip Benefits by size of Time Saving (€M's)						
	< -5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	> 5 mins	Total
Business	-278	-83	-231	1,483	1,210	1,104	3,205

Purpose	Highway Trip Benefits by size of Time Saving (€M's)						
	< -5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	> 5 mins	Total
Commuting	-136	-33	-175	547	243	154	600
Other	-17	-17	-84	690	417	595	1,585
Education	-3	0	-3	20	5	4	23
Retired	-4	-3	-14	90	17	7	92
Total	-438	-136	-507	2,830	1,892	1,863	5,505

Source: Jacobs' Analysis

Table 1-9 shows that the most significant value of benefits by Public Transport are for trips ranging between 10 and 50kms, with the majority of these being Business and Other purpose trips. This is due to trips to and from areas beyond the city centre and includes trips that have changed from travelling by private car to using public transport.

Table 1-9: Public Transport Total benefits (€m) by distance

Purpose	Public transport trip benefits by size of trip distance (€m)							
	< 1 kms	1 to 5 kms	5 to 10 kms	10 to 15 kms	15 to 20 kms	20 to 50 kms	50 to 100 kms	>100 kms
Business	8	39	283	679	998	1,004	51	53
Commuting	3	37	277	241	610	647	19	28
Other	19	20	293	766	1,048	1,449	143	125
Education	1	-5	44	147	75	99	14	4
Retired	0	0	8	12	9	13	0	0
Total	30	92	906	1,844	2,739	3,212	227	210

Source: Jacobs' Analysis

Table 1-10 shows the breakdown of total benefits by journey distance for Highway Trips. A significant amount of the benefits from highways trips accrue to trips between 20-50km in length. This is due to the number of people transferring to public transport who previously would have used the motorway network thereby reducing congestion and reducing journey times for medium distance traffic. As highlighted above average journey time savings are low so this is more to do with the volume of traffic receiving small savings.

INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER NOTE

Table 1-10: Highway Total benefits (€m) by distance

Purpose	Highway Trip Benefits by size of Trip Distance (€m)							
	< 1 kms	1 to 5 kms	5 to 10 kms	10 to 15 kms	15 to 20 kms	20 to 50 kms	50 to 100 kms	>100 kms
Business	0	82	212	407	275	1,344	623	0
Commuting	1	40	95	84	38	202	75	1
Other	-1	111	251	219	154	444	225	-1
Education	0	3	3	4	2	9	2	0
Retired	0	4	12	14	11	41	11	0
Total	-1	239	574	727	479	2,040	936	-1

Source: Jacobs' Analysis

Table 1-11 provides a breakdown of the user benefits by user class across the following impacts: travel time, VOC and user charges. The benefits are also presented by modes.

Table 1-11: User Impacts (€M's, 2011 prices and values)

User Class	User Benefits Type	Public Transport Benefits (€M's)	Highway Benefits (€M's)	Total Benefits (€M's)
Commuting	Travel Time	1,790	526	2,316
	VOC	0	17	17
	User Charges	59	52	111
	Total	1,848	596	2,444
Business	Travel Time	2,986	3,034	6,020
	VOC	0	78	78
	User Charges	90	61	151
	Total	3,076	3,174	6,250
Other (including, retired, education and "other" trips)	Travel Time	3,968	1,396	5,364
	VOC	0	240	240
	User Charges	273	48	321
	Total	4,241	1,685	5,926
Total	Travel Time	8,743	4,957	13,700
	VOC	0	336	336
	User Charges	422	161	583
	Total	9,165	5,454	14,619

Source: Jacobs' Analysis

The User Impacts accumulate to €14.6 billion benefits, with €9.2 billion from Public Transport and €5.5 billion from Highway. The large amount of benefits in the Off-Peak, Evening, and Weekend periods mean that nearly half of the total benefits occur to the Other trip purpose.

The monetary impact of indirect tax and private sector provider impacts are shown in Table 1-12. The investment column captures the net effect to the Delivery Partner through the PPP arrangement for scheme delivery.

Table 1-12: Indirect Tax and Private Sector Provider Impacts (€M's, 2011 prices and values)

Provider Impact Type	Public Transport Fare (€M's)	Highways (€M's) Toll	Investment (€M's)	Total (€M's)
Indirect Tax	-35.3	-8.1		-43.3
Private Sector Provider Impacts	205		814	1,018

Source: Jacobs' Analysis

There is a decrease in tax payments to the government, but an increase in public transport ticket sales leading to a private sector revenue increase. There are no private sector highway provider impacts as it has been assumed that revenue impacts accrue to the public sector. The fare revenues are network wide and show the aggregate change in fares to all private sector providers – they are not just fares associated with MetroLink. The investment column is the net effect to the private sector of the PPP.

Note, that the revenue provider impacts in Table 1-12 consider only the direct farebox change between DM and DS, but User Revenue Charges (shown in Table 1-11) are calculated to consider the welfare impacts of the users. A detailed description in the differences between the impacts can be found in UK Department for Transport TAG A1.3: User and Provider Impacts.

To generate the Present Value of Transport Economic Efficiency Benefits (TEE) the user impacts in Table 1-12 are combined with the private sector provider impacts in shown in Table 1-11. This estimates the impacts to be €15.6, with €9.4 billion from Public Transport and €5.5 billion from Highway.

Table 1-13 Total Impacts (€M's, 2011 prices and values)

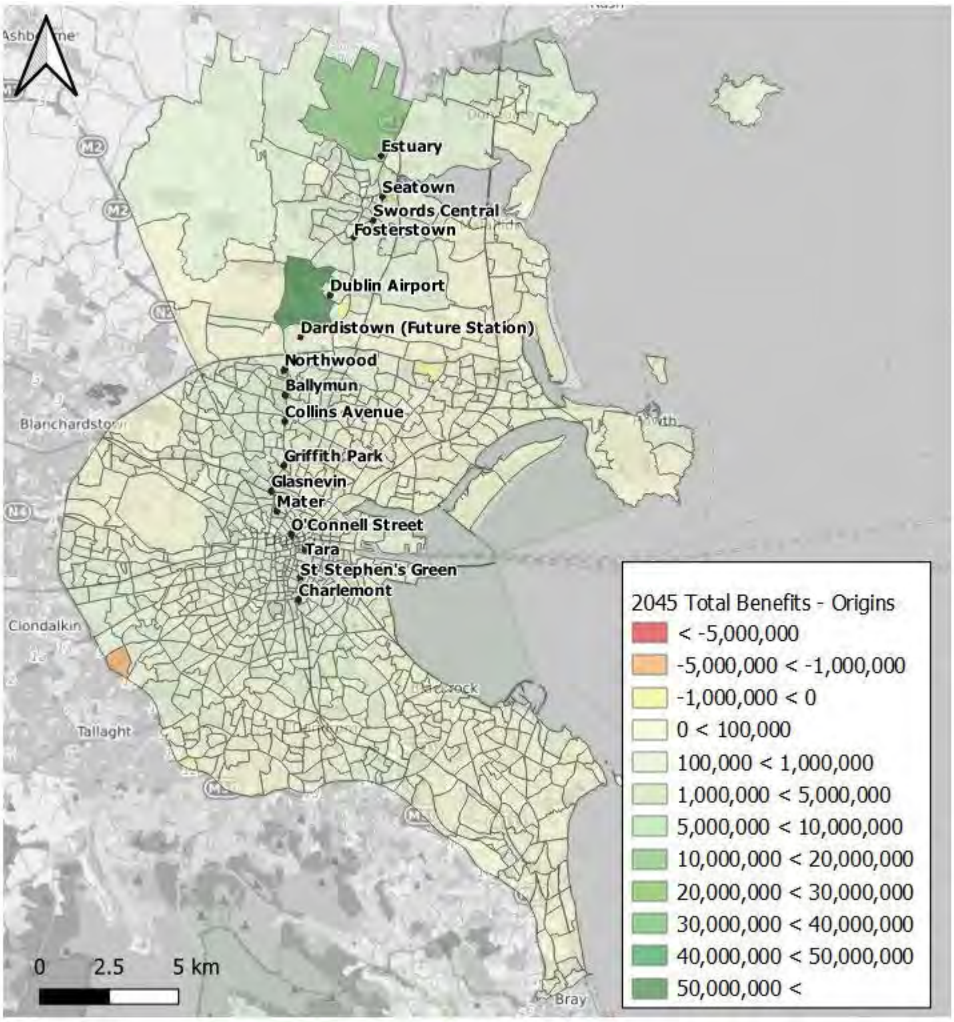
User Class	Benefits Type	Public Transport Benefits (€M's)	Highway Benefits (€M's)	Investment (€M's)	Total Benefits (€M's)
Commuting	User benefits	1,848	596		2,444
Business	User benefits	3,076	3,174		6,250
	Private Sector Provider Impacts	205		814	1,018
Other (including, retired, education and "other" trips)	User benefits	4,241	1,685		5,926
Total	User benefits	9,165	5,454		14,619
	Private Sector Provider Impacts	205		814	1,018
	Total	9,370	5,454	814	15,638

Source: Jacobs' Analysis

1.2.4 Geographic Spread of Benefits

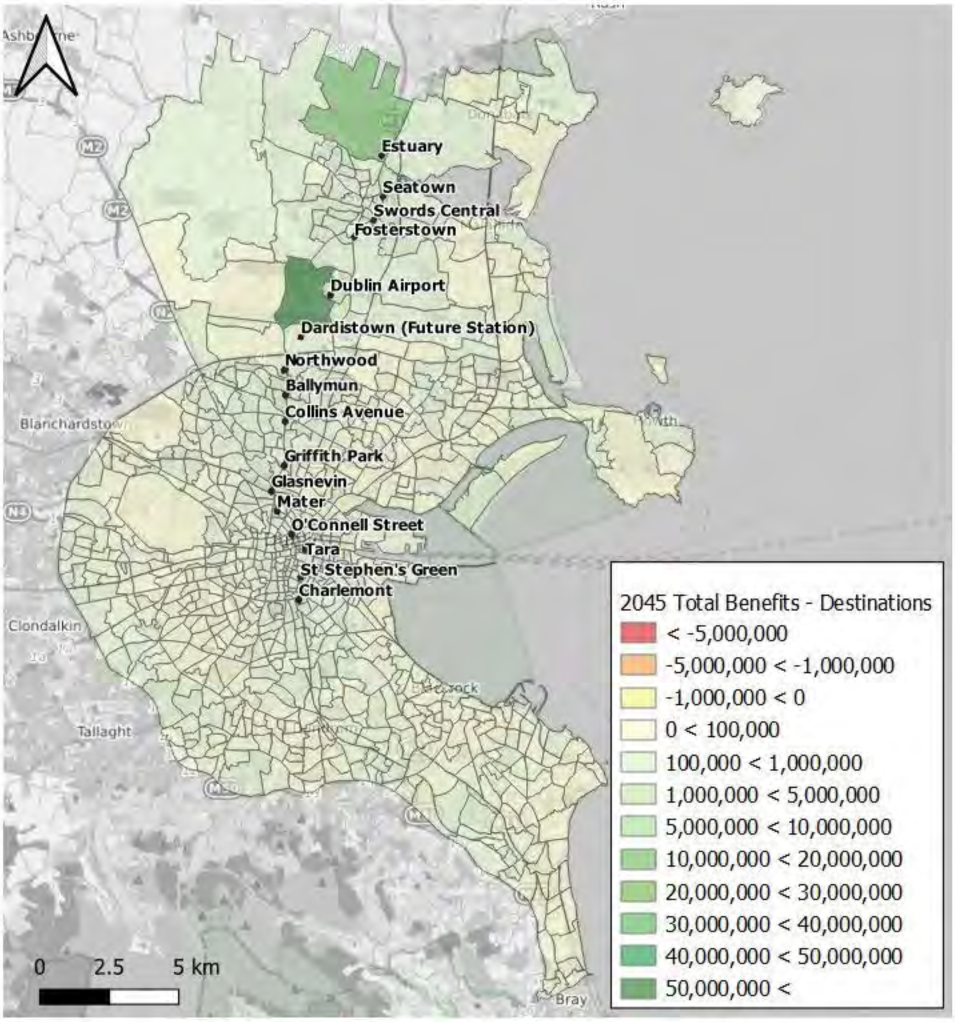
To understand the geographic spread of benefits, modelled zones were grouped into sectors, and the benefits from and to each sector were plotted. To get a complete picture of the impact of MetroLink, it is useful to look at its combined impact on both public transport and highway users. As can be seen in Figure 1-13 and Figure 1-14, the aggregate impact of MetroLink for almost all areas is positive. As well as having a large beneficial impact for some areas, Dublin as a whole will benefit from faster journey times with MetroLink in place.

Figure 1-13 Total Origin Benefits in 2045



Source: Jacobs' Analysis

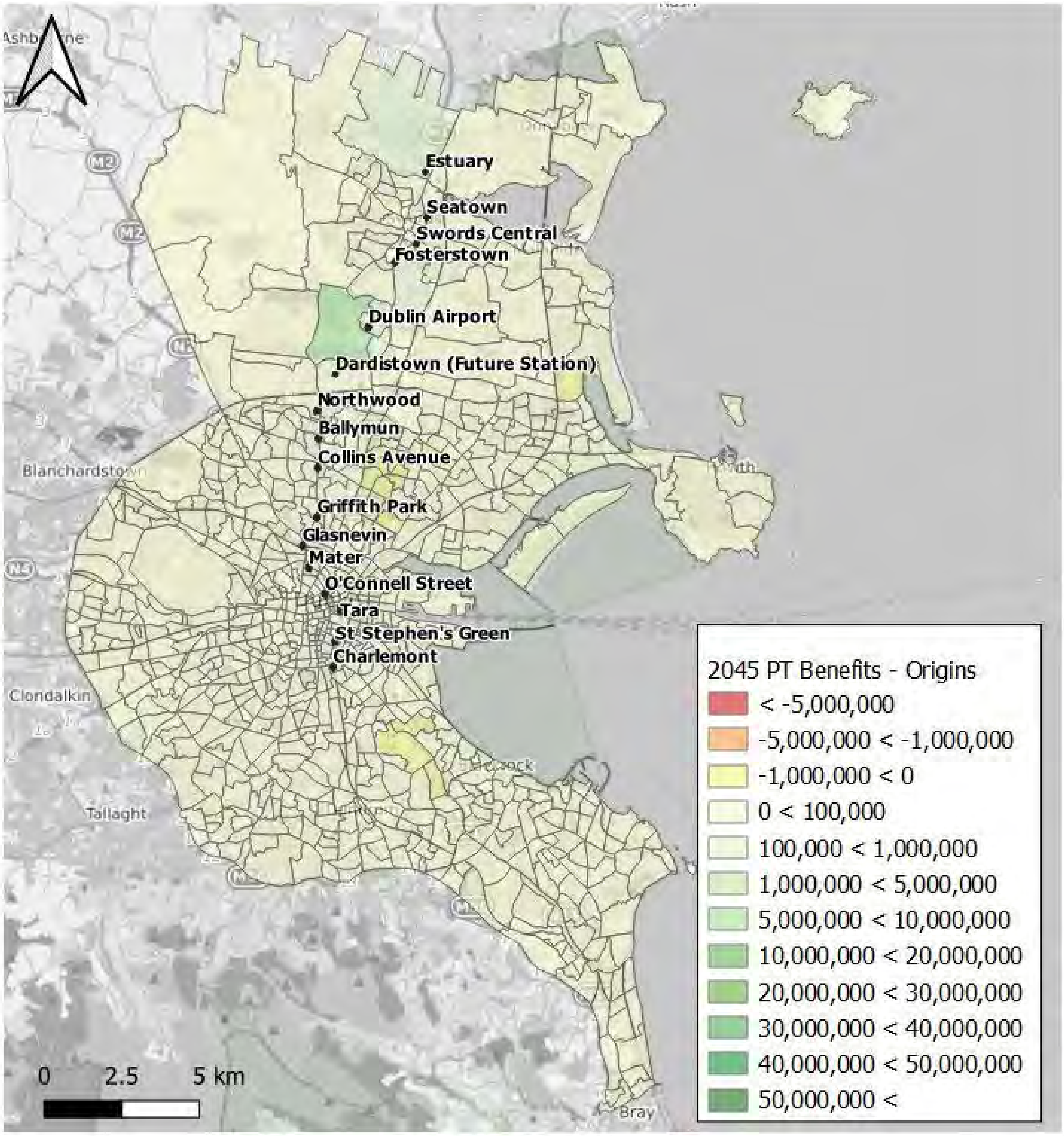
Figure 1-14: Total Destination Benefits in 2045



Source: Jacobs' Analysis

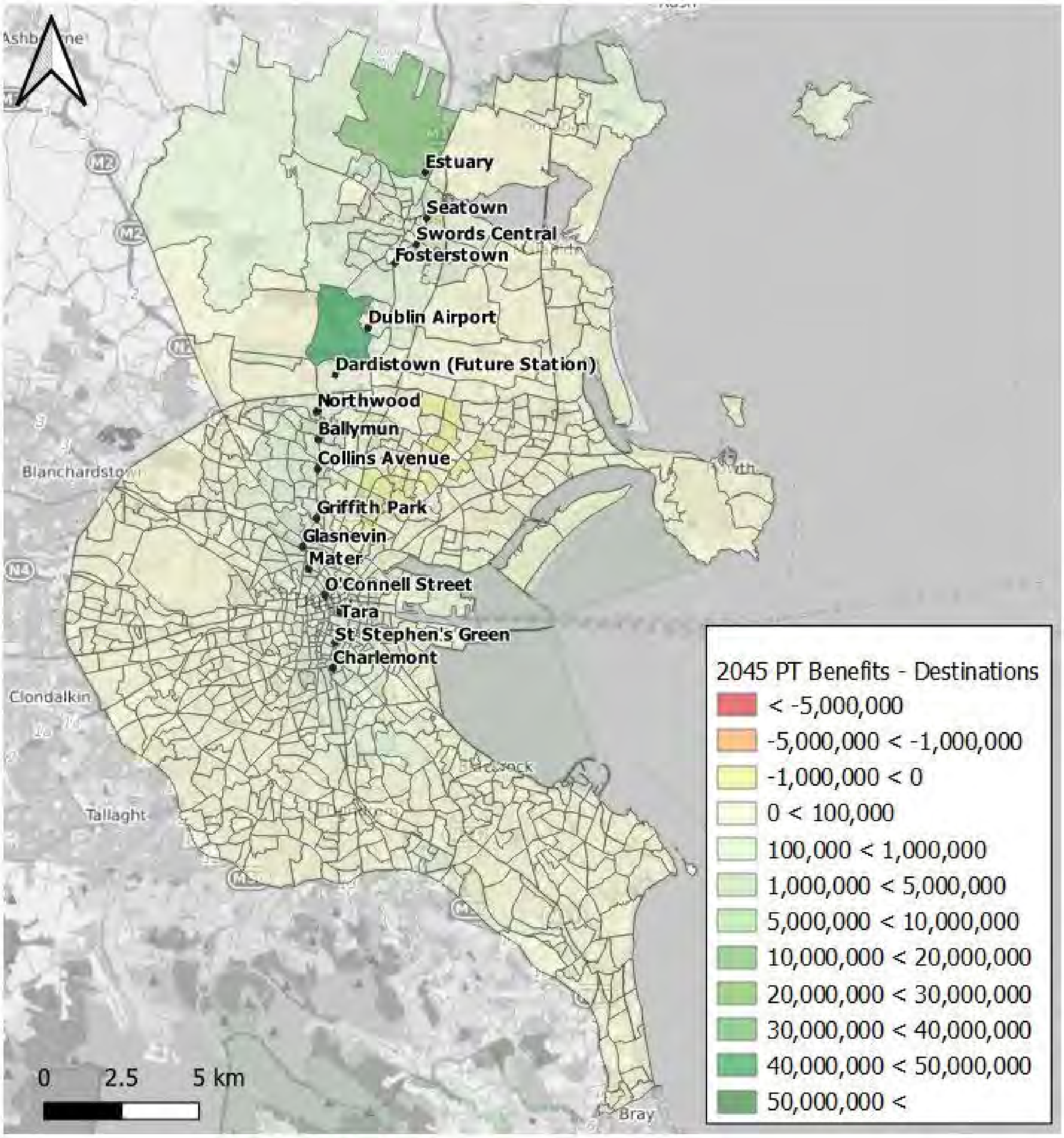
Figure 1-15 and Figure 1-16 show there are benefits for the majority of geographical areas for Public Transport trips throughout the scheme corridor in 2045. In contrast to the Highway Trip Benefits, shown in Figure 1-17 and Figure 1-18, there are also benefits for the sector that the Park and Ride Site is located within, and to the north of it.

Figure 1-15: Public Transport Origin Benefits in 2045



Source: Jacobs' Analysis

Figure 1-16: Public Transport Destination Benefits in 2045

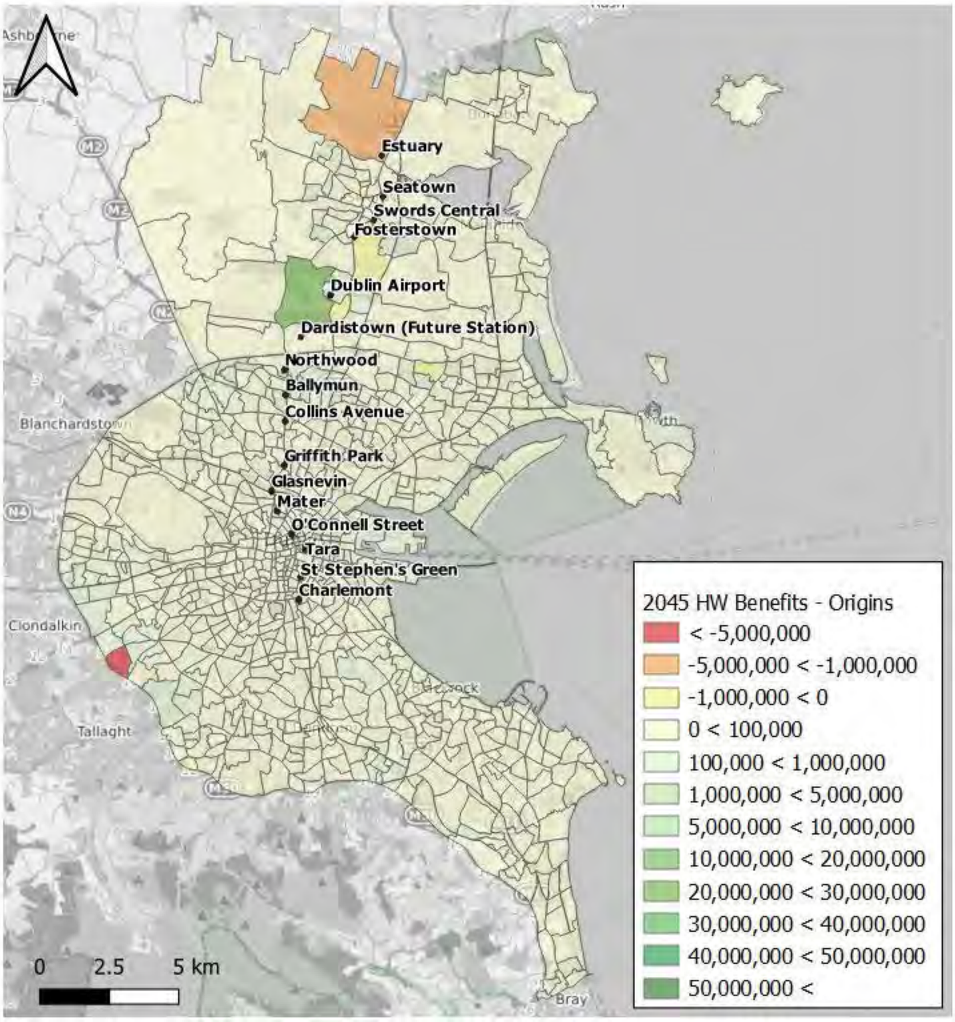


Source: Jacobs' Analysis

Figure 1-17 and Figure 1-18 illustrate the total benefits for origin and destination trips for Highway trips in 2045. Benefits accrue to most sector movements. There are disbenefits north of Estuary Park and Ride for both origin and destination trips, and as discussed previously this is due to an increase in traffic travelling to the Park and Ride Site, on already congested roads leading to further delays to the north of Estuary. The impact to users of a combined ‘through’ trip (making use of the park and ride site and MetroLink to access Dublin from the north) is positive overall with significant time savings made using MetroLink on the journey leg south of the airport, in comparison to continuing the journey by highway.

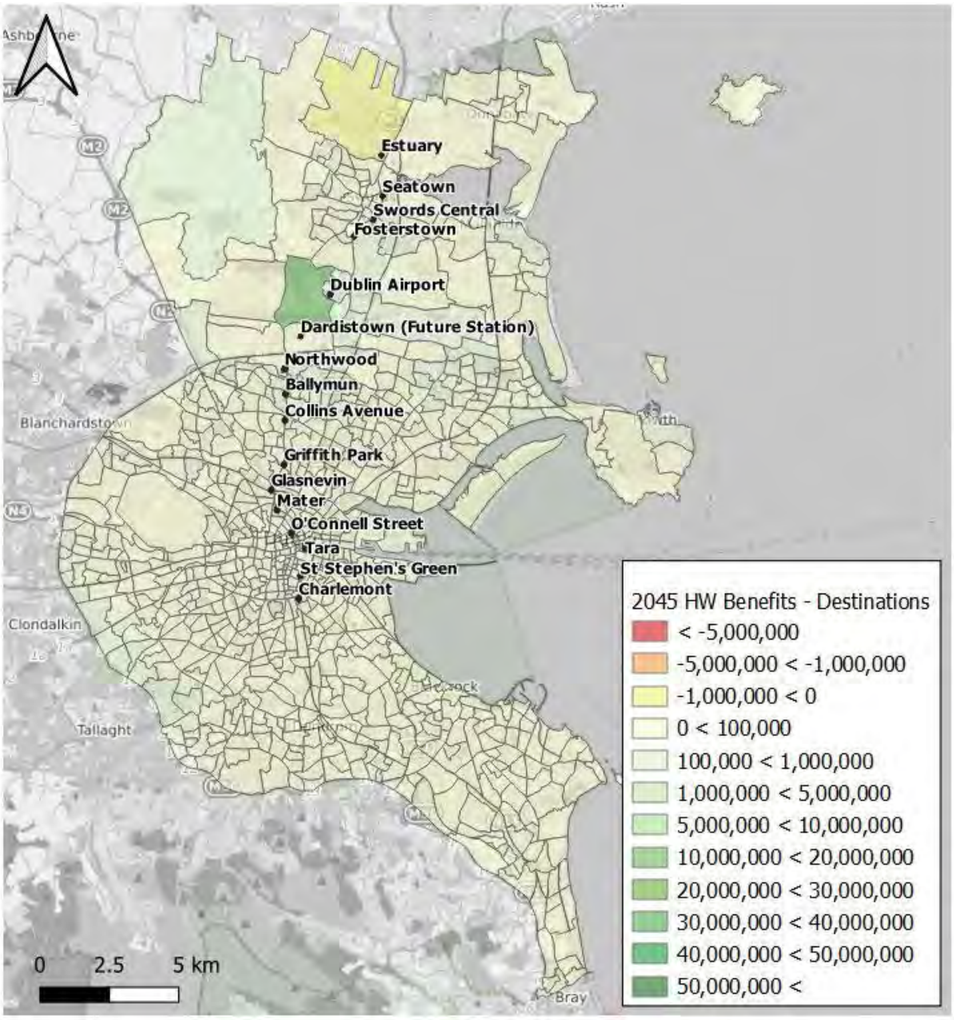
Similarly, there are disbenefits to the west of Dublin. This is likely to be due to a reduction in parking spaces used by highway trips from the north of Dublin, meaning more parking spaces available in the city centre, encouraging highway trips from the west of Dublin. This results in an increase in highway trips and slightly more congestion coming from the west of Dublin causing disbenefits for these users.

Figure 1-17: Highway Origin Benefits in 2045



Source: Jacobs’ Analysis

Figure 1-18: Highway Destination Benefits in 2045



Source: Jacobs' Analysis

Such a widespread beneficial impact is indicative of the positive transformational effect that MetroLink will have om Dublin.

1.3 Safety benefits

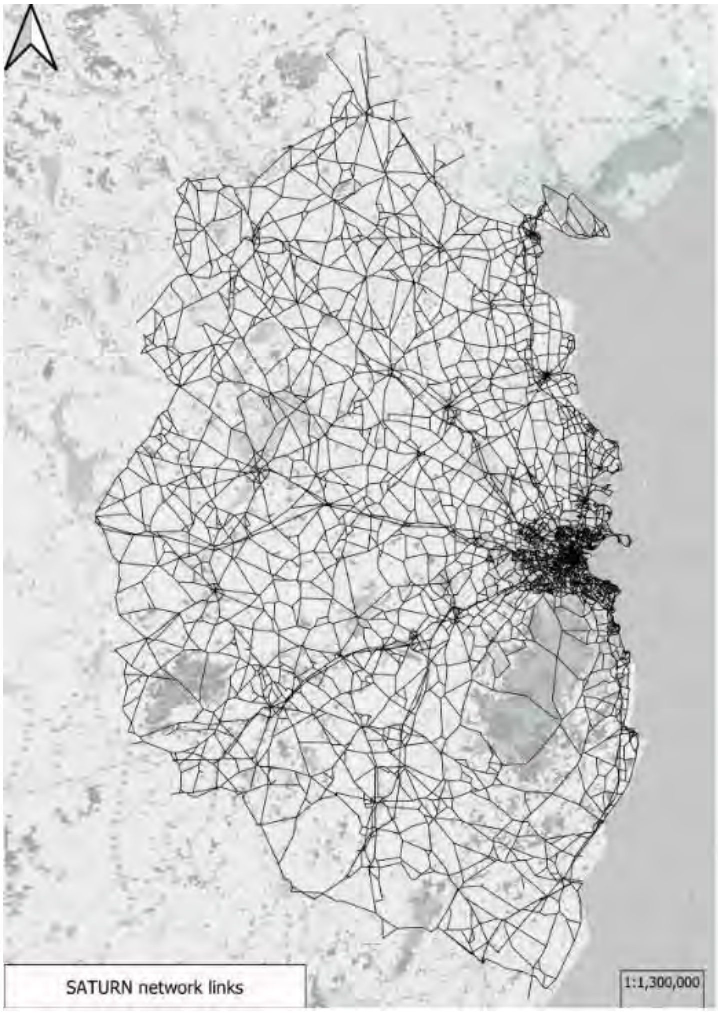
The level of traffic on the road network will be impacted by MetroLink. As a result of a decrease in highway traffic, there will be a reduction in congestion and so users who remain will be able to (on average) travel faster. The reduction in traffic and higher traffic speeds will have an impact on the number of accidents in the area. Broadly, less traffic means fewer accidents and higher speeds means more accidents. In the case of MetroLink these two effects almost balance, with a projected slight reduction in accidents over the 60-year appraisal period.

Different road types (dual/single carriageway, old/modern geometry) have different accident rates and these rates vary depending on vehicle speeds. By comparing the speeds travelled on the road network with and without the scheme, along with the accident rates on the road types, it is possible to estimate the impacts the scheme will have on road safety using COBA-LT software.

COBA-LT is the standard software used for undertaking accident analysis. Within COBA-LT, the predicted numbers of accidents with and without a scheme are compared and converted into monetary values by multiplying the numbers of accidents by their average monetised costs. The benefits for each year are discounted to 2011 prices and summed over the 60-year assessment period. COBA-LT calculates the number of accidents over the 60-year period from either default (national average) or observed (local) accident rates. For the purposes of this assessment, default values based on the link characteristics have been used. The traffic flows used for accident analysis were calculated from the modelled flows. They are consistent with flows used in other elements of the economic analysis including the TUBA assessment.

Figure 1-19 shows the links within the area used to determine the accident benefits. Professional judgement was used to identify the area that would realistically be significantly impacted by the scheme, and to consider the likely increase in traffic as a result of the Estuary Park and Ride Site.

Figure 1-19: ERM SATURN Model Extents



Source: Jacobs' Analysis

Table 1-14, provides a summary of the key assumptions use for the analysis.

Table 1-14: Accident Impact – assumptions and sources of information

Item	Assumptions / Notes
Software	COBA-LT-Ireland Version 2015.1 (current version)
Parameters file	COBA-LT-Ireland Parameters file Version 2019.10.03
Appraisal Period	60 Years
COBA-LT study area	Whole ERM highway network

Item	Assumptions / Notes
Accident data	Set out in PAG Unit 6.11: National Parameter Values Sheet
Traffic data	Base Year AADTs taken from ERM SATURN model. DM and DS AADTs for 2030 and 2045 taken from ERM model assignments
Geometric parameters	Speed limits, distances, carriageway standard, junction type etc. extracted from ERM SATURN models
Price basing and discounting	To ensure consistency with all other scheme impacts, the accident monetary impacts were calculated in 2011 prices and discounted to 2011.

Source: Jacobs' Analysis

In addition to this, the following assumptions have been made:

1. A limitation of COBA-LT is that it only considers links that have speeds in multiples of 10kph, and due to some modelled links having speeds not in multiples of 10kph, these links have been rounded to the nearest and most appropriate 10kph speed limit.

2. COBA-LT only includes links that have speeds greater than 50kph, and so to ensure all links are included within the analysis, any modelled links that were less than 50kph have been converted to be 50kph.

These assumptions help ensure that the links within the city centre are included within the accident analysis.

1.3.1 COBA-LT Results

The scheme's projected impact on the number of casualties over the 60-year appraisal period, split by severity, is shown in Table 1-15. This shows that there is predicted to be an overall decrease in the number of fatalities, as well as in the number of slight and serious casualties.

Table 1-15: Summary of Casualties

Casualty Severity	Total without Scheme Casualties	Total with Scheme Casualties	Total Casualties Saved
Fatal	1,151	1,137	15
Serious	4,714	4,667	47
Slight	121,463	120,129	1,333

Source: Jacobs' Analysis

The total monetary benefit of the reduction in the number of accidents over the 60-year assessment period equates to €33.2 million as shown in Table 1-16.

Table 1-16: Summary of Safety Benefits

Scheme	Collision Costs (€M's)
Total Without-Scheme	3,291.5
Total With-Scheme	3,258.3
Total Collision Benefits	33.2

Source: Jacobs' Analysis

It is important to note that while this COBA-LT assessment is positive overall, it is based on accident parameters that reflect national average conditions for different broad categories of road. It is not a substitute for the detailed operational safety assessment undertaken as part of further scheme development.

1.4 Employment Impacts

1.4.1 Introduction

In order to improve public investment decisions, it is important to understand the potential combined benefits of a project, including direct, indirect and induced employment benefits. Given that an integral part of the National Strategy[4] is the achievement of full employment, an analysis of the employment impact of investment projects can be of assistance in the formulation of budgetary decisions. A move to more productive jobs and individuals that are induced to take up employment as a result of reduced travel times increasing their effective wages also plays a key role in public investment decision making.

[4] Irelands National Skill Strategy 2025, 2016

1.4.2 Preliminary evaluation of employment impacts

The approach to forecasting employment impacts has been developed to assess the impact of the delivery of MetroLink during its construction phase. The analysis is based on a methodology developed for the National Roads Authority (NRA) on behalf of TII in 2013[5] and is largely based on Input-Output analysis. The NRA study assessed the impact infrastructure investment, including on transport, schools, hospitals, and social housing has on employment. The study identified that, per €1bn (2013 prices, excluding VAT) invested in rail, 12,858 years of employment are generated. Based on a standard assumption that 10 years of employment is the equivalent of one full time job then this equates to 1,286 FTE per €1bn spent on rail. This number includes direct, indirect and induced job creation. Direct job creation is employment generated specifically as part of the project, while indirect job creation is employment generated by the supply chain through the purchasing of goods, and induced job creation is employment generated in the economy from higher expenditure due to the additional direct and indirect employment. Table 1-17 outlines the job creation levels reported by the National Roads Authority.

Table 1-17: Annual Employment Impact per €1bn Government Spend

Infrastructure Types	Direct	Indirect	Induced	Total
Rail	8,146	3,001	1,711	12,858

Source: National Roads Authority on behalf of TII

MetroLink current construction expenditure, including risk but excluding inflation and VAT, is estimated to total to €8.87bn (2019 prices, undiscounted). According to the above-mentioned study MetroLink is estimated to enable, on average, 1,114,000 – 1,340,000 total years of employment over the years of project expenditure of which 720,000 – 910,000 years of labour will be direct, c.250,000-300,000 will be indirect and c.150,000-180,000 will be induced. Table 1-18 illustrates the employment that MetroLink will help to create in full time equivalent terms.

Table 1-18: MetroLink estimated annual FTE impacts (nearest 1,000)

	Direct	Indirect	Induced	Total
FTE	7,200 – 9,100	2,500-3,000	1,500-1,800	11,400-13,400

[5] The Employment Benefits of Investment Projects, October 2013

Source: Jacobs' Analysis

These numbers are indicative based on current stage of cost estimates. Tunnelling for underground mass-rapid-transit systems is on average more capital intensive, so a higher level of spend would be required to generate the number of jobs outlined in the NRA report. However, MetroLink has the potential of benefitting a whole generation of engineers, designers, architects and geologists, over the life of the project. Further it will create opportunities for businesses to upskill their workforce. London established a 'Tunnelling and Underground Construction Academy' which has trained 20,000 people over the course of 10 years, not only in rail but other sectors of the economy.

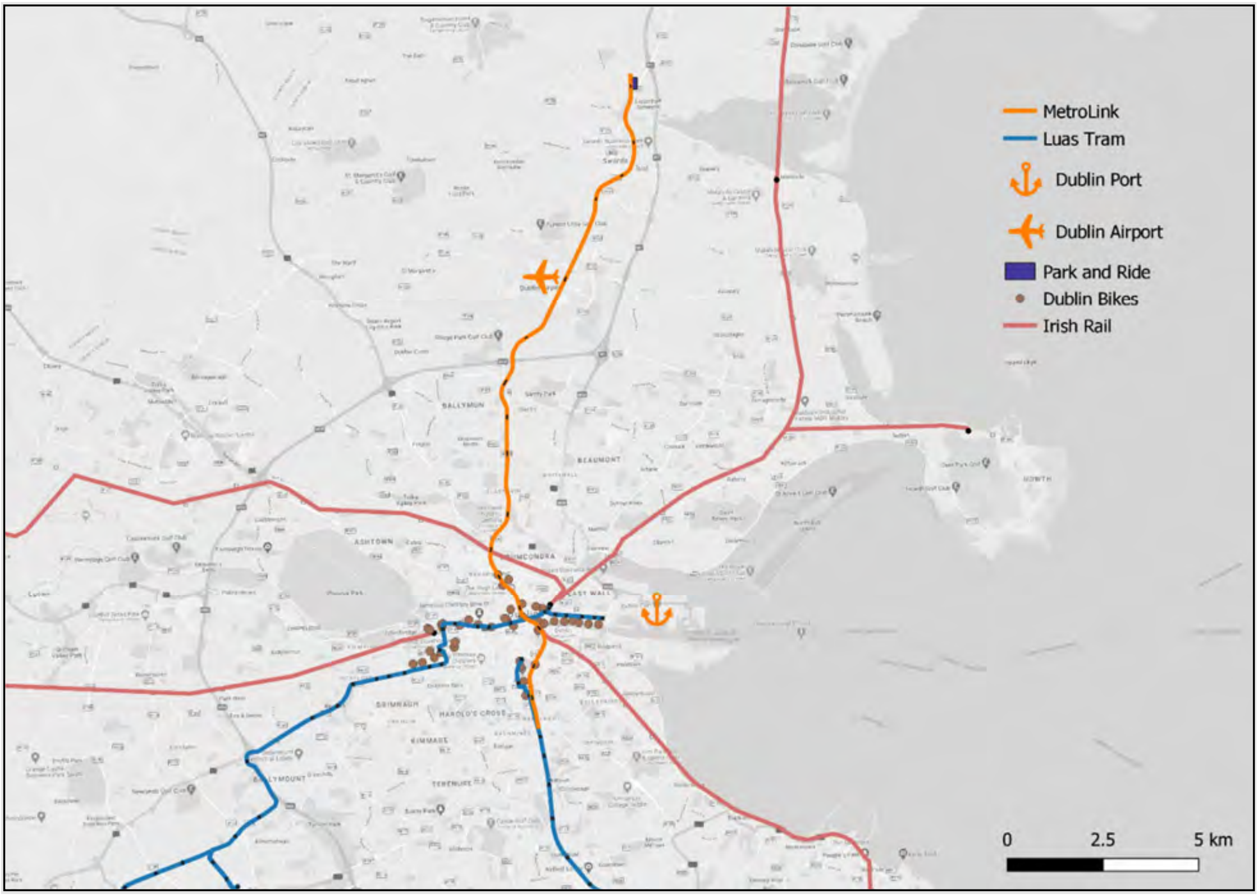
This analysis does not include the additional employment effects expected from increased productivity and clustering effects as a result of the accessibility benefits described later in this document.

1.5 Transport integration

The aim of the National Development Plan is to ensure that public investment is targeted towards projects that will fulfil the objectives of the NPF. With housing and transport so inextricably linked, the National Development Plan is directing investment towards large scale public transport infrastructure. Public transport functions best when it's properly integrated across modes. When users can change from one mode of transport to another seamlessly, with timetables and ticketing fully integrated, public transport can more effectively compete with private transport. This principle of integration and accessibility is a key element in the MetroLink project.

As well as the provision of extra capacity to support Dublin's growth, the proposed MetroLink alignment integrates with other major transport hubs. MetroLink will connect with two major Iarnród Éireann lines; the north-western line from Sligo/Maynooth to Dublin, and the south-western commuter line from Newbridge/Hazelwatch to Grand Canal Dock, these converge at Whitworth Road near Glasnevin. MetroLink will also connect with DART and Iarnród Éireann services at Tara Street and Luas at Charlemont, O'Connell Street, and St. Stephen's Green. These connections are shown in Figure 1-20.

Figure 1-20: Transport integration of MetroLink



Source: Jacobs' Analysis

MetroLink will also be designed and delivered in a manner that will complement large infrastructure assets in and around the GDA. The preferred route will have a station at Dublin Airport offering transit times between the airport to Dublin city centre of under 20 minutes.

MetroLink is part of an integrated strategy to provide sustainable mobility and promote non-mechanised modes, (walking and cycling). In line with the National Cycle Policy Framework, cycling arrangements will be appropriately considered during the design of MetroLink and where possible connect with existing sustainable transport networks. This will include items such as covered bike parking, which will be included at stations wherever feasible. In addition, underpasses and footbridges will be designed so that they are easily accessible to bikes.

The change in choices of transport modes are captured within the model, and it allows for changes in trips between highway and public transport as a result of the increased transport integration with the scheme in place. Public transport trip movements within the model include the active mode element prior to and post the public transport element of the trip.

1.6 Construction impacts

Due to the scale of the proposed scheme, construction impacts will be considered at both the strategic and the local level at each individual station, and where appropriate along the route. This will consider the impact on pedestrians, cyclists, vehicles, public transport users, loading, parking, and access. The impacts resulting from the construction phase will occur primarily due to the construction of the stations. This will require areas of road space to be removed for some time reducing the operating capacity for all road users. Each of the proposed scheme’s construction sites will also generate substantial levels of spoil removal and construction vehicles, which will impact on both the local and strategic road network.

At this stage of the project it is not feasible to monetise the construction impact of this scheme, due to there being no detailed design, knowledge of construction patterns or vehicle movements. Local modelling of all of the sites would be required, and there is not all the required detail to undertake this assessment at this stage. It is anticipated that the impact during construction will be minimal in comparison to the overall scheme benefit.

1.7 Alignment with Government policies

This section provides a summary of the impact that MetroLink has on key government policy objectives as set forth by the National Planning Framework 2040 (NPF). The results are illustrated in Table 1-19.

The key government policies which underpins the MetroLink project at a national level are the NPF and National Development Plan 2018-2027, which set out a strategic framework to guide development and investment to enhance the wellbeing and quality of life of the Irish people. The NPF establishes ten National Strategic Outcomes and 75 National Policy Objectives. Whilst the NDP sets out ten Strategic Investment Priorities that will underpin the implementation of the NPF 2040 and support its National Strategic Outcomes. National Policy Objective 74 of the NPF, is to ‘Secure the alignment of the National Planning Framework and the National Development Plan through delivery of the National Strategic Outcome’.

MetroLink directly contributes to the delivery of each of the National Strategic Outcomes, especially NSO1 Compact growth; NSO2 Enhanced regional accessibility; NSO4 Sustainable mobility; NSO6 High quality international connectivity; NSO8 Transition to a low carbon and climate resilient society; and NSO10 Access to quality childcare, education and health services. These are summarised in Table 1-19.

Table 1-19: Impact on National Strategic Outcomes

NSO Outcome	Impact of MetroLink
NSO1	By providing high capacity transport movement Metrolink supports higher density development thereby encouraging compact and sustainable growth in the GDA.
NSO2	By improving accessibility throughout the GDA it improves regional accessibility.
NSO4	MetroLink will be built to the latest standards and provide a sustainable alternative to car travel along the north Dublin Corridor.
NSO6	MetroLink will provide high quality access from central Dublin to Dublin Airport, with a transit time of 20 minutes. It also relieves traffic on the M1 link to Northern Ireland
NSO8	MetroLink will provide an attractive alternative to highway travel, encouraging people to switch to a lower carbon transport option, and reducing the negative impact of their travel choices.
NSO10	By providing frequent, safe, services within Dublin, MetroLink will help to provide access to key amenities for local residents especially Mater hospital and DCU.

Source: National Planning Framework NPF and Jacobs

1.8 Land-use Integration

From the analysis undertaken it is apparent that MetroLink compliments land-use integration at a national and local level. By carefully shaping the planning of MetroLink and by considering the location, size, density, design and diversity of land use, land-use integration can help to reduce the need to travel, reduce the length of journeys and make it safer and more accessible for people to access centres of employment, commercial and leisure facilities and services by public transport, walking and cycling. Table 1-20 outlines at a high level how MetroLink is in keeping with land use policies at a national and local level.

Table 1-20: Land-Use Integration Impacts of MetroLink

Policy	Policy Year	Impact of MetroLink
Planning Land Use and Transport (PLUTO)	2040	MetroLink seeks to provide a high-quality enhancement to the existing network, which will improve accessibility, safety and reliability in the Study Areas In addition, the proposed Scheme seeks to support the economy, communities, sustainable low-carbon public transport, with the minimisation of environmental impacts.
Fingal County Development Plan	2017-2023	MetroLink complies with Fingal County Development Plan objectives as it provides a framework for the future development of Swords in line with its vision to 2035 as a city of 100,000 people.
Dublin City Development Plan	2016-2022	MetroLink will promote high density, mixed use, walkable communities linked by high quality public transport. Additionally, it will connect the major employment nodes at the airport and Swords to the city centre and provide interconnectivity across the public transport network.

Source: National Irish Policy Paper's and Jacobs

1.9 Housing

TII recognises that a holistic transport strategy for the GDA is needed, which must be prioritised and focussed based on integrated land use. Accessibility is shaped by the structure, capacity and connectivity of transport infrastructure, which is not uniform. Since accessibility differs across the GDA, this attribute has an impact on land use, such as the location of new activities, their expansion or densification. With rising rents due to increased demand compounded by a limited supply of houses, commuter belt counties such as Kildare, Meath, Fingal and Wicklow[6] may face additional pressure to cater for the GDA's housing demand in the next 25 years.

Fingal, Meath, and Kildare have seen some of the largest population growth in the GDA, with 8%, 6%, and 6%[7] growth respectively between 2011 and 2016. In comparison the population in the more centrally located part of Dublin grew by 5%[8] in the same time period. National estimates forecast that Swords, Balbriggan, South Drogheda, Clongriffin, Ballymum, Donabate, and Dublin Airport[9], of

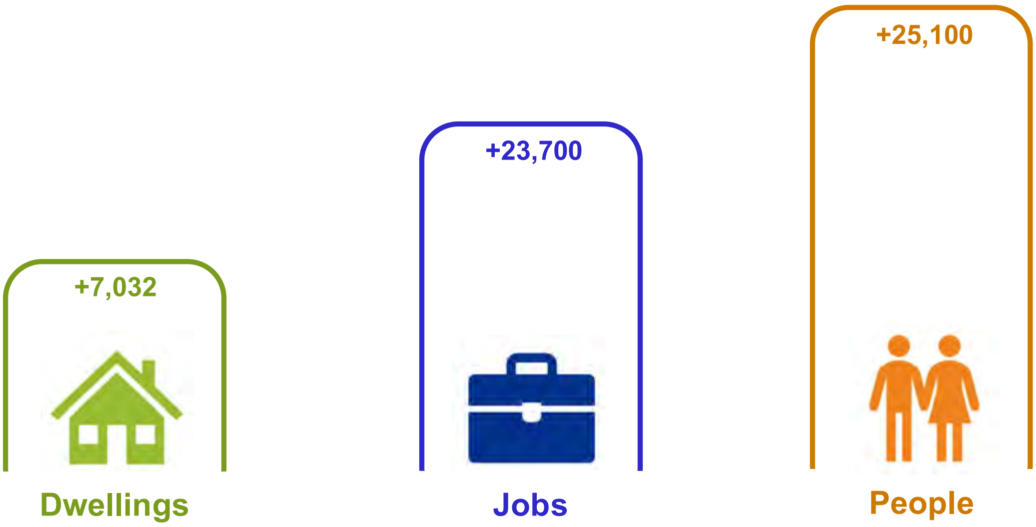
[6] Dublin Area Transport Strategy 2015-2035, March 2015
[7] Greater Dublin Area Transport Strategy 2016-2035, 2016
[8] Greater Dublin Area Transport Strategy 2016-2035, 2016
[9] Greater Dublin Area Transport Strategy 2016-2035, 2016

which some are along the proposed MetroLink route, will experience a significant growth in population and employment. Within the above areas, a significant proportion of the population will be located within Dublin's periphery. It will be difficult to effectively serve these regions with present transport services and therefore, to achieve the forecasted growth, sustainable infrastructure provision is needed.

1.9.1 Impact of housing on quality of life

The supply and demand for housing in Dublin is not balanced, which could potentially result in a deteriorating quality of life. Creating a sense of place has become a defining contributing factor to the competitiveness, attractiveness and success of a city. Housing cost problems negatively affects the decisions of businesses to invest in Dublin and can also have an impact on wellbeing. Figure 1-21 gives the number of dwellings that have been added to Dublin's housing sector in 2019, accompanied by the net additional jobs and net growth in population.

Figure 1-21: New dwellings, and population and employment growth in Dublin 2019



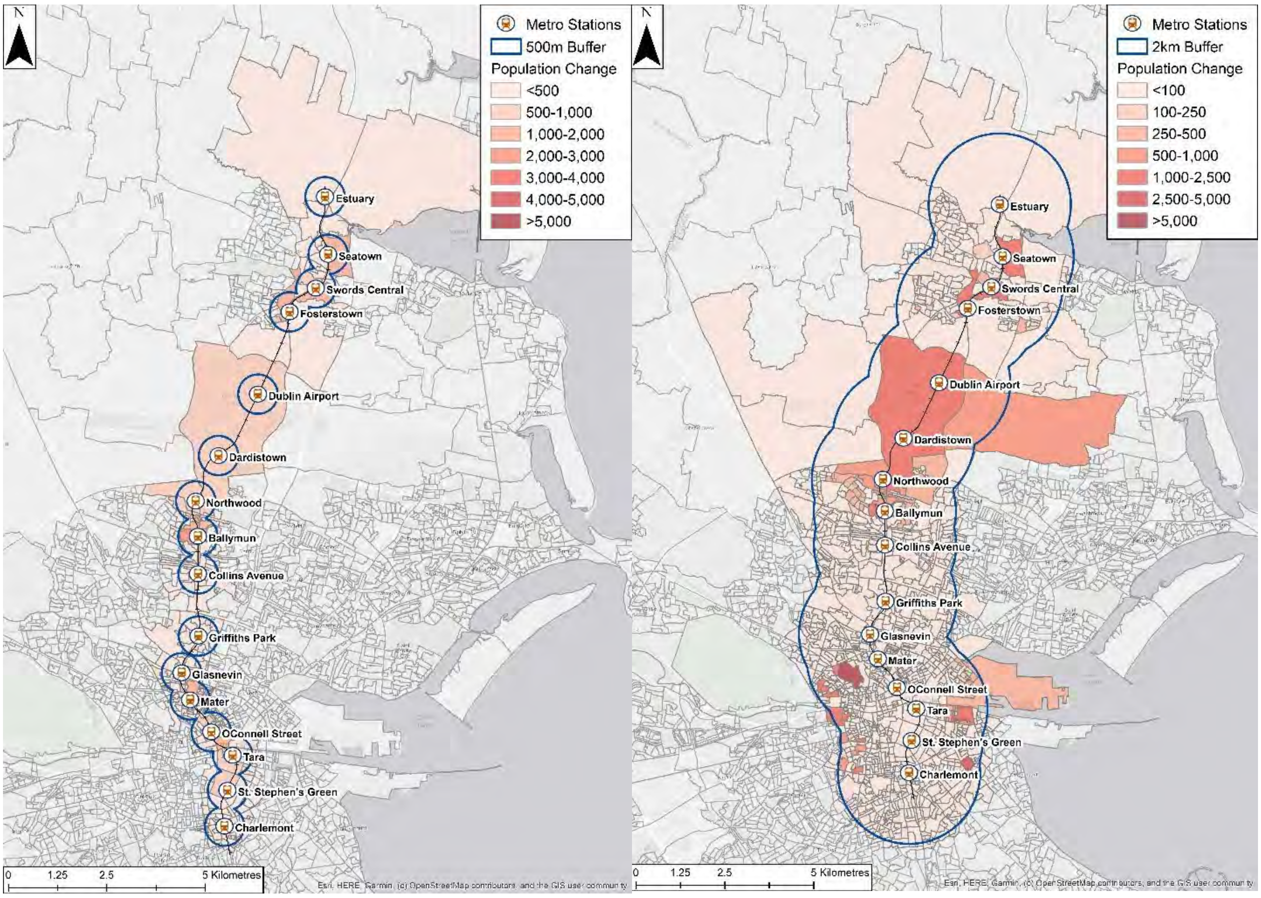
Source: CSO

Population and employment levels are rising faster than the supply of new homes. Dublin's future economic success depends on its ability to continue to accommodate population and employment growth and offer a high-quality standard of living. It is important that Dublin finds ways of unlocking housing potential within the GDA. Investment in high-quality public transport, such as in MetroLink has the potential of opening opportunities for residential and commercial property development.

1.9.2 Population growth along the MetroLink corridor

The most recent modelling undertaken, based on the NPF, confirms a strong growth in population for the north of Dublin, along the MetroLink route. The model assumes fixed-land use between the with and without MetroLink scenarios and no explicit dependent development is modelled. Figure 1-22 shows the increase in people living within 500m and 2,000m of MetroLink, between 2019 and 2045.

Figure 1-22: Increase in Greater Dublin Area population within 500m and 2km of MetroLink between 2018 and 2045



Source: Jacobs' Analysis

The number of people living within a 2 km radius of a MetroLink station is forecast to grow by 39% between 2019 and 2045. This equates to a total of 129,000 new residents along the corridor.

Table 1-21: Population within 500m, 1000m and 2000m of MetroLink (nearest 1,000)

	Distance from MetroLink		
Year	≤ 500m	≤ 1000m	≤ 2000m
2019	56,000	152,000	327,000
2030	63,000	168,000	359,000
2045	73,000	216,000	456,000
Increase by 2045 over 2019	17,000	64,000	129,000

Source: Jacobs' Analysis

1.9.3 Potential impact on house values

Property value uplifts will generally depend on the distance of the dwelling to a MetroLink station. Dwellings situated within a 500m buffer of a station may experience a higher premium than those located further away from the route. It is important to ensure that there is sufficient land zoned in the right places to meet regional and local housing targets. This will involve consolidating urban areas around the GDA and making the most efficient use of current and future infrastructure assets through integration with land use planning policy. In this regard, Ballymun, Fostertown, Dublin Airport and Swords, are forecast to experience the strongest growth in population between 2018 and 2045.

The present zoning areas in Ballymun and Swords are within the 2 km buffer zone of the MetroLink route and have also been labelled as residential development zones in the Fingal Development Plan (2017-2023). There is great potential that the land value in these areas will experience an uplift, due to the provision of high-quality public transport. Introducing high-quality public transport in an area cannot only have an impact on property values but it can also help release the value that sits within these residential and mixed-use land zones. This is confirmed by the Fingal Development Plan, which states that construction permits for the development of larger residential or mixed-use land zones are subject to the availability of high-quality public transport. The residential and commercial development stimulated by MetroLink could create opportunity for increased passenger revenue.

The 2016 Census reported that the average number of persons per household was 2.75 compared to 2.73 in 2011[10]. If we assume that each dwelling houses an average of 2.75 people by 2057, Dublin will need an additional 80-100,000 housing units based on the Project Ireland 2040 population projections. New housing can only be facilitated by ensuring that lands identified for development are adequately serviced by high quality public transport to ensure the functionality and liveability of both new and existing residential areas, via appropriate density.

Proximity to high-frequency public transport that will provide good quality connectivity and accessibility to major employment centres is a strong positive factor that is likely to elevate the value of property in each area. A study done by Mayor et al. (2008) assessed the impact of the Luas Green and Red lines on property prices. The authors found that Luas had a significant impact on property values in Zones 2 and 3. Properties located within 500-metres of the Luas Green line in Zones 2 and 3 saw the value of their property increase by an average of 12% and 17% respectively, after accounting for all other factors. Properties that are located within 500 to 2000 metres from the Luas Green Line in Zones 2 and 3 reported premiums of 7%[11], illustrating the effect of distance decay.

Taking a cautionary approach, we consider only houses within 500m of a MetroLink station and between 500m and 2000m of MetroLink station – as opposed to the line itself. It is estimated that there are approximately 20,000 housing units within 500m of MetroLink stations and 95,000 within 500-2,000m of a station. An average property price of €380,000[12] has been used and a 10% uplift for those within 500m and a 5% uplift for those between 500m and 2000m of a MetroLink station. This gives a total property uplift of €2.57bn (in 2019 prices and values) on existing properties. Additionally, the uplift in value can have revenue implications for the public sector, in the form of increases in Stamp Duty and Local Property Tax. In the long term, this could help raise funding for additional transport schemes.

[10] Census of Population 2016, 2016
[11] A Hedonic Analysis of the Transport Network in the Dublin Area, 2018
[12] Using data from CSO dataset HPAO2 for 2019.

Table 1-22 MetroLink Land Value Impacts

	Distance to MetroLink Station	
Distance to station	0 to 500m	500 to 2000m
2019 Population (Persons)	56,071	270,617
2019 Dwellings	20,389	98,406
Assumed Value Dwelling (€ 2019 prices and values)	380,000	380,000
Land Value Uplift, per dwelling	10%	5%
Land Value Uplift (€bn, 2019 prices and values)	0.76	1.81
Total Uplift (€bn, 2019 prices and values)		2.57

Source: Jacobs Analysis

The land value impacts associated with induced housing development as a result of MetroLink are not captured within this assessment. A more detailed market viability assessment, and construction cost assessment for new dwellings will be carried out, as appropriate, during the next phase of assessment to provide a valuation of the impact of new houses directly associated with MetroLink.

1.10 Geographical integration

MetroLink is an integral part of the Irish and Dublin growth agenda, which will help bridge geographic divides between the north and south of Dublin and deliver a more united and cohesive economy. The NDP 2018 – 2027, sets out ten Strategic Investment Priorities that will underpin the implementation and support the National Strategic Outcomes of the NPF 2040 over a ten-year period. Geographic integration is at the heart of the NPF 2040 and has been strongly considered within the design of MetroLink. The delivery of three of the aims and objectives of the NPF 2040 linked to geographical integration are directly supported by MetroLink, these are; NSO1 Compact growth; NSO2 Enhanced regional accessibility; and NSO6 High quality international connectivity as outlined in Table 1-23.

Table 1-23: Geographical integration impact of MetroLink

Policy	Impact of MetroLink
NSO1	MetroLink will improve accessibility to and between different centres and through a better integration with Dublin's surrounding areas by offering multiple interchange nodes with the existing public transport network. This will reduce the dependency on the private car by increasing public transport mode share and encouraging walking and cycling (Section 1.5).
NSO2	Through the inclusion of a Park and Ride site at its northern end and by offering an interchange option with the Iarnród Éireann, MetroLink improves connectivity between cities and large growth towns beyond the GDA (Section 1.5).
NSO6	MetroLink will improve domestic and international travel connections via improved access to and from Dublin Airport and Iarnród Éireann (Section1.5).

Source: National Planning Framework and Jacobs' Analysis

With reference to the above, it is considered that the proposed Scheme objectives align with these NPF objectives, where the proposed Scheme seeks to improve connectivity between Dublin city centre and the GDA.

1.11 Wider economic impacts

It is anticipated that MetroLink will have a profound effect on the economy of Dublin, and the surrounding area. It will allow for agglomeration and positive productivity impacts associated with better business to business and business to worker connectivity, improved worker productivity due to better access to jobs and an increase in people entering the labour market.

MetroLink is expected to reduce generalised journey times and costs for existing businesses and commuting users, with the quantified benefits discussed in detail in the sections above. Improving the access for workers' opportunities for employment and access for businesses to collaborate with each other has the potential for benefits over and above journey time savings. A reduction in journey time (with an appropriate fare) may mean that a worker is able to access a job that they are better at (increasing their productivity above the journey time saved), or it might mean that two businesses interact to develop an improved supply chain solution (where they would not have been able to previously). These are impacts related to, but separate from, journey time savings and are the focus of this section.

At this stage business to business impacts will be assessed qualitatively, as will productivity impacts associated with people moving to more productive jobs. The impact of people entering the labour market is considered through the increase in tax take from their work and uses business time impacts as a proxy.

Impacts discussed in this section will be considered in more detail for the FBC.

1.11.1 Inward Investment

Dublin is the leading destination city for foreign investment in headquarters in relation to its size, according to FDI's Top Headquarter Locations in Europe published in May 2020[13]. It is also the fourth most successful city in Europe, after London, Paris and Berlin, for attracting the most foreign investment projects over the past five years. The city has been successful in attracting the likes of Google, Facebook, Airbnb, PayPal, Microsoft, eBay, and LinkedIn. Most of this investment has gone into software and IT services, followed by business services and financial services.

Foreign direct investment (FDI) can have a positive impact on Dublin's and Ireland's economy. If transport investment can facilitate inward investment, then some of the spin off benefits from FDI can be additional to transport user benefits. Whilst there is an abundance of external research linking the impact of FDI and a country's GDP, directly attributing any quantum of FDI as a result of MetroLink is challenging – due to the risk of misattribution and spurious correlation. Although expected to have a positive effect on FDI, the exact impact of MetroLink has not been quantified at this stage.

There are a wide range of factors that international businesses consider when making decisions about the location of their investments, depending on the sector and type of activity. Given the wide range of potential locations, extensive use is made of the surveys and rankings produced by international consultancies such as the Big 4 accountancy firms and compensation advisors e.g. Mercer as well as specialist site selection companies to draw up short lists. Ireland and Dublin

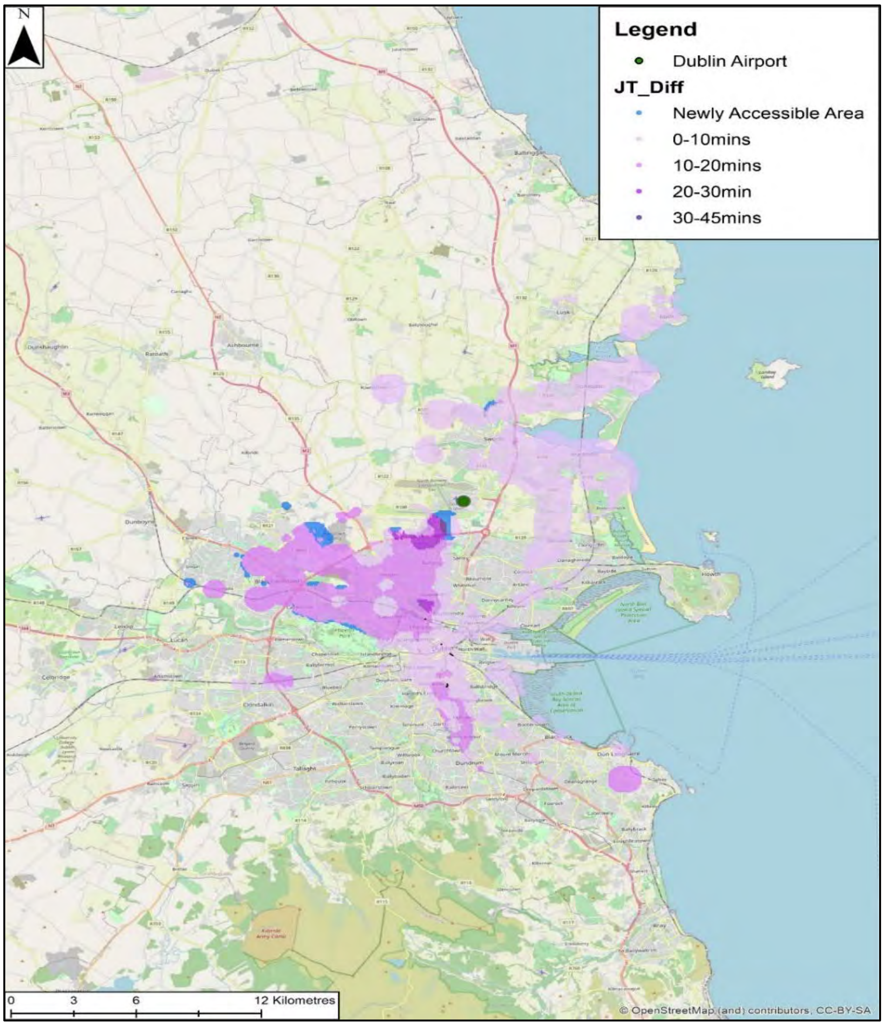
13 https://www.fdiintelligence.com/article/77217

generally perform well on these. However, there are other international city rankings where Dublin performs badly. TomTom produces an annual traffic congestion index in which Dublin is ranked the 7th worst performing European city out of 31 and 17th out of 416 worldwide. While Dublin ranks 120th out of 150 cities worldwide for raising a family[14] in part due to poor housing affordability.

By improving local accessibility MetroLink will not only assist in reducing traffic congestion in the city but will also increase the size of the labour force living within a reasonable commute of key areas such as Docklands, that have attracted multinational companies. It will also dramatically improve access to and from Dublin Airport, given that many business trips will start or end at a central Dublin business or hotel location. Dublin is one of the few major European cities not to have a light or heavy rail link between the city and its airport. Figure 1-23 and Figure 1-24 illustrates the differences in public journey time catchments when MetroLink is in place, when travelling to and from Dublin Airport in the morning peak It shows that areas to the southwest of the Airport will become accessible within 45 minutes, which they currently are not. Savings of up to 10 minutes can be seen along the northern corridor, in areas parallel to the M1.

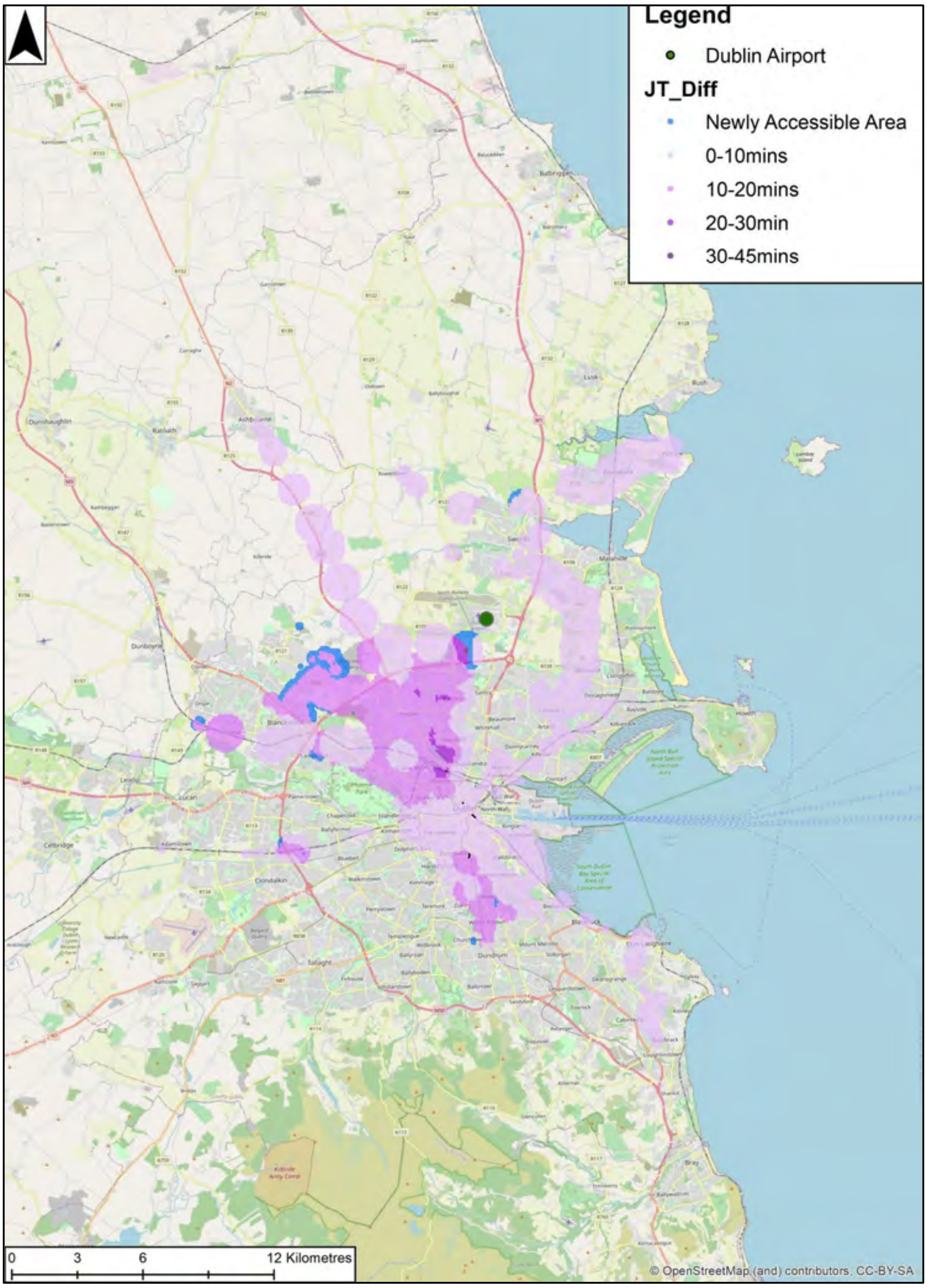
[14] https://www.irishtimes.com/life-and-style/health-family/parenting/dublin-ranks-120th-out-of-150-cities-for-raising-a-family-1.4147849

Figure 1-23: Differences in public transport journey time catchments in morning peak, trips to Dublin Airport



Source: Jacobs' Analysis

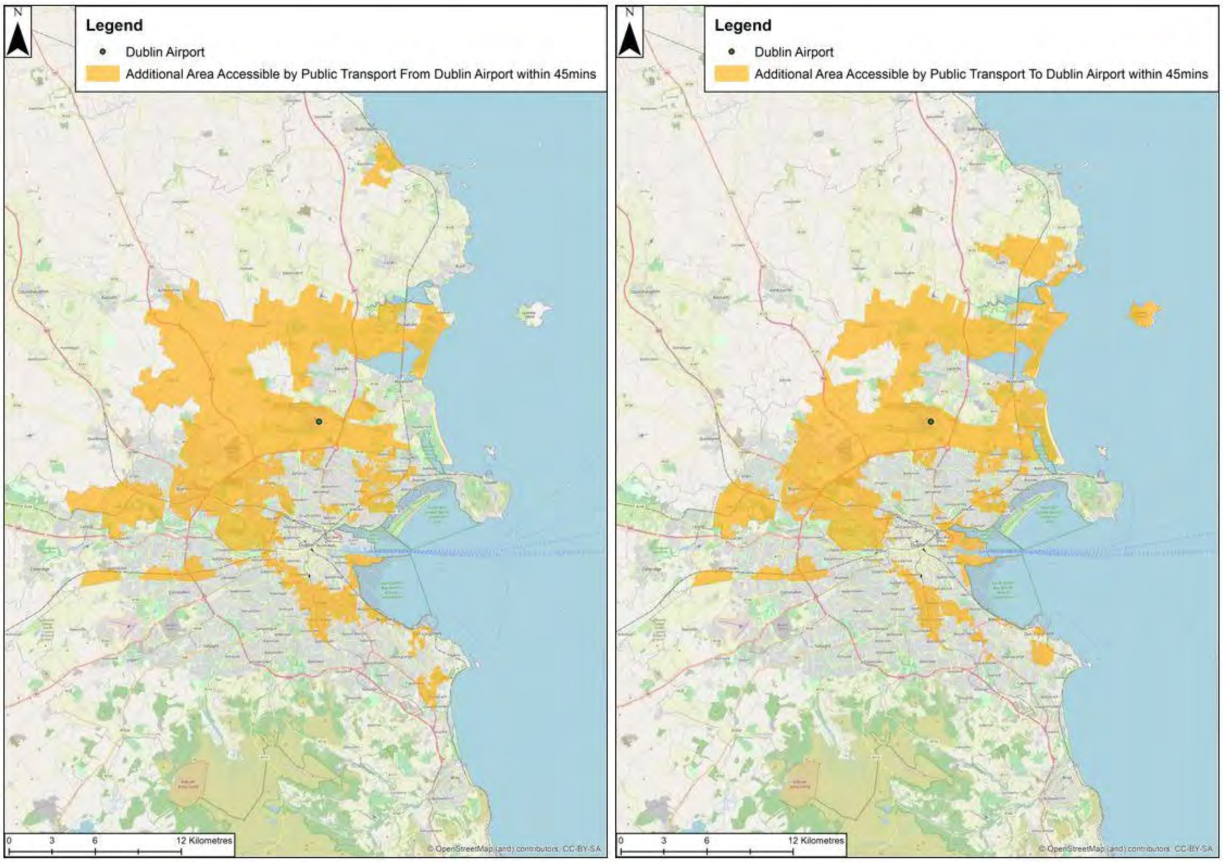
Figure 1-24: Differences in public transport journey time catchments in morning peak, trips from Dublin Airport



Source: Jacobs' Analysis

Figure 1-25 illustrates the areas where additional population have accessibility to and from Dublin Airport within a 45-minute journey time, when MetroLink is in place. With MetroLink in place, approximately 129,000 additional people are able to access Dublin Airport within 45 minutes.

Figure 1-25: Accessibility at Dublin Airport by origin (left) and destination (right) in the morning peak by public transport



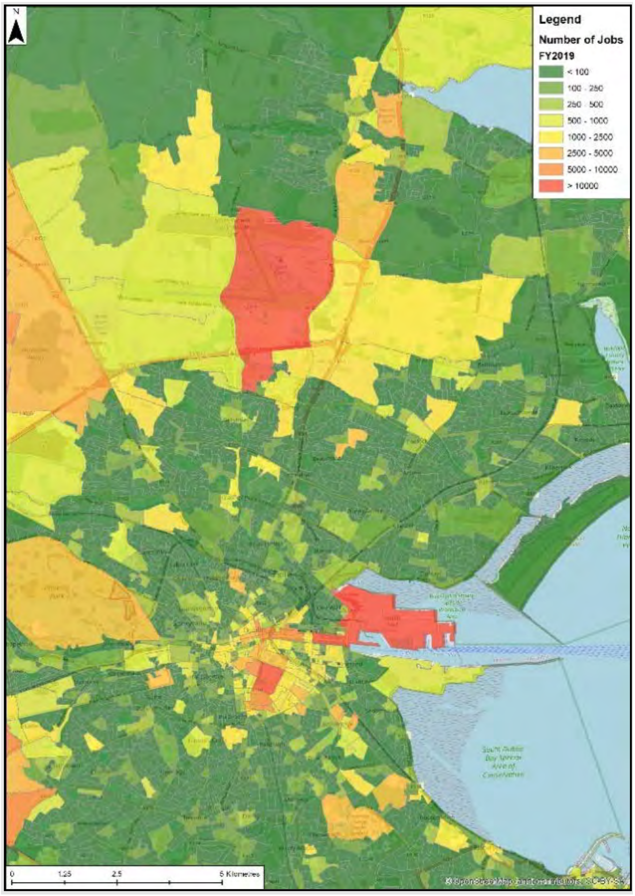
Source: Jacobs' Analysis

Most of the cities that Dublin is competing against to attract European HQs or other shared service functions already have extensive metro systems. This is important as companies are increasingly looking at their Carbon footprints and their staff's commute. The ability to promote Dublin as a low carbon city will increase in importance over time and MetroLink will help the city to achieve that and promote itself in a positive manner.

1.11.2 Agglomeration

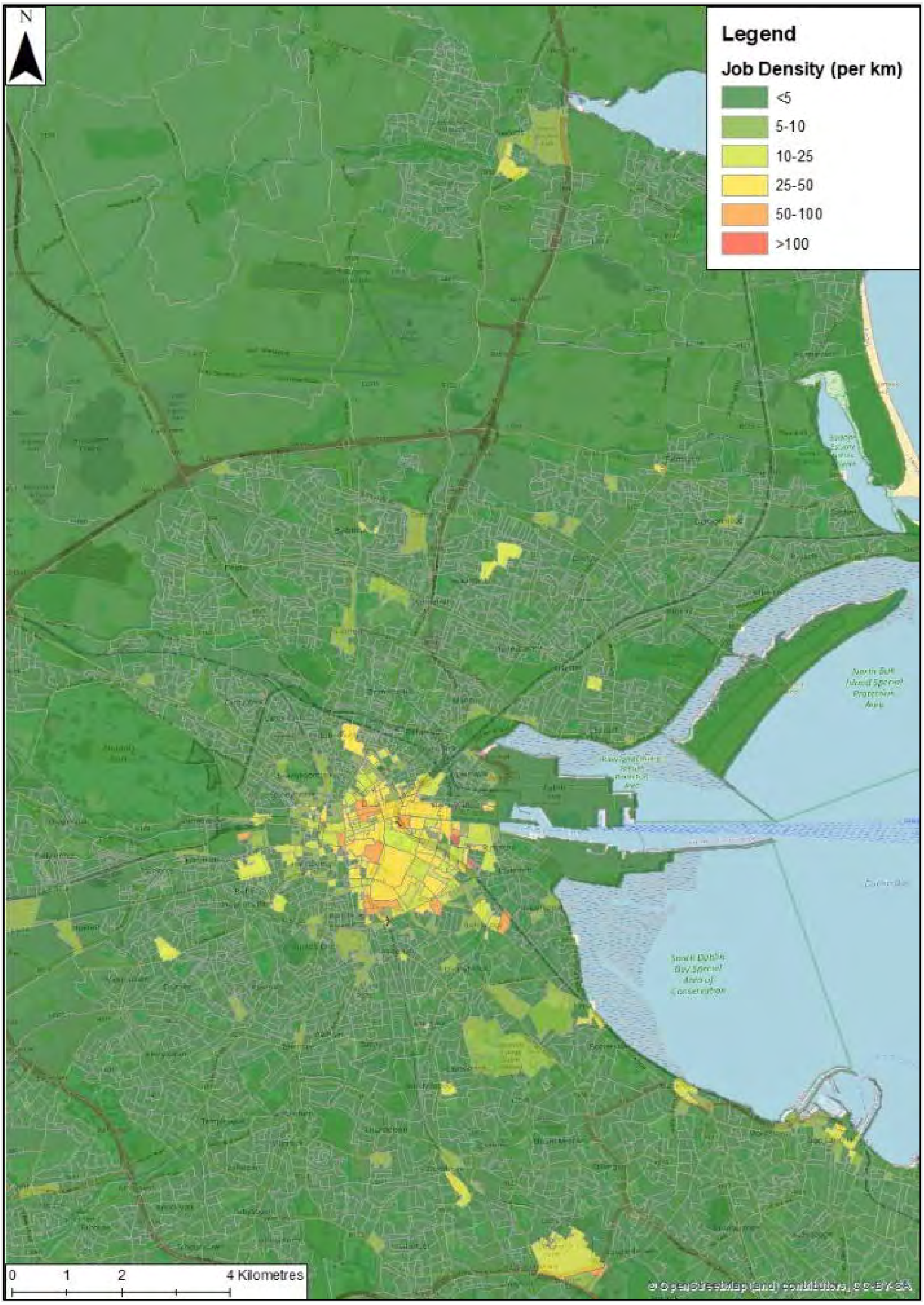
As part of this analysis, agglomeration impacts have been qualitatively appraised. Agglomeration is assessed through the changes in density of the economic activity within the context area as a result of like firms located near each other. The subsequent productivity induced, additional to the direct user benefits, reflects the positive externalities through the growth of new and existing business clusters and industries. This is driven by having access to larger product, input and labour markets, as well as knowledge and technology spill-overs from one firm to another.

Figure 1-26: Job location and density



Source: CSO and Jacobs' Analysis

Figure 1-27: Job Density within the GDA

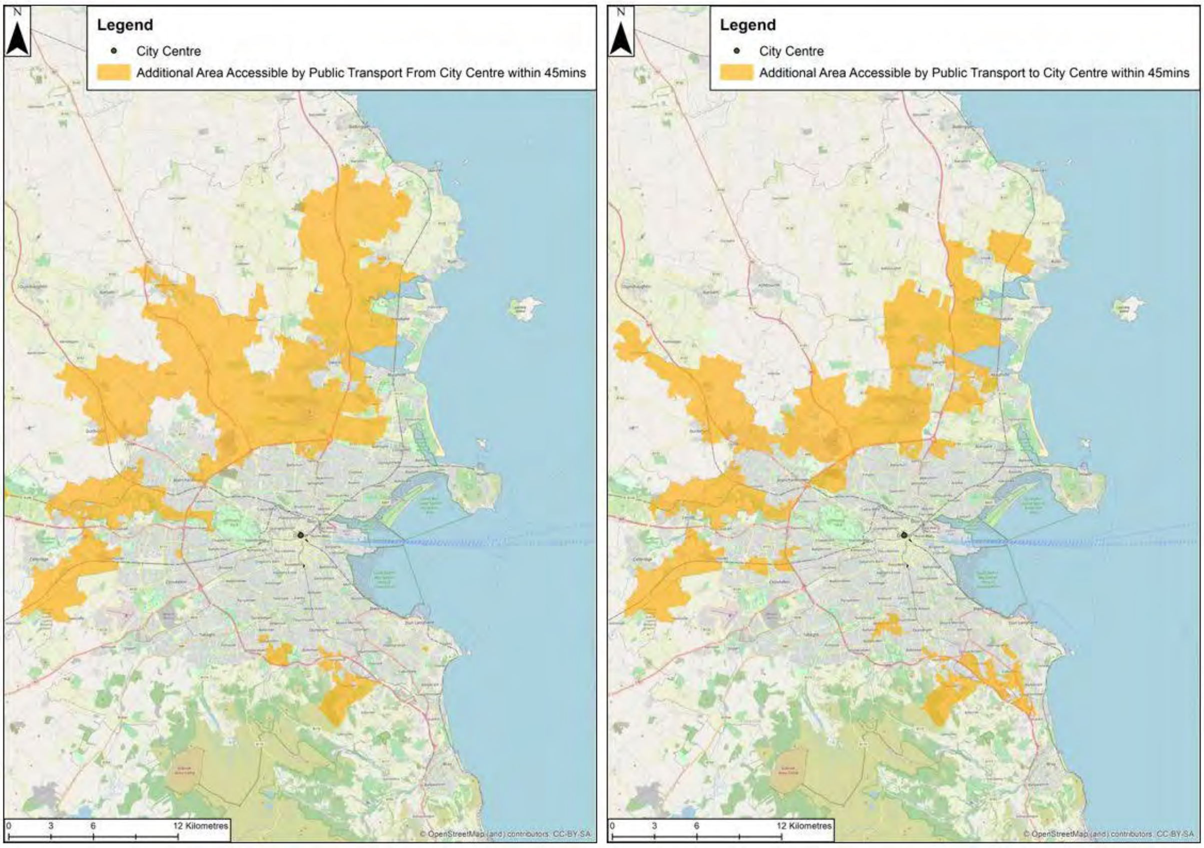


Source: CSO and Jacobs' Analysis

Figure 1-26 and Figure 1-27 show the number and density of jobs along the MetroLink route. As can be seen the greatest density of jobs occurs within central Dublin, but in absolute terms there are areas with significant employment along the entire MetroLink route. MetroLink offers users better accessibility for these key areas for firms and workers alike, effectively increasing the proximity for both parties. By supporting better transport links between firms and workers within Dublin and its surrounding towns there is a reduction in barriers to work and cost of interaction, but also an increased willingness to travel, would be realised, ultimately resulting in higher overall productivity within the city.

Figure 1-28 highlights the areas from which the city centre is accessible within 45 minutes, following the introduction of MetroLink, for which the city centre is not accessible within 45 minutes currently. There is an approximate 24,000 additional people that are able to access the City Centre within 45 minutes with MetroLink in place, with a large increase in population within the north corridor gaining improved accessibility.

Figure 1-28: Accessibility to Dublin City Centre by origin (left) and destination (right) in the morning peak by public transport



Source: CSO and Jacobs' Analysis

Whilst high-value jobs are prominent within Dublin, the growth of Dublin's clusters and the associated foreign direct investment is being challenged by the persistent issues Dublin is facing on congestion. Analysis conducted by Tech Nation in their 2020 report, and supported by the UK Government, identified that between 2014 and 2019, Dublin was in the top European cities for total tech investment. However, its position has dropped from 4th in 2016, to 10th in 2017, to 12th in 2018/2019. Dublin has now been overtaken by smaller cities such as Cambridge and Oxford. MetroLink can strengthen existing agglomeration impacts by increasing the economic productivity through the enabling of growth and densification of the Dublin area.

According to the 2016 Census, the largest identifiable sectors in Dublin are shown in Table 1-24.

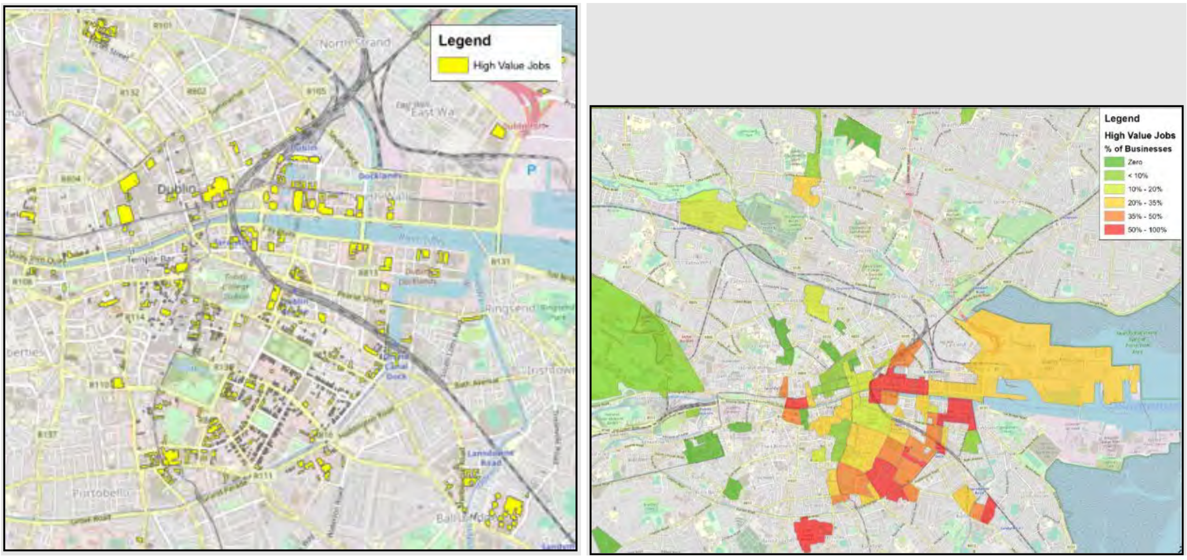
Table 1-24: Employment sectors in Dublin centre

Industry	Persons at work
Computer programming, consultancy and Information service activities	31,251
Hospital activities	28,767
Public administration compulsory social security activities	27,506
Residential care and social work activities	26,324
Financial service activities, except insurance and pension funding	25,228
Retail sale in non-specialised stores with food, beverages or tobacco predominating	15,613
Restaurants and mobile food service activities	15,509
Primary education	12,745
Higher education	11,732
Insurance, reinsurance and pension funding, except compulsory social security	11,062

Source: Irish Census 2016

Dublin's employment continues to grow strongly, in 2019 Q3 employment in ICT and insurance and real estate activities recorded all-time highs. The industry sectors with the highest levels of productivity, which will drive agglomeration impacts, are computer programming, consultancy and information activities and financial services. Bringing businesses together promotes the clustering effect, increasing the commercial attractiveness for new business to locate within close proximity of other firms in its industry. Large technology clusters are already present in Dublin, especially in and around Docklands. Figure 1-29 presents the percentage of high-value businesses within Dublin, alongside the specific locations of these jobs. This includes legal and accounting, financial services (except insurance and pension funding) and real estate jobs.

Figure 1-29: Location of high value jobs within Dublin city centre



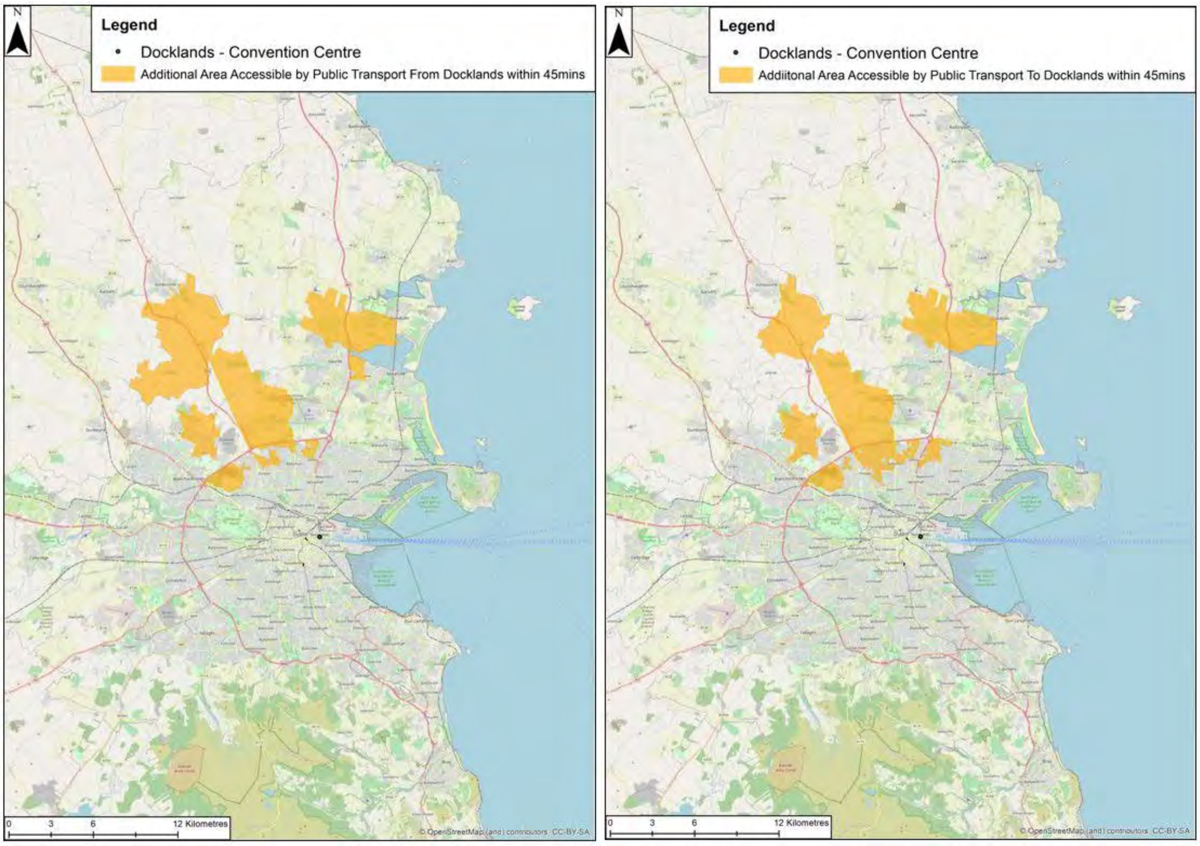
Source: CSO and Jacobs' Analysis

A recent study found that only 8% of residential tenants in Dublin's Docklands are Irish, with 52% classed as European and 32% as international[15]. In that context, there is a growing importance to address the competitiveness challenges associated with housing, infrastructure and costs, if the city is to continue to attract international talent, in high-skilled sectors, such as IT. Failure to address these issues will limit Dublin's ability to compete - for investment and talent - into the next decade. MetroLink will increase Dublin's effective density through shorter journey times by giving employers located along the route better access to a larger, more highly skilled labour market with more choice of skilled employees.

Figure 1-30 illustrates the areas which will have enhanced accessibility to and from Docklands within 45 minutes, when MetroLink is in place. In total an additional 29,100 people are able to access Docklands in less than 45 minutes.

[15] Dublin Economic Monitor: February 2020

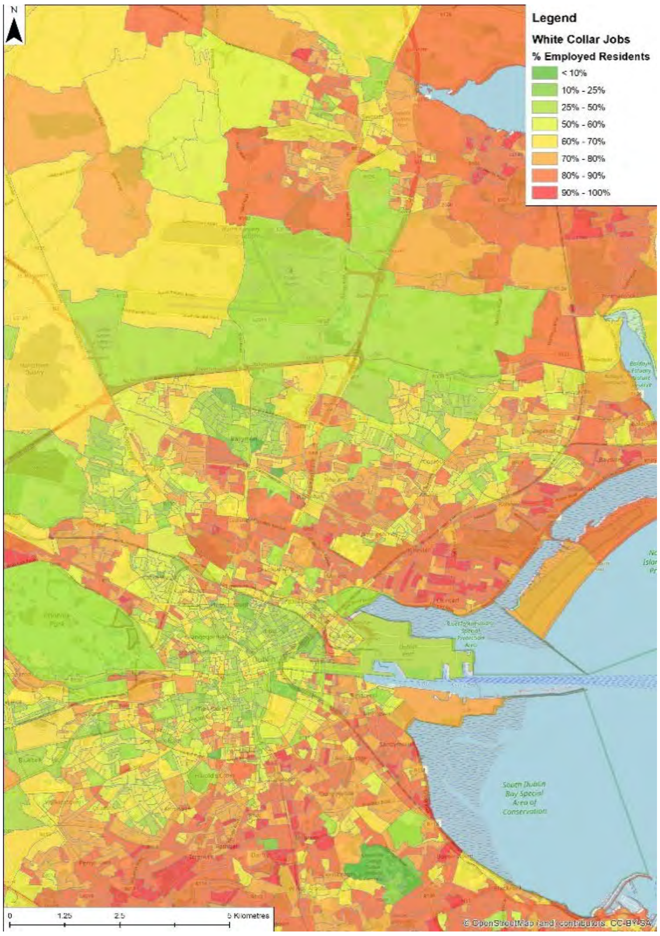
Figure 1-30: Docklands accessibility by origin (left) and by destination (right) in the morning peak by public transport



Source: Jacobs' Analysis

It is not just people working in high tech sectors that will benefit from Metrolink. Figure 1-31: shows the proportion of residents in blue- and white-collar jobs in each zone. It is clear from the figure that there will be benefits to both blue- and white-collar workers.

Figure 1-31: White collar workers as a percentage of total blue and white collar employment (home residence)



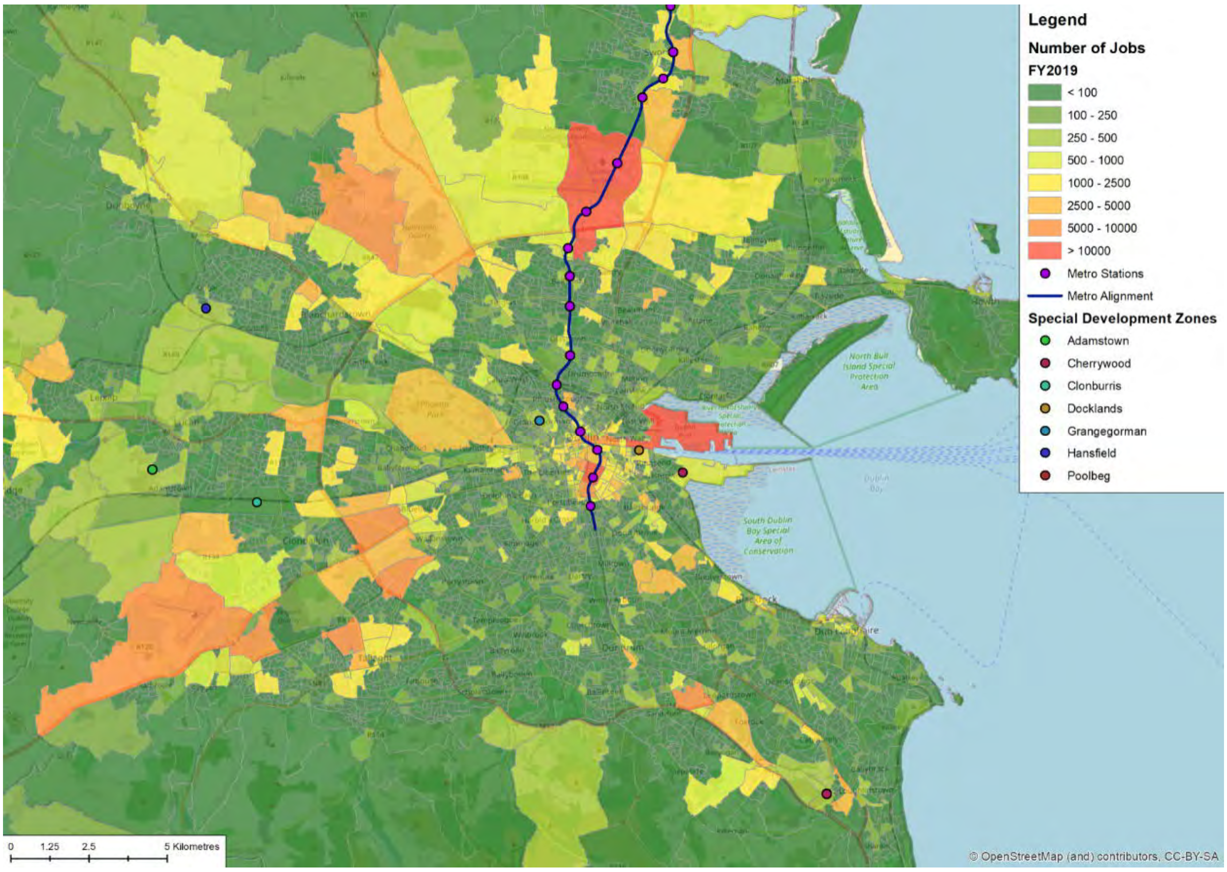
Source: CSO and Jacobs' Analysis

MetroLink will benefit businesses located in Dublin in both the long and short term. Businesses benefit from more efficient logistics, access to new markets for their goods and services, improved productivity and the ability to use a wide pool of labour from local communities both from the new service but also benefiting from reduced road congestion as people switch modes. Reduced transport costs also mean that businesses can connect with potential suppliers, enabling them to access higher-quality and/or lower cost inputs. The impact of MetroLink on the wider economy will be substantial.

The proposed MetroLink corridor also complements the Strategic Development Zones (SDZ) in Dublin, which have been identified by central government as being strategically important. These parcels of land have been designated to stimulate accelerated economic growth through mixed-use development and a fast-tracked planning process, serving both residential and industrial purposes.

Figure 1-32 shows how the Docklands and Grangegorman SDZ lie within the immediate proximity of the MetroLink line. The area covered by both SDZs totals approximately 95 hectares, with an estimated population of 7,800 – 8,300 and employment around 31,000 - 33,000 on completion (expected in 2025)[16]. As the SDZs become viable sites for development and MetroLink reaches completion, it will create dynamic effects promoting the establishment of future clusters and supporting existing clusters in Dublin. Combined with accessibility to Iarnród Éireann services this will make commuting to and from these locations viable for people in the west, north and south of Dublin.

Figure 1-32: Special Development Zone locations

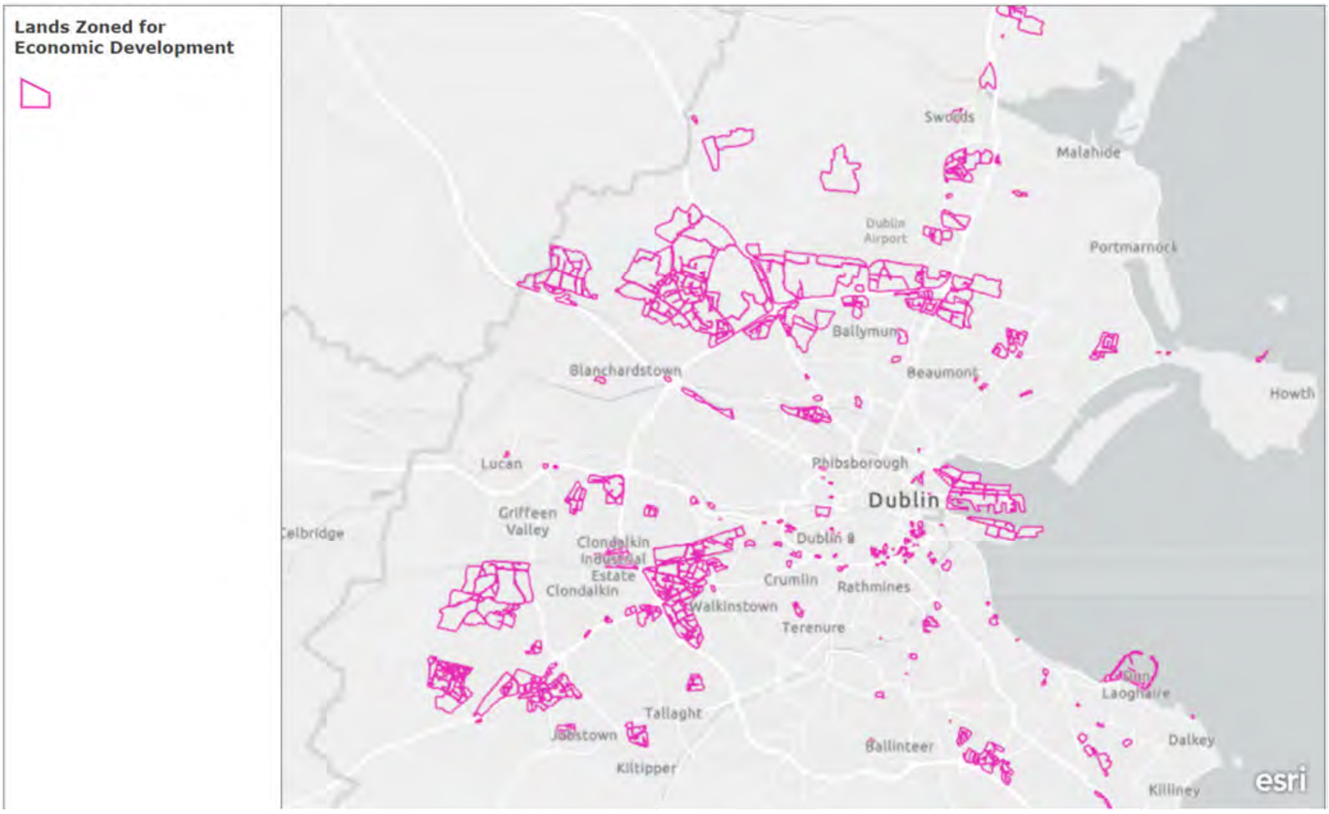


Source: Jacobs' Analysis

[16] Dublin Economic Monitor - Dublin's Strategic Development Zones (2015).

Furthermore, MetroLink will improve the connectivity of the SDZs to Ireland's international gateways such as the airport and the port. The figure above also demonstrates how these zones currently do not provide that many jobs relative to other areas around Dublin. This acts as a strong indicator that the SDZs, in conjunction with MetroLink, will result in the emergence of more jobs, supporting the potential quantum of agglomeration benefits that could be realised in Dublin.

Figure 1-33: Lands zoned for economic development 2017 (CSO)



Source: CSO

Figure 1-33 illustrates geographically delimited areas which the government has zoned for economic development in the GDA. A large cluster of which can be found in the north, specifically around Ballymun, Dublin Airport and Swords. Research identifies the provision of hard and soft infrastructure such as high-quality public transport systems, as critical success factors for zone development and impact[17]. Integrating land-use with transport planning can more easily support active clustering and specialisation efforts in these zones.

[17] Special Economic Zones - United Nations Trade and Development, 2019

The respective initiatives combined have the capacity to become major catalysts for sustainable economic activity in the region and have a compounding effect onto the existing agglomeration impacts in Dublin and beyond. Further considerations should also be made against future development. Within major cities such as Dublin, planning applications are often contingent on the transport network having sufficient capacity to support the expected increase in population/demand.

This demonstrates how MetroLink further supports the necessary accommodation of the expected growth in population and employment stemming from wider strategic objectives. In turn, agglomeration and labour supply impacts are likely to grow as a result of the attractiveness for both workers and firms to relocate or work within the zones. Agglomeration impacts accrue to business and commuting users. For the purpose of this analysis a conservative approach has been adopted, wherein the impacts accruing to business users only are considered. As the scheme progresses, the impact of agglomeration on commuting users will also be estimated.

Using business user time benefits as a proxy for agglomeration, a range of potential agglomeration benefits are estimated. These are presented in Table 1-25 and show that the agglomeration benefits are presently estimated to be in the range of €625-€1,875m.

Table 1-25: Agglomeration benefits[18]

	Value (€m, 2011 prices and values)
Business user time benefit	649
10% agglomeration test	625
30% agglomeration test	1,875

Source: Jacobs' Analysis

More detailed analysis will be undertaken for the FBC to provide a fully quantified assessment of the agglomeration impacts of the scheme.

[18] The test values are based on Feldman O., Nicol J., Simmonds D., Sinclair C., and Skinner A. (2008*) "Use of integrated transport land use models in the wider economic benefits calculations of transport schemes"*. Paper presented at 87th Transportation Research Board Annual Meeting, January 13-17, 2008, Washington, D.C., USA

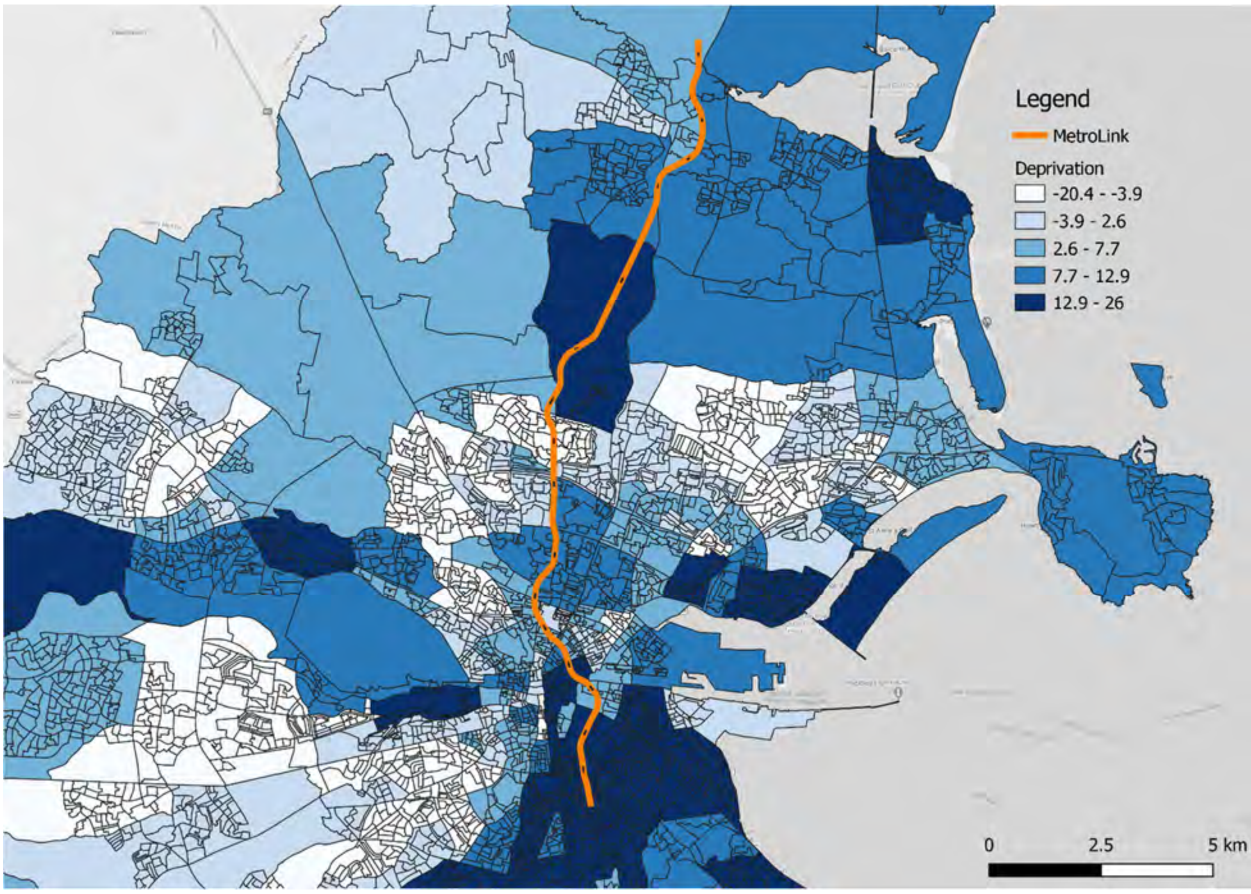
1.11.3 Employment Effects

Employment effects such as productivity or labour supply impacts, due to accessibility changes, are not being considered in detail at this stage, they will be considered for the FBC.

1.12 Distributional Impacts

Evidence suggests that different communities have varying propensities to impacts and benefits created by the scheme as a result of ethnicity, social and demographic structure and relative deprivation. This section provides an overview of how the scheme might impact disproportionately upon some communities and vulnerable people. The aim of the baseline review is to understand the impacts the scheme may have on communities located along the proposed scheme as a result of variations in social and demographic factors and relative deprivation in communities.

Figure 1-34: An Pobal HP Deprivation Index 2011 by Electoral Division (Negative means more deprived)



Source: POBAL

Figure 1-34 presents an assessment of deprivation through the An Pobal Deprivation Index, providing a measure of affluence or disadvantage in Dublin with a low figure representing high deprivation. Statistics such as proportion of skilled professionals, education levels, employment levels and single-parent households are assessed. The indicators show that, across the proposed MetroLink route, the highest levels of deprivation are in East Ballymun (-19.8) and (-20.4) in East Kilmore. To the south of Dublin, are some of the lowest levels of deprivation, with Mansion House (26.0). In light of this, the scheme is expected to improve accessibility and hence opportunities for key areas of deprivation along the northern section of MetroLink. A summary of potential impacts is provided in Table 1-26.

Table 1-26: Distributional Impacts

Deprivation Effect	MetroLink Impact
Construction Phase	As noted, the scheme runs through relatively deprived areas north of Dublin city centre. Although likely to benefit significantly from MetroLink when it is opened, these areas are the ones which will be most affected during the construction phase. People living along the line may be exposed to elevated levels of noise or other disturbances during construction. Detailed modelling will be undertaken to understand fully the likely spatial impacts during and after construction, to understand better precisely which groups will be affected. There may be opportunities for targeted training programmes to allow residents to obtain employment on the construction and operation of the scheme.
Economic Barriers	MetroLink has not yet undertaken an affordability study to assess the impact the fare regime may have on the people using it; however, the scheme does acknowledge that pricing is an important factor in making MetroLink inclusive and accessible to all. A further review will be undertaken, once a detailed fare schedule is agreed, to understand the potential impact that the fare structure will have on vulnerable groups.
Accessibility	Older people have different mobility needs to younger people, requiring a different approach to transport provision. Transport's socially enabling aspects are particularly important for older groups, as giving up driving due to age is linked to a decrease in well-being and an increase in depression and related health problems[19]. There is evidence that people use public transport more as they age – but people that are vulnerable (e.g. those with mobility impairments) are significantly less likely to use public transport[20]. MetroLink will assess the needs of the vulnerable and deprived and implement their requirement into the planning as necessary. A detailed study will be undertaken as part of the next phase.
Employment	The integration of MetroLink with existing modes of transport can improve the employment and economic opportunities for people living along the proposed route, providing access to areas of employment specifically for deprived and

[19] How can Transport and Associated Built Environment Infrastructure be Enhanced and Developed to Support the Mobility needs of Individuals as they Age: 2015

[20] Disabled People's Travel Behaviour and Attitudes to Travel: 2017

Deprivation Effect	MetroLink Impact
	vulnerable persons. A more detailed review will be undertaken for the FBC to understand which segments of the labour market are most likely to benefit from the introduction of MetroLink, and to help ensure that those who currently struggle to access work benefit from its implementation.

Source: Jacobs' Analysis

1.13 Cost Benefit Analysis

The CBA for MetroLink has been carried out using the appraisal parameters set out in the PSC. The following key parameters were assumed for the base case:

- The ERM model opening year is 2030, therefore for economic modelling 2030 has been used as the opening year, current construction program is reflecting the Metro to open during Q1 2031;
- 14 years of spending prior to opening in 2030;
- An appraisal period of 30 years, after opening year (i.e. after 2030);
- A residual value period of a further 30 years;
- A discount rate of 4% for the first 30 years, 3.5% for years 31 to 60, 3% for years 61 - 100;
- A shadow price of public funds to account for the effects of taxation in public spending, which adds 30% on to estimate costs (a shadow price factor of 1.3);
- A shadow price of labour of which does not increase estimated costs (a shadow price factor of 1);
- Prescribed values of time for commuting, business and other trips, provided by the Department of Transport;
- Fuel consumption parameters from UK TAG (necessary for the TUBA software and comparable to CAF parameters);
- Non-fuel costs from CAF;
- Collision and casualty related costs from CAF.

All scheme cost elements are considered in 2011 prices and values, and are net of all indirect taxation and VAT.

This section considers the appraisal of the MetroLink scheme, using the core assumptions. A range of alternate scenarios (which consider the impact of different levels of growth, the impact of the inclusion of complimentary infrastructure and a high cost test, among others) are presented in Section 1.15

Valuations provided by TUBA rely on the model outputs for accuracy. The results in this Appendix should be read in conjunction with the technical modelling documentation to understand the level of confidence which can be placed in each of the tests undertaken.

Table 1-28 provides a summary of the overall benefits that have been monetised to generate the initial (PVB). The project is expected to deliver a core PVB of €15.6bn (2011 prices and values).

Delivery of the scheme in present value of costs (PVC) is an estimated €8.6bn (2011 prices and values). Further details of the costs is given in “ML1-JAI-LSI-ROUT_XX-RP-y-00001_V21 Technical Appendix - Scheme Costs” and “ML1-JAI-LSI-ROUT_XX-RP-y-00001_V21_Financial Case”, with a summary given in Table 1-27

Table 1-27 Costs for CBA (2011 Prices and Values)

Element	Bn (€)
Construction Costs	1.9
Client Costs	0.6
Capex Risk Adjustment	1.7
O&M and Renewals	0.7
Unitary Charges	1.5
Total funding requirement	6.4
Additional Shadow Price Adjustment	1.9
Passenger / user revenue	0.3
Net funding requirement	8.6

Source: Jacobs Analysis

This generates an NPV of €7.0bn (2011 prices and values), and a scheme benefit to cost ratio (BCR) of 1.8:1.

Table 1-28: Core Scenario AMCB Table (€000's), 2011 values and prices.

Analysis of Monetised Costs and Benefits

Accidents	€	33,207	*(17)*
Economic Efficiency: Consumer Users (Commuting)	€	2,444,018	*(1a)*
Economic Efficiency: Consumer Users (Other)	€	5,925,542	*(1b)*
Economic Efficiency: Business Users and Providers	€	7,268,100	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-€	43,337	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	€	15,627,530	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	€	8,616,686	*(10)*
Present Value of Costs (see notes) (PVC)	€	8,616,686	*(PVC) = (10)*
OVERALL IMPACTS			
Net Present Value (NPV)	€	7,010,844	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		1.8	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Source: Jacobs' Analysis

The scheme will also give rise to non-user impacts such as increase in output in imperfectly competitive markets, land value uplift and agglomeration. These benefits have been combined under “non-user impacts”. To account for the range in which the agglomeration benefits could lie between, the adjusted AMCB, Table 1-29, captures a range in the PVB. The adjusted PVB is between €17.7-€19.0bn (2011 prices and values). The adjusted BCR subsequently is between 2.2-2.3.

Table 1-29: Core Scenario Adjusted AMCB Table (€000’s), 2011 values and prices.

Analysis of Monetised Costs and Benefits

Non-user impacts	€ 3,124,147	€ 4,374,074	*(16)*
Accidents	€ 33,207	€ 33,207	*(17)*
Economic Efficiency: Consumer Users (Commuting)	€ 2,444,018	€ 2,444,018	*(1a)*
Economic Efficiency: Consumer Users (Other)	€ 5,925,542	€ 5,925,542	*(1b)*
Economic Efficiency: Business Users and Providers	€ 7,268,100	€ 7,268,100	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-€ 43,337	-€ 43,337	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	€ 18,751,677	€ 20,001,604	*(PVB) = (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	€ 8,616,686	€ 8,616,686	*(10)*
Present Value of Costs (see notes) (PVC)	€ 8,616,686	€ 8,616,686	*(PVC) = (10)*
OVERALL IMPACTS			
Net Present Value (NPV)	€ 10,134,991	€ 11,384,918	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	2.2	2.3	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Source: Jacobs’ Analysis

The Economic Efficiency of the Transport System (TEE) Table 1-30 captures the travel time, VOC, user charges by user class. The table also captures the private sector provider impacts generated through the PPP delivery mechanism. The Present Value of Transport Economic Efficiency Benefits is €15.6bn.

Table 1-30: Core Scenario TEE Table (€000's), 2011 values and prices.

Non-business: Commuting	**ALL MODES**		**Highways**		**Public Transport**	
User benefits	**TOTAL**				**Passengers**	
Travel time	€ 2,315,808		€ 526,223		€ 1,789,585	
Vehicle operating costs	€ 17,371		€ 17,371		€ -	
User charges	€ 110,839		€ 52,111		€ 58,728	
During Construction & Maintenance	€ -		€ -		€ -	
NET NON-BUSINESS BENEFITS: COMMUTING	€ 2,444,018	*(1a)*	€ 595,705		€ 1,848,313	
Non-business: Other	**ALL MODES**		**Highways**		**Public Transport**	
User benefits	**TOTAL**				**Passengers**	
Travel time	€ 5,364,249		€ 1,396,198		€ 3,968,051	
Vehicle operating costs	€ 240,187		€ 240,187		€ -	
User charges	€ 321,106		€ 48,442		€ 272,664	
During Construction & Maintenance	€ -		€ -		€ -	
NET NON-BUSINESS BENEFITS: OTHER	€ 5,925,542	*(1b)*	€ 1,684,827		€ 4,240,715	
Business			**Highways**		**Public Transport**	**Investment**
User benefits			**Road Personal**	**Road Freight**	**Passengers**	
Travel time	€ 6,020,092		€ 2,488,903	€ 545,405	€ 2,985,784	
Vehicle operating costs	€ 78,409		€ 39,230	€ 39,179	€ -	
User charges	€ 151,132		€ 20,652	€ 40,253	€ 90,227	
During Construction & Maintenance	€ -		€ -	€ -	€ -	
Subtotal	€ 6,249,633	*(2)*	€ 2,548,785	€ 624,837	€ 3,076,011	
Private sector provider impacts						
Revenue	€ 1,742,684				€ 204,534	€ 1,538,150
Operating costs	€ -					
Investment costs	-€ 724,218					-€ 724,218
Grant/subsidy	€ -					
Subtotal	€ 1,018,467	*(3)*	€ -		€ 204,534	€ 813,933
Other business impacts						
Developer contributions		*(4)*				
NET BUSINESS IMPACT	€ 7,268,100	*(5) = (2) + (3) + (4)*	€ 2,548,785	€ 624,837	€ 3,280,545	€ 813,933
TOTAL Present Value of Transport Economic Efficiency Benefits (TEE)	€ 15,637,660	*(6) = (1a) + (1b) + (5)*				

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2011 prices and values

Source: Jacobs' Analysis

Table 1-31 shows the Public Accounts (PA) table. This captures the costs that will accrue to the public sector as a result of the scheme being delivered. In 2011 present values and prices, the scheme is estimated to the cost the public purse €8.6bn (2011 prices and values).

Table 1-31: Core Scenario PA Table (€000's), 2011 values and prices.

	ALL MODES		Highways	Public Transport
Local Government Funding	TOTAL		INFRASTRUCTURE	
Revenue				
Operating Costs				
Investment Costs				
Developer and Other Contributions				
Grant/Subsidy Payments				
NET IMPACT	€ -	(7)		
Central Government Funding: Transport				
Revenue	€ 342,772		€ 365,498	-€ 22,726
Operating costs	€ 897,127			€ 897,127
Investment Costs	€ 7,376,787			€ 7,376,787
Developer and Other Contributions	€ -			
Grant/Subsidy Payments	€ -			
NET IMPACT	€ 8,616,686	(8)		
Central Government Funding: Non-Transport				
Indirect Tax Revenues	€ 43,337	(9)	€ 8,053	€ 35,284
TOTALS				
Broad Transport Budget	€ 8,616,686	(10) = (7) + (8)		
Wider Public Finances	€ 43,337	(11) = (9)		

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2011 prices and values.

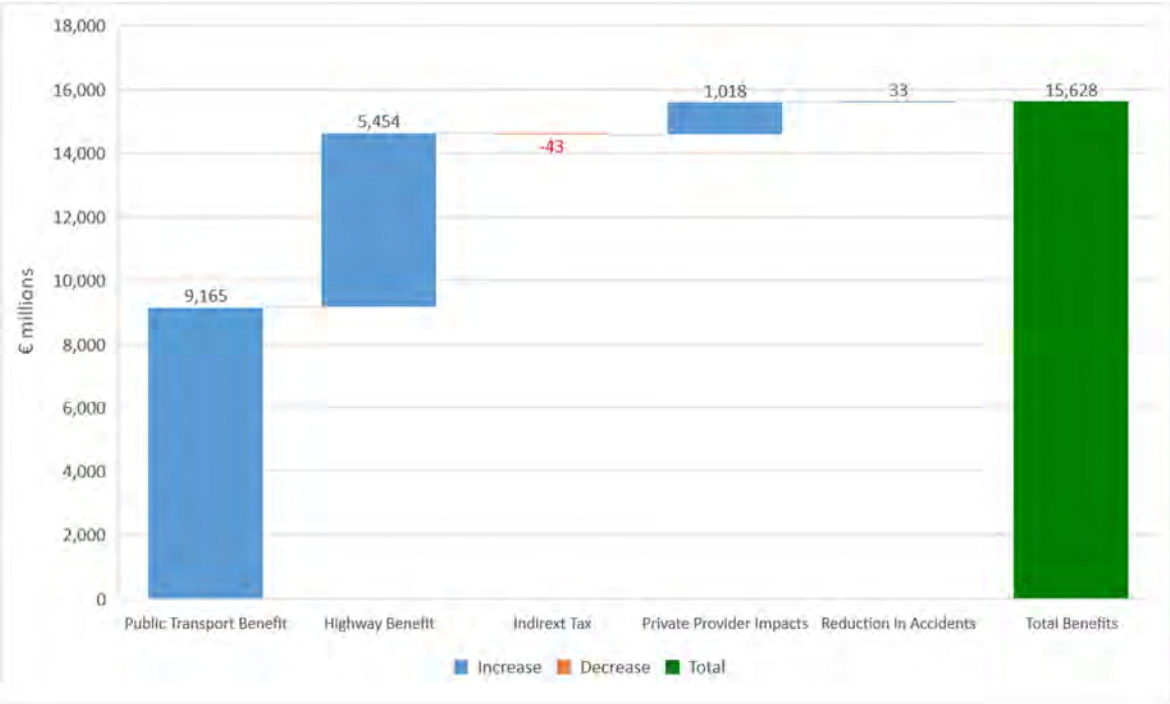
Source: Jacobs' Analysis

1.14 Project Appraisal Balance Sheet (PABS)

1.14.1 Overview

The value for money (VfM) assessment of a scheme considers not just the monetised costs and benefits, which are used to inform its NPV, its BCR and its Economic Internal Rate of Return (EIRR), but also the effect of other, qualified impacts. TII requires schemes to undertake a Project Appraisal Balance Sheet (PABS). The purpose of PABS is to provide a summary appraisal of project impacts based on qualitative and quantitative outcomes obtained from the Multi-Criteria Analysis (MCA) assessment. PABS is a mechanism used by the TII to easily compare schemes across the country in order to prioritize schemes for investments.

Figure 1-35: Total MetroLink Benefits (2011 prices and values, 60-year appraisal)



Source: Jacobs' Analysis

Figure 1-35 shows the contribution in € millions of the different components of the impact for MetroLink. It is estimated that MetroLink could generate €15.6bn of benefits over the appraisal period. Most benefits originate from public transport and highway with a large share also stemming from agglomeration. These numbers may change as further appraisal work may be undertaken as part of the full business case. Quantitative impacts is one medium in which MetroLink may benefit Ireland, however Table 1-33 also provides a summary of further impacts that have been assessed qualitatively.

1.14.2 Outcome

The PABS identifies three important elements in a scheme.

1. The qualitative statement summarises the impact of the project in qualitative terms,

2. The quantitative statement, identifies the impacts of the scheme that are monetised; and

3. A scaling statement that ranks the project according to a seven-point scale.

Table 1-33 lists the different objectives the scheme can deliver and if they have been assessed qualitatively or quantitatively. MetroLink's objectives have been aligned to five of the seven CAF objectives: Economy, Safety, Integration, Environment, and Accessibility and Social Inclusion. Below is a summary of how MetroLink will deliver the objectives set out by the CAF. MetroLink will:

1. provide great opportunities to maximise the potential of Dublin, providing both increased economic and environmental benefits, as well as improving safety, accessibility, integration and social inclusion, contributing to the creation of a sustainable, forward-looking city.

2. support the economy in a number of ways, such as by supporting the growing travel demand along the corridor driven by a strong growth in the local population (Section 0). The capital expenditure will help create direct, indirect and induced jobs during the construction phase creating legacy benefits for Dublin and Ireland as a whole (Section 1.4).

3. reduce journey times for individuals along the north Dublin Fingal corridor and help shift people away from single car journeys and onto public transport effectively reducing urban congestion in Dublin (Section 1.2).

4. likely reduce the number of trips on other modes of transport, potentially easing congestion and providing time savings on the Dublin transport network generating transport benefits for Dublin as a whole.

5. help deliver the nation's strategy to improve transport safety and security in Dublin. People will switch from commuting by car to commuting by metro, reducing congestion and traffic on the road network. A reduction in the number of cars on Dublin's road is likely to reduce the number of accidents, due to a re-balance of vehicle speeds and a change in flows (Section 1.3).

6. offer convenient connections via interchange nodes with Iarnród Éireann lines, DART, Luas and BusConnects (Section 1.5) and with pre-existing bike lanes and park and ride options. A seamless integration between all modes of transport, supported by a fully integrated

ticketing system (Section 1.5) is vital to ensure that people will get out of the comfort of their cars and onto public transport.

7. help reduce CO2 emissions, improve air quality, lower noise pollution and encourage regeneration where needed making Dublin a better place to live, work, shop or visit. Radical interventions, such as MetroLink, are needed to shift Ireland onto a low carbon pathway as it manages an increasing population and more demand for housing and employment.

8. help promote social inclusion by tackling accessibility problems experienced by those more disadvantaged in society. The entire length of the system, inclusive of all stations, will be accessible for wheelchair and pushchair users.

9. be equipped with audio and visual devices that will assist people with visual or hearing difficulties. The barriers on every platform will also give people an extra layer of safety that will help prevent accidental falls and other injuries. At its core MetroLink is a people focused scheme with "accessibility for all" at the centre of its planning and design work.

Table 1-32 provides the analysis scale for the PABS, and Table 1-33 provides the PABS itself.

Table 1-32 Multi Criteria Analysis Scale

Multi Criteria Analysis Scale		
Highly Positive	7	Highly Positive
Moderately Positive	6	Moderately Positive
Minor or Slightly Positive	5	Slightly Positive
Neutral	4	Neutral
Minor or Slightly Negative	3	Slightly Negative
Moderately Negative	2	Moderately Negative
Highly Negative	1	Highly Negative

Source: Common Appraisal Framework

INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER NOTE

JACOBS IDOM

Table 1-33: Project Appraisal Balance Sheet (PABS)

Criteria	Qualitative statement	Quantitative statement	Sub-criteria score (1-7 where 7 is the highest)	Appraisal criteria score
Economy				
Transport Efficiency and Effectiveness		Scheme will deliver a significant reduction in travel times. PVB: €15.6 billion.	7	Significantly Positive
Transport Reliability and Quality	Operate with greater reliability and frequency than other modes of mass transit such as Luas		6	
Wider Economic Impacts	Inward Investment: MetroLink is a high-quality transport investment, and is likely to help facilitate inward investment. Employment Benefits: Employment impacts due to changes in effective return to labour are likely to be an additional benefit of the scheme.	Agglomeration: Scheme will deliver a significant reduction in travel times leading to large agglomeration benefits PVB: €3.1-4.4bn Employment Impacts: MetroLink will support 11,400-13,400 FTE, through direct, indirect and induced employment effects.	7	

INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER NOTE

Criteria	Qualitative statement	Quantitative statement	Sub-criteria score (1-7 where 7 is the highest)	Appraisal criteria score
Safety				
Safety		Scheme predicted to decrease the overall number of fatalities, as well as serious and slight casualties. Monetary Benefit: €33.2 million	4	Neutral
Physical Activity				
Physical Activity	People who use public transport are more physically active than people who use their car[21]. MetroLink will reduce the reliance on private cars and shift people towards public transport. The scheme will also offer walking and cycling solutions, such as covered bike parking. Overall MetroLink is anticipated to offer a marginal positive impact on physical activity.		4	Neutral
Environment				

[21] Victorian Integrated Survey of Travel and Activity (VISTA), 2014

Criteria	Qualitative statement	Quantitative statement	Sub-criteria score (1-7 where 7 is the highest)	Appraisal criteria score
Air Quality	MetroLink will help reduce road congestion, energy and oil consumption and thus contribute to improvement in air quality.		5	Neutral
Noise and Vibration	It is anticipated that the overall impact will be marginally positive, with improvements caused by a reduction in highway traffic offset to some extent by an increase in noise and vibration caused by the MetroLink rolling stock.		4	
Landscape and Visual Quality	Modern stations are expected to interact with the urban environment and increase rather than decrease the value of the public space. Additionally, the design will be appropriate to Dublin and provide context and character.		4	
Environment				
Cultural, Archaeological, and Architectural Heritage	Tunnelling and construction works will enable archaeological explorations to take place.		4	Neutral

Criteria	Qualitative statement	Quantitative statement	Sub-criteria score (1-7 where 7 is the highest)	Appraisal criteria score
Land use, soils, and geology	Likely to be a large impact on land-use. Positive land use change associated with desired development facilitated by MetroLink will be partially offset by the need to purchase land for the construction of MetroLink.		4	
Water resources			Not Applicable	
Accessibility and Social Inclusion				
Vulnerable Groups	It is anticipated that MetroLink will have a positive impact for vulnerable groups by improving accessibility.		5	Moderately Positive
Deprived Geographic Areas	It is anticipated that MetroLink will have a strong positive impact for within deprived geographic areas – facilitating regeneration and access to employment and amenities.		6	
Integration				

Criteria	Qualitative statement	Quantitative statement	Sub-criteria score (1-7 where 7 is the highest)	Appraisal criteria score
Transport Integration	Full integration with all major and minor forms of public transport in Dublin, including an integrated ticketing system		6	Moderately Positive
Land Use Integration	Fully supportive of policy of integrating land-use with transport planning on a national and local level. Increases accessibility, to SDZ's, low and high density and mixed land-use. Supports the commercial viability of land along the MetroLink corridor and through the GDA due to the scheme's strong emphasis on transport integration.		6	
Geographical Integration	MetroLink is designed to be fully compatible with the objectives of the NPF 2040 and other regional and local relevant policies		6	
Other Governmental Policy Integration	MetroLink has fully considered local, national and international governmental policies and has aligned its objectives and delivery of the scheme accordingly.		6	

Source: Common Appraisal Framework and Jacobs

1.15 Sensitivity Tests

In line with guidance, it is necessary to undertake sensitivity tests, to understand a range of impacts as a result of variance from the central scenario as outlined below.

1.15.1 Not Used

Not Used

1.15.2 Low Growth Scenario

The low growth scenario assumes that underlying transport usage grows at a lower rate than in the core scenario. It assumes that growth is roughly 20% below the level in the core scenario in 2030 and 25% below in 2045.

Under this scenario, the PVB is lower, whilst the PVC remains the same. The changes to the PVB are captured in the AMCB/TEE tables presented in Table 1-34 Low Growth Scenario. Under this scenario accident benefits increase marginally, however the transport user benefits generated through TUBA decrease. The revised PVB is €13.6bn (2011 prices and values), resulting in a lower NPV of €5bn (2011 prices and values). The BCR is 1.6.

Table 1-34 Low Growth Scenario AMCB Table (€000's), 2011 values and prices.

Analysis of Monetised Costs and Benefits

Accidents	€	40,186	*(17)*
Economic Efficiency: Consumer Users (Commuting)	€	2,315,655	*(1a)*
Economic Efficiency: Consumer Users (Other)	€	5,017,867	*(1b)*
Economic Efficiency: Business Users and Providers	€	6,287,808	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-€	42,507	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	€	13,619,009	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	€	8,587,362	*(10)*
Present Value of Costs (see notes) (PVC)	€	8,587,362	*(PVC) = (10)*
OVERALL IMPACTS			
Net Present Value (NPV)	€	5,031,647	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		1.6	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Source: Jacobs' Analysis

The TEE Table 1-35 presents the benefit break down in more detail by user class as well as by mode.

Table 1-35 Low Growth Scenario TEE Table (€000's), 2011 values and prices.

	ALL MODES TOTAL		Highways		Public Transport Passengers	
Non-business: Commuting						
User benefits						
Travel time	€ 2,189,732		€ 479,162		€ 1,710,550	
Vehicle operating costs	€ 11,582		€ 11,582		€ -	
User charges	€ 114,341		€ 55,865		€ 58,476	
During Construction & Maintenance	€ -		€ -		€ -	
NET NON-BUSINESS BENEFITS: COMMUTING	€ 2,315,655	(1a)	€ 546,629		€ 1,769,026	
Non-business: Other						
User benefits						
Travel time	€ 4,502,143		€ 1,110,368		€ 3,391,775	
Vehicle operating costs	€ 223,236		€ 223,236		€ -	
User charges	€ 292,488		€ 51,476		€ 241,012	
During Construction & Maintenance	€ -		€ -		€ -	
NET NON-BUSINESS BENEFITS: OTHER	€ 5,017,867	(1b)	€ 1,385,080		€ 3,632,787	
Business			Highways		Public Transport	Investment
User benefits			Road Personal	Road Freight	Passengers	
Travel time	€ 5,022,516		€ 2,068,563	€ 385,702	€ 2,568,253	
Vehicle operating costs	€ 67,009		€ 33,582	€ 33,427	€ -	
User charges	€ 141,332		€ 20,571	€ 39,656	€ 81,105	
During Construction & Maintenance	€ -		€ -	€ -	€ -	
Subtotal	€ 5,230,859	(2)	€ 2,122,716	€ 458,785	€ 2,649,358	
Private sector provider impacts						
Revenue	€ 1,781,167				€ 243,016	€ 1,538,150
Operating costs	€ -					
Investment costs	-€ 724,218					-€ 724,218
Grant/subsidy	€ -					
Subtotal	€ 1,056,949	(3)	€ -		€ 243,016	€ 813,933
Other business impacts						
Developer contributions		(4)				
NET BUSINESS IMPACT	€ 6,287,808	(5) = (2) + (3) + (4)	€ 2,122,716	€ 458,785	€ 2,892,374	€ 813,933
TOTAL						
Present Value of Transport Economic Efficiency Benefits (TEE)	€ 13,621,330	(6) = (1a) + (1b) + (5)				

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2011 prices and values

Source: Jacobs' Analysis

1.15.3 High Cost Scenario

Under this sensitivity it is assumed that the construction and operational, maintenance and renewal costs all increase by 30%. The Impact of this can be seen across the TEE/PA/AMCB tables. The increase in scheme cost assumes that the Delivery Partner will also increase the initial contribution under the PPP agreement. The Unitary charge is also assumed to increase by 30%.

The impacts at a high level are summarised in the AMCB Table 1-36. Under the high cost scenario, the PVC increases to €11.1bn (2011 prices and values), with the NPV decreasing to €4.8bn (2011 prices and values). The schemes BCR with the cost increase would be an estimated 1.4.

Table 1-36 High Cost Scenario AMCB Table (€000's), 2011 values and prices.

Analysis of Monetised Costs and Benefits

Accidents	€	33,207	(17)
Economic Efficiency: Consumer Users (Commuting)	€	2,444,018	(1a)
Economic Efficiency: Consumer Users (Other)	€	5,925,542	(1b)
Economic Efficiency: Business Users and Providers	€	7,512,280	(5)
Wider Public Finances (Indirect Taxation Revenues)	-€	43,337	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	€	15,871,710	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	€	11,098,860	(10)
Present Value of Costs (see notes) (PVC)	€	11,098,860	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	€	4,772,850	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		1.4	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Source: Jacobs' Analysis

The PA Table (Table 1-37 High Cost Scenario) presents the impact of the increase in costs to the public purse.

Table 1-37 High Cost Scenario PA Table (€000's), 2011 values and prices.

	ALL MODES TOTAL		INFRASTRUCTURE Highways	INFRASTRUCTURE Public Transport
Funding				
Revenue				
Operating Costs				
Investment Costs				
Contributions				
Grant/Subsidy Payments				
NET IMPACT	0	*(7)*		
Transport				
Revenue	€ 342,772		€ 365,498	-€ 22,726
Operating costs	€ 1,166,265			€ 1,166,265
Investment Costs	€ 9,589,823			€ 9,589,823
Developer and Other Contributions	€ -			
Grant/Subsidy Payments	€ -			
NET IMPACT	€ 11,098,860	*(8)*		
Central Government Funding: Non-Transport				
Indirect Tax Revenues	€ 43,337	*(9)*	€ 8,053	€ 35,284
TOTALS				
Broad Transport Budget	€ 11,098,860	*(10) = (7) + (8)*		
Wider Public Finances	€ 43,337	*(11) = (9)*		

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2011 prices and values.

Source: Jacobs' Analysis

The TEE Table (Table 1-38) presents the benefit breakdown in more detail by user class as well as by mode.

Table 1-38: High Cost Scenario TEE Table (€000's), 2011 values and prices.

	ALL MODES		Highways		Public Transport	
Non-business: Commuting	**ALL MODES**		**Highways**		**Public Transport**	
User benefits	**TOTAL**				**Passengers**	
Travel time	€ 2,315,808		€ 526,223		€ 1,789,585	
Vehicle operating costs	€ 17,371		€ 17,371		€ -	
User charges	€ 110,839		€ 52,111		€ 58,728	
Maintenance	€ -		€ -		€ -	
NET NON-BUSINESS BENEFITS: COMMUTING	€ 2,444,018	*(1a)*	€ 595,705		€ 1,848,313	
Non-business: Other	**ALL MODES**		**Highways**		**Public Transport**	
User benefits	**TOTAL**				**Passengers**	
Travel time	€ 5,364,249		€ 1,396,198		€ 3,968,051	
Vehicle operating costs	€ 240,187		€ 240,187		€ -	
User charges	€ 321,106		€ 48,442		€ 272,664	
Maintenance	€ -		€ -		€ -	
OTHER	€ 5,925,542	*(1b)*	€ 1,684,827		€ 4,240,715	
Business			**Highways**		**Public**	**Investment**
User benefits			**Road Personal**	**Road Freight**	**Passengers**	
Travel time	€ 6,020,092		€ 2,488,903	€ 545,405	€ 2,985,784	
Vehicle operating costs	€ 78,409		€ 39,230	€ 39,179	€ -	
User charges	€ 151,132		€ 20,652	€ 40,253	€ 90,227	
Maintenance	€ -		€ -	€ -	€ -	
Subtotal	€ 6,249,633	*(2)*	€ 2,548,785	€ 624,837	€ 3,076,011	
Private sector provider impacts						
Revenue	€ 2,204,129				€ 204,534	€ 1,999,595
Operating costs	€ -					
Investment costs	-€ 941,483					-€ 941,483
Grant/subsidy	€ -					
Subtotal	€ 1,262,647	*(3)*	€ -		€ 204,534	€ 1,058,113
Other business impacts						
Developer contributions		*(4)*				
NET BUSINESS IMPACT	€ 7,512,280	*(5) = (2) + (3) + (4)*	€ 2,548,785	€ 624,837	€ 3,280,545	€ 1,058,113
TOTAL						
Present Value of Transport Economic Efficiency Benefits (TEE)	€ 15,881,840	*(6) = (1a) + (1b) + (5)*				

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2011 prices and values

Source: Jacobs' Analysis

1.15.4 Alternative Growth Scenario

Under this scenario only the present value of benefits delivered through the scheme proposals change as a result of one possible outcome of the economic impact of COVID-19. The present value of costs is assumed to be the same.

In broad terms the alternative growth scenario assumes that the reduction in travel due to COVID reduces, and that by 2030 the same level of transport use occurs as in the final year pre-COVID. Transport use grows from that point, and in 2045 has reached levels that were assumed by 2035 if the pandemic had not occurred.

The rate at which transport use will return is uncertain at this time, and this test is informed by parameters provided by the NTA for us in COVID-19 scenario testing.

The present value of benefits under this scenario reduce to €13.5bn (2011 prices and values), this subsequently leads to a reduction in the NPV, with the new estimate at €5bn (2011 prices and values). The benefit to cost ratio reduces to 1.6 as a result of the economic impact of COVID -19.

Table 1-39 Alternative Growth Scenario AMCB Table (€000's), 2011 values and prices.

Accidents	€	33,207	*(17)*
Economic Efficiency: Consumer Users (Commuting)	€	1,842,535	*(1a)*
Economic Efficiency: Consumer Users (Other)	€	5,402,196	*(1b)*
Economic Efficiency: Business Users and Providers	€	6,322,731	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-€	50,930	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	€	13,549,739	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	€	8,594,886	*(10)*
Present Value of Costs (see notes) (PVC)	€	8,594,886	*(PVC) = (10)*
OVERALL IMPACTS			
Net Present Value (NPV)	€	4,954,853	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		1.6	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Source: Jacobs' Analysis

The TEE Table (Table 1-40) presents the benefit breakdown in more detail by user class as well as by mode.

Table 1-40:Alternative Growth Scenario TEE Table (€000's), 2011 values and prices.

Non-business: Commuting	ALL MODES		Highways	Public Transport
User benefits	TOTAL			Passengers
Travel time	€ 1,739,521		€ 424,290	€ 1,315,231
Vehicle operating costs	-€ 4,238		-€ 4,238	€ -
User charges	€ 107,252		€ 54,218	€ 53,034
During Construction & Maintenance	€ -		€ -	€ -
NET NON-BUSINESS BENEFITS: COMMUTING	€ 1,842,535	*(1a)*	€ 474,270	€ 1,368,265

Non-business: Other	ALL MODES		Highways	Public Transport
User benefits	TOTAL			Passengers
Travel time	€ 4,854,505		€ 1,264,816	€ 3,589,689
Vehicle operating costs	€ 236,622		€ 236,622	€ -
User charges	€ 311,069		€ 54,094	€ 256,975
During Construction & Maintenance	€ -		€ -	€ -
NET NON-BUSINESS BENEFITS: OTHER	€ 5,402,196	*(1b)*	€ 1,555,532	€ 3,846,664

Business			Highways		Public Transport	Investment
User benefits			Road Personal	Road Freight	Passengers	
Travel time	€ 5,009,413		€ 2,120,090	€ 426,155	€ 2,463,168	
Vehicle operating costs	€ 69,254		€ 34,045	€ 35,209	€ -	
User charges	€ 151,053		€ 23,481	€ 46,290	€ 81,282	
During Construction & Maintenance	€ -		€ -	€ -	€ -	
Subtotal	€ 5,229,720	*(2)*	€ 2,177,616	€ 507,654	€ 2,544,450	
Private sector provider impacts						
Revenue	€ 1,817,229				€ 279,078	€ 1,538,150
Operating costs	€ -					
Investment costs	-€ 724,218					-€ 724,218
Grant/subsidy	€ -					
Subtotal	€ 1,093,011	*(3)*	€ -		€ 279,078	€ 813,933
Other business impacts						
Developer contributions		*(4)*				
NET BUSINESS IMPACT	€ 6,322,731	*(5) = (2) + (3) + (4)*	€ 2,177,616	€ 507,654	€ 2,823,528	€ 813,933

TOTAL Present Value of Transport Economic Efficiency Benefits (TEE)	€ 13,567,462	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2011 prices and values

Source: Jacobs' Analysis

1.15.5 Delivery of Complimentary Infrastructure Scenario

This test includes all infrastructure included within the National Development Plan, within the Do Minimum. Full details can be found in in "ML1-JAI-TRA-ROUT_XX-PL-Y-00001 Traffic Modelling Plan", but in summary the following schemes are included, above what is considered within the core case:

1. Complete DART expansion (non-tunnel elements)
2. Full Bus Connects Routes and Services
3. Enhanced Rail and Bus Park and Ride provision
4. Greater Dublin Area Park and Ride

As well as these named schemes are range of more minor highway improvements are included within the model.

The impact of this is a reduction in the quantum of present value of benefits that can be attributed to the delivery of this scheme. The present value of benefits are an estimated €12.9bn (2011 prices and values), giving rise to a lower NPV of €4.6bn (2011 prices and values). The benefit to cost ratio is 1.5.

INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER NOTE

Table 1-41 Complementary Infrastructure Scenario AMCB Table (€000's), 2011 values and prices.

Accidents	€	33,207	(17)
Economic Efficiency: Consumer Users (Commuting)	€	1,682,116	(1a)
Economic Efficiency: Consumer Users (Other)	€	5,403,863	(1b)
Economic Efficiency: Business Users and Providers	€	5,796,173	(5)
Wider Public Finances (Indirect Taxation Revenues)	€	22,745	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	€	12,938,104	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	€	8,358,483	(10)
Present Value of Costs (see notes) (PVC)	€	8,358,483	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	€	4,579,621	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		1.5	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Source: Jacobs' Analysis

The TEE Table (Table 1-42) presents the benefit breakdown in more detail by user class as well as by mode.

Table 1-42: Complementary Infrastructure Scenario TEE Table (€000's), 2011 values and prices.

Non-business: Commuting	ALL MODES		Highways	Public Transport
User benefits	TOTAL			Passengers
Travel time	€ 1,713,127		-€ 76,458	€ 1,789,585
Vehicle operating costs	-€ 85,648		-€ 85,648	€ -
User charges	€ 54,637		-€ 4,091	€ 58,728
During Construction & Maintenance	€ -		€ -	€ -
NET NON-BUSINESS BENEFITS: COMMUTING	€ 1,682,116	*(1a)*	-€ 166,197	€ 1,848,313

Non-business: Other	ALL MODES		Highways	Public Transport
User benefits	TOTAL			Passengers
Travel time	€ 5,104,011		€ 1,135,960	€ 3,968,051
Vehicle operating costs	€ 48,875		€ 48,875	€ -
User charges	€ 250,977		-€ 21,687	€ 272,664
During Construction & Maintenance	€ -		€ -	€ -
NET NON-BUSINESS BENEFITS: OTHER	€ 5,403,863	*(1b)*	€ 1,163,148	€ 4,240,715

Business			Highways		Public Transport	Investment
User benefits			Road Personal	Road Freight	Passengers	
Travel time	€ 4,687,255		€ 1,403,652	€ 297,819	€ 2,985,784	
Vehicle operating costs	€ 32,717		€ 17,063	€ 15,654	€ -	
User charges	€ 57,734		-€ 22,029	-€ 10,464	€ 90,227	
During Construction & Maintenance	€ -		€ -	€ -	€ -	
Subtotal	€ 4,777,706	*(2)*	€ 1,398,686	€ 303,009	€ 3,076,011	
Private sector provider impacts						
Revenue	€ 1,742,684				€ 204,534	€ 1,538,150
Operating costs	€ -					
Investment costs	-€ 724,218					-€ 724,218
Grant/subsidy	€ -					
Subtotal	€ 1,018,467	*(3)*	€ -		€ 204,534	€ 813,933
Other business impacts						
Developer contributions		*(4)*				
NET BUSINESS IMPACT	€ 5,796,173	*(5) = (2) + (3) + (4)*	€ 1,398,686	€ 303,009	€ 3,280,545	€ 813,933

TOTAL Present Value of Transport Economic Efficiency Benefits (TEE)	€ 12,882,152	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2011 prices and values

Source: Jacobs' Analysis

1.15.6 Low Cost Scenario

Under this sensitivity it is assumed that the construction, operational, maintenance and renewal costs all decrease by 30%. The Impact of this can be seen across the TEE/PA/AMCB tables. The decrease in scheme cost assumes that the Delivery Partner will also reduce the initial contribution under the PPP agreement. The Unitary charge subsequently also decreases by 30%.

The impacts at a high level are summarised in the AMCB. Under the low-cost scenario, the PVC decreases to €6.1bn (2011 prices and values), with the NPV decreasing to €9.2bn (2011 prices and values). The schemes BCR with the cost decrease would be an estimated 2.5.

Table 1-43 Low Cost Scenario AMCB Table (€000's), 2011 values and prices.

Source: Jacobs' Analysis

The PA Table (Table 1-43) presents the impact of the decrease in costs to the public purse

Analysis of Monetised Costs and Benefits

Accidents	€	33,207	*(17)*
Economic Efficiency: Consumer Users (Commuting)	€	2,444,018	*(1a)*
Economic Efficiency: Consumer Users (Other)	€	5,925,542	*(1b)*
Economic Efficiency: Business Users and Providers	€	7,023,920	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-€	43,337	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	€	15,383,350	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	€	6,134,512	*(10)*
Present Value of Costs (see notes) (PVC)	€	6,134,512	*(PVC) = (10)*
OVERALL IMPACTS			
Net Present Value (NPV)	€	9,248,838	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		2.5	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

1.15.7 National Development Plan with Alternative Demand

In order to address the request for a further sensitivity test for the Metrolink scheme, we have assessed the results from model runs undertaken for the scheme to date. Our understanding is that a combination of the Enhanced Transport Network – National Development Plan and the Alternative Demand scenario would be appropriate for the additional test required.

This captures the impact of COVID-19 on future trip patterns as well containing transport proposals to be delivered in the State by 2027. Under this scenario, the revised Present Value of Benefits is an estimated €12.7bn (2011 prices and values), which corresponds to a BCR of 1.5. This can be seen in the AMCB table below.

Table 1-44 National Development Plan with Alternative Demand Scenario AMCB Table (€000's), 2011 values and prices.

Analysis of Monetised Costs and Benefits

Noise		(12)
Local Air Quality		(13)
Greenhouse Gases		(14)
Journey Quality		(15)
Physical Activity		(16)
Accidents	€ 33,207	(17)
Economic Efficiency: Consumer Users (Commuting)	€ 1,311,714	(1a)
Economic Efficiency: Consumer Users (Other)	€ 5,870,893	(1b)
Economic Efficiency: Business Users and Providers	€ 5,408,186	(5)
Wider Public Finances (Indirect Taxation Revenues)	€ 30,016	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	€ 12,654,016	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	€ 8,397,090	(10)
Present Value of Costs (see notes) (PVC)	€ 8,397,090	(PVC) = (10)
OVERALL IMPACTS		
Net Present Value (NPV)	€ 4,256,926	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	1.5	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Source: Jacobs' Analysis

Similarly, the revised Present Value of Transport Economic Efficiency (TEE) is an estimated €12.6bn (2011 prices and values),

Table 1-45 National Development Plan with Alternative Demand Scenario TEE Table (€000's), 2011 values and prices.

	ALL MODES		Highways		Public Transport	Investment
Non-business: Commuting	**ALL MODES**		**Highways**		**Public Transport**	
User benefits	**TOTAL**				**Passengers**	
Travel time	€ 1,335,702		-€ 76,458		€ 1,412,160	
Vehicle operating costs	-€ 85,648		-€ 85,648		€ -	
User charges	€ 61,660		-€ 4,091		€ 65,751	
During Construction & Maintenance	€ -		€ -		€ -	
NET NON-BUSINESS BENEFITS: COMMUTING	€ 1,311,714	*(1a)*	-€ 166,197		€ 1,477,911	
Non-business: Other	**ALL MODES**		**Highways**		**Public Transport**	
User benefits	**TOTAL**				**Passengers**	
Travel time	€ 5,244,589		€ 1,135,960		€ 4,108,629	
Vehicle operating costs	€ 48,875		€ 48,875		€ -	
User charges	€ 577,429		-€ 21,687		€ 599,116	
During Construction & Maintenance	€ -		€ -		€ -	
NET NON-BUSINESS BENEFITS: OTHER	€ 5,870,893	*(1b)*	€ 1,163,148		€ 4,707,745	
Business			**Highways**		**Public Transport**	**Investment**
User benefits			**Road Personal**	**Road Freight**	**Passengers**	
Travel time	€ 4,604,343		€ 1,403,652	€ 297,819	€ 2,902,872	
Vehicle operating costs	€ 32,717		€ 17,063	€ 15,654	€ -	
User charges	€ 100,125		-€ 22,029	-€ 10,464	€ 132,618	
During Construction & Maintenance	€ -		€ -	€ -	€ -	
Subtotal	€ 4,737,185	*(2)*	€ 1,398,686	€ 303,009	€ 3,035,490	
Private sector provider impacts						
Revenue	€ 1,395,219				-€ 142,932	€ 1,538,150
Operating costs	€ -					
Investment costs	-€ 724,218					-€ 724,218
Grant/subsidy	€ -					
Subtotal	€ 671,001	*(3)*	€ -		-€ 142,932	€ 813,933
Other business impacts						
Developer contributions		*(4)*				
NET BUSINESS IMPACT	€ 5,408,186	*(5) = (2) + (3) + (4)*	€ 1,398,686	€ 303,009	€ 2,892,558	€ 813,933
TOTAL Present Value of Transport Economic Efficiency Benefits (TEE)	€ 12,590,793	*(6) = (1a) + (1b) + (5)*				

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2011 prices and values

Source: Jacobs' Analysis

1.16 Further Appraisal

Further appraisal work will be undertaken for the FBC and in parallel with the EIA, so that this can inform the development of the scheme taken forward. A key part of any future business case and EIA will be to undertake stakeholder engagement to understand people's concerns and perceptions so that these can be taken into account in assessing the potential impacts this scheme has on those living in areas of deprivation and vulnerable people.

This preliminary business case sets out a justification for the investment that is required. The resources put into developing a preliminary business case should be proportionate to the scale of the proposal. Therefore, we have provided a high-level view of some of the benefits that MetroLink may deliver in the GDA. Further areas of work to be undertaken at FBC include quantifying agglomeration, employment and development impacts.

1.17 Conclusion

The introduction of MetroLink to Dublin is predicted to have a wide-ranging positive impact, across the entire city. Journey times for all purposes will decrease, and people will move from highway to public transport trips, with the associated positive environmental impacts. The largest driver of benefits associated with MetroLink are journey time savings – due both to the faster travel time on MetroLink itself (in comparison to existing public transport infrastructure), and due to the associated decongestion effects which occur as people switch from highway to public transport modes.

It is anticipated that MetroLink will have a wider positive effect than this. It is estimated to support ~11,000 jobs (directly and indirectly) during the construction phase, and to add between €1.2 and €2.5 bn to the economy, post opening due to the transformational effect it will have on business to business interactions and the labour market.

The core scenario predicts benefits worth €15.6Bn, and a BCR of 1.8 – so for every €1 spent, the economy receives €1.80 back. When wider impacts are considered – including the effect of job creation, land value changes and enhancements in business to business interactions - the estimated return is between €2.2 and €2.3 for every €1, spent.

A range of scenarios has been assessed, to understand the impact that MetroLink will have across a range of possible futures. For all of the these the level of benefit associated with MetroLink is above the cost of the scheme, with the lowest return indicating that MetroLink will deliver at least €1.40 for every €1 spent. This helps to provide assurance that MetroLink will deliver value, even of the assumptions used to build the core scenario are not met.

Appendix A. Key Origin Destination Travel Time Impacts

Table 1-46 shows the journey time changes between key origin-destination pairs around Dublin. Negative values are shown in green and represent a travel time reduction. Journey time increases are related to re-routing within the model and are linked to the issues discussed in “Technical Note - Appraisal Travel Cost Assessment”.

Table 1-46 2045 Journey Time Change (Minutes)

Journey Time 2045 DS - 2045 DM Business Case AM Period	O'Connel Street	St. Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connel Street	0.0	0.0	0.0	0.0	-7.5	0.2	0.2	-12.1	0.3	0.2	0.0	0.0	-0.8	-1.1	0.0	0.0	0.0	-26.0	0.8	-23.0
St. Stephen's Green	0.0	0.0	0.1	-2.9	-11.3	0.1	0.2	-14.5	-2.0	0.0	0.0	0.0	-2.2	-3.4	0.0	0.0	0.0	-32.7	-0.9	-14.3
College Street (Trinity)	0.0	0.0	0.0	0.2	-8.3	0.2	0.2	-12.7	0.4	0.1	0.0	0.0	-0.2	-0.9	0.0	0.0	0.0	-27.3	5.3	-8.7
Glasnevin	-3.8	-9.3	-2.1	0.0	-0.1	-6.4	-8.5	2.1	0.2	-16.8	0.4	0.4	-11.7	-0.9	-5.5	-8.7	0.1	-28.7	-14.1	-24.5
DCU	-4.8	-9.9	-4.7	0.1	0.0	-9.9	0.0	0.0	0.3	-16.5	-3.2	-3.2	-12.5	-1.3	-23.0	-15.4	-0.8	-13.5	-12.8	-9.7
Rathgar Road	0.1	0.1	0.2	-4.6	-15.6	0.0	0.3	-18.9	-0.4	0.0	0.2	0.5	-6.6	-5.8	-0.8	-2.9	0.0	-34.3	-1.8	-22.4
Coolock	0.3	0.3	0.2	-7.0	0.2	0.3	0.0	-0.1	0.2	-0.8	0.5	0.3	0.3	-1.0	0.3	0.3	-3.9	0.0	0.3	0.3
Ballymun	-9.3	-14.7	-8.6	2.4	0.0	-15.6	-0.5	0.0	0.3	-20.5	-0.2	-0.2	-21.5	-1.2	-12.4	-18.0	-0.8	-11.1	-10.4	-8.1
Finglas	0.2	-6.2	0.1	-1.0	0.0	-0.7	-0.6	0.0	0.0	-11.7	2.3	2.3	0.0	-1.1	-0.9	-15.5	7.9	-10.3	-11.2	-7.3
Sandyford	0.0	0.0	0.0	-8.2	-15.8	-0.1	-1.2	-18.7	-1.7	0.0	0.0	0.0	-4.1	-6.4	-0.4	-0.3	-0.1	-35.0	-2.3	-23.7
Tallaght	0.0	0.0	0.0	1.7	-6.3	-0.1	0.2	-10.4	1.9	0.1	0.0	0.0	0.2	1.2	0.0	0.0	0.0	-23.6	5.4	-18.5
Red Cow	0.0	0.0	0.0	1.6	-6.2	-0.1	0.2	-10.4	1.4	0.2	0.0	0.0	0.2	1.2	0.0	0.0	0.0	-22.5	7.1	1.8
Blanchardstown	1.6	0.0	0.7	-12.1	-3.5	-1.0	0.1	-8.4	0.0	-1.6	0.2	0.2	0.0	-2.1	0.0	0.0	0.0	-22.3	-2.0	-21.3
Ashbourne	-0.5	-0.5	-0.5	-0.5	-0.2	-0.5	0.0	1.7	-0.7	-2.0	0.3	0.3	-9.3	0.0	-6.9	-14.3	1.2	-18.4	-16.7	3.7
Donabate	5.5	0.0	0.0	7.3	-13.9	1.0	5.6	-14.1	-8.2	-1.8	5.5	5.5	5.5	-17.2	0.0	0.0	0.0	1.0	0.2	-9.1
Balbriggan	0.0	7.8	7.8	-7.7	6.8	8.8	0.2	-16.2	3.6	6.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	3.4	-0.3	2.0
Drogheda	0.0	0.0	0.0	-5.2	0.8	1.0	0.8	4.8	-12.9	-1.7	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	4.1	-0.3	1.1
Swords Pavilion	-15.4	-17.9	-7.7	-40.6	-17.4	-14.1	2.1	-17.3	-18.3	-20.0	-7.6	-7.5	-24.3	-33.3	0.7	0.3	-8.4	0.0	0.0	-9.3
Swords East	2.4	3.5	4.4	-14.6	-15.9	2.7	-0.4	-15.9	-16.9	-4.0	4.2	3.6	-7.4	-25.0	0.8	0.3	0.2	-0.3	0.0	-5.9
Airport	-13.7	-11.8	-7.8	-24.8	-6.9	-21.0	-0.3	-5.7	-6.7	-25.6	-3.6	13.0	-20.4	-14.0	-2.3	0.3	-0.2	3.1	3.5	0.0

Source: Jacobs' Analysis

Appendix K: Monitoring and Evaluation Plan

MetroLink

Monitoring and Evaluation Plan

ML1-JAI-LSI-ROUT_XX-RP-Y-00002 | P02

2021/10/27

MetroLink

Project No:	32108600
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Revision	Date	Description	Author	Checker	Reviewer	Approver
P01	24/11/20	Monitoring and Evaluation Plan	CM	BD	GC	NC
P02	27/10/21	Monitoring and Evaluation Plan rev 2	CM	GC	JS	NC

Contents

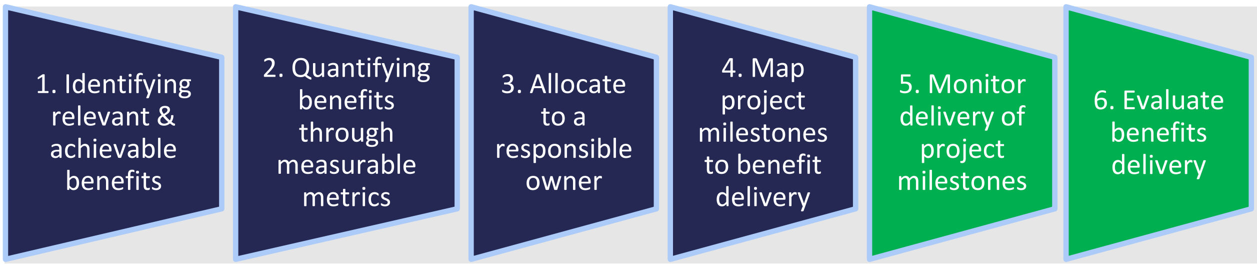
1. Technical Appendix: Monitoring and Evaluation Plan

1.1 Introduction

Monitoring and evaluation will be undertaken, in line with Public Spending Code (PSC) 2019 and Common Appraisal Framework (CAF) 2020 guidance, to assess the realisation of benefits. Benefits realisation is a post-delivery activity. However, effective benefits realisation is dependent on front end programme planning and the establishment of quantifiable metrics to measure the delivery of benefits. The evaluation will inform performance improvement and will be disseminated to the relevant authorities, including the NTA.

The section below details a potential structure for the monitoring and evaluation of MetroLink, this is subject to review and further development at Final Business Case (FBC) stage, to make sure that it includes the final considerations in terms of benefits, planning and construction process and recommendations made by decision makers at the different stages of business case approval.

Figure 1-1-1: Benefits Management Process



It is expected that at FBC stage, responsibility for each area of monitoring and evaluation will be assigned and that this will be overseen by a nominated officer in TII, who will be in charge of managing data gathering plans and monitoring the KPIs identified to measure the performance of the project.

KPIs will be objectively evaluated and where possible baseline data should be captured before commencement of works or when appropriate. Dates will be agreed at FBC through workshops with the relevant parties. The baseline year for monitoring will be the year before main construction works start. Annual progress reports will be published from a year after the opening year.

The spatial extent of monitoring will focus on locations within the catchment areas of new and existing stations which would see significant socio-economic improvements as set out in the Economic Case as a consequence of the scheme.

Reporting process will follow the requirements set out in the PSC and the CAF.

1.2 SMART Objectives

Table 1-1 outlines the project objectives, which gives a comprehensive definition of the issues that Metrolink aims to address. Following PSC guidance, Metrolink has updated some of its objectives to meet specific, measurable, attributable, realistic and time bound (SMART) criteria. These SMART objectives are consistent with those outlined in 'Metrolink Project Objectives and Sub Objectives Paper'.

Table 1-1 MetroLink SMART Objectives

SMART Objective	
1	Cater for existing public transport travel demand and support long-term patronage growth along this corridor through the provision of a high frequency, high-capacity public transport service which supports sustainable economic development and population growth.
2	Deliver an efficient, low carbon and climate resilient public transport service, which contributes to a reduction in congestion on the road network in the Dublin Region and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets
3	Provide a high standard of customer experience including provision for clean, safe, modern vehicles and a reliable and punctual service with regulated and integrated fares*
4	Improve accessibility to jobs, education and other social and economic opportunities through the provision of improved inter-modal connectivity and integration with other public transport services and connectivity for national and international visitors using Dublin Airport
5	Enable compact growth, unlock regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of high capacity Public Transport whilst integrating into the existing public realm

***** Customer experience has not been appraised at PBC stage, yet it may be included as part of the economic appraisal at FBC stage.

Source: TII/Jacobs/Turner & Townsend

1.3 Key Benefits to be Measured

Figure 1-2 expands on the summary table above in the form of a Project Logic Map. Logic mapping is a systematic way of presenting the key steps required in order to turn a set of resources into activities that are designed to lead to a specific set of outcomes. This approach is also referred to as the 'Theory of Change'.

Logic mapping has a number of key components, these are:

- Current Context: The objectives of the intervention and the key issues needing to be addressed.
- Output: What has been produced from the intervention.
- Outcomes: What are the expected short-medium term results and the potential longer term impacts as a result of the intervention.

At the PBC stage it is not appropriate to assign specific KPIs and targets to the project, instead potential outcomes are considered. Later in this report these outcomes are linked to potential indicators and data sets, to show how the final monitoring and evaluation strategy should be structured.

For the purposes of Metrolink, the five SMART objectives indicate the intervention context and the key deliverables Metrolink sets out to achieve. The output outlines the physical output that the intervention will create, which is a sustainable, safe, efficient, integrated and accessible Metro between Swords, Dublin Airport and Dublin City Centre.

Outcomes are categorised into two groups, short-medium term and long-term and incorporate the economic impacts highlighted in the project appraisal balance sheet (PABS) as part of the economic appraisal. The short-medium term outcomes are the immediate impacts expected to occur if Metrolink and the associated SMART objective deliverables are met. The long-term outcomes are the potential impacts that could occur if Metrolink and associated SMART objective are delivered and the short-medium term outcomes occur. In this sense, some long-term outcomes are dependent on the successful delivery of shorter-term outcomes.

A final agreement on the alignment between SMART objectives, output and outcomes will be determined with stakeholders at the FBC stage.

Logic mapping of this nature is particularly useful for projects such as Metrolink where there are several different actions taking place simultaneously and the links between the scheme objectives and potential outcomes are not straightforward. Theory of Change is an important tool post-implementation, as it allows the evaluator to understand how much progress has been made towards the delivery of the final impacts.

Since economic benefits were forecasted ex-ante using the best information available at the time, metrics will be used to assess the successful realisation of benefits from this project ex-post. An indicative list of the metrics is identified at PBC stage, these will also be confirmed at FBC stage. Please note that for benefit cost analysis in the economic case some of these benefits have been monetised. However, for monitoring and evaluation purpose it is more practical to use interim measures than monetary outcomes. For example, although in the economic case journey time savings have been monetised it is more practical to use time instead of euros as the metric.

The review should evaluate the following three stages post project conception: project planning, project implementation and project operational performance.

- Project planning includes the definition of clear MetroLink objectives.
- Project implementation will be evaluated through the output of MetroLink
- Project operational performance will be monitored through a robust set KPIs.

Figure 1-2 - Project Logic Map

SMART Objective	Output	Short -Medium Term Outcomes	Long Term Outcomes
Cater for existing public transport travel demand and support long-term patronage growth along this corridor through the provision of a high frequency, high capacity public transport service which supports sustainable economic development and population growth	A sustainable, safe, efficient, integrated and accessible Metro service between Swords, Dublin Airport and Dublin City Centre.	• Increased public transport use • Reduction in private transport share along the corridor • Increased capacity on North-South corridor through integration of different modes • Reduction in journey times to improve business and non-business efficiency and along this corridor	• Additional housing provision along the corridor • Location of new businesses along the corridor • Increased jobs in catchment area • Increased Productivity and Output.
Deliver an efficient, low carbon and climate resilient public transport service, which contributes to a reduction in congestion on the road network in the Dublin Region and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets	A sustainable, safe, efficient, integrated and accessible Metro service between Swords, Dublin Airport and Dublin City Centre.	• Reduction in congestion on the road network • Reduction in harmful emissions • Suitable alternative to car-based travel • Reduction in highway traffic leading to lower noise levels. • Increased provision of walking and cycling network raising levels of physical activity	• Low emission transport system • Reduction of Greenhouse Gases • Improvement in air quality • Improved health • Reduces noise impact from transport in surrounding area

SMART Objective	Output	Short -Medium Term Outcomes	Long Term Outcomes
		• Reduction in carbon per person kilometre travelled along the corridor	
Provide a high standard of customer experience including provision for clean, safe, modern vehicles and a reliable and punctual service with regulated and integrated fares	A sustainable, safe, efficient, modern, reliable, integrated and accessible Metro service between Swords, Dublin Airport and Dublin City Centre.	• Full integration with existing transport infrastructure within Dublin with a single integrated ticketing system • Increase capacity on North-South corridor through integration of different modes • Decrease the overall number of fatalities, as well as serious and slight casualties. • Suitable alternative to car-based travel • Increased reliability of services	• Improved customer experience • Increased number of multi-modal trips and hence higher sustainable transport market share
Improve accessibility to jobs, education and other social and economic opportunities through the provision of improved inter-modal connectivity and integration with other public	A sustainable, safe, efficient, integrated and accessible public transport service between Swords, Dublin Airport and Dublin City Centre.	• Increased access to jobs, education centres, health facilities and airport • Increased access to other facilities for socio-economic development • Reduction in journey times to improve business efficiency along this corridor	• Improved quality of life • Better job matching • Increased productivity and output. • Improved domestic and international travel experience.

SMART Objective	Output	Short -Medium Term Outcomes	Long Term Outcomes
transport services and connectivity for national and international visitors using Dublin Airport		• Better connected more wide-reaching public transport will improve accessibility for vulnerable groups • Better transport connectivity for areas with high levels of deprivation • Make new land viable for commercial development • Location of new businesses along the corridor • Increased public transport mode share for those working at and travelling through Dublin Airport	• Increased jobs in catchment area. • People moving into new homes • Connection between communities with different socio-economic characteristics • Increase in land value through viability for development by improved connectivity
Enable compact growth, unlock regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of high capacity public transport whilst integrating into the existing public realm	A sustainable, safe, efficient, integrated and accessible public transport service between Swords, Dublin Airport and Dublin City Centre.	• High quality transport investment likely to attract inward investment • Positive land use change associated with development. • Increase land value through viability for development by improved connectivity	• People moving into new homes • Location of new businesses along the corridor • Improved business and non-business connectivity • Increased jobs in catchment area. • Increased productivity and output

SMART Objective	Output	Short -Medium Term Outcomes	Long Term Outcomes
		• Interaction of stations with urban environment raising the visual appearance of surrounding area • Increased accessibility to SDZs, low and high density and mixed land use • Metrolink is fully aligned with objectives of NPF 2040 and other regional and local planning frameworks. • Metrolink fully incorporates local, national and governmental policies through its design and delivery.	• Improved quality of life • Rebalances population - affecting housing availability and prices • New sustainable communities

1.4 Benefits Measurement Metrics

At the FBC stage, a final list of outcomes will be agreed with indicators and targets assigned to all outcomes. Each will have at least one indicator, with the potential for some to have more. An example of a potential method for recording this in a table is given in Table 1-2

Table 1-2 Example Benefit Measurement Method Table

Ref	Benefit	Indicator	Target	Type	Data Requirements	Owner
Desired Outcome						
1	**Reduce congestion on the roads**	e.g. Improved journey times	e.g. 10% reduction on journey times on key corridors	Quantified	e.g. actual journey time measures baseline journey time measures	e.g. TII – Officer X
2	TBD	TBD	TBD	TBD	TBD	TBD

Source: Jacobs

It is not proportionate at PBC stage to assign final metrics and targets for the different impacts. This will be defined at FBC stage based on the updated economic analysis, availability and cost of baseline data and monitoring effort. However, Table 1-3 sets out a menu of type of indicators to be considered for inclusion in the final Monitoring and Evaluation Plan. The list is not exhaustive, and not all indicators will be included within the final monitoring and evaluation plan, but it gives an indication as to how the final plan will look. In some instances, multiple indicators could be combined to produce a single overall indicator yet this will be determined at FBC stage. Some potential indicators included below are informed by previous work in the economic appraisal and those highlighted in the SMART objectives.

Table 1-3 Potential Indicators

Ref	Impacts	Potential Indicators
Desired Outcomes		
1	Increased public transport use	Metro patronage levels Public Transport patronage levels
2	Reduce congestion on the roads	Traffic levels on specified roads Queue length at specified junctions along the corridor Shift from car to Metro Journey times on specific corridors
3	A suitable alternative to car-based travel	Population within 10 minutes of a station Increase in patronage levels of public transport
4	Increased jobs in catchment area	Population within 45 minutes of specific job clusters Job Density per km within Greater Dublin Area % of high value jobs within Dublin City Centre
5	Increase land value through viability for development by improved connectivity	SqM of commercial land within X metres of a public transport interchange. Sale price of commercial land within X metres of a public transport interchange
6	Increase capacity on North-South corridor and integration of e different modes	Average travel time between fixed north / south locations Number of long distance north / south trips Proportion of trips using more than one sustainable mode of transport
7	Reduction in harmful emissions	CO_2 levels NOx levels PM levels
8	Reduction in traffic noise	Noise Levels
9	Make new land viable for commercial development	SqM of land re-zoned for commercial development SqM of completed commercial development sold

10	Integration with existing transport infrastructure	Number of interchanges between MetroLink and other modes Number of first / last leg made by bicycle
11	New sustainable communities	Population within X band of An Pobal HP Deprivation index Increase in Greater Dublin Area population within 500m and 2km of Metrolink stations
12	Connection between communities with different socio-economic characteristics	Additional area accessible by public transport from Swords within 45 mins Additional area accessible by public transport from St Stephen's Green within 45 mins Additional area accessible by public transport from City Centre within 45 mins Additional area accessible by public transport from Docklands within 45 mins
13	Increased access to jobs, education centres, health facilities and airport	Public transport accessibility catchments by time band to Dublin Airport Additional area accessible by public transport from Dublin Airport within 45 mins Public transport accessibility catchments by time band to Dublin City University Additional area accessible by public transport from Dublin City University within 45 mins Public transport accessibility catchments by time band to St James's Hospital Additional area accessible by public transport from St James's Hospital within 45 mins Changes in Live Register along the corridor
14	People moving to new homes	Number of new homes within a 2km catchment of Metrolink stations Increase in Greater Dublin Area population within 500m and 2km of Metrolink
15	Improved customer experience	Customer Satisfaction Surveys Operator Contract Performance Measures Punctuality and reliability levels
16	Improved reliability	Higher Public Performance Measure (PPM) scores from increased reliability of services

Source: Jacobs

In order to set and measure targets the availability, quality and style of available data needs to be considered. Table 1-4 groups the indicators by type, and provides a range of potential data sources to measure performance against the targets which will be set and agreed at the FBC stage. It is noted that some data is available in virtually real time while other are published only every few years and often with a delay in doing so. Identifying proxies or correlating data will therefore be useful in some cases.

Table 1-4 Potential Data Sources Indicator Metrics

Ref	Data Area	Potential Data Sources
1	**Road Traffic Data**	Toll crossings for motorways and Dublin Tunnels Counts from existing ATC locations within Dublin Implementation of new ATC locations / manual classified counts TomTom data sets
2	**Public Transport Data**	MetroLink station footfall data Ticket sales Gate line passenger counts Interchange counts Questionnaires Published timetables
3	**Land Use Impacts Data**	CSO House completion and house sale data sets CS0 Job location and type data Dublin CC Land Use / Local Plan allocation data CSO Census population data
4	**Community Impacts Data**	An Pobal IMD data CSO data sets on employment / education status CSO census population data Travel impact data (data sources as for 1 & 2) Live Register
5	**Business Impacts Data**	Survey data (direct or via Chamber of Commerce) CSO data sets on employment CSO census population data Travel impact data (data sources as for 1 & 2) Land use changes (data sources as for 3)
6	**Environmental Data**	Noise receptors (existing or bespoke)

		Air quality receptors (existing or bespoke)

Source: Jacobs

1.5 Conclusion

This document provides an overview of the type of areas which will be considered for inclusion within the Monitoring and Evaluation Plan at the FBC stage, along with potential data sources. This is fundamental to ensure that the expected benefits of the scheme materialise.

At the FBC stage this will be refined further, with specific indicators and metrics defined. For each indicator included a clear rationale for inclusion will be given, along with a specific target and an owner – who is responsible for monitoring and collating information with regard to the impact area being assessed.

It is anticipated that this will be captured within a project logic map. The current project logic map is presented in Figure 1-2, demonstrating how SMART objectives create a number of likely short-medium term and potential long-term outcomes.

The final structure of the logic map and benefits realisation plan will be agreed with stakeholders at the FBC stage, to ensure that they cover all the expected outcomes and commitments associated to the delivery and operation of Metrolink.

Appendix L: Cost Forecasting Methodology

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

METROLINK

MetroLink

Cost Forecasting Methodology

Document Control Information

Version	1	
Date	January 2021	
Description	Cost Forecasting Methodology	
Prepared	J Robinson	
Reviewed	A Lyons	
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Approved	P Walsh	

Table of Contents

List of Tables

List of Figures

Abbreviations

Abbreviation	Definition
APM	Association for Project Management
CESSM	Civil Engineers Standard Method of Measurement
CKBS	Chandler KBS
DoT	Department of Transport
EIA	Environmental Impact Assessment
GMP	Guaranteed Maximum Price
HSE	Health Service Executive
IPA	Infrastructure and Projects Authority
IRM	Institute of Risk Management
J/I	Jacobs / Idom
NTA	National Transport Authority
QCRA	Quantitative Cost Risk Analysis
QSRA	Quantitative Schedule Risk Analysis
QRA	Quantitative Risk Analysis
RCF	Reference Class Forecasting
RPA	Railway Procurement Agency
SBC	Scheme Base Cost
TII	Transport Infrastructure Ireland
T&T	Turner & Townsend
TPCE	Total Preliminary Cost Estimate
WBS	Work Breakdown Structure

Table 1 – Abbreviations

1. Executive Summary

Context

Large and complex transport projects suffer from considerable uncertainty and risks which often change the circumstances in the way a project is developed and delivered. This has resulted in significant cost overruns in some cases. Eight out of ten past metro projects had cost overruns. Overruns of up to 50% are common, and overruns over 50% are not uncommon. Nearly one in three metro projects exceeded their cost estimates by more than 50%.

The purpose of this paper is to:

- Summarise the issues in respect to overruns in large projects;
- Confirm what standards and guidance will be used to support the cost forecast for the MetroLink project; and
- Confirm the cost forecast and risk techniques available to test the cost forecast.

Cost Forecasting Techniques and Guidance

To provide greater confidence in developing the robust cost forecast, both TII and NTA have engaged the services of three cost advisors Jacobs / Idom – London Bridge Associates (LBA), Turner & Townsend (T&T) and Chandler KBS (CBS) in preparing the Scheme Base Cost element of the Total Preliminary Cost Estimate (TPCE).

The Scheme Base Cost estimates will be developed in accordance with the National Transport Authority (NTA) Cost Management Guidelines for Public Transport Projects, and the Transport Infrastructure Ireland (TII) Project Services Group Cost Estimating Procedure. Where possible depending on the development and detail of the current preliminary design and where applicable the quantification of the works will be carried out in accordance with Civil Engineering Standard Method of Measurement 4 (CESMM4). The Scheme Base Cost (SBC) estimate will be prepared using a combination of benchmark and first principles methods using actual and historic cost data.

The National Transport Authority (NTA) Cost Management Guidelines for Public Transport Projects also stipulate the requirement for a Quantitative Risk Assessment (QRA) technique to be adopted in the development of the risk aspect of the cost forecasts. The three cost advisors will collectively participate in the QRA process with TII and NTA. The QRA will be used to forecast risk exposure to provide an allowance to cover the potential impact of risk events occurring and identifying key areas of risk to focus TII management attention. Prior to the initiating the QRA, TII needs to consider its risk appetite which is discussed later in the report. On recent projects TII has utilised the P80 output (80^{th} percentile of confidence) to establish project risk exposure via the Quantitative Risk Analysis Process and it intends to utilise the P80 output for the MetroLink Cost Forecast and for the Preliminary Business Case, however, will review the P30 and P50 outputs also.

Both the Scheme Base Cost and the QRA are based on an 'inside view' of the project. The estimation approach breaks the whole of works down into work packages. The work packages are then estimated with regards to cost, schedule and risk and summed up to arrive at a project level estimate. Therefore these 'inside view' estimates are likely to include a range of biases.

Validation of estimated costs

Reference Class Forecasting is an established method to address the root causes of cost and schedule overruns in projects. These root causes, namely optimism bias and political bias can lead to underestimations of projects' costs and schedules, which can later result in cost and / or schedule overruns. Reference Class Forecasting is a method of seeking an 'outside view' and is used as a means of validating and assuring the project budget / schedule. Reference Class Forecasting uses historic data of similar completed projects. Thus, a Reference Class Forecast takes a top-down approach in respect to cost, schedule and risk forecasting. The Reference Class Forecast involves three steps: (1) compile a Reference Class of past, similar, completed projects; (2) establish the distribution of the variables in question in the Reference Class; (3) compare the 'inside view' and 'outside view' estimates and identify the potential level of biases depending on the risk appetite of decision makers. The Reference Class Forecast helps to predict the final cost of the MetroLink project.

Utilising the Reference Class data and breaking it down further in to asset classes (e.g., tunnels, stations etc.) will aid the cost comparison between the bottom-up estimate approach (Scheme Base Cost and QRA) and the top-down approach (RCF). The Reference Class data and associated asset classes have been mapped to the Scheme Base Cost - Cost Breakdown Structure (CBS) to aid the review.

Finally, Expert Judgement will be applied to determine whether a suitable approach and methodology has been applied to develop the Total Preliminary Cost Estimate and an appropriate risk and contingency assessment has been developed and included for MetroLink.

Recommendation

Combining forecasting based on inside and outside views and expert judgement for the MetroLink project ensures the project uses industry-recognised, best-practice cost forecast methodologies. This will help to define a robust cost forecast for the MetroLink project. This will enable Government decision makers, at the key milestones of the project, to make informed decisions on whether to proceed to the following phase gates and through to the implementation of the project.

2. Foreword to MetroLink Cost Forecasting Methodology

We have heard time and time again of governments spending more on infrastructure than they told taxpayers they would. Yet, there has been little in the way of informed debate about understanding and curing underlying or root causes.

Announcement of premature cost estimates undermines the decision-making process. There is a tendency to seek early cost estimates at a stage when little information is available. Premature announcements haunt projects for years as they anchor later-stage cost forecasts. This is to the detriment of accurate forecasting and informed decision-making. Forecasts must be de-biased and must use the best available data. They should also reflect the risk appetite of the decision makers.

There is also a tendency to hang onto unreliable forecasts that have not been subjected to rigorous due diligence of a wider range of proven methodologies used in forecasting megaprojects.

TII is committed to jettisoning unreliable forecasts and applying a more robust approach to forecasting the cost, schedule and benefits of MetroLink in the interest of presenting the best available information to decision makers before a commitment to invest scarce public funds in this transformative public infrastructure is made.

Three key questions must be answered. Is the project economically viable? Is the project affordable? What project budget and timeline should be set? To answer these questions, project sponsors and funders should use probabilistic forecasts – considering the full range of outcomes – instead of single point forecasts to capture this reality. Conventionally, the simplest form of a probabilistic forecast is a forecast for the best case, most likely case and the worst case. Decision makers must be presented with a realistic forecast statement of risks, costs and benefits at key decision points. In the case of MetroLink, the first key decision point is the approval of the Business Case. This occurs prior to making the Railway Order. The second is the approval of the updated Business Case prior to entering main works contracts.

We commit to sound analysis and planning of infrastructure and to making decisions with broad social and economic benefit. We must avoid announcing project costs before they have been properly assessed. Understated costs, for whatever reason, makes it impossible for decision-makers to differentiate good projects from bad.

Producing reliable cost forecasts is vital. Current international cost estimation guidance is inconsistent, omits valuable tools, and not all draw sufficiently on previous projects because of the inconsistency or scarcity of relevant data. We strive to address shortcomings of previous practice.

We learn from experience. Our infrastructure systems should promise what is worth having, and then deliver what is promised. We should settle for nothing less. This document presents TII's thinking on the methodology to be adopted to increase accuracy in forecasting costs.

The Cost Forecasting Methodology is in line with the provision in the Public Spending Code 2019 in that it applies the new project life cycle and reflects leading practice in this field in Ireland and internationally.

3. Cost and schedule overruns in metro projects: international experience

According to recent research nearly eight out of ten metro projects have cost overrun. The study shows that overruns of up to 50% are common, and further shows overruns over 50% are not uncommon. Nearly one in three metro projects exceeded their cost estimates by more than 50%. (See table 2)

	Average	Median	Range	Frequency of overrun	Sample size (n)
Cost overrun	+47%	+31%	-46% to +1016%	77%	189
Schedule overrun	+55%	+29%	-16% to +410%	63%	43

Table 2 – Cost and schedule overrun in metro projects

Overrun affects private as well as public sector projects, and trends are not improving; the frequency of overruns have remained constantly high for the 30-year period for which comparable data exists. Geography also does not seem to matter; projects in all countries and continents for which data are available suffer from overruns.

2.1 Comparison with other transport infrastructure projects

The above study shows that the average cost overrun on metro projects (47%) is statistically greater than the cost overruns in roads, bridges and non-urban rail projects (24%, 27% and 29% respectively). The frequency of cost overrun in transport infrastructure projects is comparable, where 8 out of 10 projects have experienced cost overruns. Table 3 below captures both cost and schedule overruns in roads, bridges, tunnels and non-urban rail projects.

The average schedule overrun in metro projects is 63%. The study shows that the schedule risk of metro projects is similar to that of all other transport projects (within a range 50%-71%).

	Cost (mean)	overrun Frequency cost overrun	Schedule overrun (mean)	Frequency schedule overrun	Sample size (n)
Metro	+47%	77%	+55%	63%	189
Roads	+24%***	72%	+20%	71%	1834
Bridges	+27%***	64%	+23%	68%	96
Tunnels	+38%	73%	+22%	50%	75
Rail	+29%***	70%	+25%	56%	257

******p < 0.0001; **p < 0.01, * p < 0.005 (p-values based on difference between metro projects and other project types using two-sample Wilcoxon tests)*

Table 3 – Metro projects compared to transport infrastructure projects

4. Process to define cost forecasting methodology

In most recent years, there have been several publications, which have identified lessons learned in cost forecasting methodology. TII have completed a comprehensive study on this and detailed some of the findings below.

Lack of sufficiently comprehensive or robust planning for the process to establish cost forecast

Most recently, as a result of cost and schedule overruns at the New Children's Hospital in Ireland, the Health Service Executive (HSE) on behalf of the government, engaged PwC to carry out a review of the reasons for the cost escalations on the project and document its findings. The following three excerpts have been noted during a review of the report and are relevant to MetroLink.

> *'Significant failures occurred during the crucial planning and budgeting stages of the project. The basis of the original budget was flawed, and risks were understated in the business case'.*
>
> *'The understanding of the risk profile associated with the procurement and contracting strategy was poor at all levels of the governance structure. The capital budget made no provision for the price premium that the public sector would need to pay the contractors to bear the risks transferred to them… As a consequence, the budget significantly underestimated the likely outturn cost. Furthermore, red flags indicating the inadequacy of the budget were missed;'*
>
> *'In our view the €450m increase in projected costs in the NPH Project are attributable to the following areas…:*
>
> 1. *Underestimation: Costs that are a consequence of underestimation, principally during the planning, budgeting as well as set-up stages of the project. In our assessment, €294m (65%) of the cost increase can be attributed to issues that should have been identified prior to the approval of the DBC. It includes, for example, the price of risk transferred to the subcontractors that was insufficiently priced as well as costs that would have been absorbed by the inclusion of an allowance for optimism bias and a more appropriate level of contingency;'*

The UK Department of Transport and the Infrastructure and Projects Authority (IPA) have also published lessons learned following the issues they experienced with a range of major projects and the Northern Line, Thameslink project and Crossrail in particular; the following captures the most relevant to the MetroLink project as it sets to define its Cost Forecasting methodology.

Set a realistic cost envelope

> *Lesson A4.2 Set a realistic cost envelope – "Establish a full cost envelope based on reference class data or benchmarking and include adjustments for optimism bias. Identify explicit de-scoping options in case early affordability issues emerge after supplier prices become available. Report projected outturn costs with percentage confidence indicators against the target cost and total budget envelope."*

Test value for money through benchmarking

> *"Lesson C2.1 Test value for money through benchmarking – "Collect and review cost data across government and use cross-sectoral and international comparisons for common cost items. Challenge the delivery organisation and its supply chain to evidence their cost estimates. Ensure this evidence employs both top-down and bottom-up benchmarking to test value for money." (Infrastructure and Projects Authority)*

Refrain from early announcement of cost envelopes

A key component to the accuracy of the cost forecasting methodology is the consideration and approach to risk-based estimating. In Australia the Grattan Institute has also previous published its own report following cost overrun and over expenditure on transport projects within the previous 15 years. A key factor they attribute to political bias.

> *'Ministers and opposition spokespeople often promise to build a road or bridge or rail line, for a particular cost. They are especially prone to doing so in the lead-up to elections…*
>
> *… It is normally premature and unwise to announce project costs this early in the planning process. History shows that projects with costs announced prior to a formal budget commitment experience far larger cost overruns than projects with later cost announcements. Over the past 15 years, 74 per cent of the total value of cost overruns is explained by the 32 per cent of projects with early cost announcements'* (Grattan Institute)

Use a combination of techniques for cost forecasting including Expert Judgement

In the same report the Grattan Institute also highlights the importance of robust risk-based estimating, combining both, a bottom-up and top-down approach, to gain a reliable and comprehensive assessment.

> *'There is no single "right" way to measure risk, but for an approach to risk measurement to be considered complete, it must be both reliable and comprehensive. Assessments of project risks can be considered:*
>
> ***reliable*** *if expert opinion is used to tailor risk estimates to projects' specific characteristics, and objective information is used to counter the challenges of optimism bias and strategic misrepresentation; and*
>
> ***comprehensive*** *if known, unknown, moderate and extreme risks are all accounted for.*
>
> *No single risk measurement tool achieves all these objectives, which means that a combination of tools is required.* Table 4 *on the following page summarises how each risk measurement tool can, if used* (Grattan Institute)

Attributes of each risk management tool, where ✓ indicates that a tool can be used satisfy the criteria, (✓) indicates that a tool can be used to get part way towards the criteria and ✗ indicates that a tool cannot be used to achieve the criteria.

			Reliable		Comprehensive			
			Tailored	Objective	Moderate	Extreme	Known	Unknown
Expert judgement	Expected value		✓	✗	✓	✓	✓	✗
	Probability pricing	Moderate (*e.g.* P50)	✓	✗	✓	✗	✓	✗
		High (*e.g.* P90)	✓	✗	✗	(✓)	✓	✗
	Sensitivity analysis		(✓)	(✓)	✗	✗	✓	✗
Monte Carlo simulation	Expected value		(✓)	(✓)	✓	✓	✓	✗
	Probability pricing	Moderate (*e.g.* P50)	(✓)	(✓)	✓	✗	✓	✗
		High (*e.g.* P90)	(✓)	(✓)	✓	(✓)	✓	✗
	Value at Risk		(✓)	(✓)	✓	✓	✓	✗
Reference class forecasting	Expected value		✗	✓	✓	✓	✓	✓
	Probability pricing	Moderate (*e.g.* P50)	✗	✓	✓	✗	✓	✓
		High (*e.g.* P90)	✗	✓	✗	(✓)	✓	✓
	Value at Risk		✗	✓	✗	✓	✓	✓
Characteristics of complete risk measurement			✓	✓	✓	✓	✓	✓

Source: Grattan analysis.

Table 4 – Complete approaches to risk measurement satisfy all the conditions for reliability and comprehensiveness by using a combination of tools

Finally, the publication by the Infrastructure and Projects Authority, Improving Infrastructure Delivery, Project Initiation Route map, Risk Management Module outlines how QRA and RCF are techniques being used together to quantify the risk and inform the allocation of contingency.

> *'At the outset of the project, there will be many uncertainties and opportunities for the project to evolve along a number of different routes. At this stage RCF approach is more appropriate. As the project nears completion, the 'bottom up' approach will be more applicable, as there will be detailed information available about most aspects and few remaining uncertainties.'*

As a project develops through its phase gates and the definition of the design matures, it is good practice to review both approaches (RCF / QRA) however at any one point one of the approaches will dominate. Figure 1 below shows the project lifecycle and shows the change in approach aligned to the greater degree of definition and maturity of the project.

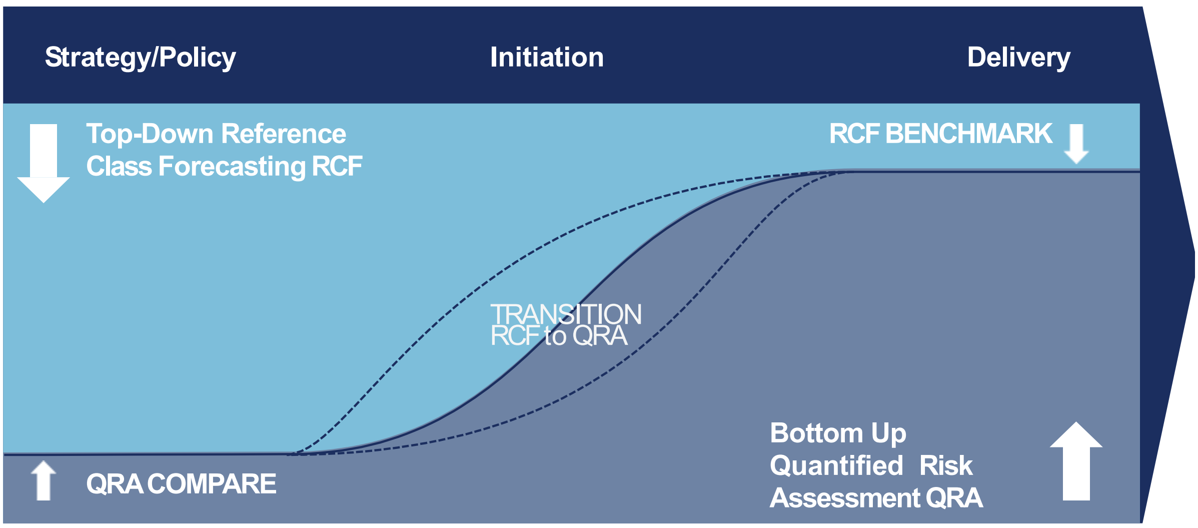


Figure 1 – Risk Assessment and Estimating mathodologies as the design matures

There a number of common themes running through the publications listed above, including:

- Setting robust cost envelope and accurate budget setting;
- Complete risk approach and definition of risk appetite; and
- De-biased estimates using the best available date.

Considering the high percentage of Metro projects that overrun their budgets and schedules, the scale of these overruns and considering these lessons learned, TII defined a cost forecasting methodology for the MetroLink project to create and support informed decision-making.

5. Process to define the Total Preliminary Cost Estimate

The MetroLink project will follow a multistage approach to forecast costs throughout the design phases as it moves towards the Business Case, consisting of:

- Design development;
- Bottom-up estimates of the Base Cost, verified by three independent cost advisors;
- Quantitative Risk Analysis (inside view);
- Reference Class Forecasting (outside view); and
- Expert Judgement.

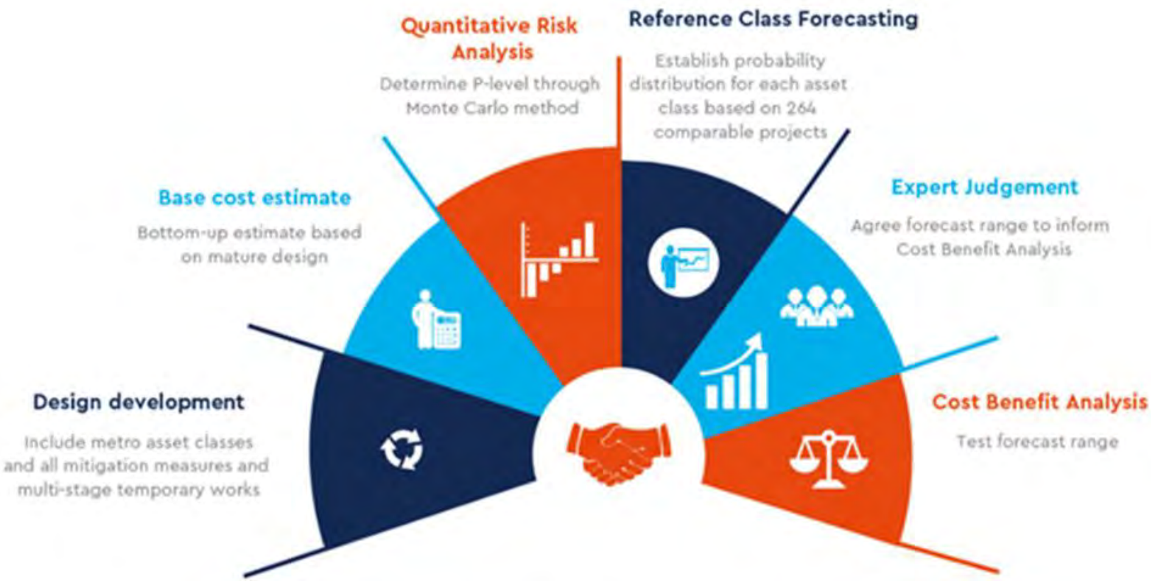


Figure 2 – Multi Stage Approach to forecast cost.

Design development

The Scheme Base Cost estimate is prepared utilising the Preliminary Design which has been prepared by Jacobs / Idom. TII and NTA have engaged the services of three cost advisors Jacobs / Idom – London Bridge Associates (LBA), Turner & Townsend (T&T) and Chandler KBS (CBS) in preparing the Scheme Base Cost element. Each of the estimating parties will individually review and assess the design maturity of the various elements / asset class as part of its estimating process. Following this review, the estimator will propose a 'price and design' tolerance level, which will be considered and incorporated into its estimate as it develops and finalises its Scheme Base Cost. A Cost Breakdown Structure (CBS) has been developed based on the current scheme to facilitate the production and review of the estimate.

Industry guidance used to support development of Scheme Base Cost and Quantitative Risk Analysis

The Scheme Base Cost estimate and QRA will be prepared in accordance with the National Transport Authority (NTA) Cost Management Guidelines for Public Transport Projects, dated September 2010 and the Transport Infrastructure Ireland (TII) Project Services Group Cost Estimating, dated May 2013. Where the Preliminary Design detail permits, the estimate will be prepared in accordance with the Civil Engineering Standard Method of Measurement 4 (CESMM4). In addition, the QRA will be developed in line with guidance from the Institute of Risk Management (IRM) and the Association of Project Management (APM).

Process to define the Scheme Base Cost estimate (inside view)

The Scheme Base Cost estimate will be prepared using a combination of benchmark and first principle estimating methods using currently available and historic data (where applicable and uplifted to the base date). The estimate will include allowance for provisional sums and percentage uplifts for items such as preliminaries and insurances.

The Scheme Base Cost estimate will capture the direct works, indirect costs and client costs.

The Total Preliminary Cost Estimate (TPCE) shall capture the Scheme Base Cost plus inflation, contractor and client (employer) risks and contingency and VAT.

The estimate's base date has been set at Q4 2019, escalation to the estimate base date will be required and clearly demonstrated in the estimate build-up where historical rates have been used. Forecast escalation shall be individually assessed however an inflation model and calculator shall also be developed, which will enable an overall inflation index to be developed and used specifically for MetroLink, enabling either a mid-point assessment or a quarterly cash flow assessment. Individual bespoke indices will be developed and applied against specific cost elements and components pre agreed by NTA and TII. The indices contain historic data, dating back to 2008, and will be forecast from the current reporting period to the end of the MetroLink Construction period.

The three cost advisors will interface at various meetings throughout the development of the estimate to agree on a consistent approach on various elements, including Cost Breakdown Structure coverage rules, Indirect Costs, Inflation and Risk. However, each estimate will be prepared on an entirely independent basis.

TII with support from T&T shall develop the Client Cost element of the Scheme Base Cost. Utilising the outline procurement strategy and the MetroLink Consolidated Organisational Design Report a staffing structure shall be developed for the key consultancy packages and assessment shall be made in respect to the other aspects of client cost. These shall be structure into the following headings:

- Planning and Design;
- Client / Sponsoring Agency Costs;
- Client Partner
- Project Delivery Partner; and

- Other / Third Party Costs.

TII shall also develop the Land and Property cost estimate for the scheme, this shall then be validated by Dublin based property consultancy firms, who have a good understanding of the local market and future trends. The assessment of the Land and Property cost estimate shall further have oversight from Transport for London, to bolster experience from an international large transport infrastructure perspective.

Quantitative Risk Analysis (inside view)

Risk is defined as "*An uncertain event or set of circumstances that, should it occur, will have an effect on achievement of one or more objectives.*"

The fundamental aim of Quantitative Risk Analysis (QRA) is to forecast risk exposure which can be used to provide an indication of allowance required to cover the potential impact of risk events occurring and identifying key areas of risk to focus management attention.

The three cost advisors will collectively support the Quantitative Risk Analysis (QRA) process. During the development of the Scheme Base Cost the cost advisors shall individually identify risks and pass them through to TII for incorporation in to the MetroLink risk register. Once the identified risks have been incorporated in to the MetroLink Risk register the three cost advisors, TII and the NTA shall collectively participate in the Quantitative Cost Risk Assessment (QCRA) and Quantitative Schedule Risk Analysis (QSRA).

Discrete risk costs – A discrete risk is an uncertain event with the potential to have an effect on project objectives (negative threats or positive opportunity). This is in essence the output from the quantified project risk register. Discrete risk cost impacts are measured in terms of likelihood of occurrence of cost impact by applying an appropriate distribution of impact range. The cost impact estimates should, where available, be evidence based on impacts from similar projects (historic data).

Estimate Uncertainty (EU) assessment – involves determining the estimate confidence range for each relevant area of the Scheme Base Cost Estimate. This is typically determined by the status / quality of the design and the relevant market testing of rates.

Cost of Schedule Delay – utilising the outputs from the QSRA. Alignment will be reached on what activities / milestones within the schedule best represent the key changes in phases on the project from which the cost of the delay changes from that of the previous (e.g., increase in design team contractor(s) mobilised). The associated cost of delay will be established for each of the agreed project phases, the costs of delay should when available be evidenced based on impacts from similar projects (historic data).

Unknown unknowns – Given the nature of unknown unknowns and the current phase of the project, Preliminary Business Case Stage, it is proposed to adopt a percentage uplift to the Scheme Base Cost, utilising SME judgement and historical data. When considering the uplift consideration should be given to the following:

- The unique nature of the project;
- The potential for standardisation and repetitiveness of the works related to delivery;
- The phase of the project and its associated design maturity;

- Estimating bias within the Scheme Base Cost; and
- Historical analysis of cost overrun and trends.

A recent study from OGP has noted that catastrophic risks, such as the current pandemic, are a challenge for conventional risk identification and assessment. Analysis of the common causes of failures on metro and urban rail projects found that overruns of 100%+ even 400% are caused by non-catastrophic events, which may suggest that these risks can be largely ignored. The QRA will consider some low probability high impact events that have the ability to be assessed as it can provide an indication on the profile of the risk exposure. Albeit it is acknowledged that the QRA might not provide a sufficient allowance should events such as the low likelihood and a high impact. Catastrophic risk (extremely low likelihood and / or extreme high impact) such as the pandemic will be excluded from the QRA assessment. In accordance with the MetroLink Risk Management Plan, any exclusions from the QRA need to be agreed and signed off by the Project Director.

Inflation

Forecast inflation will be assessed by each of the three independent estimating parties and will be calculated using an inflation model. All inflation indices used must be in accordance with recognised practice. The proposed inflation model should be tailored to the local economy and examine construction inflationary / market trends based on historical published data and consider the future economic outlook for the construction sector for the duration of the project. The base cost data date shall be set at Q4 2019. Exchange rate date was confirmed set on 2nd December 2019.

- Each component of the estimate should be assigned an inflation rate to express the cost in the years of expected expenditure;
- The years of expenditure must be based on the preliminary design outline Project Programme which must reflect a realistic scenario, considering project planning and development durations as well as construction; and
- Inflation rates may be different for specific cost elements, but assumptions made in determining the most appropriate inflation rate to use should be clearly identified in the estimate.

VAT

VAT should be forecast at the applicable rates and captured on all element of the Total Preliminary Cost Estimate. The standard VAT rate is currently 23%, however there are elements within the Total Preliminary Cost Estimate that will be eligible for the reduced rate of 13.5%.

6. Reference Class Forecasting (top-down estimate)

In October 2018, TII commenced a collaboration with Professor Bent Flyvbjerg and Dr Alexander Budzier of Oxford Global Projects to support the establishment of a robust cost forecast.

With the assistance of Oxford Global Projects and access to its database of previous similar project outcomes, we will put in place a comprehensive approach to forecasting project costs. This will enable that Government decision makers have the best cost forecast information available to them. When final decisions about the project need to be made, all this information will be included in the Business Case for the MetroLink project. Reference Class Forecasting (RCF) will be used on MetroLink as a method of seeking an 'outside view' and to guard against the effects of biases on projects, which can ultimately result in the underestimation of projects costs and schedules. This underestimation can often result in cost and schedule overruns.

Reference Class Forecasting will be used in addition to the standard TII bottom-up Scheme Base Cost development and QRA process, as a means of benchmarking / validating the project budget / schedule.

A Reference Class forecast (RCF), in the context of MetroLink project, is a forecast which will be utilised to help predict the outcome of the MetroLink project in terms of final cost based on utilising historic data of similar projects (that is, projects in the same 'reference class') to that being forecast. It is believed that the RCF avoid any potential for bias by using information from similar international projects. For the purposes of the MetroLink project, Oxford Global Projects will provide the technical expertise and historic data set to support the RCF process.

The outline process adopted by Oxford Global Projects shall include:

- Selecting the reference class. Identify a sample of past, similar projects;
- Assess the distribution of outcomes and establish the position of the MetroLink project in relation to the outcomes; and
- Assessment of the forecasts and consider what adjustments or further analysis, if any, are required to be made to the MetroLink estimate.

The specific process to be adopted for the RCF for MetroLink is further explained in detail below:

1. TII have responsibility for both national roads and light rail projects. Due to the nature of light rail projects in Ireland, there are a limited number of these and, thus, insufficient projects to form a Reference Class of Irish Projects. Therefore, the historic data (reference class) will be provided by Oxford Global Projects. Oxford Global Projects review and analysis to date has shown that for cost risk metro projects and tunnelling projects have a statistically similar profile and should be pooled. Whilst metro projects and tunnelling projects do not share all the characteristics being exactly alike in terms of scope and nature of the engineering works in terms of their risk profile, they are statistically similar. The overall reference classes for metro projects and tunnelling projects include 264 projects for cost overruns and for 2,451 schedule overruns. For schedule risk the Oxford Global Projects analysis has showed that there are no differences between metro projects and any other types of transport infrastructure projects. Thus, for schedule risk a broad reference class of transport projects will be considered. TII will work closely with Oxford Global Projects to align their asset class data with the MetroLink Cost Breakdown Structure (CBS), enabling the

direct application of the reference class curves to the CBS. The creation of the reference class curves is performed in parallel with the preparation of the Scheme Base Cost estimate and the QRA. It is important to note that the base data for the asset classes must not contain contingency. The data is based on outturn costs for historic projects;

2. Assess the distribution of outcomes and establishing the position of the MetroLink project in relation to the outcomes – e.g., identify the cost overruns of these projects. Figure 3 provides an example of how the cumulative distribution curve of the data (cost overruns) are charted; and
3. Assessment of the forecasts and consider what adjustments or further analysis, if any, are required to be made to the estimates. The Reference Class Forecast will help provide focus on SBC elements (asset classes) such as tunnelling, stations etc., to help further analysis / uplift should the bottom-up estimate (Scheme Base Cost estimate and QRA) not align with the RCF. See figure 3 below. Utilising the same curve, the cumulative percentage of projects now becomes the acceptable chance of overrun. The uplift associated with a specific P-level represents the performance of the projects within the asset class. The decision to apply a certain uplift to achieve a certain level of confidence (P-level) will be taken as part of the process for defining the cost forecast for the scheme and will rely on the bottom-up techniques, on Reference Class Forecasting and on Expert Judgement.

Recent trends in the market suggest that clients who are undertaking large and complex projects are seeking a higher level of confidence and are utilising P90 and P95 in terms of their QRA outputs, however this is completely dependent on the risk appetite of the decision maker.

Oxford Global Projects have prepared a separate study to support TII with their assessment of risk appetite for the MetroLink project, its findings are summarised in the section 7 below.

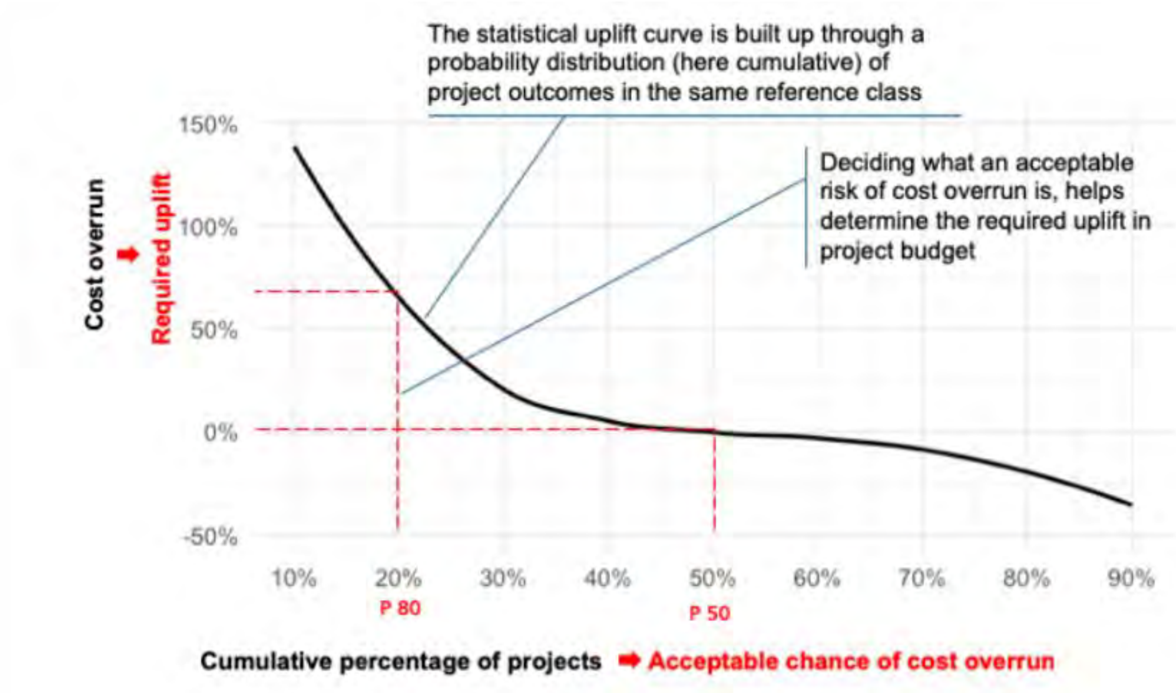


Figure 3 – Establishing the uplift as a function of the acceptable change of cost overrun based on the cumulative distribution of cost overrun in the reference class

Oxford Global Projects produced a number of Reference Class Curves for the MetroLink project, including a general metro curve and 18 asset classes curves. Breaking down the data as shown in Appendix A below helps better understand the data.

The general curve, reflects historic and completed metro and tunnel projects, thus is comparable to the overall risk profile of MetroLink.

A weighted curve for MetroLink has been produced by applying 18 asset classes' curves to the costs of the associated assets. The resulting curve converges closely to the general metro curve in the tail, which is based on client data related to 264 comparable projects.

When defining curves for individual asset classes, Oxford Global Projects used data from the same scope element across all industries (i.e., not only metros and tunnels) that are comparable. This assumes, for example, that road works have a similar risk of cost overrun on earthworks; or that utility diversions have a similar cost overrun than other utility projects like main laying, sewerage works etc.

However, the comparison between the general curve and the summation of the asset class curves shows a gap, this occurs not only in metros but also in other industries (for example nuclear power and decommissioning), which are riskier than others. This gap represents a "metro rail premium", which shows that these projects are generally of higher risk. This is due to factors such as more complex logistics, more difficult locations (e.g., working under and around historic buildings, noise regulation in urban areas, more complex traffic management, more limited number of work phases in station etc.).

For example, a common risk is increasing cost in utility diversions which exceeds the typical cost overrun risk of utility providers' own projects. For this reason, for lower levels of confidence (up to P70) it is prudent to use the general curve based on 264 projects to define the upper bound of the risk and the weighted curve to represent the lower bound.

7. Risk Appetite

Risk appetite is defined as the amount of risk organisation / decision makers are willing to take in order to meet / pursue its objectives.

In the context of MetroLink's forecast of cost, schedule and benefits; the risk appetite will determine the level of certainty sought in the forecast or the inverse the acceptable chance of an overrun for the project. More risk averse organisations seek a higher level of confidence in their estimates and have a lower acceptable chance of overruns.

Current best practice of forecasting provides the full range of estimated outcomes with their respective probability. A P50 cost estimate, for example, means that the project is as likely as not to deliver within that estimate (providing a 50% probability that the overall outturn cost will be greater). A P80 estimate, means that there is an 80% certainty that the estimate will be sufficient and 20% chance that it will be exceeded. A P30 estimate, means that there is an 30% probability that the estimate will be sufficient and a 70% change that it will be exceeded.

Risk appetite and project appraisal

Risk appetite is a key consideration during the front end of projects. Specifically in the project appraisal stage decision-makers ask different questions, which have a different risk appetite:

- Is the project economically viable?
- Is the project affordable?
- What is the cost, time, benefit targets for the project?

Lastly, a key question for every project is setting targets, like budgets and delivery dates. Targets often need to balance risk aversion of decision makers and the economic affordability of large risk amounts. A range of cost forecasts associated with the probabilities from P30 to P80 is deemed by the TII and NTA to provide an appropriate range for cost forecasting and budgeting purposes. The project will utilise the outputs from both the QRA and RCF to support this process.

Range Description	Cost Forecast
Management Stretch Target	P30 (Low)
Management Base Target	P50 (Medium)
Prudent Client Appraisal Value	P80 (High)

Table 5 – Preliminary Cost Forecast Range Summary

The range of cost forecasts approach attempts to balance the tension between ensuring that enough funding is available to the projects should they run in to difficulties and at the same time holding projects accountable for their estimates and driving towards better performance, and therefore will be considered in conjunction with the agreement on whether TII changes it risk appetite from the P80 output as typically utilised on its projects.

8. Expert Judgement

The final step in the cost forecasting approach is Expert Judgement. The methodology adopted in the final step of the reference class forecast will include additional analysis of the reference classes to better understand the data, a review of the outliers in the historical data will identify the drivers behind the outliers and whether these drivers need to be considered or disregarded in respect to the MetroLink project. This is where the Expert Judgement comes into effect, because the reference class forecast assumes that MetroLink is as good or as bad as past, historic projects. Reviewing the historical data, learning from the drivers of overrun and assessing these drivers against our detailed knowledge and understanding of the MetroLink project's treatment of risks and opportunities will enable decision makers to identify target ranges that are based on historical data and on concrete plans how to outperform and improve on the performance of past, historical projects. While this Expert Judgement is not disregarding the historical information it helps, building stakeholder confidence in the ability of the project to deliver and calibrates the reasonable level of accepted risk in decisions.

Upon completion of the Scheme Base Cost estimate, the QRA and the RCF, meetings will be convened with the Expert Judgement Group, TII, NTA, Oxford Global Projects and the Project team to review and discuss the outputs and incorporate the Expert Judgement. At the first meeting, TII, the Project Team and Oxford Global Projects shall present the outputs to the Expert Judgement Group, this shall include the Scheme Base Cost, The Independent Estimate Report, The QRA Report and associated Risk Register, The Reference Class Forecast Report, The Construction Programme and the Design Maturity assessment report. The approach and methodology adopted and incorporated are explained to the Expert Judgement Group and it is an open forum to raise queries and gain a greater understand of how the outputs were derived. The Expert Judgement Group are then issued all information to read and review and meet individually as a group to discuss and compare notes and observations. Finally, a feedback meeting is convened to discuss and document their findings and capture any areas for improvement of further works to improve the robustness of the Total Preliminary Cost Estimate or to help minimise risk as the project moves through the next design phase. The Expert Judgement Group also confirm whether they are satisfied that the approach and methodology adopted is what they would expect to see at this stage of the project and confirm it aligns to industry recognised practice.

9. Cost Forecasting for MetroLink

The following figure 4 shows in a diagram how the whole cost forecast process will be performed.

The Scheme Base Cost will be prepared in the first instance, as mentioned above both TII and NTA have engaged the services of the three cost advisors to help deliver a robust Scheme Base Cost estimate. Once received, TII will carry out its own initial comparison between the estimates where significant cost differences are noted to greater understand the reasoning behind the forecasts.

The Quantitative Risk Analysis (QRA) and the Reference Class Forecast (RCF) can be developed in parallel with each other. The three cost advisors, NTA and TII will support the development of the QRA, and Oxford Global Project (Oxford Global Projects) will assist in the application of the reference class data and associated distribution curves.

The project team and TII will hold a structured workshop to review the outputs from both the bottom-up cost forecasting process and the top-down cost forecasting process and using Expert Judgement will record any specific project factors (e.g., environmental factors) that may exist that would lead to the project being either more or less risky than the Reference Class. The project team and TII will decide, considering the outcome of the above, the appropriate cost forecast to be used for the Preliminary Business Case. The discussions, considerations and adjustments should be documented for governance and assurance.

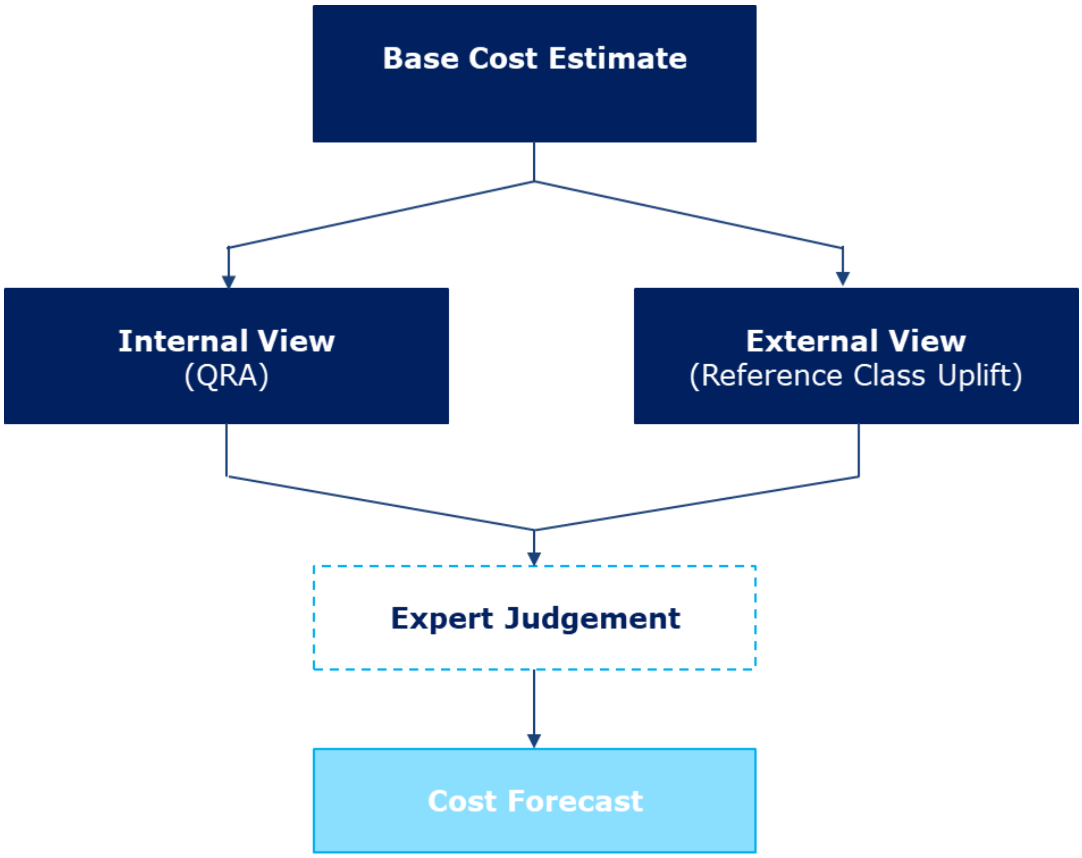


Figure 4 – Graphical Representation of the Cost Forecasting Process

10. References

1. New Children's Hospital: Independent review of escalation in costs: 05 April 2019: PricewaterhouseCoopers
2. Lessons from transport for the sponsorship of major projects: April 2019: Department for Transport and Infrastructure and Projects Authority
3. Cost overruns in transport infrastructure: October 2016: Grattan Institute, Australia
4. Improving Infrastructure Delivery: Project Initiation Route Map, Risk Management Module: June 2016: Infrastructure and Project Authority
5. Reference Class Forecast, Project Report: February 2019: Oxford Global Projects

11. Appendix A – Tier-1 reference classes for cost uplifts at Outline Business Case stage

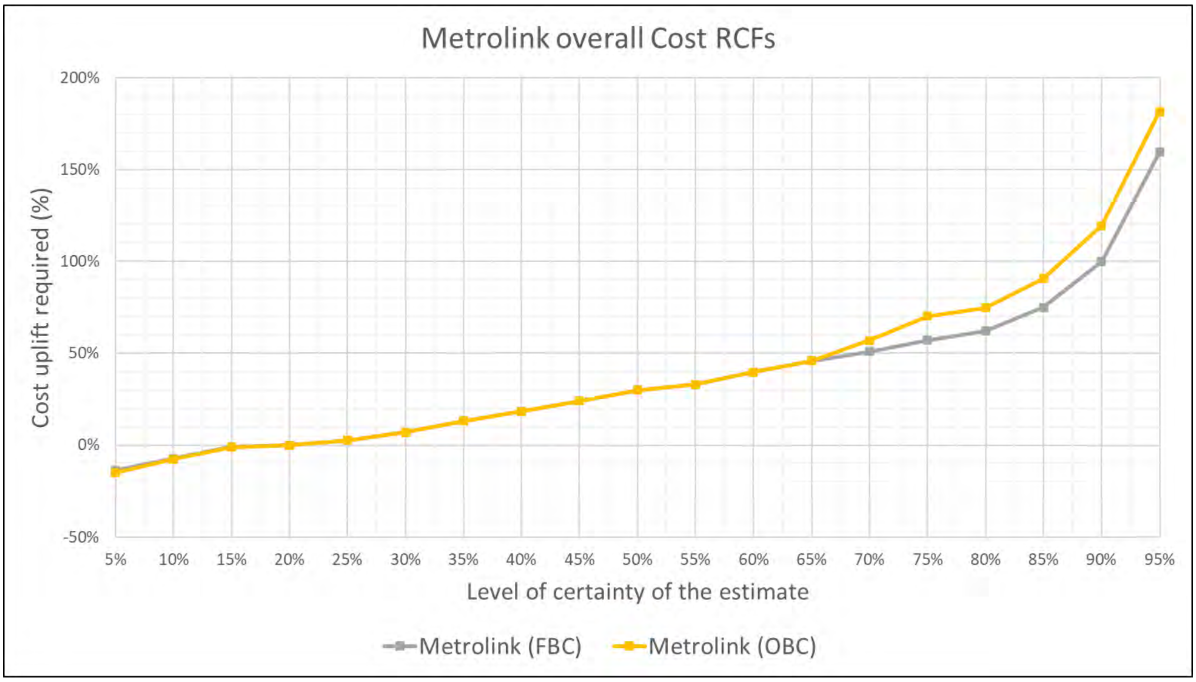
The following table provide the key uplifts for P30, P50, P80 and P90 for the cost and schedule uplifts at the outline business case stage.

Percentile (P-value)	**70% acceptable chance of cost overrun (P30)**	**50% acceptable chance of cost overrun (P50)**	**20% acceptable chance of cost overrun (P80)**	**10% acceptable chance of cost overrun (P90)**
Metro Overall (Metros & Tunnel)	7%	30%	62%	100%
Tunnels	7%	25%	85%	126%
Stations	2%	14%	107%	220%
Bridges	-1%	12%	62%	105%
Buildings	1%	13%	101%	219%
Urban Rail	13%	38%	77%	104%
Electrification	-1%	0%	32%	43%
Signalling/ Systems	-12%	0%	60%	194%
Rolling Stock	21%	30%	81%	103%
Planning and Design	-37%	2%	67%	126%
Preliminaries	4%	18%	76%	116%
Advance works	-69%	-56%	16%	131%
Utility diversions	1%	8%	58%	71%
Archaeology	-75%	-48%	-6%	0%
IT Systems	-12%	0%	60%	194%
Partner	20%	25%	49%	59%
Construction supervision	-40%	-14%	71%	151%
Construction	3%	16%	72%	102%
Land & Property	-29%	0%	62%	133%

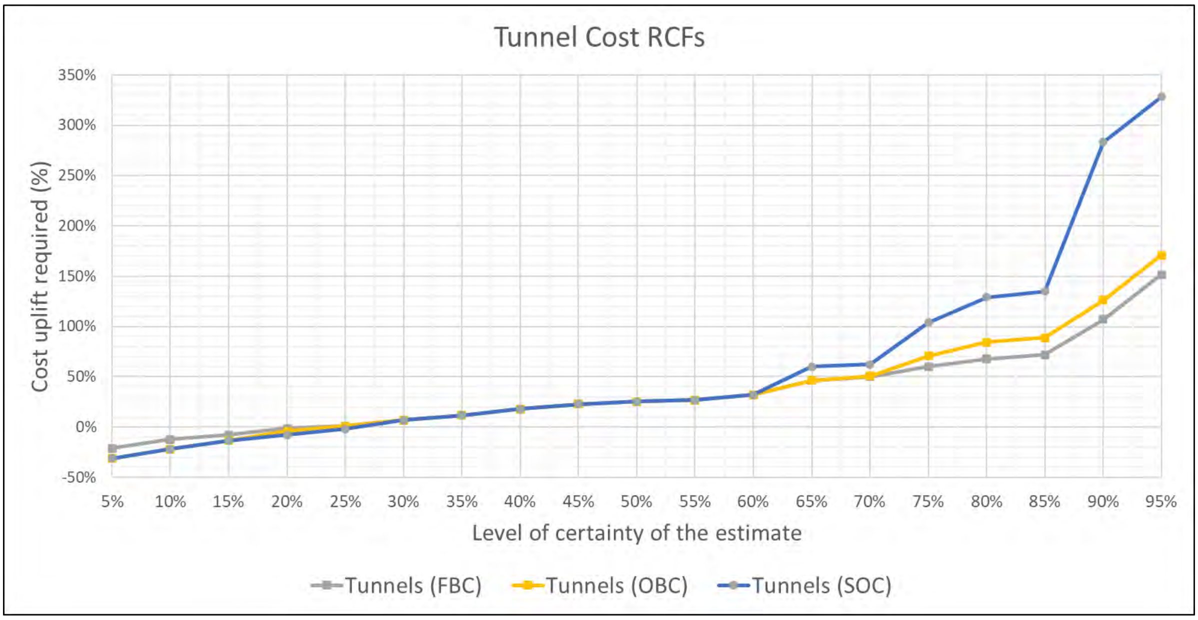
Table 6 – Project Appraisal

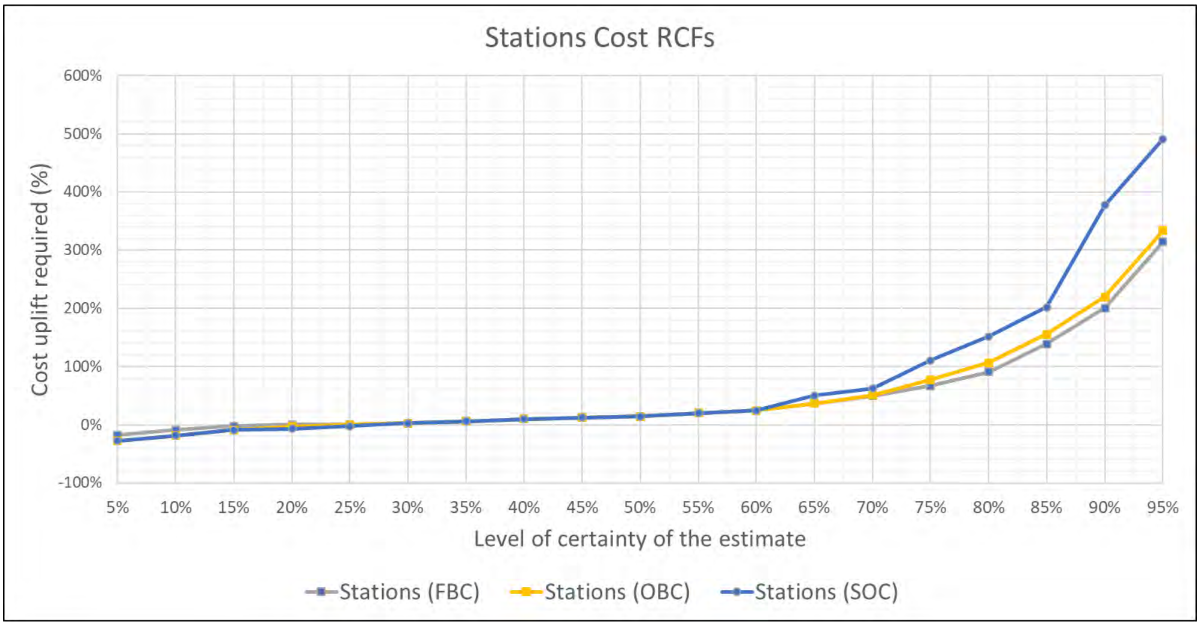
The graphs shown below show the reference class curves which have been developed by Oxford Global Projects to support the development of the Reference Class Forecast for the MetroLink Project. The graphs below have been broken down into the pre-agreed individual asset classes in accordance with table 6 above.

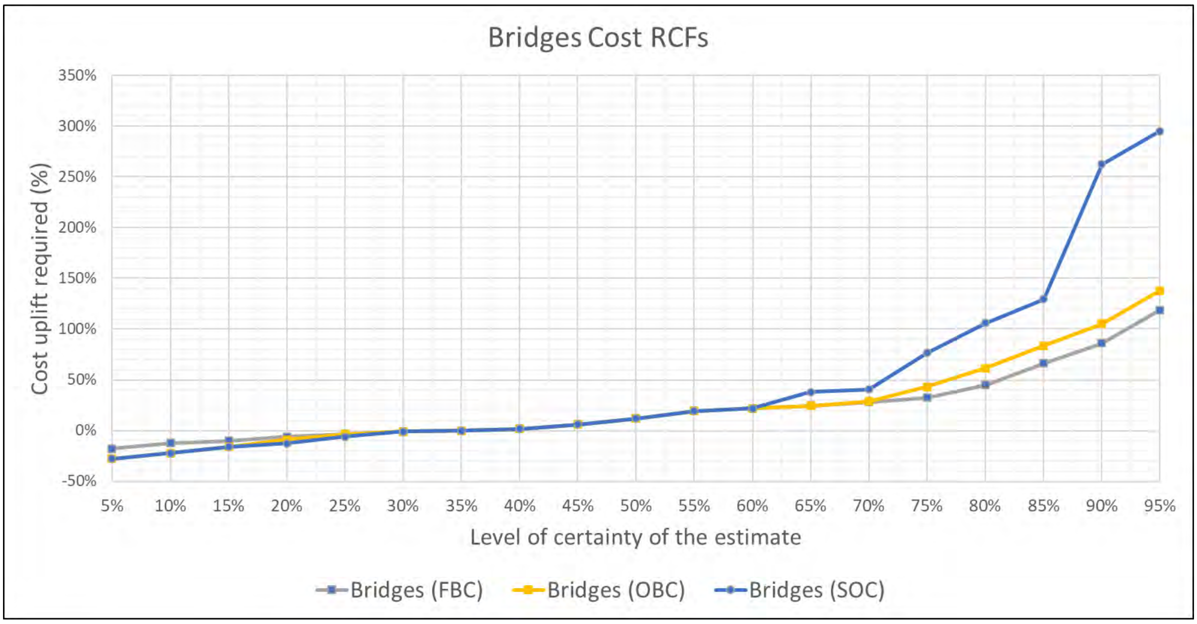
General Curve

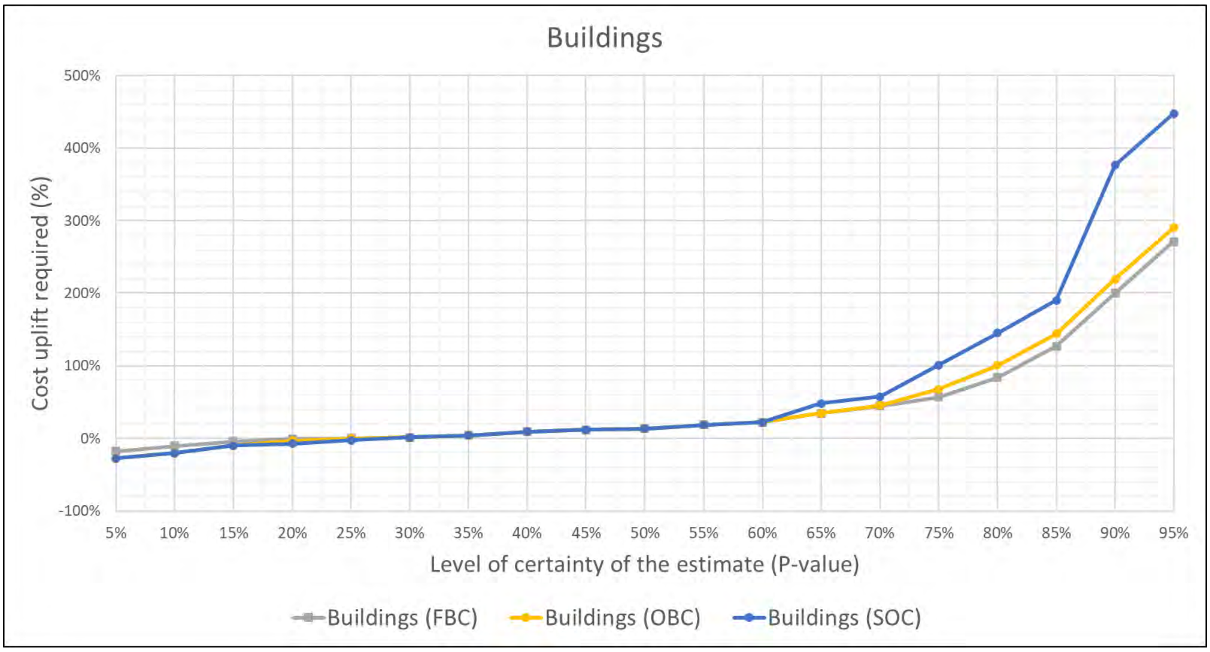


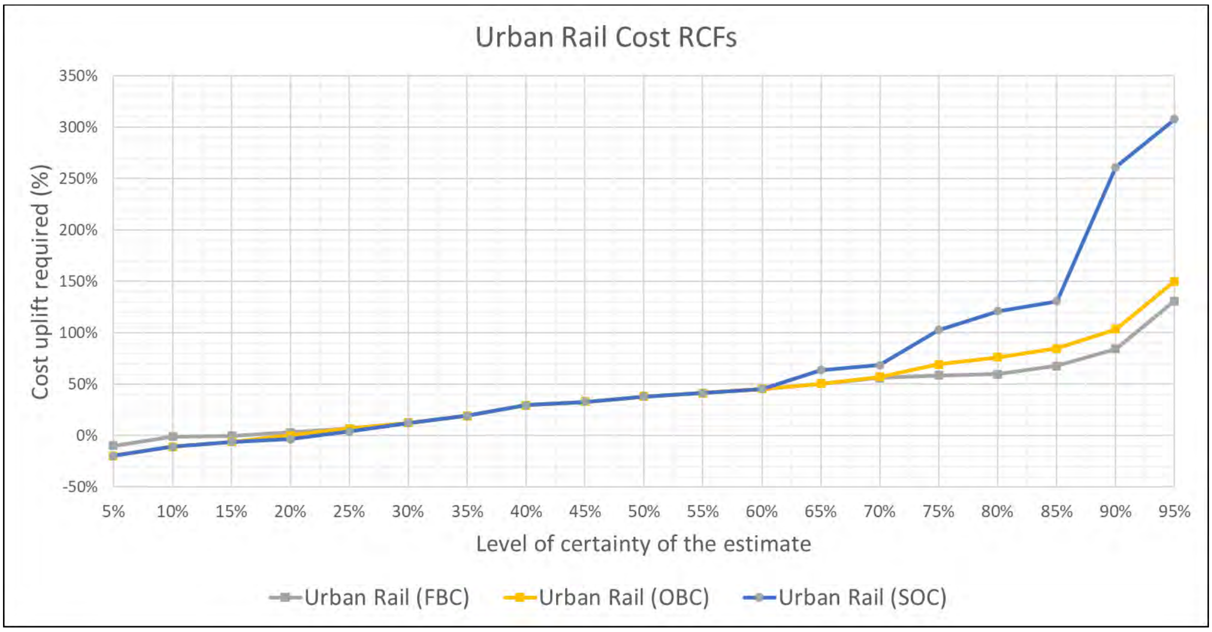
Individual Asset Class Curves

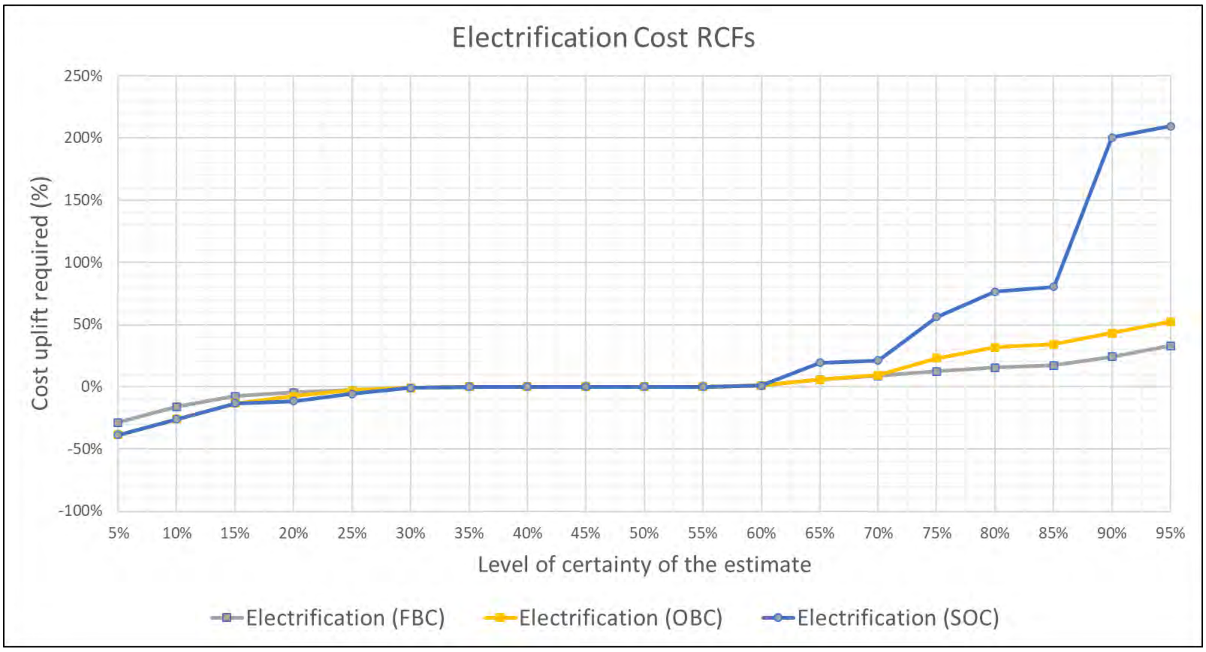


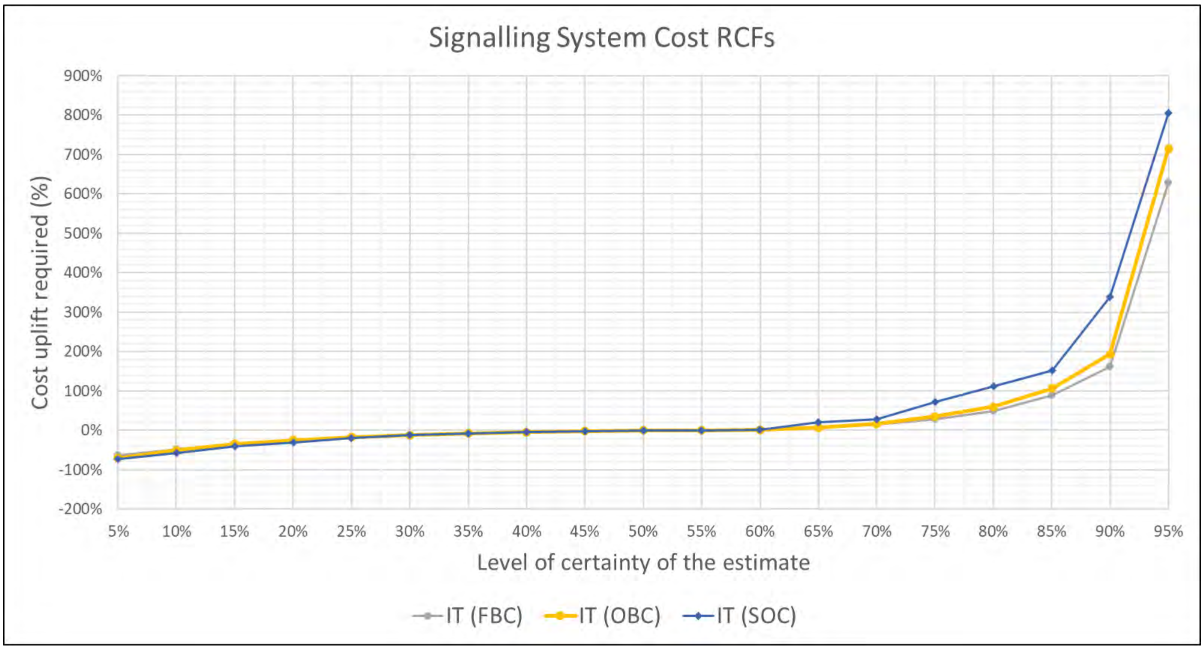

Stations Cost RCFs
600%
500%
400%
300%
200%
100%
0%
-100%
Cost uplift required (%)
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
Stations (FBC)
Stations (OBC)
Stations (SOC)

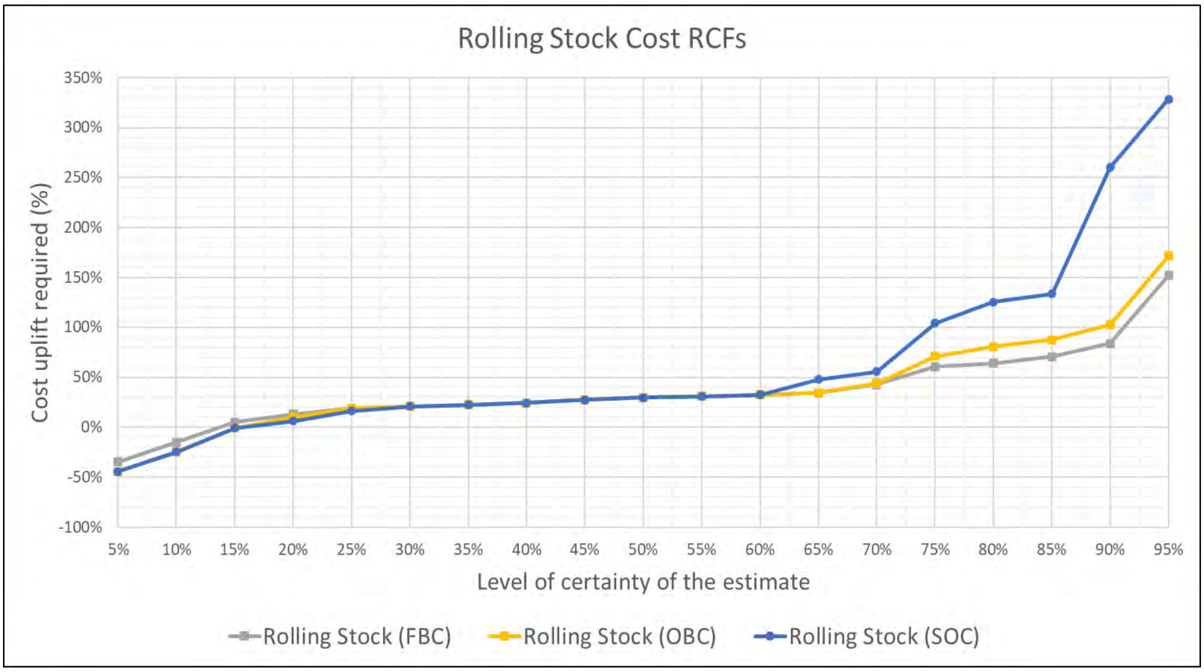

Bridges Cost RCFs
350%
300%
250%
200%
150%
100%
50%
0%
-50%
Cost uplift required (%)
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
Bridges (FBC)
Bridges (OBC)
Bridges (SOC)

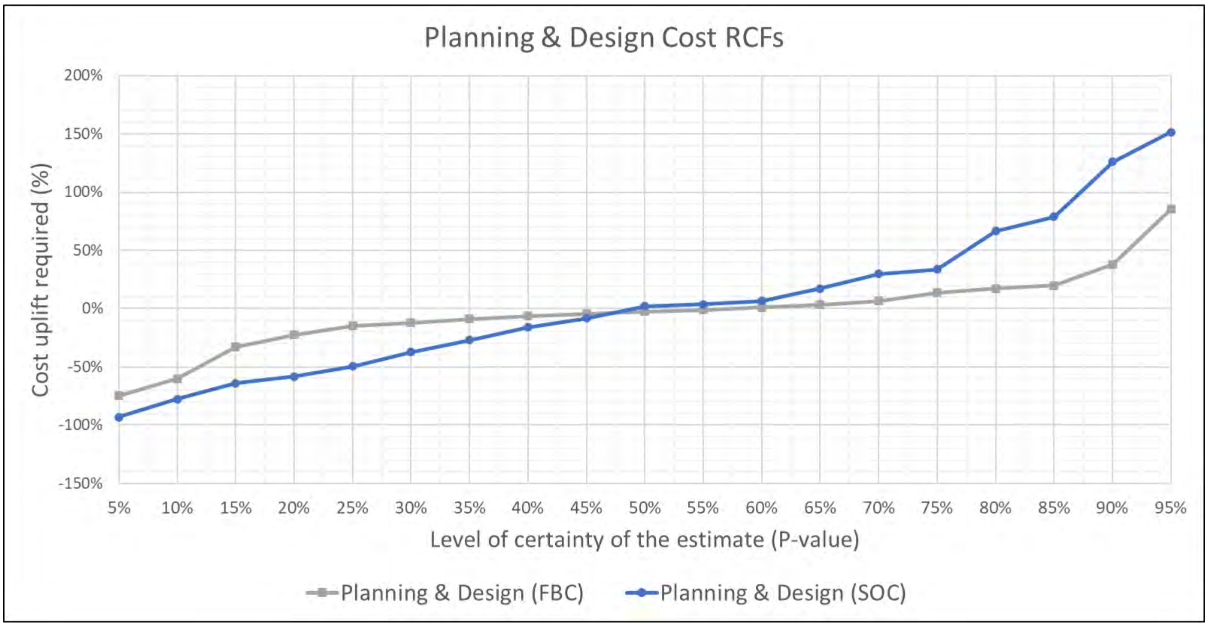

Buildings
500%
400%
300%
200%
100%
0%
-100%
Cost uplift required (%)
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate (P-value)
Buildings (FBC)
Buildings (OBC)
Buildings (SOC)

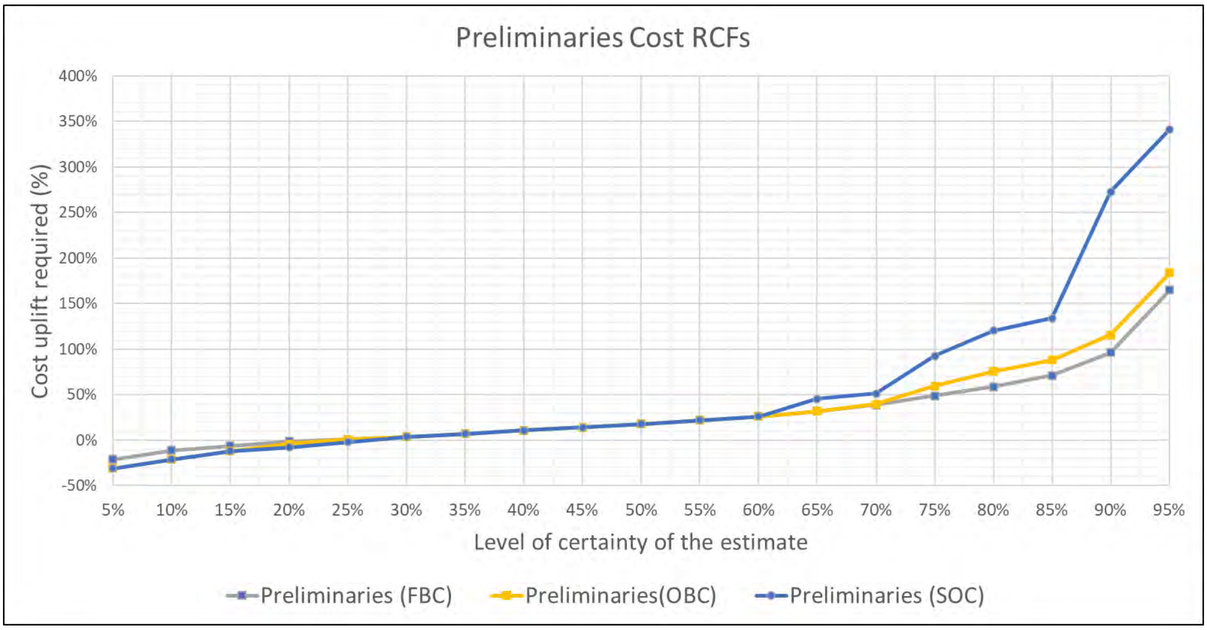

Urban Rail Cost RCFs
350%
300%
250%
200%
150%
100%
50%
0%
-50%
Cost uplift required (%)
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
Urban Rail (FBC)
Urban Rail (OBC)
Urban Rail (SOC)

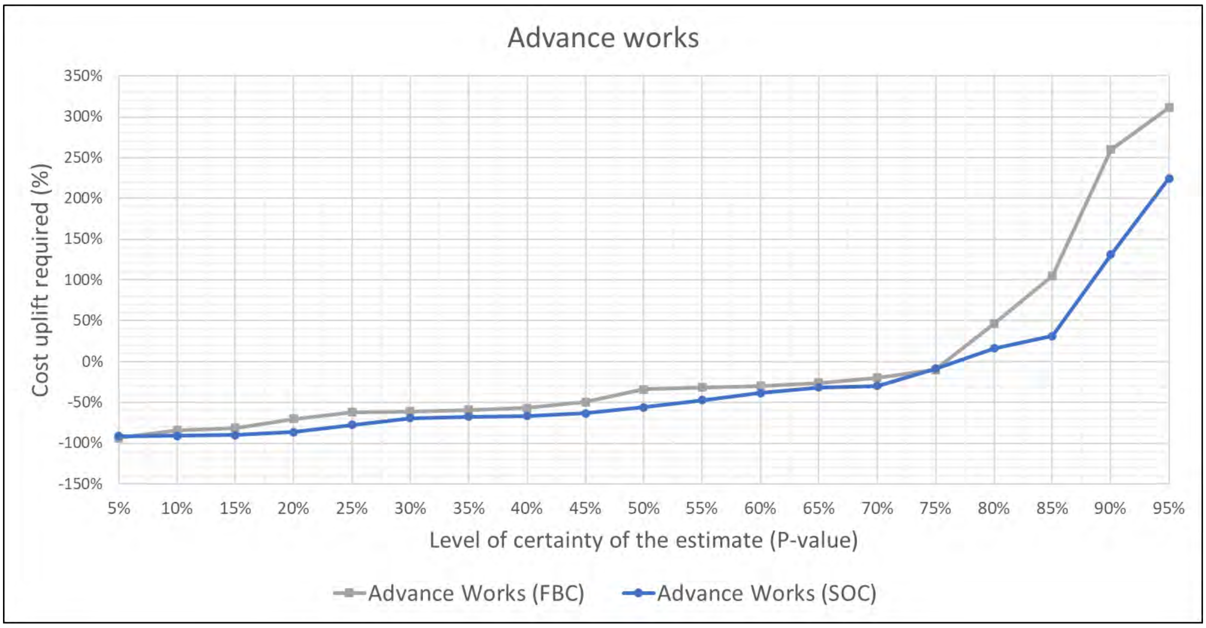

Electrification Cost RCFs
Cost uplift required (%)
250%
200%
150%
100%
50%
0%
-50%
-100%
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
Electrification (FBC)
Electrification (OBC)
Electrification (SOC)

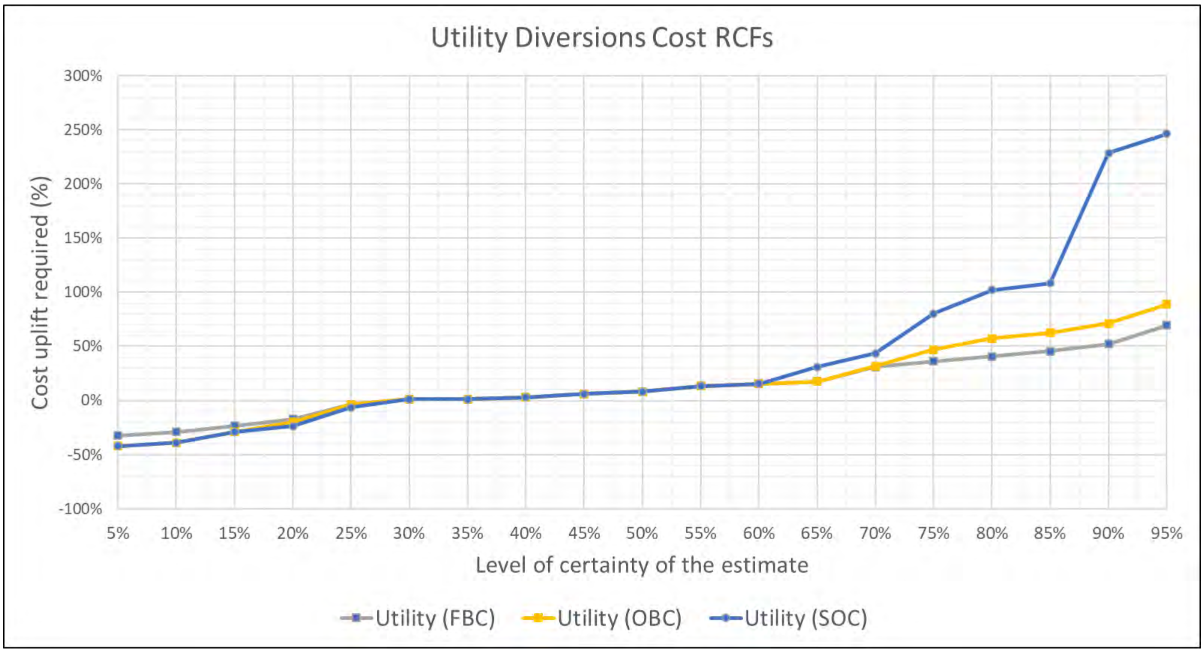

Signalling System Cost RCFs
Cost uplift required (%)
900%
800%
700%
600%
500%
400%
300%
200%
100%
0%
-100%
-200%
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
IT (FBC)
IT (OBC)
IT (SOC)

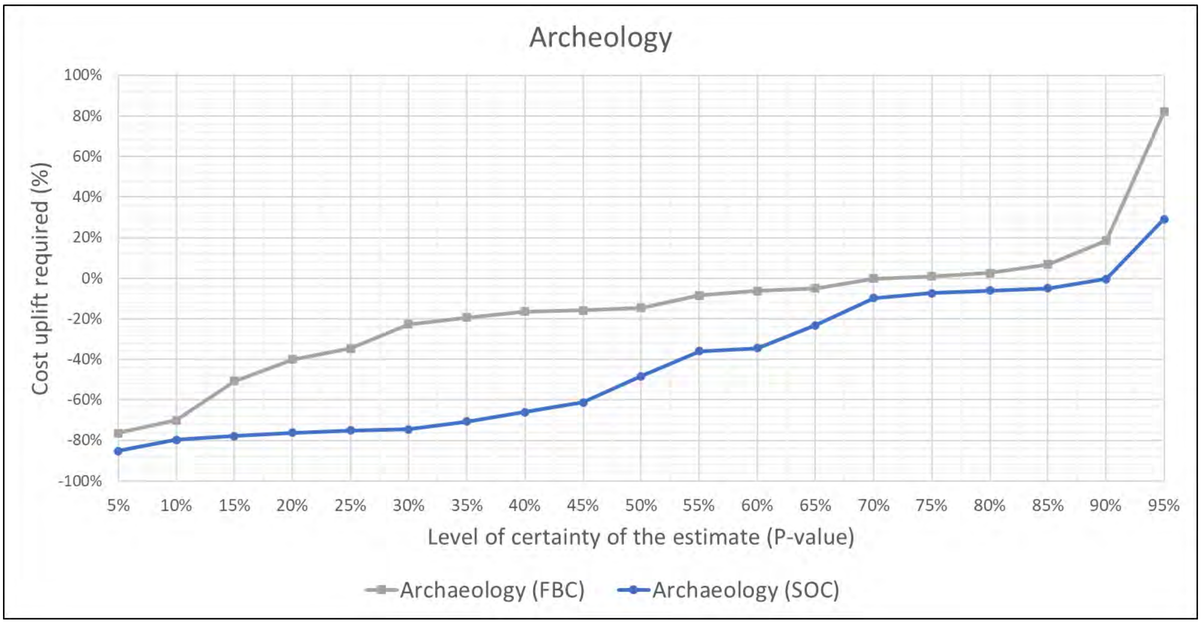

Rolling Stock Cost RCFs
Cost uplift required (%)
Level of certainty of the estimate
Rolling Stock (FBC)
Rolling Stock (OBC)
Rolling Stock (SOC)

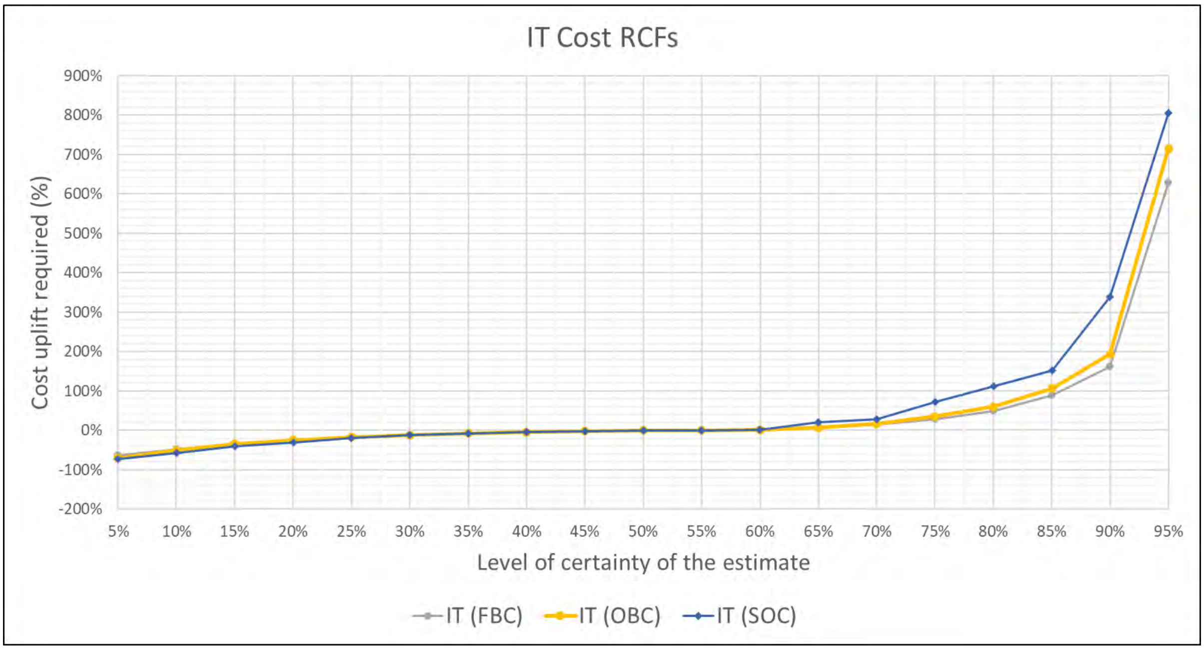

Planning & Design Cost RCFs
Cost uplift required (%)
Level of certainty of the estimate (P-value)
Planning & Design (FBC)
Planning & Design (SOC)

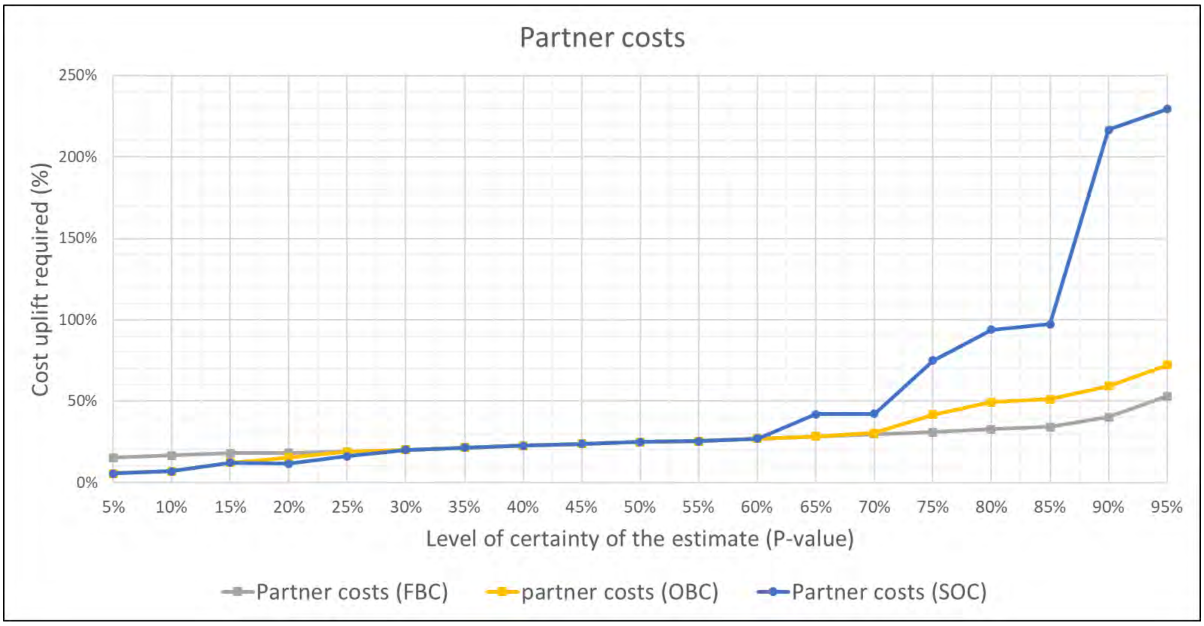

Preliminaries Cost RCFs
400%
350%
300%
250%
200%
150%
100%
50%
0%
-50%
Cost uplift required (%)
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
Preliminaries (FBC)
Preliminaries(OBC)
Preliminaries (SOC)

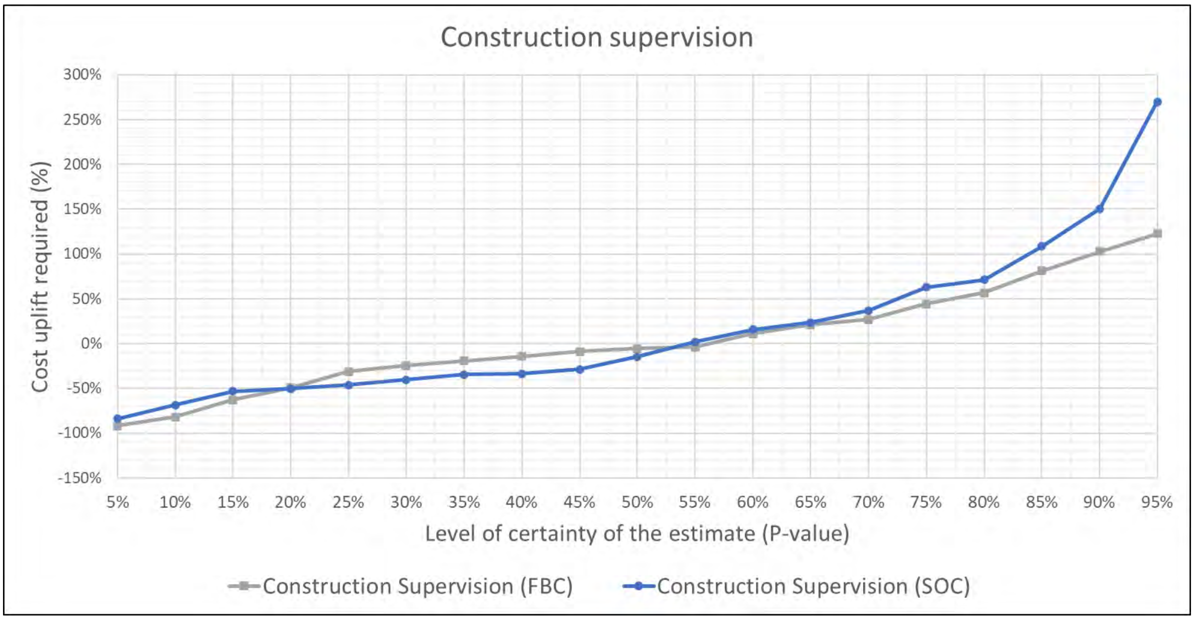

Advance works
350%
300%
250%
200%
150%
100%
50%
0%
-50%
-100%
-150%
Cost uplift required (%)
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate (P-value)
Advance Works (FBC)
Advance Works (SOC)

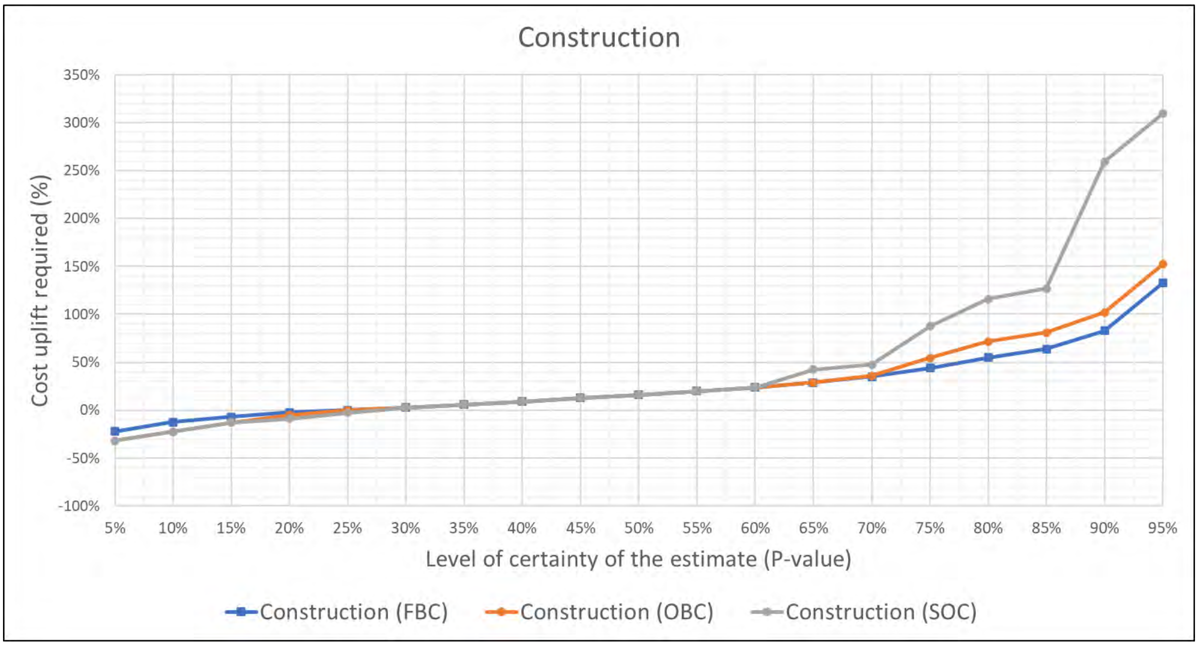

Utility Diversions Cost RCFs
Cost uplift required (%)
300%
250%
200%
150%
100%
50%
0%
-50%
-100%
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
Utility (FBC)
Utility (OBC)
Utility (SOC)

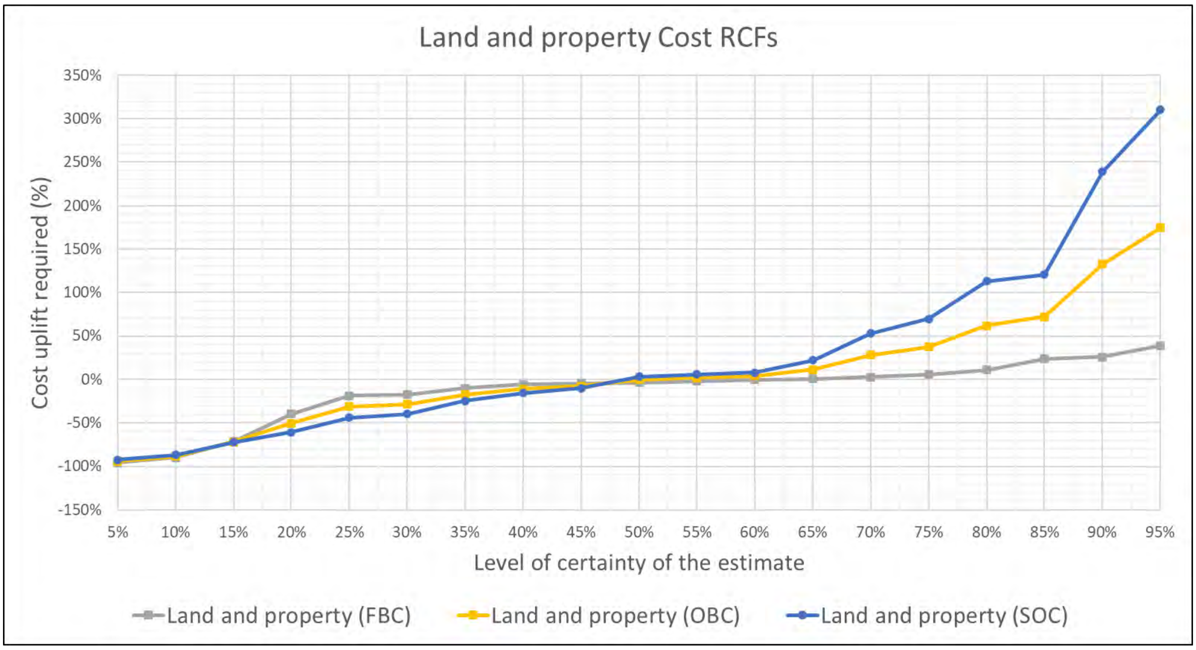

Archeology
Cost uplift required (%)
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate (P-value)
Archaeology (FBC)
Archaeology (SOC)


IT Cost RCFs
Cost uplift required (%)
900%
800%
700%
600%
500%
400%
300%
200%
100%
0%
-100%
-200%
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
IT (FBC)
IT (OBC)
IT (SOC)


Partner costs
Cost uplift required (%)
250%
200%
150%
100%
50%
0%
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate (P-value)
Partner costs (FBC)
partner costs (OBC)
Partner costs (SOC)


Construction supervision
300%
250%
200%
150%
100%
50%
0%
-50%
-100%
-150%
Cost uplift required (%)
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
Level of certainty of the estimate (P-value)
Construction Supervision (FBC)
Construction Supervision (SOC)


Construction
350%
300%
250%
200%
150%
100%
50%
0%
-50%
-100%
Cost uplift required (%)
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
Level of certainty of the estimate (P-value)
Construction (FBC)
Construction (OBC)
Construction (SOC)


Land and property Cost RCFs
Cost uplift required (%)
350%
300%
250%
200%
150%
100%
50%
0%
-50%
-100%
-150%
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95%
Level of certainty of the estimate
Land and property (FBC)
Land and property (OBC)
Land and property (SOC)

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Appendix M: Traffic Modelling Report

MetroLink

Transport Modelling Report – Business Case

ML1-JAI-TRA-ROUT_XX-RP-Y-00009 | P04.2

2021/09/20

MetroLink

Project No:	32108600
Document Title:	Transport Modelling Report – Business Case
Document No.:	ML1-JAI-TRA-ROUT_XX-RP-Y-00009
Revision:	P04.2
Date:	2021/09/20
Client Name:	TII / NTA
Client No:	
Project Manager:	Neil Cowie
Author:	A. GOSS
File Name:	ML1-JAI-TRA-ROUT_XX-RP-Y-00009.docx

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Document history and status

Revision	Date	Description	Author	Checker	Reviewer	Approver
P04.2	20/09/21	Updated – sensitivity test added	LPAG	MF	MF	NC
P03	25/02/21	First Issue	LP	MF	MF	NC
P02	03/02/21		AG	MF	MF	NC
P01	01/02/21		LP	MF	MF	NC

Contents

Executive Summary

The Transport Modelling Report details the model development, data inputs, model calibration and validation, and development of future year models.

The purpose of this report is to describe the work that has been undertaken, to make the case for using the transport model as the basis for the appraisal of the scheme, to detail the way in which the model has been built and to provide evidence that the model is sufficiently capable of reflecting observed conditions relating to transport and traffic flows. It also makes clear the basis for any projections produced by the model and provides a clear view of the impact of the scheme that is being assessed on the direct vicinity of the project and its greater surrounding area.

The following scenario years have been used for the MetroLink scheme assessment:

- Opening Year: 2030;
- Design Year: 2045 (opening year + 15); and
- Forecast Year: 2060 (opening year + 30).

The Business Case (referred to as 'Core') runs utilise a Do Committed Schemes scenario. The Core run has been modelled for each of the scenario years, as well as sensitivity tests, including Slow Growth, Low Frequency, Alternative Demand, Enhanced Transport Networks, and Enhanced Transport Networks in conjunction with the Alternative Demand scenario. All years (2030, 2045 and 2060) have been modelled and are presented in this report.

A summary comparing all Core runs, both northbound and southbound, is presented below. In the 12hr period, the total number of boarding passengers increases by 22% from 2030 to 2045, from 128,182 passengers to 156,091 passengers respectively. This further increases to 209,815 boarding passengers in 2060, representing an increase of 34% from 2045 to 2060.

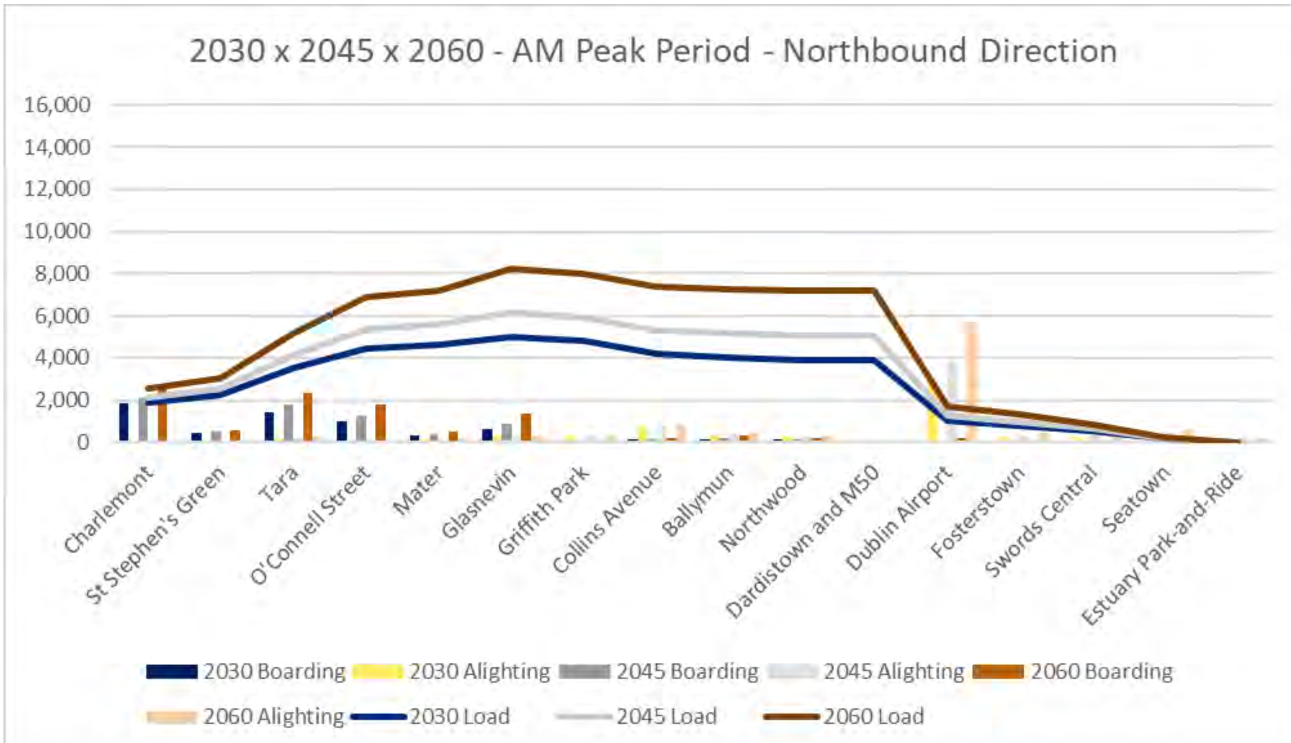


Figure 1: Core Run Comparisons – AM Peak Period Northbound

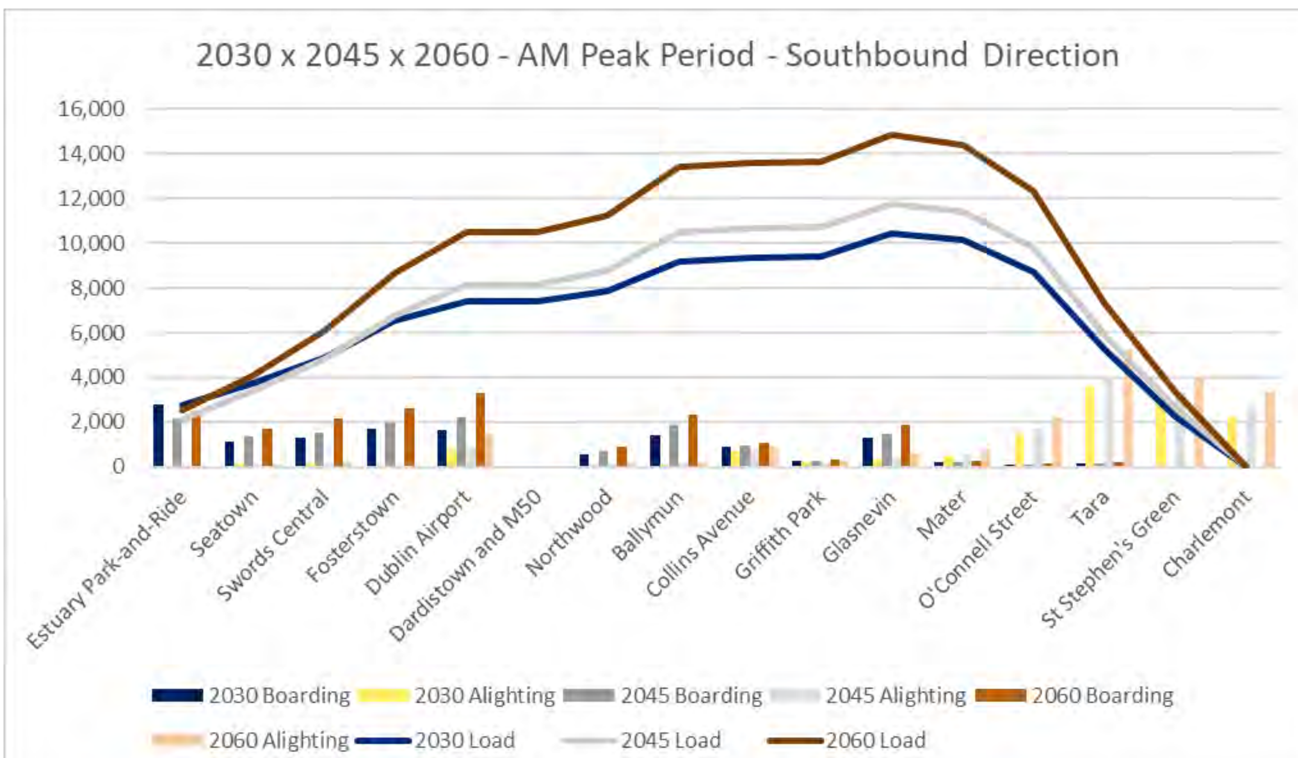


Figure 2: Core Runs Comparison – AM Peak Period Southbound

1. Introduction

1.1 Purpose of the Transport Modelling Report

The Transport Modelling Report (TMR) details the model development, data inputs, model calibration and validation, development of future year models, modelling results and results of appraisal tools for the proposed MetroLink scheme.

The report describes the work that has been undertaken and makes the case for using the transport model as the basis for the appraisal of the MetroLink scheme. It details the way in which the model has been built and provides evidence that it is sufficiently capable of reflecting observed conditions relating to public transport and traffic flows. It also makes clear the basis for any projections produced by the model and provides a clear view of the impact of the scheme that is being assessed on the direct vicinity of the proposed scheme and its wider surrounding area.

1.2 Methodology / Structure of the MetroLink Transport Model

As described in the Transport Modelling Plan (TMP, ML1-JAI-TRA-ROUT_XX-PL-Y-00001), the following chart outlines the assessment methodology including the high-level inputs, the strategic multi-modal modelling assessment, the interaction with local / micro modelling, and the outputs and deliverables. The strategic multi-modal modelling will underpin the assessment and comprise the main assessment of benefits and impacts as part of the Business Case, feeding into local / micro models where potentially significant impacts are identified and assessed as part of the EIAR/TIA.

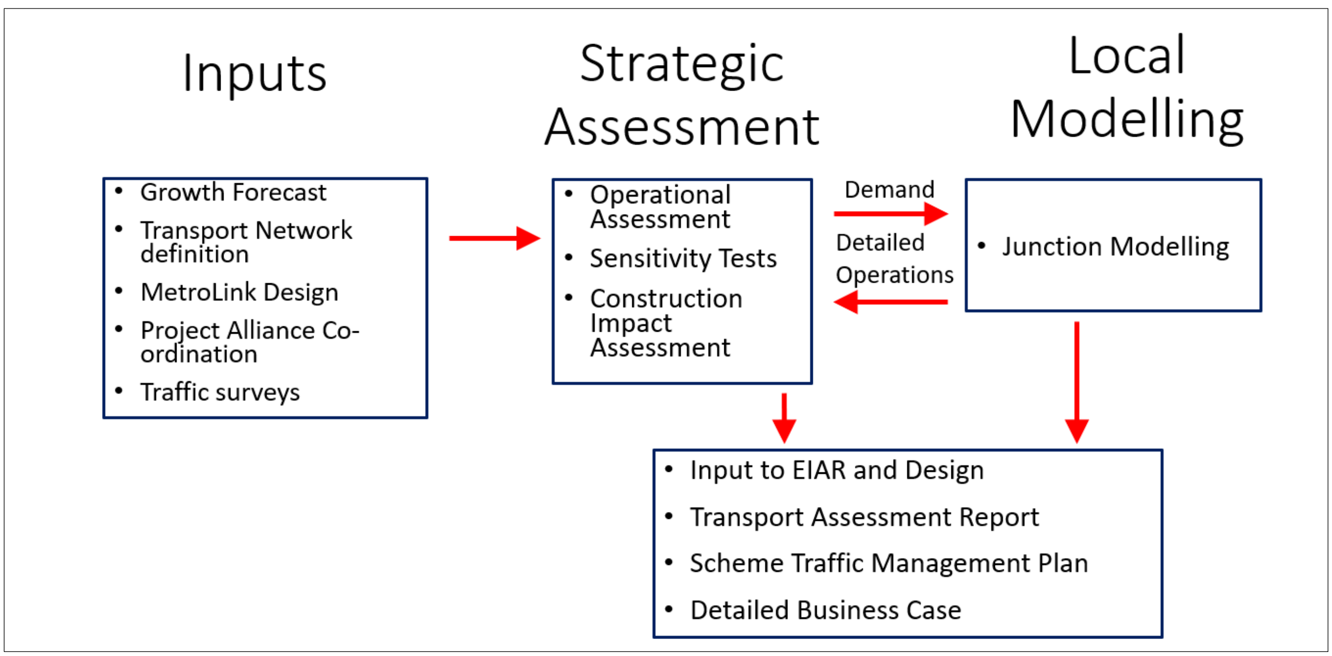


Figure 1-1: Transport Assessment Approach

1.3 NTA East Regional Model

The National Transport Authority (NTA) has developed a Regional Modelling System (RMS) for Ireland that allows for the appraisal of a wide range of potential future transport and land use alternatives.

The RMS comprises the National Demand Forecasting Model (NDFM); five large-scale, detailed, multi-modal regional transport models; and a suite of Appraisal Modules. The five regional models comprising the RMS are focused on the travel to-work areas for Dublin (represented by the East Regional Model (ERM)), for Cork (represented by the South West Regional Model (SWRM)), for Limerick (represented by the Mid-West Regional Model (MWRM)), for Galway (represented by the West Regional Model (WRM)) and for Waterford (represented by the South East Regional Model (SERM)). The key attributes of the five regional models include; full geographic coverage of each region, detailed representations of all major surface transport modes including active modes, road and public transport networks and services, and of travel demand for five time periods (AM, 2 Inter-Peaks, PM and Off-Peak). The RMS encompasses behavioural models calibrated to 2016 Household Survey data that predict changes in trip destination and mode choice in response to changing traffic conditions, transport provision and/or policies which influence the cost of travel.

The RMS has been developed to provide the NTA with the means to undertake comparative appraisals of a wide range of potential future transport and land use options, and to provide evidence to assist in the decision-making process.

The RMS captures all day travel demand, thus enabling more accurate modelling of mode choice behaviour and increasingly complex travel patterns, especially in urban areas where traditional nine-to-five working is decreasing. Best practice, innovative approaches were applied to the RMS demand modelling modules including car ownership; parking constraint; demand pricing; and mode and destination choice. The RMS is therefore significantly more responsive to future changes in demographics, economic activity and planning interventions than traditional models.

The strategic model used for the MetroLink Scheme Appraisal is the ERM developed by the NTA. The ERM is a multi-modal, network based transport model that includes all main surface modes of travel, including: Full Geographic Coverage of the Eastern Region, a detailed representation of the road network, a detailed representation of the public transport network & services, a detailed representation of all major transport modes including active modes, accurate mode choice modelling of residents, a detailed representation of travel demand 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.

This ERM has a base year of 2016 and is calibrated to 2016 Census, 2017 National Household Travel Survey and localised multi-modal surveys.

Further detail and background to the development of the ERM can be found in the NTA's report 'Model Development Report – Eastern Regional Model'.

2. Data Collection

The latest version of ERM was calibrated to a base year of 2016, full details on the data collection used in the development of the model and in the validation and calibration of the model is contained within the NTA's report 'Model Development Report – Eastern Regional Model'.

In May 2018 traffic surveys were undertaken on 108 sites along the proposed MetroLink corridor. Vehicle and pedestrian movement surveys were undertaken for all 108 locations over three separate days and for 24-hour sessions at each. The surveys were undertaken on neutral weekdays, defined as Tuesday, Wednesday or Thursday, and were undertaken out with any school or public holidays.

3. Forecast Years

3.1 Forecast Years

The following forecast years have been used in the MetroLink scheme assessment.

- Opening Year: 2030.
- Design Year: 2045 (opening year + 15).
- Forecast Year: 2060 (opening year + 30).

The Business Case runs will utilise a Do Committed Schemes. Details of the schemes that form part of these different scheme scenarios are contained within the Traffic Modelling Plan.

The Central Case is referred to as Business Case Core Run within this report. This report presents the results of this Core Run and the associated sensitivity tests that were undertaken as part of the development of the Preliminary Business Case.

3.2 Future Growth Rates

In order to ensure that the MetroLink Project can operate efficiently and deliver benefits into the future, forecasts are required to determine the likely future levels of demand on Dublin's transport system. The TII PAG states that *"Unbiased future demand projections are a critical input in ensuring that capacity for transport infrastructure is neither too large nor too small to meet the future demand. Furthermore, travel demand projections inform the economic and environmental appraisal of transport schemes and therefore play a fundamental role in deciding whether a scheme is to progress".*

The NTA has prepared a set of future planning variables which form a key input into the National Trip End Model (NTEM) and is referred to as the planning sheet reference case.

As part of the process the NTA has determined forecasts for key trip generation and destination variables listed below.

- Population;
- Population by age cohorts;
- Population by school level (Primary, Secondary, Third level);
- Principal Economic Status;
- Employment places at destination;
- Employment places at destination by type (Health, Retail, Food Retail); and
- Education places at destination by level (Primary, Secondary, Third level).

The foundation of this planning sheet is heavily based on published policy documents. The National Planning Framework (NPF) was launched in February 2018, following which the Department of Housing, Planning and Local Government issued an Implementation Roadmap. This document set out the target population figures for each county for 2026 and 2031. In addition, the Department of Housing supplied employment figures for each county up to 2040. There are figures provided for the 'At-Work' population as well as the number of employment places per county.

The NTA have worked with the Regional Assemblies and the Local Authorities to incorporate their housing and growth priorities in the planning sheet. While the planning sheet is controlled at the regional and county level by published policy documents (NPF & RSES), the distribution of growth within counties is discussed and agreed with Local Authorities. Where agreement has not been made the NTA has based the distribution on existing patterns and zoning within the development plans.

These planning sheets are the principal land use scenario for all plans and schemes. Interim year planning sheets for years between 2016 and 2040, are straight line interpolation between 2016 and 2040. For years after 2040, these planning datasheets are created by extending this straight-line interpolation onwards to the forecast year, such as 2045 or 2060.

Figure 3-3 illustrates the increase in population and jobs within the Greater Dublin Area (GDA), and Figure 3-4 illustrates the increase in the population and number of jobs within a 1km catchment distance of stations along the MetroLink, using data from the NTA planning sheets. A 1km catchment buffer has been selected as it takes 15minutes to walk approximately 1.6km.

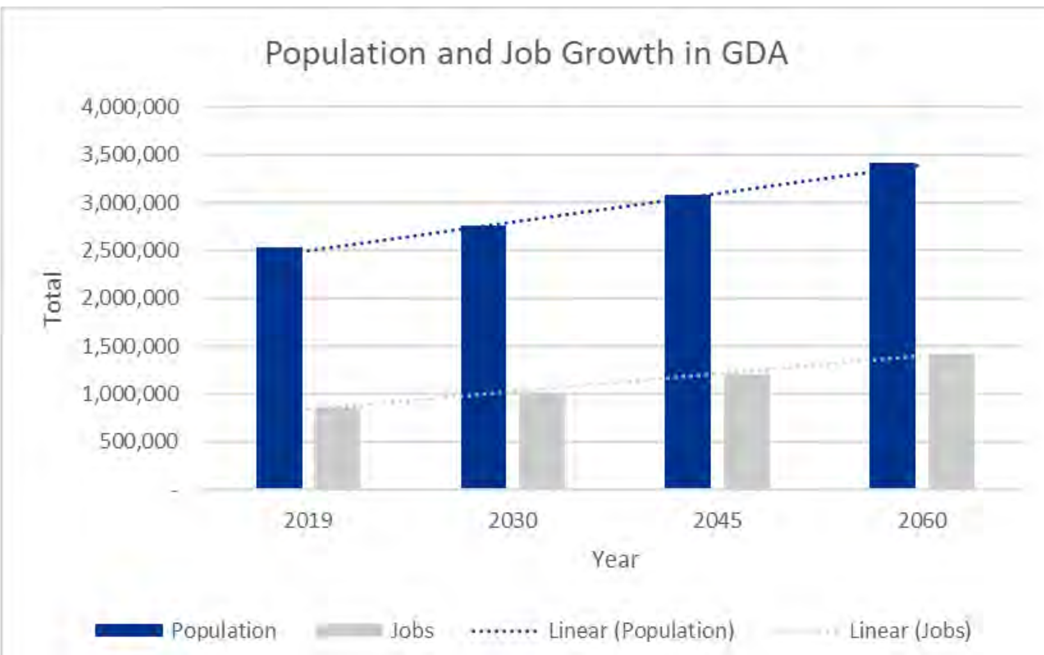


Figure 3-1: Population and Job Growth in Greater Dublin Area 2019 -2060

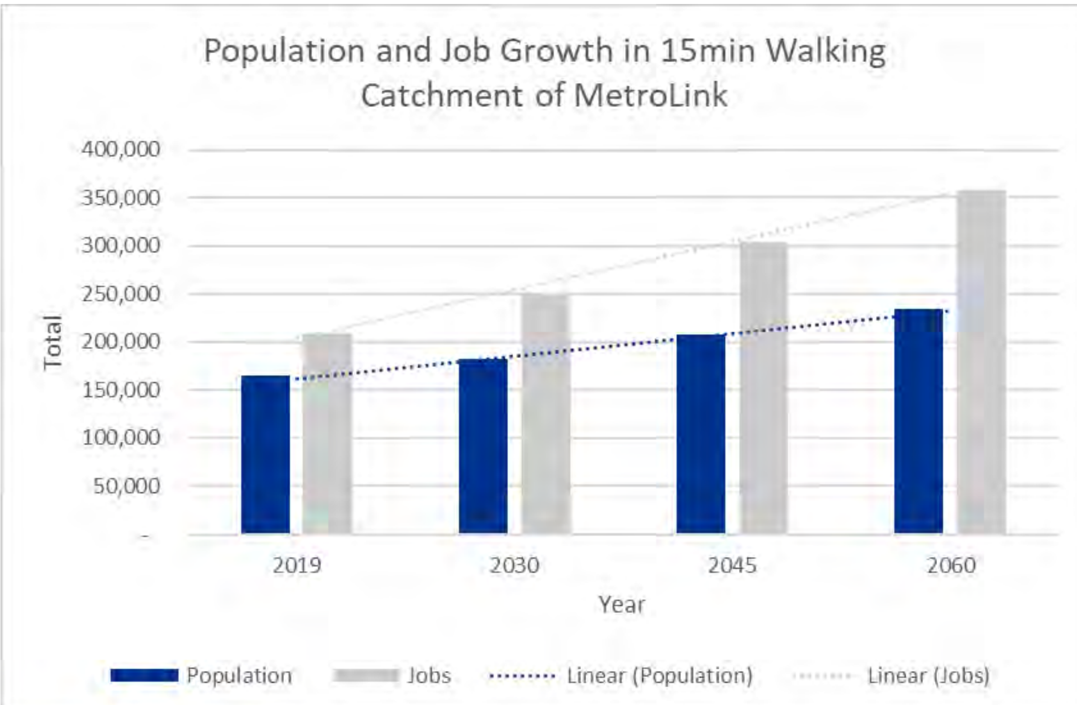


Figure 3-2: Population and Job Growth within 15min Walking Catchment of MetroLink

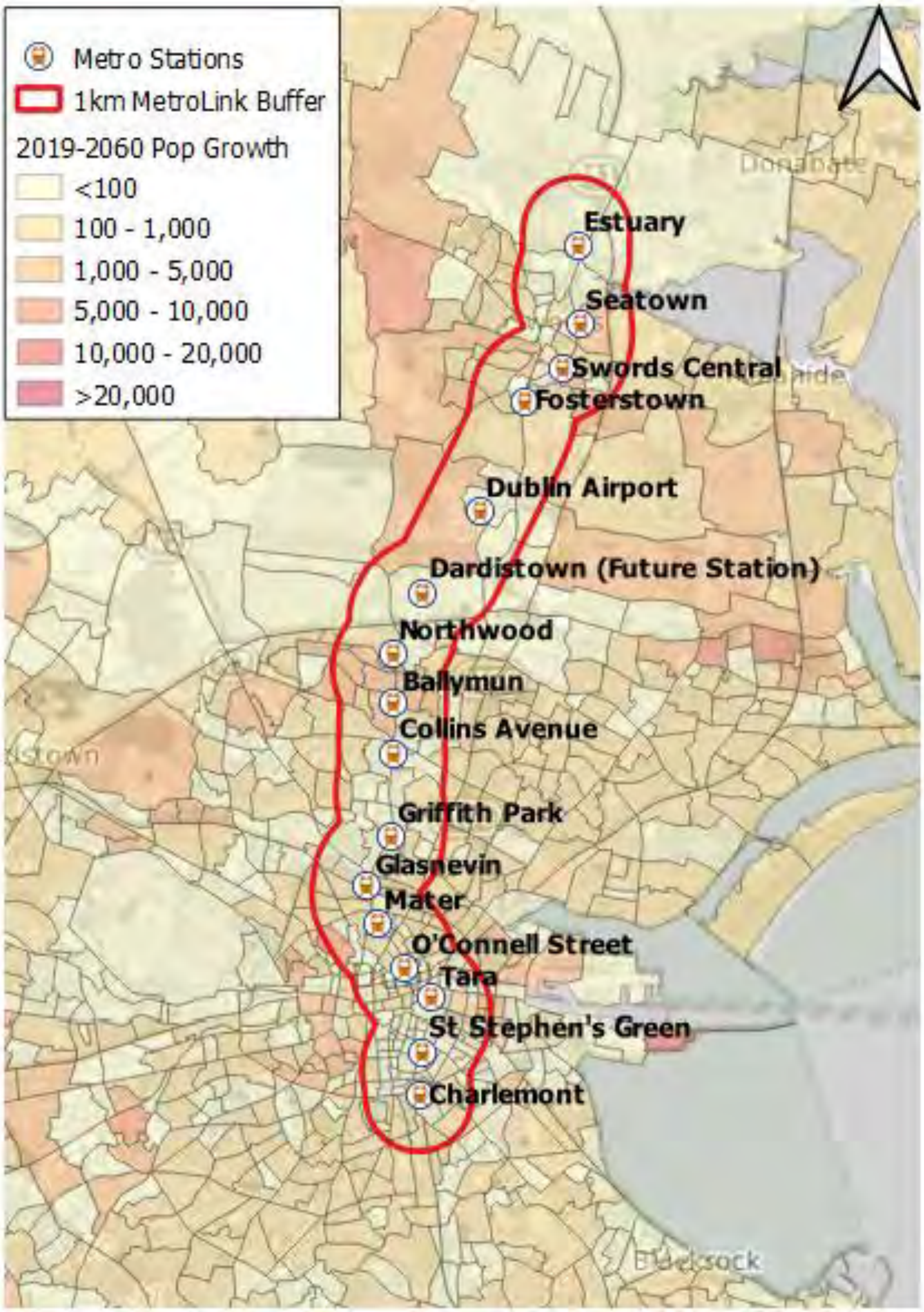


Figure 3-3: Population Growth from 2019 to 2060

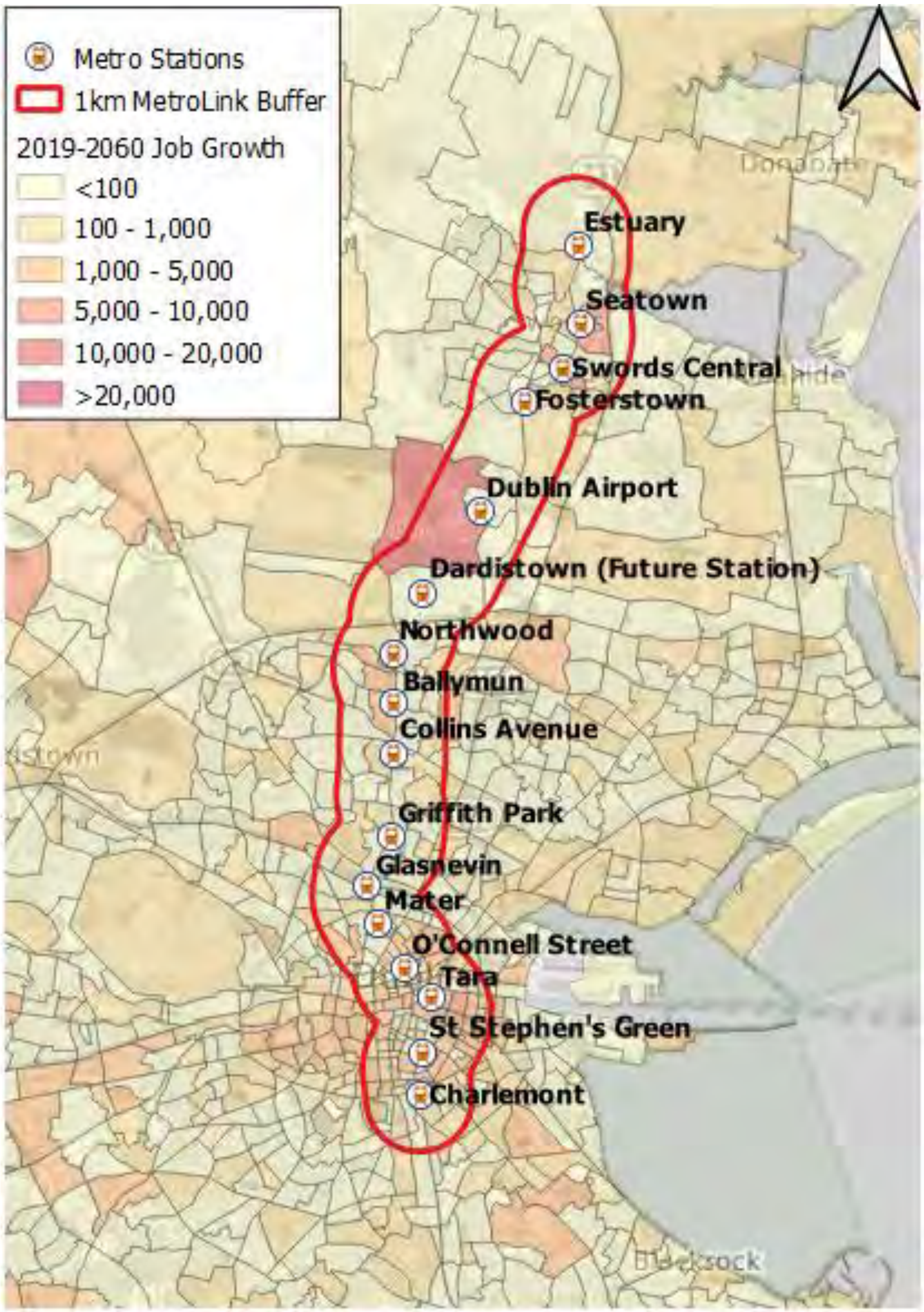


Figure 3-4: Job Growth from 2019 to 2060

3.3 Specific developments

In addition to the forecast growth associated with the typical land use patterns, Dublin Airport is a key growth driver in the corridor and has a different growth associated with flight travel demand. Within the ERM, growth in landside demand is determined for passengers, staff and freight, applied to the Dublin Airport Special Zone. Freight and staff numbers are forecasted on a scaling factor, which are aligned with passenger growth forecasts.

The passenger growth forecasts are based on the central growth forecast from the DTTAS report "Review of Capacity Needs at Ireland's State Airports - August 2018", and the Central Statistics Office (CSO) 2016-2019 Aviation Stats' TAM05. The CSO stats are used to calculate the growth rate up to 2019 and the growth rate from 2020 to 2050 is determine by interpolation from the 2019 passenger forecast to the 2050 passenger forecast contained within the DTTAS report.

4. Network Development

This section describes the development of the models and scenarios used to assess the MetroLink scheme Business Case. This included identifying the area of influence, as well as coding appropriate schemes in the Do Minimum and Do Something scenario networks. 29 different model runs have been undertaken, which are detailed in Section 4.5.

4.1 Area of Influence

To determine the main area of influence, two baseline model runs have been carried out; one without the MetroLink scheme, and one with the MetroLink scheme. The public transport and highway outputs from these two runs have been compared to identify the area of influence of the MetroLink scheme, and the results are provided in the 'Area of Influence' Technical Note.

- 2018 Do Nothing - 2018 present day model, without the MetroLink alignment and stations; and
- 2018 Do Scheme - 2018 present day model with the MetroLink alignment and stations.

The area of influence for the MetroLink scheme can be seen in Figure 4-1. As expected, the main area of influence is in North Dublin directly adjacent to the MetroLink scheme, due to the walking catchment, the proximity of the MetroLink Scheme to the counties in the North of Leinster, and the easy access to the proposed park and ride for car users and interchange for passengers on public transport from these areas. The area of influence also extends to the West and South of Dublin along major radial corridors, and the M50 due to opportunities to combine Luas Green Line trips with MetroLink, and to access the Park and Ride Stations.

The impacts of the MetroLink scheme can and do extend beyond this area of influence, however this area of influence has been used to identify an area where any future network schemes would be included within the future forecast models.

Figure 4-1 Area of Influence for the MetroLink

4.2 Do Committed Minimum Scenario

The Do Committed Minimum Scenarios includes additional transport schemes that are under construction or committed to be implemented post the base-year of the ERM base (2016), and the respective forecast transport demand. The network defined for the future years (2030, 2045 and 2060) are similar, with slight differences on the Public Transport services.

The definitions for Do Minimum scenario and committed schemes are based on the Project Appraisal Guidelines, which outlines that *"the Do-Minimum option should include those transportation facilities and services that are committed within the appraisal period"*. For committed schemes, the document identifies as *"improvements that have been progressed through planning and are either under construction or are programmed into the capital expenditure budget."*

Schemes coded under the Do Minimum Scenario includes:

- Committed road and traffic management schemes within the MetroLink's area of influence; and
- Committed Public Transport Schemes within the MetroLink's area of influence.

Further details on the schemes that have been included within the Do Committed Minimum scenario are contained within the TMP (ML1-JAI-TRA-ROUT_XX-PL-Y-00001).

4.3 Do Scheme Scenario

The Do Scheme scenarios for 2030, 2045 and 2060 contains the schemes coded for the respective years Do Minimum Scenarios plus the MetroLink scheme. The assumptions made for the MetroLink scheme for each forecast year is detailed in Table 4-1.

The MetroLink stations have been coded into the model in detail with walking links included within, which allow for modelling the impacts of the time taken to travel from the entrance to the station platforms.

Table 4-1 MetroLink - Modelling Assumptions

Attribute	2030/2045	2060
Service Pattern	Estuary P&R – Charlemont Charlemont – Estuary P&R	
Headways	All periods: 2mins	All periods: 90 secs
Fares	Integrated Ticketing	
Capacity (per vehicle)	Crush capacity: 500 Seat capacity: 125	
Crowding curve	ERM standard crowding curve for Luas/Metro used	
Waiting curve	Standard NTA wait curve	

Boarding penalties	10 min all modes
Transfer penalties	15 min to/from rail, also Dublin Bus to Dublin Bus 15min; all other 5mins

The current proposed alignment of the MetroLink is shown in Figure 4-2. The Dardistown station will only service the depot and not all services will stop at the station, accordingly the Dardistown station was coded as a "non-stopping" station within the model runs.

Figure 4-2 Preferred Metrolink Route

4.4 Sensitivity Scenarios

The following sensitivity tests have been undertaken for the MetroLink appraisal.

- Slow Growth;
- Low Frequency;
- Alternative Demand;
- Enhanced Transport Network: National Development Plan (NDP);
- Enhanced Transport Network: National Development Plan (NDP) + Alternative Demand; and
- Enhanced Transport Network: NTA Greater Dublin Area Strategy (GDA).

These scenarios show how sensitive the performance of the MetroLink is to slower growth, to operating a lower frequency service, to a change in travel behaviour (such as higher percentages of work from home), and finally how it performs where other proposed infrastructure and demand management measures are delivered over the lifetime of MetroLink.

Details of these sensitivity tests and their results are provided in Section 7 of this report.

4.5 Modelled Scenario Summary

35 model runs have been undertaken for the assessment of the MetroLink scheme Business Case. The scenarios cover the base year, opening year and forecasted years and a range of different sensitivity tests, as summarised in Table 4-2.

Full model results are contained within the Appendices of this report.

Table 4-2: MetroLink Modelled Scenarios

Model Year		Run Code	Description
2030	Business Case (Core)	ADC	2030 Do Minimum (DM)
	Business Case (Core)	ADD	2030 Do Scheme (DS)
	Slow Growth	ACN	2030 DM
	Slow Growth	ACO	2030 DS
	Low Frequency	ACT	2030 DS
	Alternative Demand	ADI	2030 DM
	Alternative Demand	ADJ	2030 DS
	Enhanced Network Do NDP	ACA	2030 DoNDP DM
	Enhanced Network Do NDP	ACB	2030 DoNDP DS
	Enhanced Network Do NDP + Alternative Demand	AFA	2030 Do NDP+AD DM
	Enhanced Network Do NDP + Alternative Demand	AFB	2030 Do NDP+AD DS
2045	Business Case (Core)	ADE	2045 Do Minimum (DM)
	Business Case (Core)	ADF	2045 Do Scheme (DS)
	Slow Growth	ACP	2045 DM
	Slow Growth	ACQ	2045 DS
	Low Frequency	ACU	2045 DS
	Alternative Demand	ADK	2045 DM
	Alternative Demand	ADL	2045 DS
	Enhanced Network Do NDP	ADS	2045 DoNDP DM
	Enhanced Network Do NDP	ADT	2045 DoNDP DS
	Enhanced Network Do GDA	ACC	2045 DoGDA DM
	Enhanced Network Do GDA	ACD	2045 DoGDA DS
	Enhanced Network Do NDP + Alternative Demand	AFC	2045 Do NDP+AD DM
	Enhanced Network Do NDP + Alternative Demand	AFD	2045 Do NDP+AD DS
2060	Business Case (Core)	ADG	2060 Do Minimum (DM)
	Business Case (Core)	ADH	2060 Do Scheme (DS)
	Slow Growth	ACR	2060 DM
	Slow Growth	ACS	2060 DS
	Low Frequency	ACV	2060 DS

	Alternative Demand	ADM	2060 DM
	Alternative Demand	ADN	2060 DS
	Enhanced Network Do GDA	ACE	2060 DoGDA DM
	Enhanced Network Do GDA	JAAF	2060 DoGDA DS
	Enhanced Network Do NDP + Alternative Demand	AFE	2060 Do NDP+AD DM
	Enhanced Network Do NDP + Alternative Demand	AFF	2060 Do NDP+AD DS

5. Model Validation/Calibration

This section provides an overview of the NTA ERM model validation along with the convergence statistics for the modelling undertaken for the MetroLink project.

5.1 NTA Model

Details on calibration and validation of the NTA's ERM model is contained with the model development report (Regional Modelling System Model Development Report – East Regional Model (Model Version 3), with reference to section 13 of that report, the following is noted:

"The model was developed, calibrated and validated in line with current transport modelling guidance, primarily from United Kingdom Department for Transport's Transport Analysis Guidance, building on the work undertaken to deliver Version 2 of the RMS in 2016/2017. Each component was developed using the best available data, such as the 2016 Census, National Household Travel Survey, recent traffic and passenger volume data, standard PT timetable data formats such as Google(sic)[1] Transit Feed Specification and GPS-based journey time data."

It further notes the following,

"The ERM was calibrated and validated against the recommended criteria set out in the UK TAG. The level of calibration and validation achieved across each of the model components is of a high standard when considering the model scale and type."

5.2 MetroLink Model

ERM incorporates a variable demand model which is run for a fixed number of iterations. Overall and by-mode convergence statistics have been calculated using standard processes which reported convergence measures (GAP) for each of the iterations. The size of GAP values typically increase as forecasts are made over longer periods, so 2045 values are typically larger than those for 2030 results. A separate analysis was undertaken for the MetroLink to identify if there were significant variations in flows between the penultimate and final iterations of the demand model, refer to Section 8.4 of this report.

For the Business Case Core runs the difference in total 12-hour MetroLink trips is small (2.4% in 2030 and 3.7% in 2045). For NDP runs lower percentage differences are obtained (0.2% in 2030 and 2.1% in 2045). The largest flow differences typically occur on the Estuary-Airport section of MetroLink. This is because the congestion in the M1 and R132 area contributes to changes in choices between road and PT modes (and also between use of MetroLink and DART routes into city centre) between the iterations of the demand model.

As the capacity constraint mechanism does not strongly constrain the use of the Estuary Park and Ride facility in line with its available capacity this also contributes to changes between iterations. This is seen as oscillations between the Park and Ride site being underloaded and overloaded on consecutive iterations. The effect of overloading of the Estuary Park and Ride facility is considered further in Section 8.2.

The values obtained for convergence are typical for a model of this size and complexity operating over a medium length forecast period in urban congested conditions. The error range in forecast MetroLink usage

[1] GTFS – General Transit Feed Specification.

arising due to model convergence, at below 4%, is small when compared with the uncertainties of demographic and economic growth over that period. The same would still be the case if the percentage of excess MetroLink trips were added into the convergence percentage error.

Table 5-1: MetroLink Model Convergence Summary - Core Scenarios

Run	Overall GAP					
	AM	LT	SR	PM	OP	Overall
2030 Core Do Minimum	0.62	1.15	0.71	0.65	1.64	**0.78**
2030 Core Do Scheme	0.98	2.32	1.00	1.25	1.75	**1.31**
2045 Core Do Minimum	0.99	1.26	1.37	1.02	1.88	**1.16**
2045 Core Do Scheme	1.27	3.40	1.68	1.77	1.87	**1.87**
2060 Core Do Minimum	1.72	3.21	4.52	1.58	1.86	**2.51**
2060 Core Do Scheme	2.99	2.02	4.67	2.78	1.96	**3.06**

6. MetroLink Modelling Results: Core Run Analysis

6.1 Introduction

The Core runs have been modelled for the years 2030, 2045 and 2060. This section will present details of the following:

- Loading Profiles;
- Overall Network Statistics (Road and Public Transport Networks);
- Boarding and Alighting Numbers;
- Mode Share (including percentage change per zone);
- Public Transport Network Analysis (including Link Flows, Journey Time analysis, Transfers to and from MetroLink and Passenger Profiles); and,
- Road Network Analysis (including Link Flows, Volume Capacity Ratio and Delay Impacts).

Model outputs for all time periods can be found in Appendix A.

6.2 Loading Profile

Figure 6-1 and Figure 6-2 show the AM peak period load passengers in each direction for all three forecast years. Figure 6-3 and Figure 6-4 illustrate the PM peak load passengers in each direction. LT and SR results are contained in Appendix A and the accompanying spreadsheet.

The loading profile for each year follows a similar trend, increasing in volume each year respectively as a result of the increase in population and jobs in the surrounding area, as noted in Section 3.2.

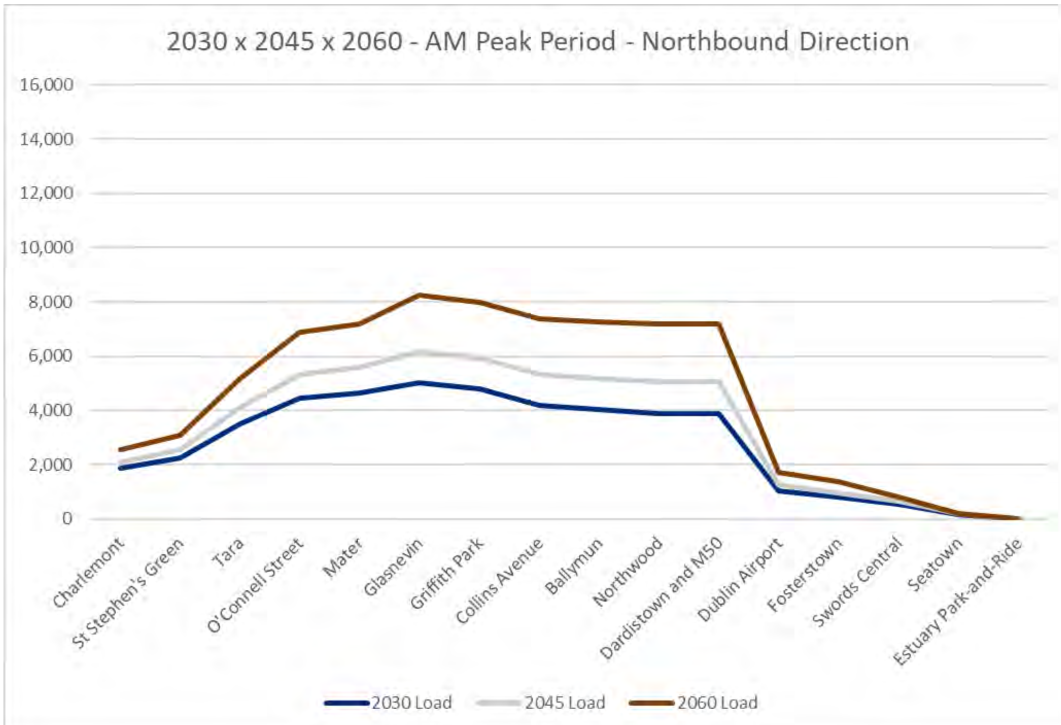


Figure 6-1: AM Peak Period - Northbound MetroLink Forecast Line Flows

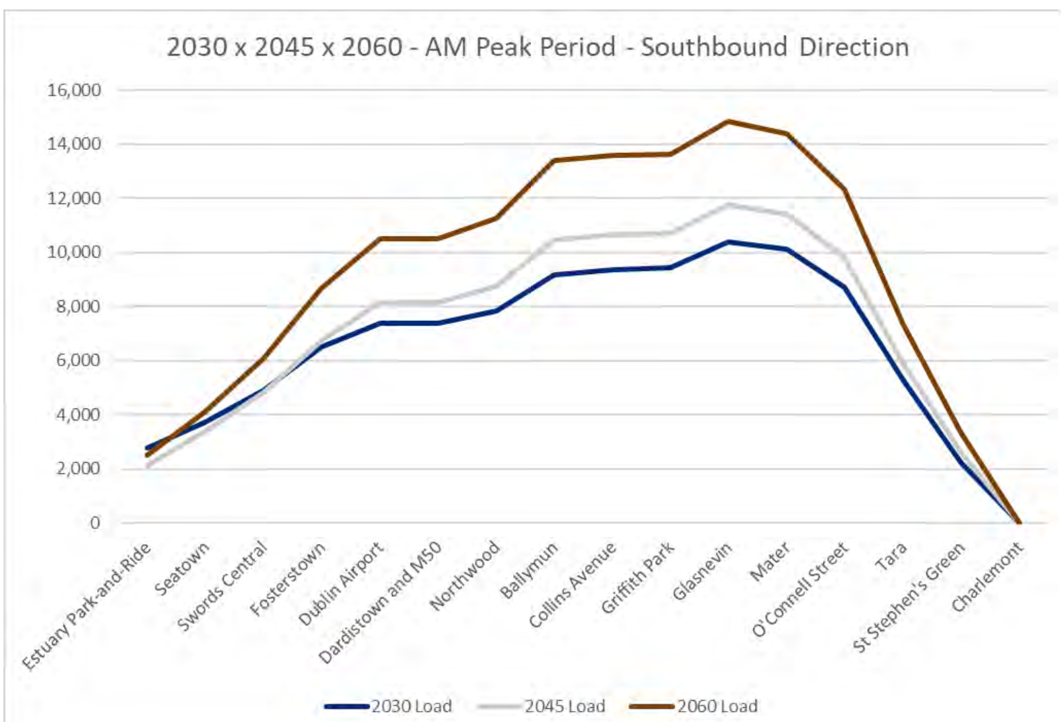


Figure 6-2: AM Peak Period – Southbound MetroLink Forecast Line Flows

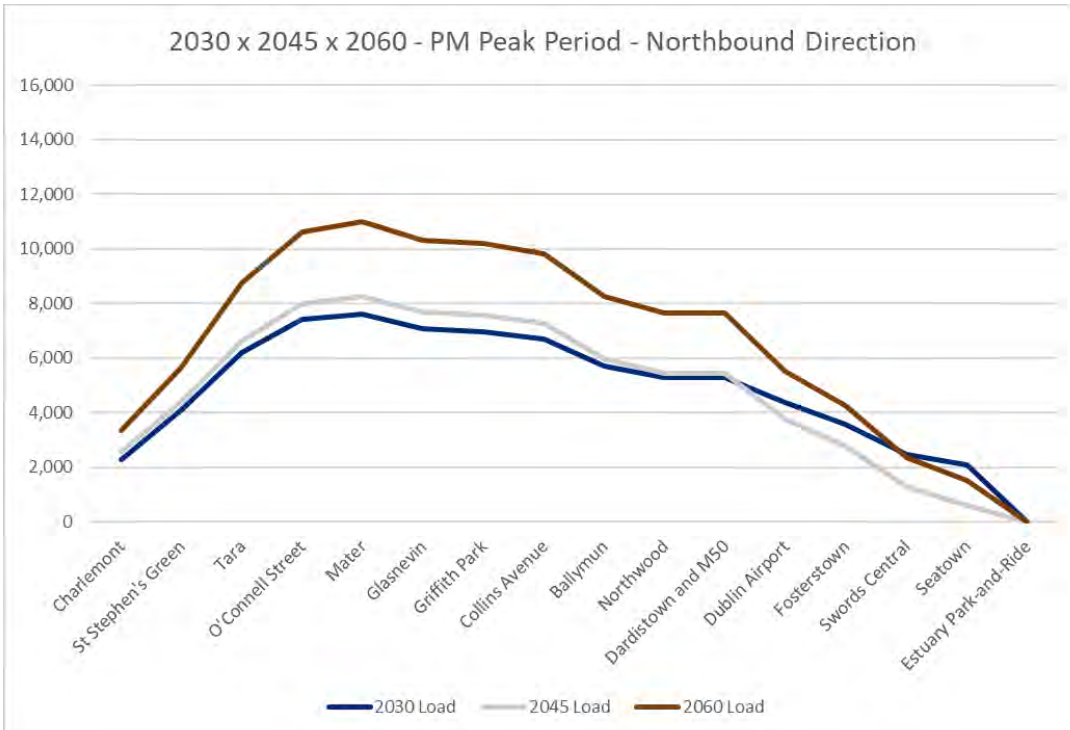


Figure 6-3: PM Peak Period MetroLink Forecast Line Flows

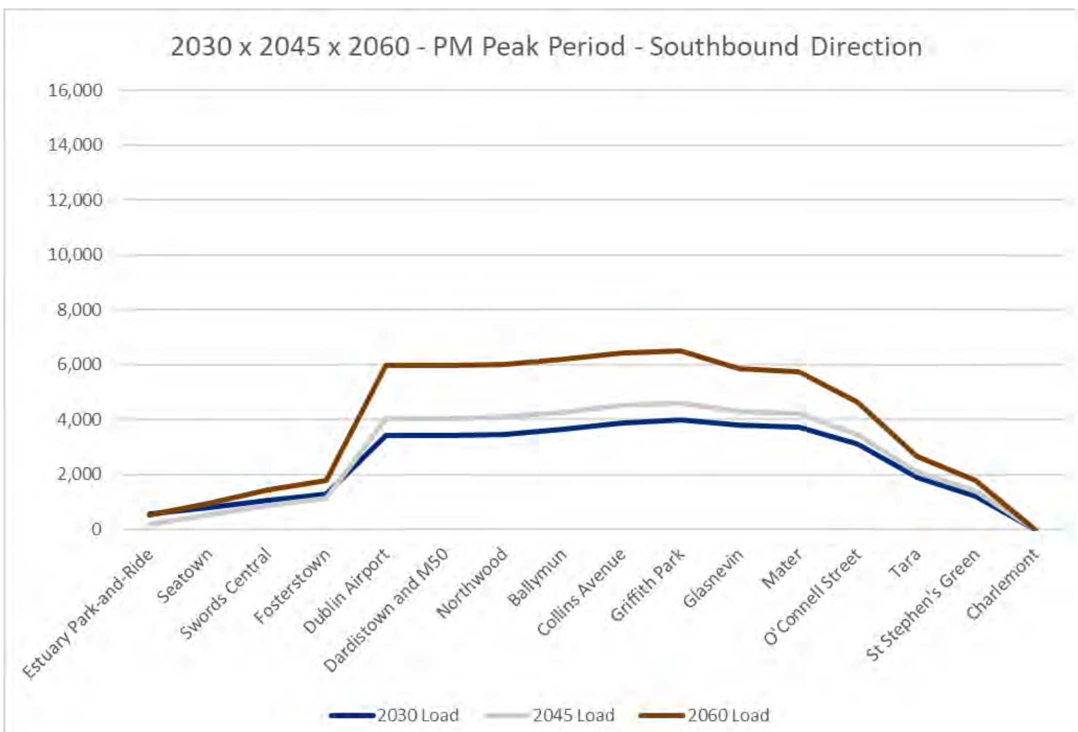


Figure 6-4: PM Peak Period MetroLink Forecast Line Flows

6.3 Boarding and Alighting Numbers

The 12-hour boarding and alighting totals on the MetroLink are shown in Figure 6-5. The boardings and alightings at each station generally increase across the modelled years. Total 12-hour boardings go from 128,182 in 2030 to 156,091 in 2045 (an increase of 21.8% between these years), then to 208,815 in 2060 (an increase of 33.8% between 2045 and 2060).

The busiest stations across the all the model periods are, Dublin Airport, Tara Street, Charlemont and O'Connell Street. The Dardistown station is currently only scheduled to operate as a stop for the depot and has been treated as a non-stopping station within the Business Case runs.

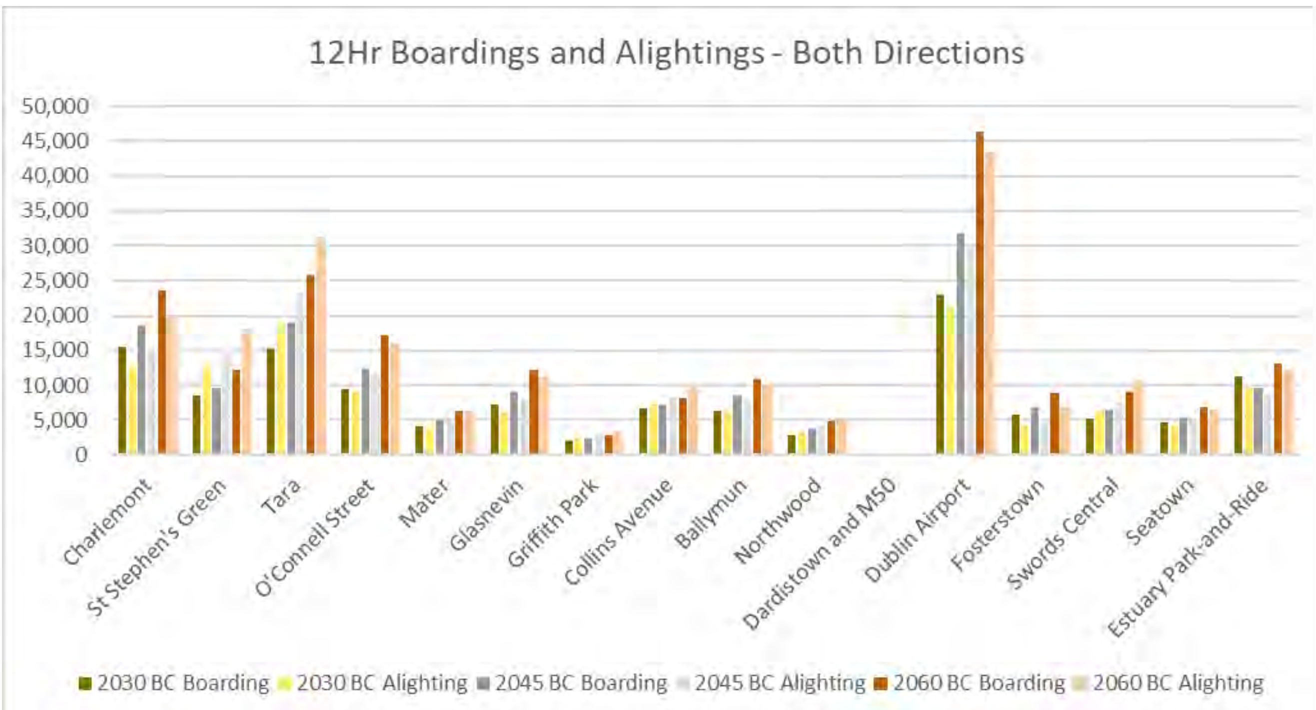


Figure 6-5: 12hr Boarding and Alighting

6.4 Overall Network Statistics

A high-level summary of network statistics for the model comparing the Do Minimum and Do Scheme scenarios for the AM and PM periods are presented in Table 6-1 and Table 6-2. A reduction can be seen in the road time travel and distance travelled in the AM and PM periods when comparing the Do Minimum and Do Scheme scenarios, which can be attributed to the reduction of congestion across areas of the network where people are switching to use the proposed scheme and Park and Ride facilities. The average road network speed increases as a result of the Do Scheme, which can also be related to congestion reduction across the network.

Table 6-1: AM Peak Period Summary Network Statistics

Network Statistics	2030		2045		2060	
	Do Minimum	Do Scheme	Do Minimum	Do Scheme	Do Minimum	Do Scheme
Total Road Travel Time (pcu.hrs)	159,726	158,880	190,863	186,057	222,682	214,052
Total Road Distance Travelled (pcu.km)	7,291,245	7,304,301	8,291,512	8,096,762	9,177,830	8,879,845
Average Road Network Speed (kph)	46	46	43	44	41	42

Table 6-2: PM Peak Period Summary Network Statistics

Network Statistics	2030		2045		2060	
	Do Minimum	Do Scheme	Do Minimum	Do Scheme	Do Minimum	Do scheme
Total Road Travel Time (pcu.hrs)	147,706	147,901	173,126	168,007	198,474	188,643
Total Road Distance Travelled (pcu.km)	6,979,879	6,999,539	7,834,600	7,628,528	8,598,786	8,260,824
Average Road Network Speed (kph)	47	47	45	45	43	44

Table 6-3 presents the public network statistics in the Do Minimum and Do Scheme scenarios in 2030, 2045 and 2060 during the AM 3h period, with Table 6-4 presenting the PM 3h period statistics. In all scenarios, the total passenger km is higher in the PM period. When comparing the two scenarios during the AM period, there is a reduction of approximately 232,000 passenger km by bus when MetroLink is in place in 2030. This increases to a reduction of almost 235,000 passenger km in 2045, and a reduction of over 228,000 passenger km by bus in 2060 when MetroLink is in place. In total, there is an increase of approximately 122,000 passenger km between the Do Minimum and Do Scheme scenarios in 2030 AM period. In 2045, the total passenger km travelled increases by approximately 266,000 when comparing the two scenarios. In 2060, the total passenger km travelled over the AM period increases by over 518,000 when MetroLink is in place, illustrating the positive shift towards public transport use in this scenario.

Table 6-3: AM 3h Period Public Transport Network Statistics

Network Statistics	Mode	2030		2045		2060	
		Do Minimum	Do Scheme	Do Minimum	Do Scheme	Do Minimum	Do Scheme
Passenger Km	**Bus**	1,838,414	1,606,171	2,036,484	1,802,215	2,294,383	2,066,119
	Rail	1,522,848	1,500,272	1,868,167	1,934,494	2,327,160	2,504,802
	Luas	355,837	344,336	416,153	410,426	491,839	489,818
	Metro	-	388,346	-	440,156	-	570,870
	Total	3,717,099	3,839,124	4,320,804	4,587,291	5,113,382	5,631,609

When comparing the two scenarios during the PM 3h period, there is a reduction of approximately 202,000 passenger km by bus when MetroLink is in place in 2030. There is a reduction of almost 175,000 passenger km in both 2045 and 2060 when MetroLink is in place. In total, there is an increase of approximately 129,000 passenger km between the Do Minimum and Do Scheme scenarios in 2030 PM peak period. In 2045, the total passenger km travelled increases by approximately 245,000 when comparing the two scenarios. In 2060, the total passenger km travelled over the PM period increases by almost 468,000 when MetroLink is in place, illustrating the positive shift towards public transport use in this scenario.

Table 6-4: PM 3hr Period Public Transport Network Statistics

Network Statistics	Mode	2030		2045		2060	
		Do Minimum	Do Scheme	Do Minimum	Do Scheme	Do Minimum	Do Scheme
Passenger Km	Bus	1,829,062	1,627,921	2,005,246	1,830,269	2,231,740	2,057,119
	Rail	1,795,866	1,786,709	2,205,257	2,272,131	2,690,532	2,832,831
	Luas	336,412	329,602	396,009	391,745	469,318	467,359
	Metro	-	345,863	-	357,112	-	502,228
	Total	3,961,340	4,090,094	4,606,512	4,851,257	5,391,591	5,859,537

6.5 Mode Share

Mode share comparisons between the Do Minimum and Do Scheme scenarios have been undertaken to understand the percentage change in modal split between the two scenarios. Similarly, comparisons have also been undertaken to understand the percentage change in modal split from 2030, to 2045 and 2060. Do Minimum and Do Scheme mode split over 12hrs is shown in Table 6-5.

Table 6-5: DM -DS Summary of Mode Split in Business Case Runs – 12hrs

	2030		2045		2060	
Do Minimum						
	12hr (No. of Trips)	% Mode Split	12hr (No. of Trips)	% Mode Split	12hr (No. of Trips)	% Mode Split
PT	780,914	12.15%	911,292	12,68%	1,066,792	13.41%
Road	4,189,107	65.16%	4,611,483	64.15%	4,990,056	62.71%
Cycle	142,195	2.21%	168,819	2.35%	201,028	2.53%
Walk	1,316,388	20.48%	1,497,306	20.83%	1,700,026	21.36%
Total	6,428,604		7,188,900		7,957,902	

Do Scheme						
PT (Incl Metro)	821,336	12.73%	958,484	13.32%	1,140,466	14.28%
Road	4,188,280	64.9%	4,584,785	63.68%	4,950,080	62%
Cycle	138,473	2.15%	164,487	2.28%	195,001	2.44%
Walk	1,305,039	20.22%	1,491,281	20.71%	1,698,695	21.28%
Total	6,453,128		7,199,037		7,984,242	

In 2030, the mode share of PT (including Metro) increases from 12.15% to 12.73% in the Do Scheme scenario. In 2030. In the 2045 scenario, PT (including Metro) increases its mode share by 0.6% between the Do Minimum and Do Scheme scenarios, whilst Road mode share decreases by 0.5%, indicating a modal shift from private vehicles to public transport when MetroLink is in place. In 2060, the PT (including Metro) increases its mode share from 13.41% in the Do Minimum scenario, to 14.28% in the Do Scheme scenario, whereas the Road mode share falls by 0.71%.

6.5.1 Percentage change

Figure 6-6 to Figure 6-8 illustrates the percentage change in road mode share per zone surrounding the scheme alignment, in the AM period.

Throughout the design years, road mode share reduces by up to 5% in a number of zones to the east of the alignment, in areas such as Malahide, and in zones to the south of the M50. At Dublin Airport, the road mode share decreases by up to 30% in 2060. Similarly, when Metro Link is in place, the road mode share falls by up to 10% around Swords.

Figure 6-9 to Figure 6-11 illustrates the public transport (including MetroLink) mode share change along the alignment. The largest increase in mode share can be seen at Estuary station, with an increase of 30%-40% in all years.

With the road mode share reductions seen at Swords and Dublin Airport, there is a corresponding increase in PT (including MetroLink) mode share. An increase of 5%-20% can be seen in zones in the Swords area, with Dublin Airport seeing an increase of between 10% and 30% in 2060

Figure 6-12 to Figure 6-17 illustrate the percentage mode share change between the Do Minimum and Do Scheme scenarios in the PM peak, with Figure 6-12 to Figure 6-14 presenting the change in Road mode share per zone, and Figure 6-15 to Figure 6-17 presenting the change in public transport (including MetroLink). As with the AM period, Road mode share decreases by up to 30% across all years in the zones at Estuary station as a result of the Park and Ride facility at this station. Similar decreases can be seen in the zones at Dublin Airport, where the largest number of MetroLink boarding and alighting passengers occur.

As with the AM period, the largest increases in mode share of public transport (including MetroLink) can be seen at stations along the R132 (in particular, Estuary station) and at Dublin Airport. The MetroLink corridor at Ballymun and Dublin City University also sees increases of between 5% and 20% as a result of MetroLink.

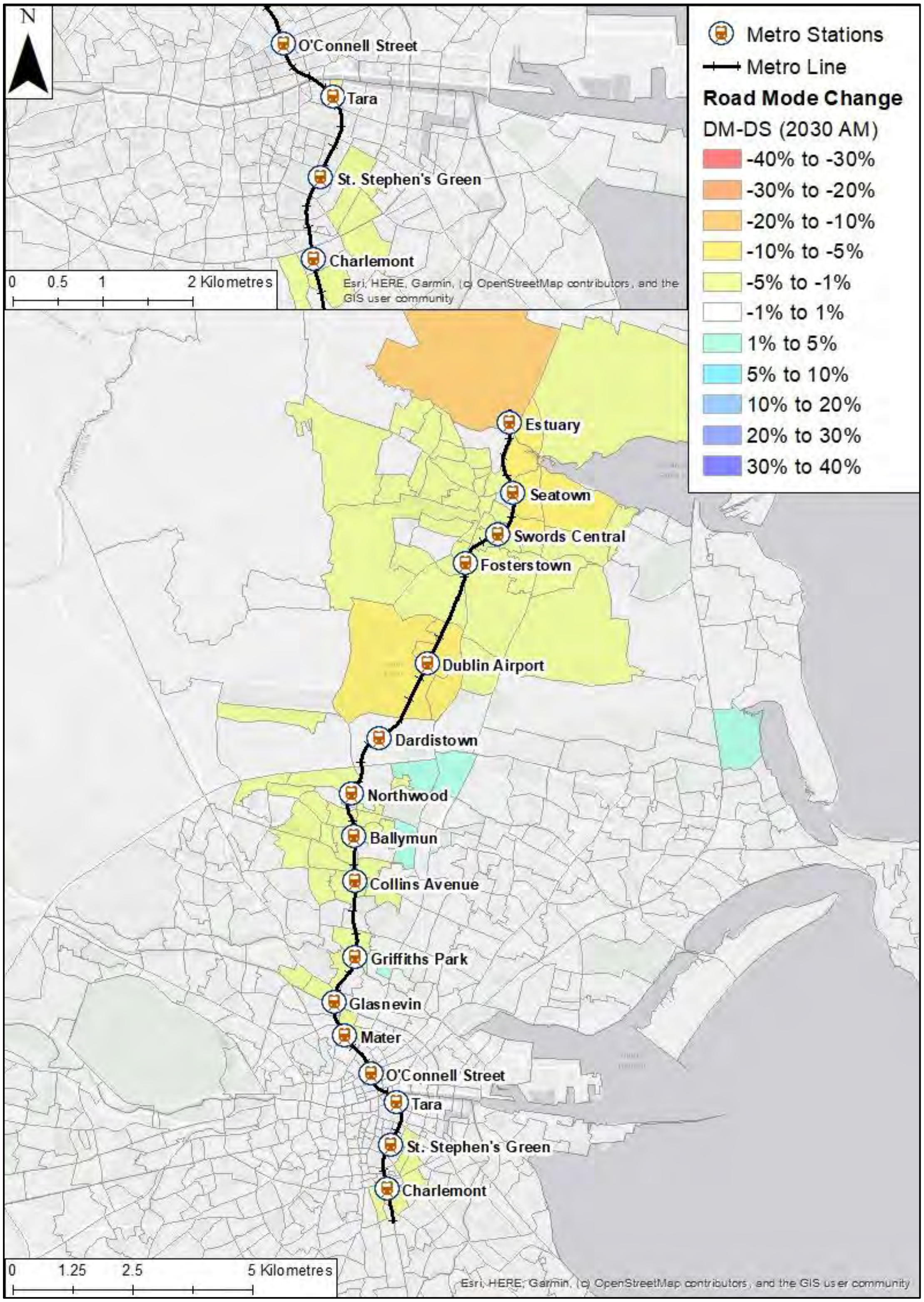


Figure 6-6: Road Mode Share Change between Do Minimum and Do Scheme scenarios – 2030 AM

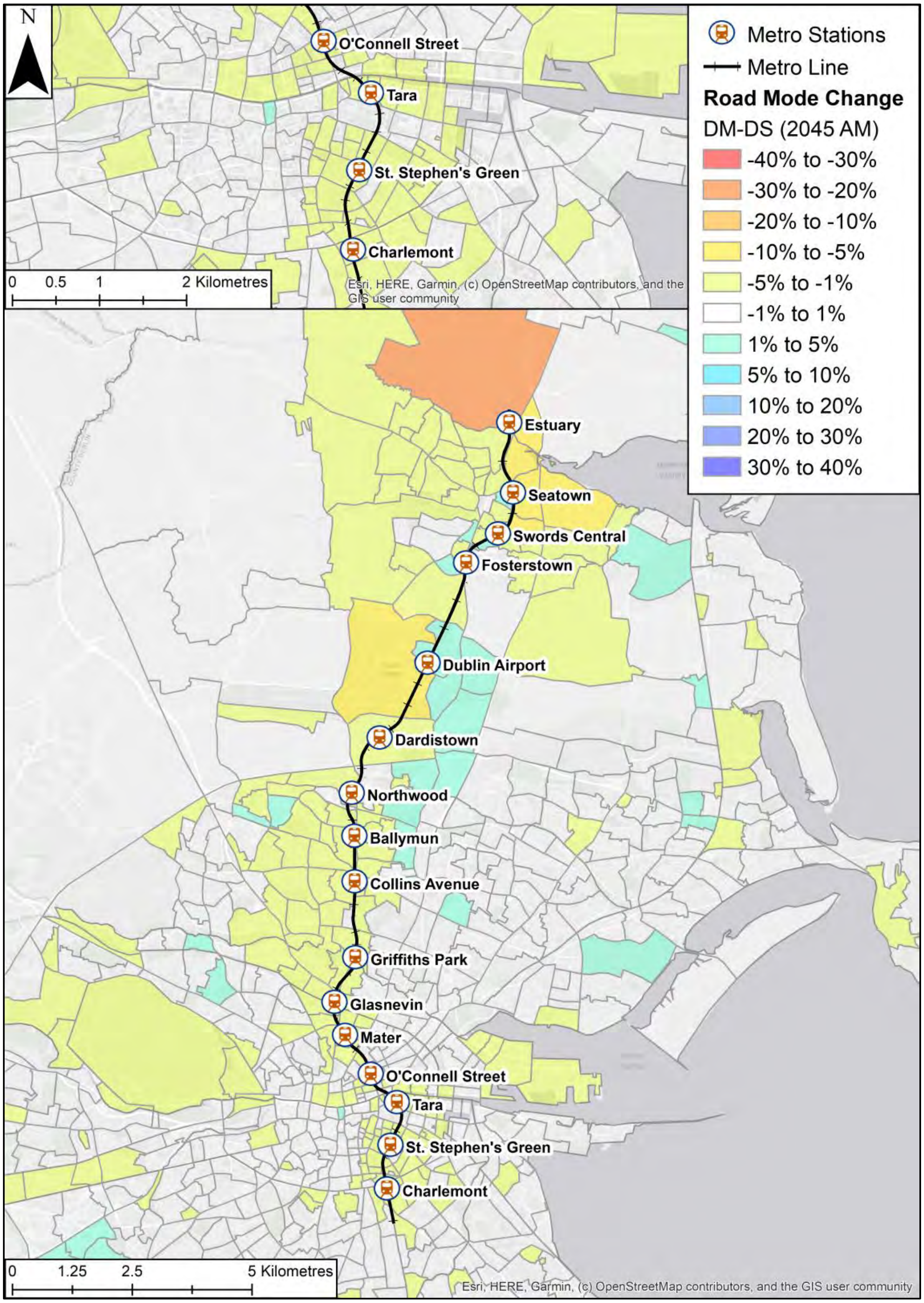


Figure 6-7: Road Mode Share Change between Do Minimum and Do Scheme scenarios – 2045 AM

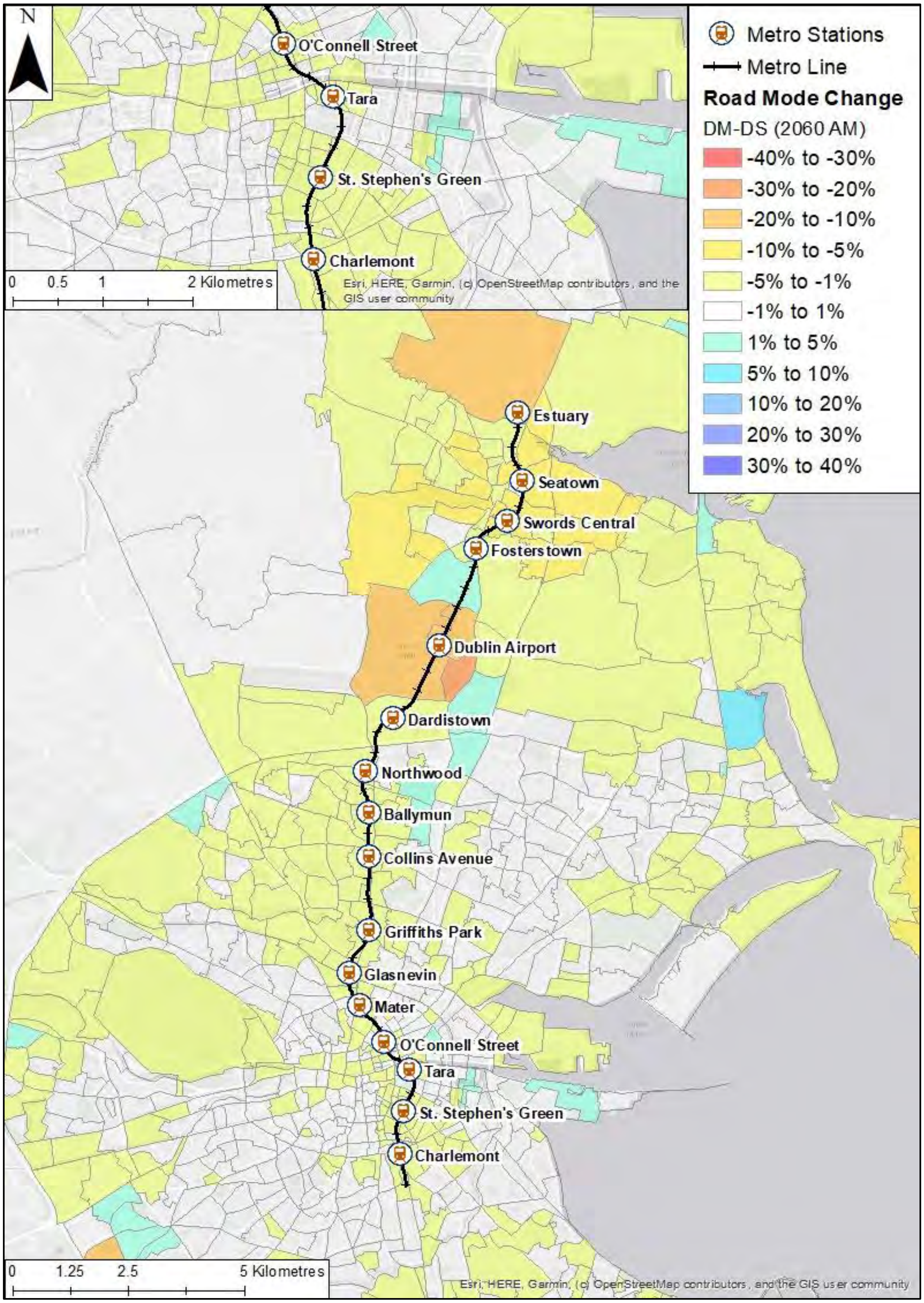


Figure 6-8: Road Mode Share Change between Do Minimum and Do Scheme scenarios – 2060 AM

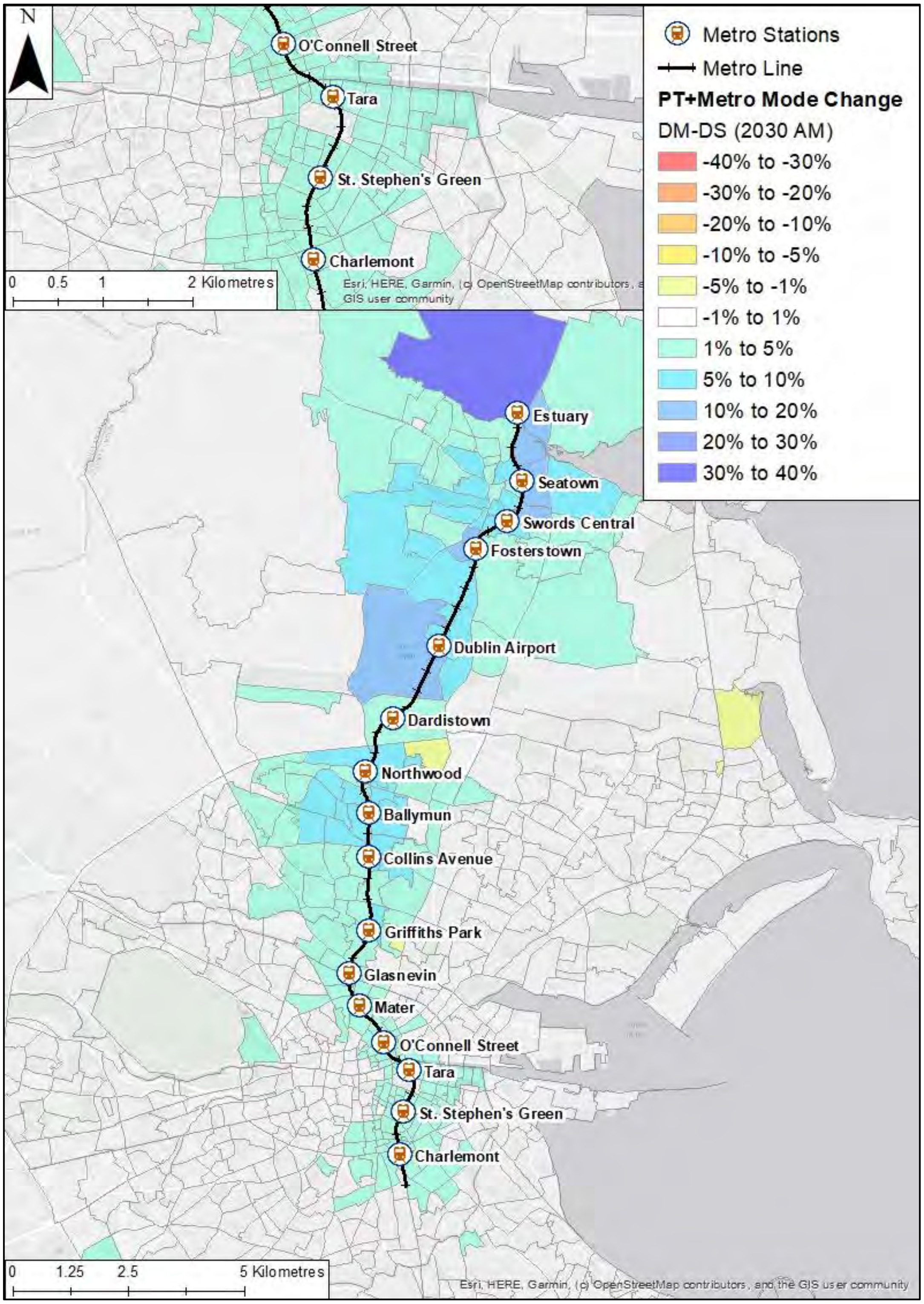


Figure 6-9: PT (Including MetroLink) Mode Share Change between Do Minimum and Do Scheme scenarios – 2030 AM

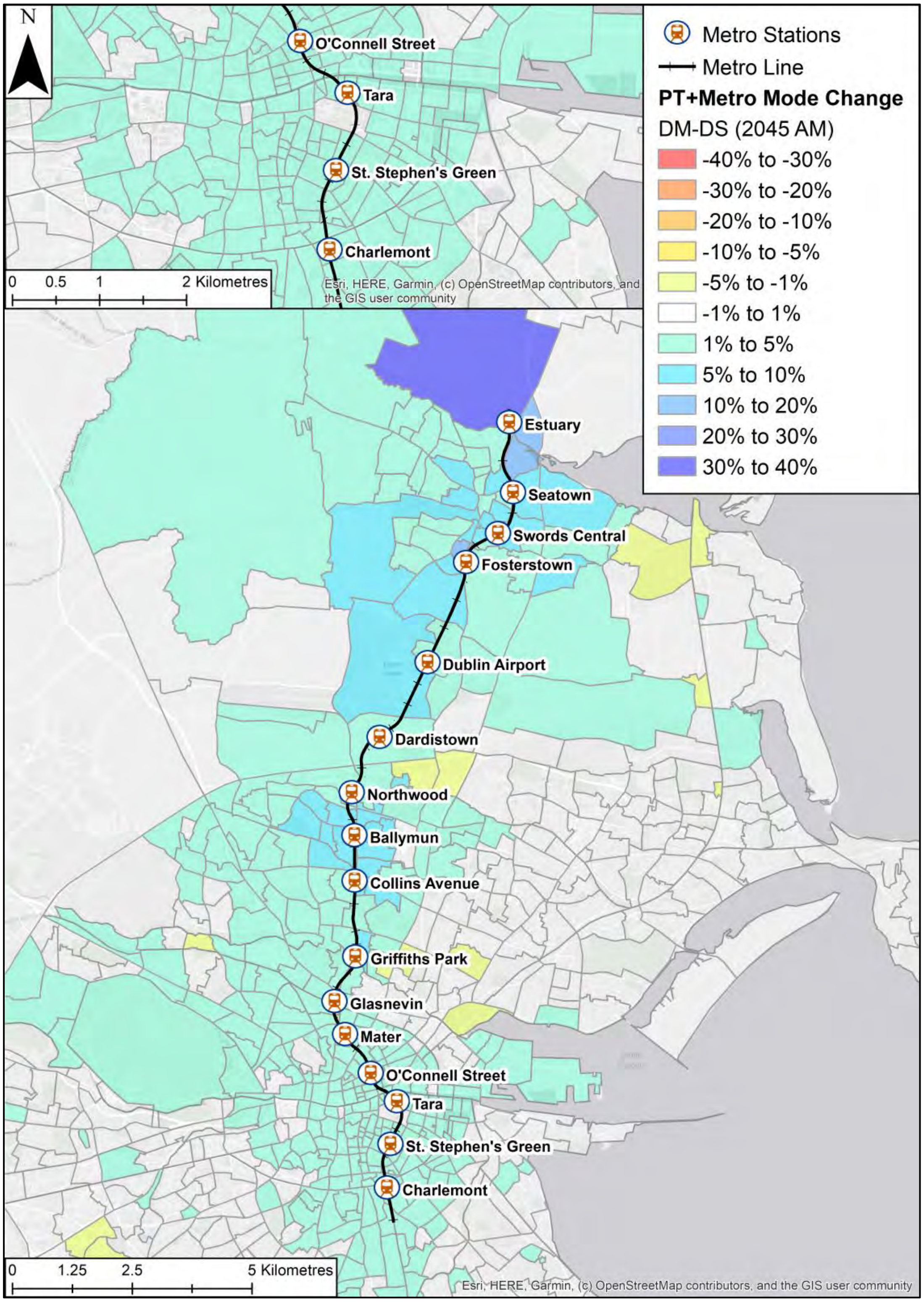


Figure 6-10: PT (Including MetroLink) Mode Share Change between Do Minimum and Do Scheme scenarios – 2045 AM

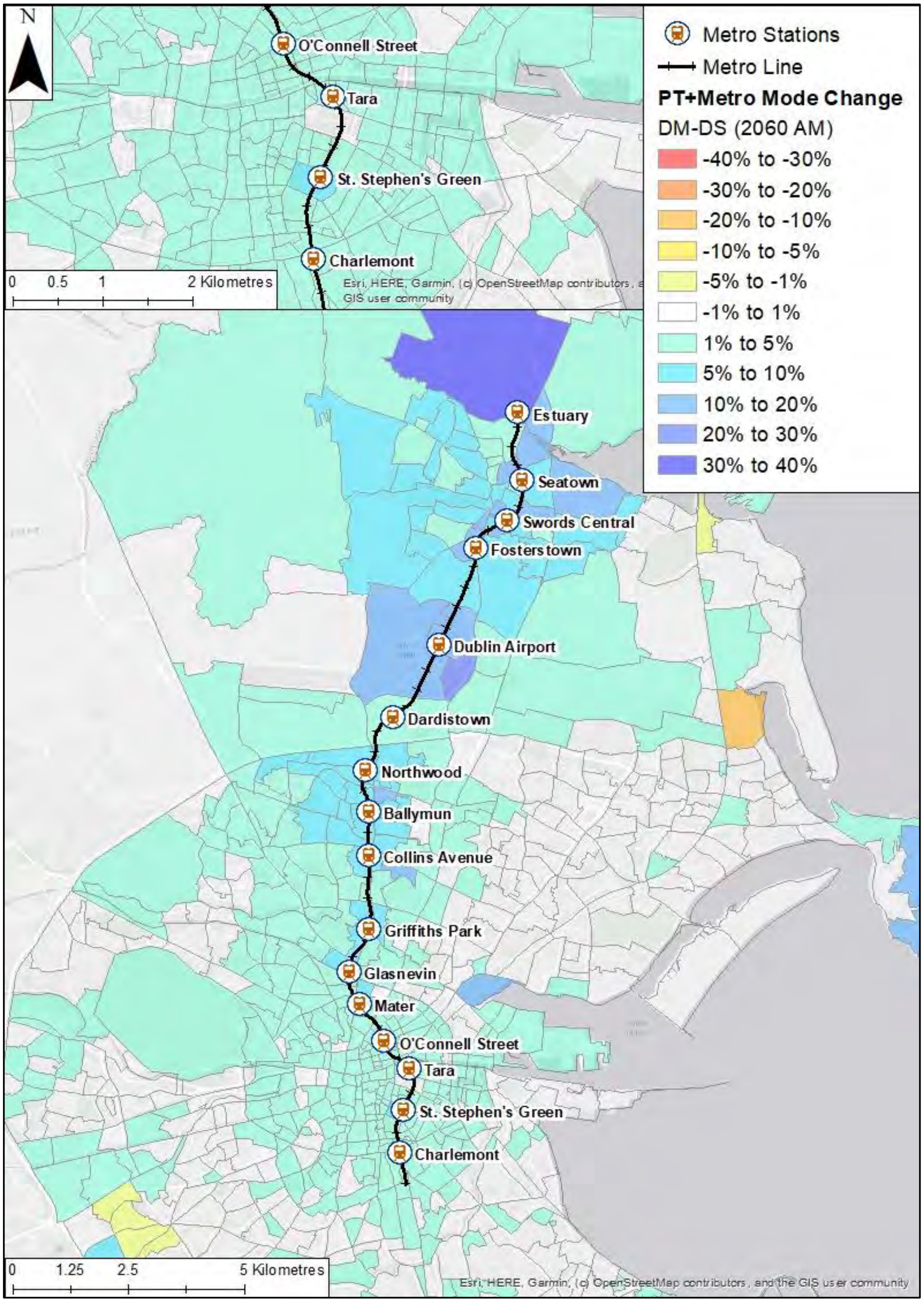


Figure 6-11: PT (Including MetroLink) Mode Share Change between Do Minimum and Do Scheme scenarios – 2060 AM

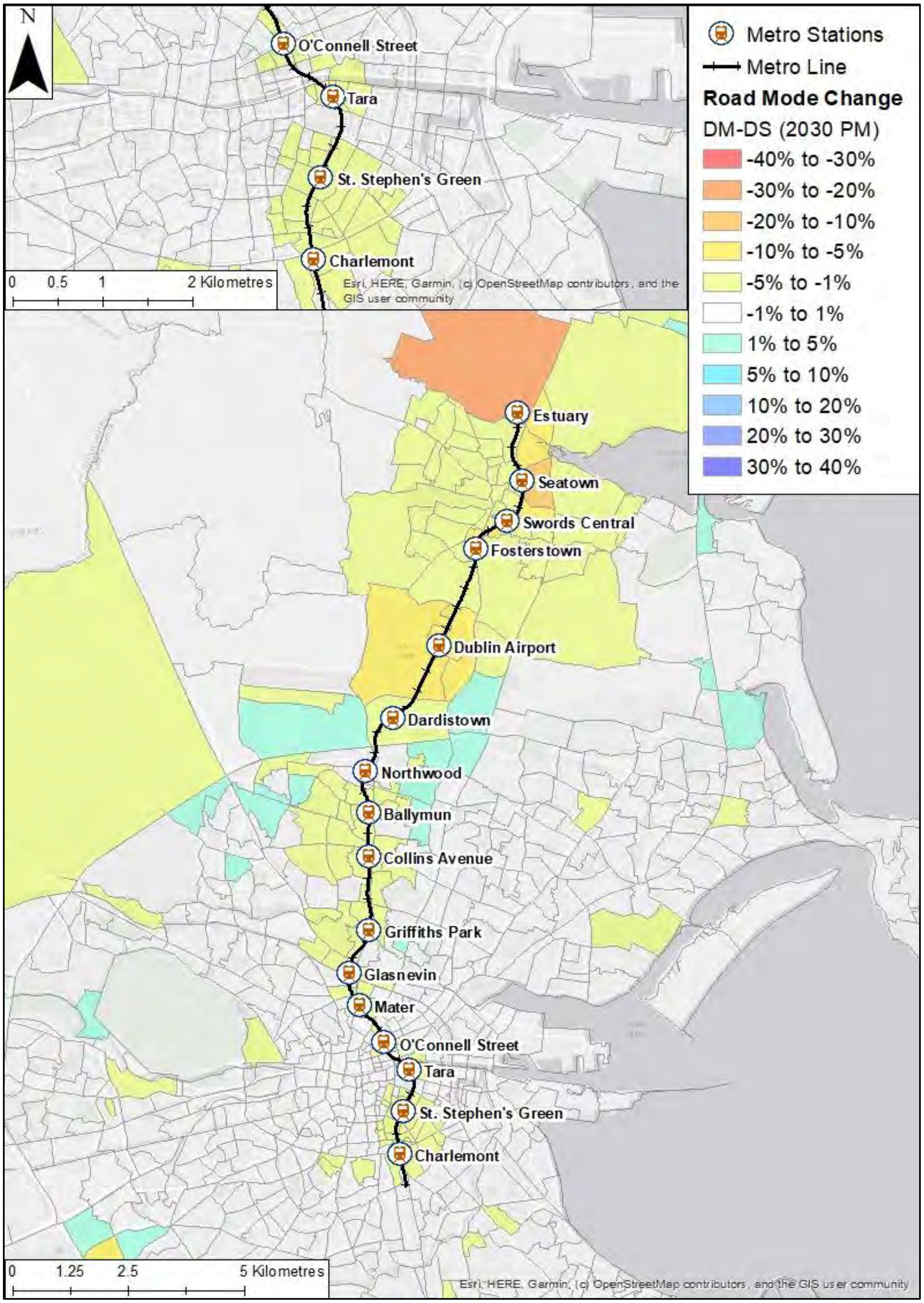


Figure 6-12: Road Mode Share Change between Do Minimum and Do Scheme scenarios – 2030 PM

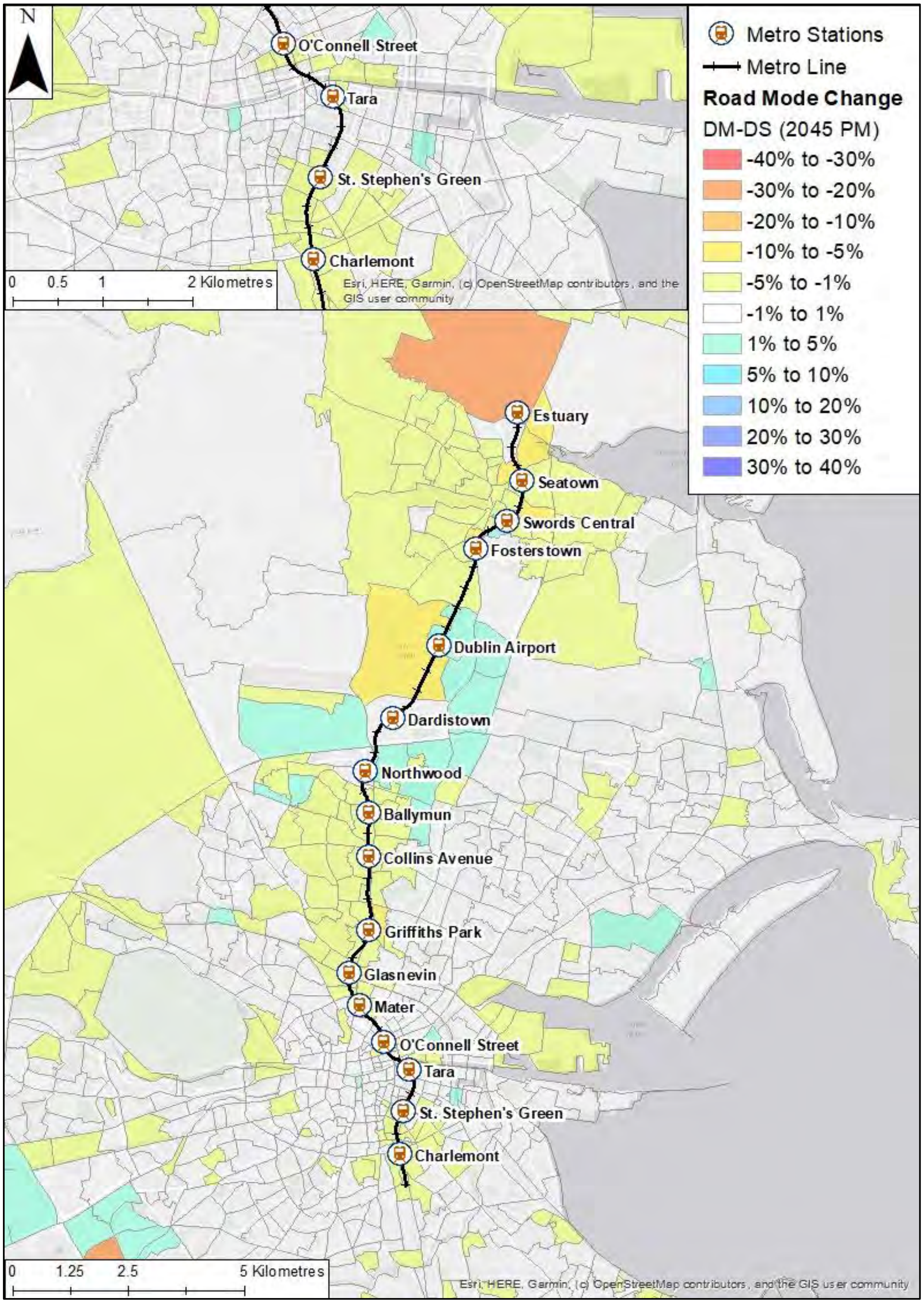


Figure 6-13: Road Mode Share Change between Do Minimum and Do Scheme scenarios – 2045 PM

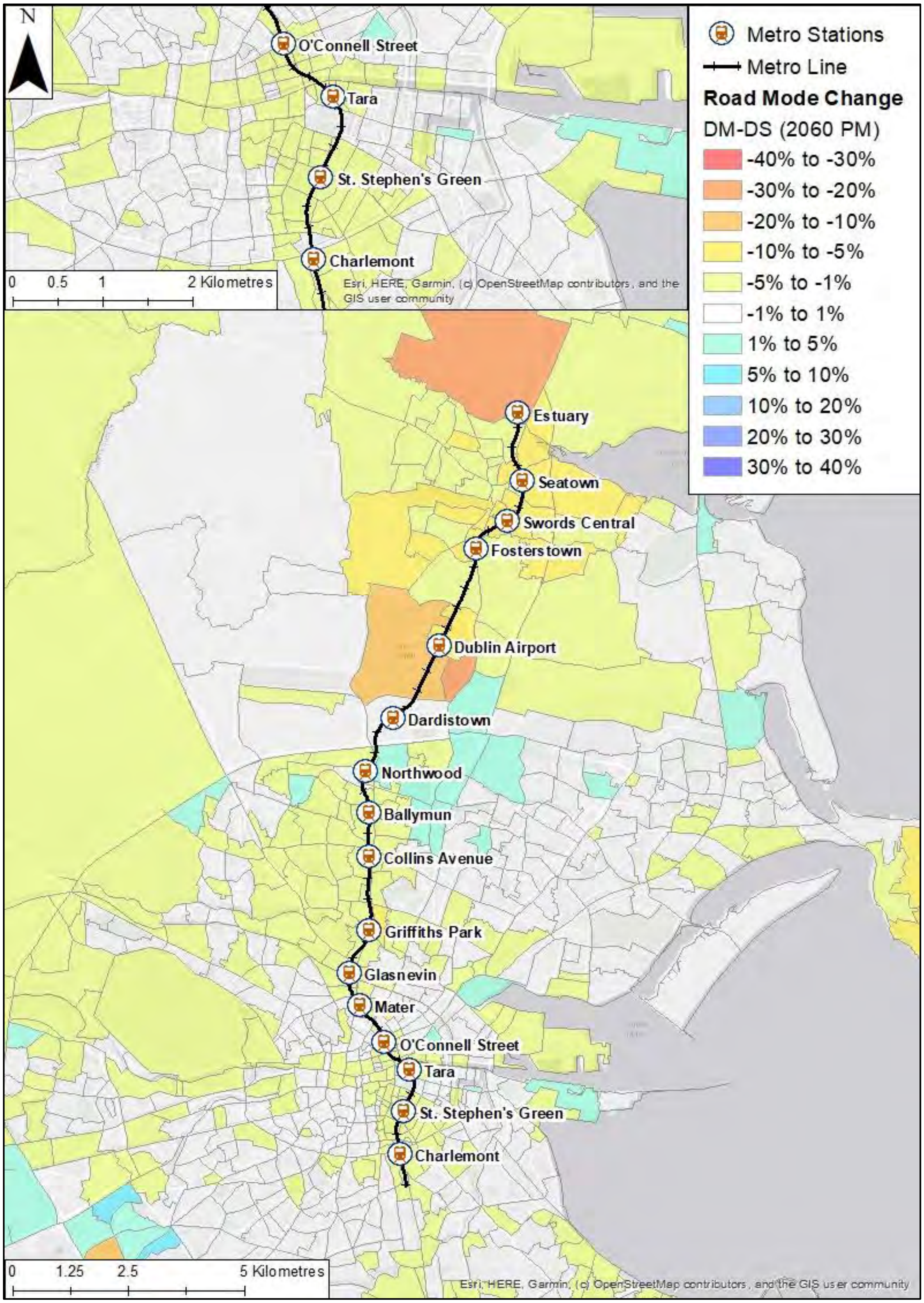


Figure 6-14: Road Mode Share Change between Do Minimum and Do Scheme scenarios – 2060 PM

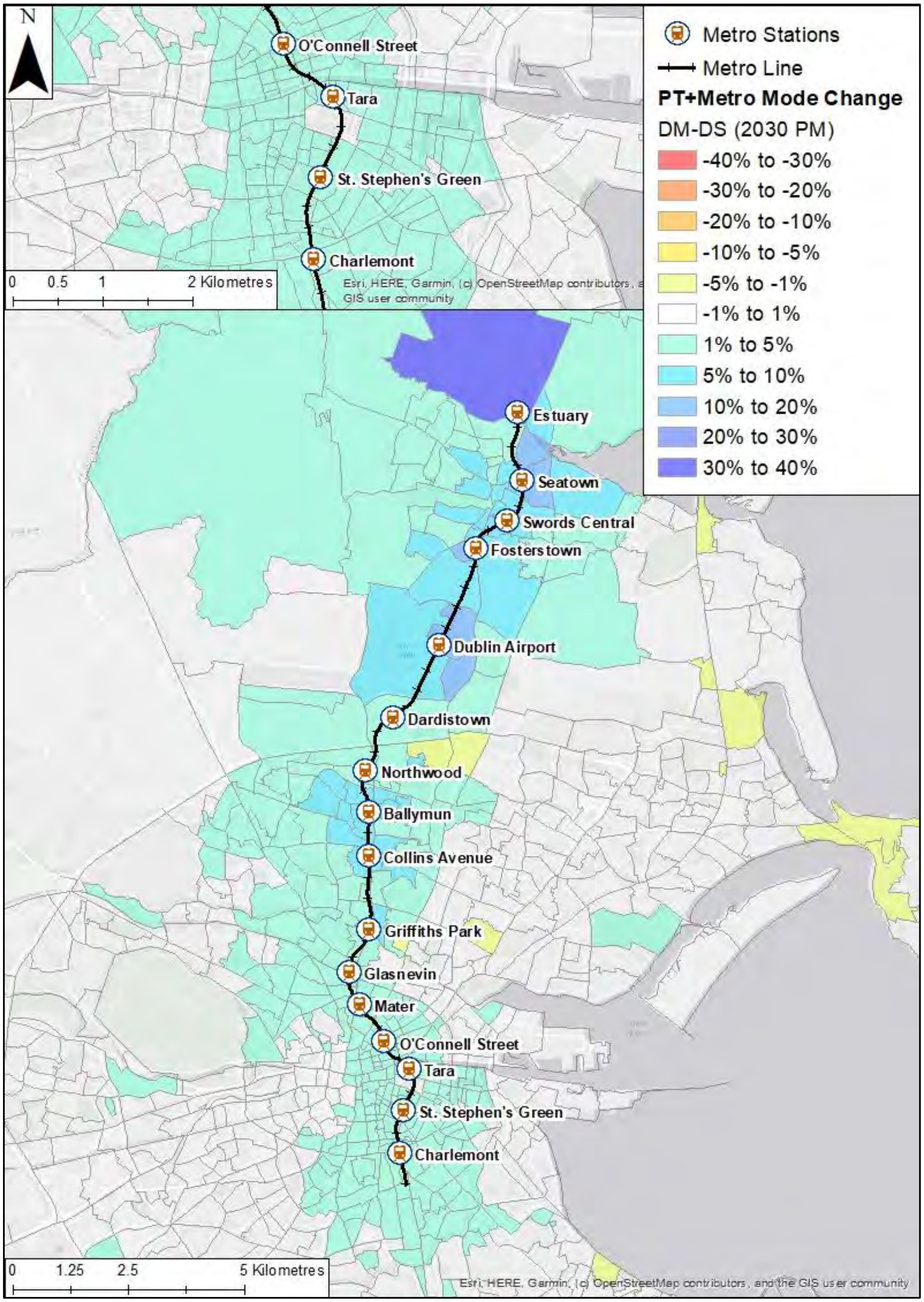

N
O'Connell Street
Tara
St. Stephen's Green
Charlemont
0 0.5 1 2 Kilometres
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Metro Stations
Metro Line
PT+Metro Mode Change
DM-DS (2030 PM)
-40% to -30%
-30% to -20%
-20% to -10%
-10% to -5%
-5% to -1%
-1% to 1%
1% to 5%
5% to 10%
10% to 20%
20% to 30%
30% to 40%
Estuary
Seatown
Swords Central
Fosterstown
Dublin Airport
Dardistown
Northwood
Ballymun
Collins Avenue
Griffiths Park
Glasnevin
Mater
O'Connell Street
Tara
St. Stephen's Green
Charlemont
0 1.25 2.5 5 Kilometres
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Figure 6-15: PT (including MetroLink) Mode Share Change between Do Minimum and Do Scheme scenarios – 2030 PM

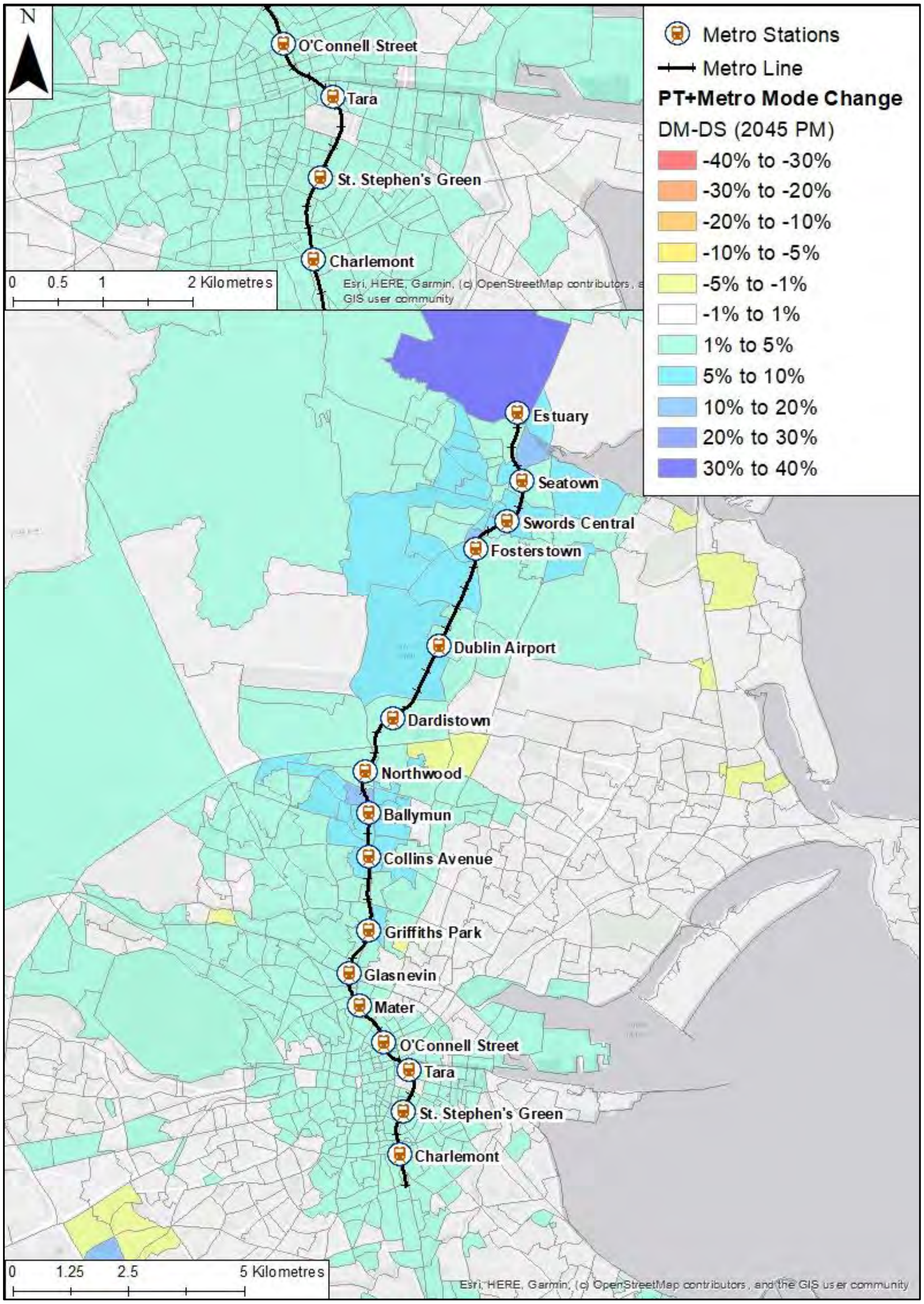


Figure 6-16: PT (including MetroLink) Mode Share Change between Do Minimum and Do Scheme scenarios – 2045 PM

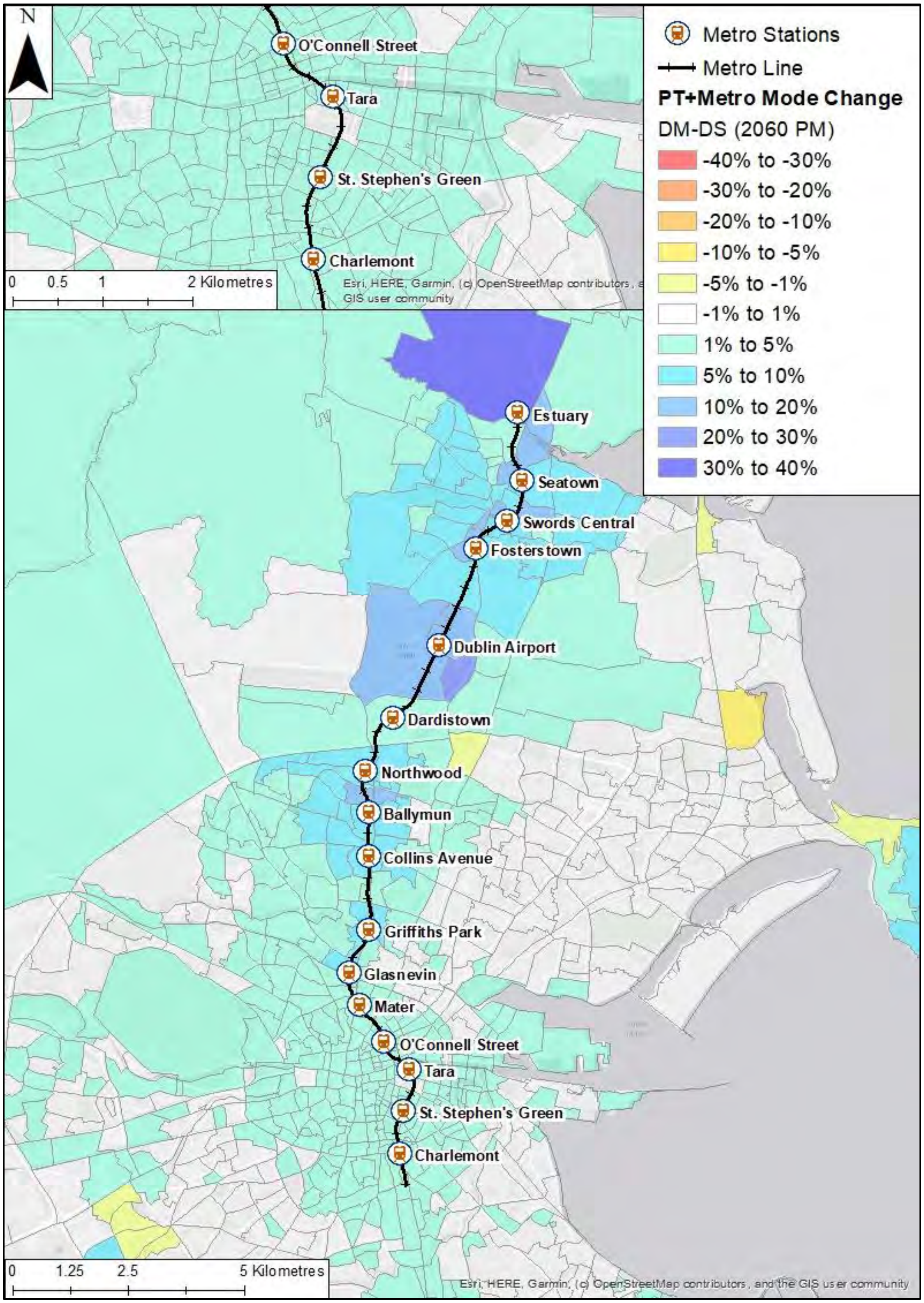


Figure 6-17: PT (including MetroLink) Mode Share Change between Do Minimum and Do Scheme scenarios – 2060 PM

6.6 Public Transport Network Analysis

6.6.1 Public Transport Link Flows

Figure 6-18 to Figure 6-19 illustrates the change in public transport flows in the AM and PM peaks when MetroLink is in place. Blue lines represent an increase in public transport flow, whereas green lines represent a reduction in flow. Figure 6-18 illustrates changes to the bus network only, whereas Figure 6-19 illustrates changes in flow with MetroLink included.

Large reductions on the bus network can be seen along the M50 Port Tunnel towards Dublin Airport, with a complementary large uptake in MetroLink use across all years. Reductions on the bus network can also be seen along the Ballymun corridor, where the MetroLink alignment is proposed to run. Increases in flows can also be seen to the north and south of the alignment, indicating areas of interchange with MetroLink.

Table 6-6 and Table 6-7 present the changes in public transport flows as result of MetroLink, during the AM and PM peak hours. The AM peak hour is defined as 08:00-09:00, and the PM peak hour is defined as 17:00-18:00. Large increases in flows can be seen on the Kildare and Maynooth lines as result of the interchange at Glasnevin station.

Table 6-6: Changes in Public Transport Flows due to MetroLink – AM Peak Hour

Public Transport Line	2018 AM Peak Hour	Change MetroLink 2030	% Change 2030	Change MetroLink 2045	% Change 2045	Change MetroLink 2060	% Change 2060
DART Coastal Northern Line	7,869	-746	-9%	-552	-7%	-295	-4%
DART Coastal South East Line	4,653	66	1%	333	7%	430	9%
Kildare Line	2,812	58	2%	320	11%	530	19%
Maynooth Line	4,682	199	4%	274	6%	540	12%
Luas redline	5,399	55	1%	50	1%	170	3%
Luas Green Line (South of Charlemont)	6,593	180	3%	358	5%	348	5%

Table 6-7: Changes in Public Transport Flows due to MetroLink – PM Peak Hour

Public Transport Line	2018 PM Peak Hour	Change MetroLink 2030	% Change 2030	Change MetroLink 2045	% Change 2045	Change MetroLink 2060	% Change 2060
DART Coastal Northern Line	6,320	-367	-6%	-466	-7%	-421	-7%
DART Coastal South East Line	3,064	50	2%	162	5%	231	8%
Kildare Line	2,919	80	3%	322	11%	406	14%
Maynooth Line	3,115	270	9%	328	11%	560	18%
Luas redline	5,999	71	1%	70	1%	125	2%

Luas Green Line (South of Charlemont)	6,044	172	3%	215	4%	421	7%

Source: National Heavy Rail Census 2018, Luas: www.cso.ie (2018)

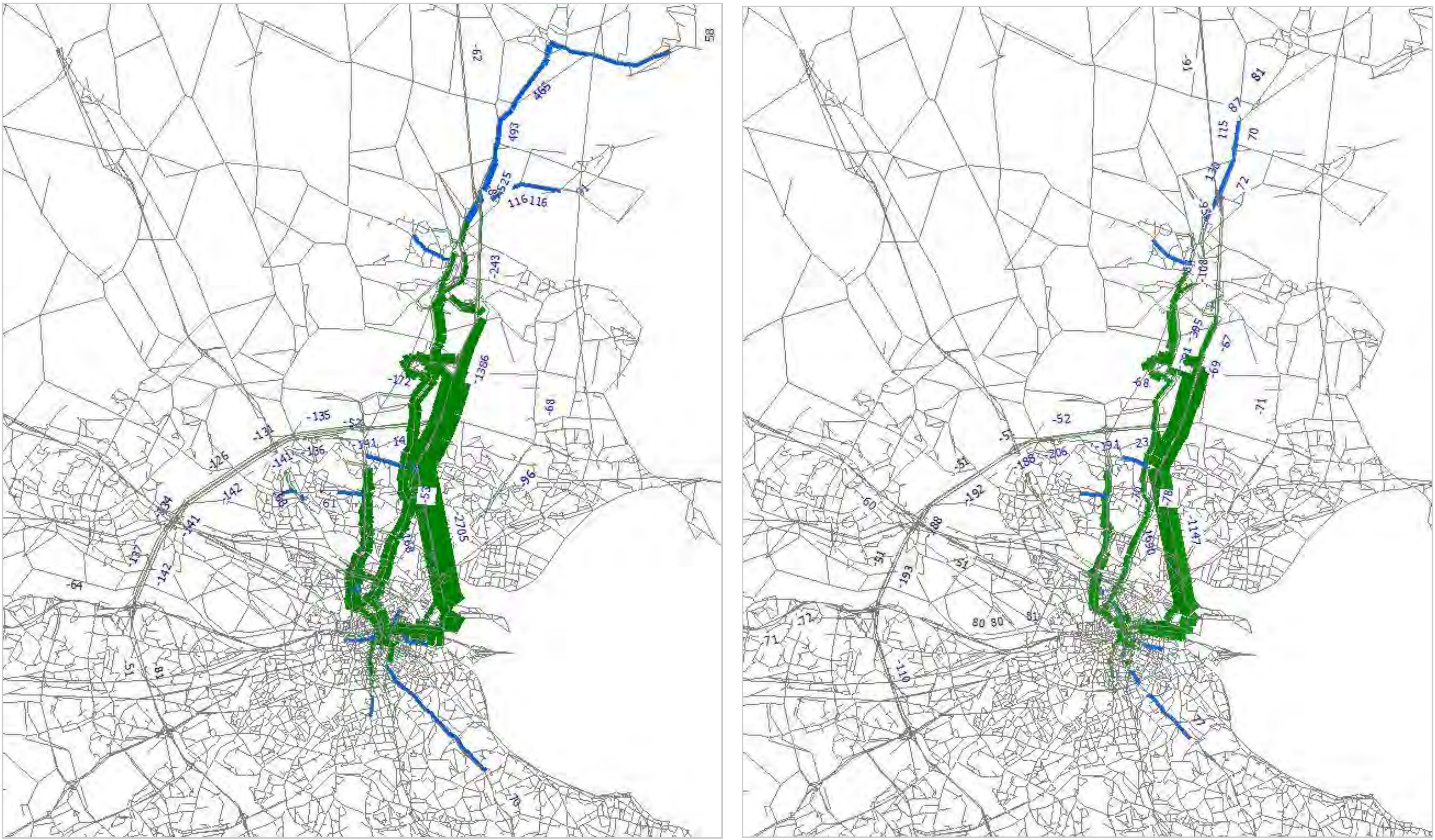


Figure 6-18: 2030 Do Scheme Bus Only (Left AM peak hour, Right PM peak hour)

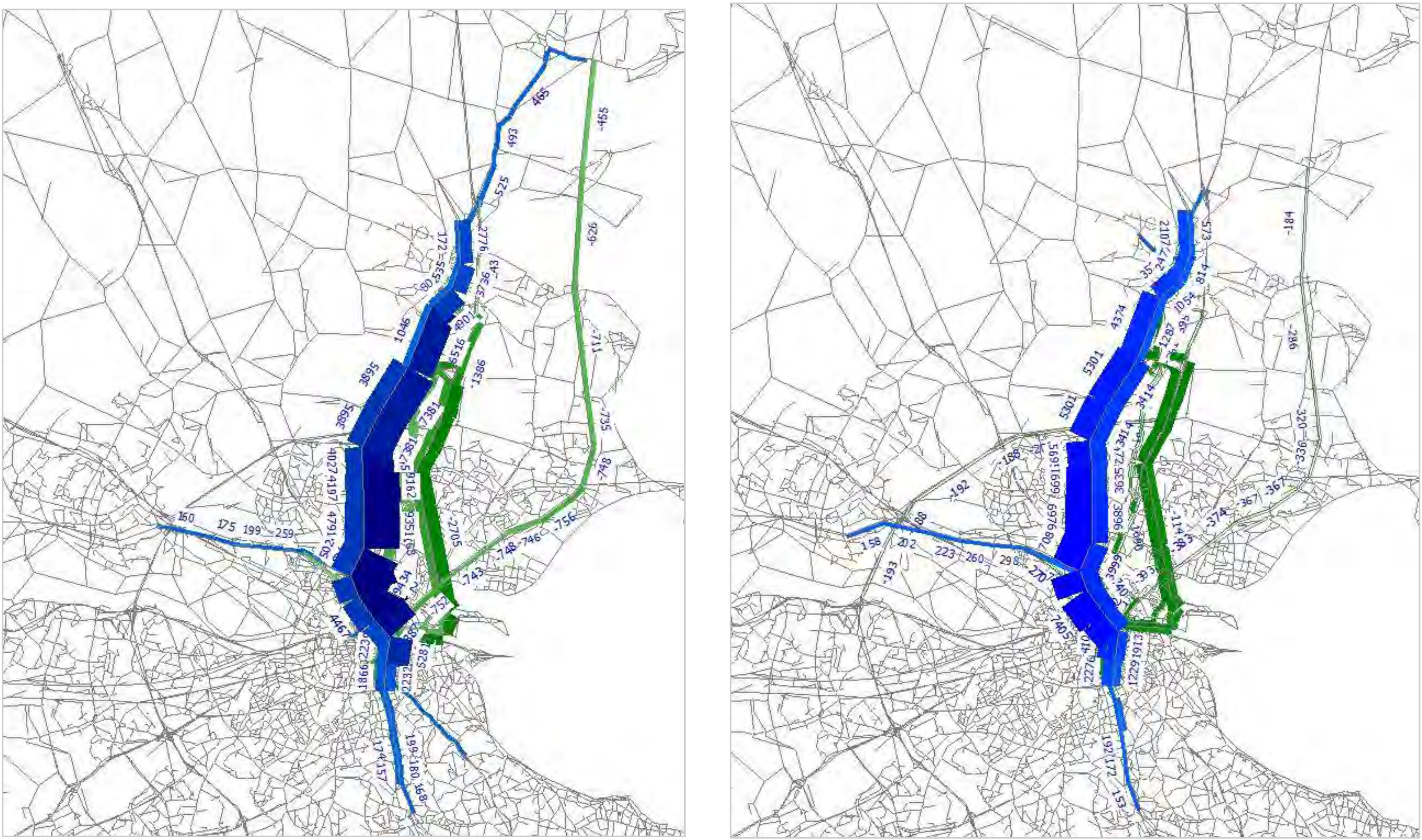


Figure 6-19: 2030 Do Scheme MetroLink (Left AM peak hour, Right PM peak hour)

6.6.2 Journey Time

Journey time comparisons between the Do Minimum and Do Scheme scenarios has been undertaken to investigate benefits to journey time with the MetroLink scheme in place. The assessment was carried out for zones located across the city as illustrated in Figure 6-20 and detailed within Table 6-8.

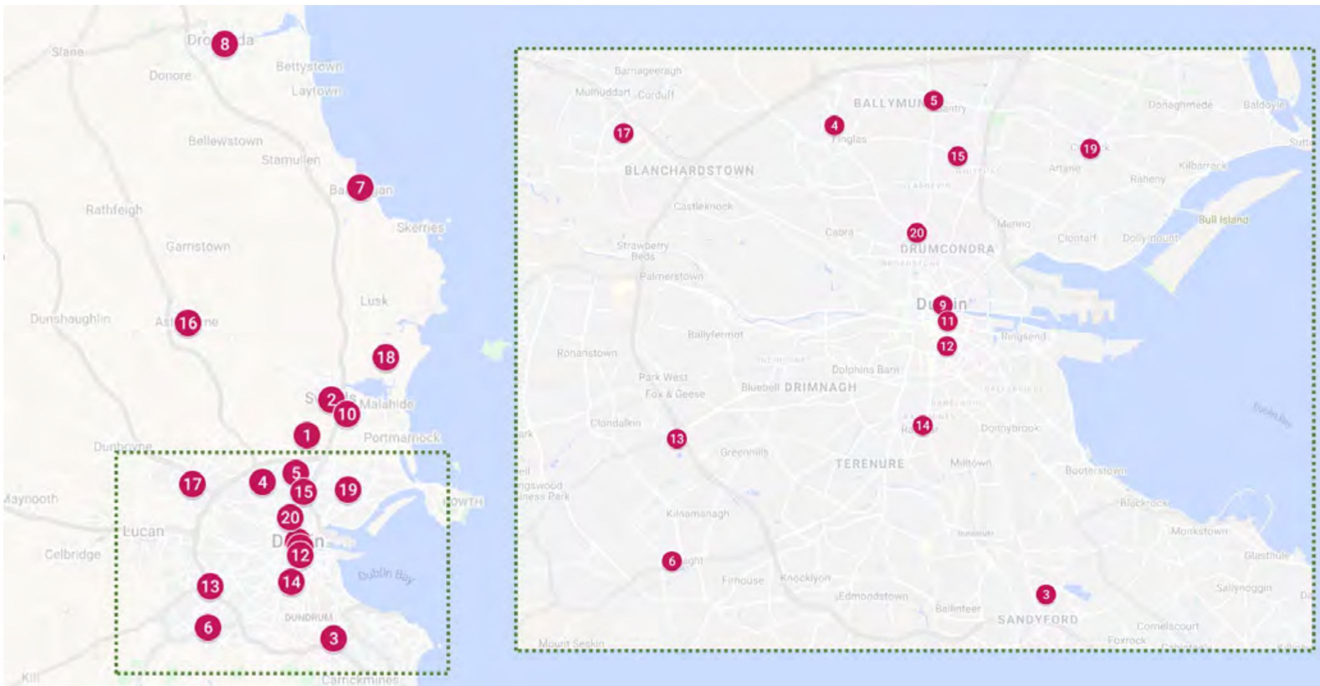


Figure 6-20: Zones assessed for journey time

Table 6-8: Zones assessed for journey time

Nb	Location	Nb	Location	Nb	Location	Nb	Location
1	Dublin Airport	**6**	Tallaght	**11**	College Street	**16**	Ashbourne
2	Swords Pavilion	**7**	Balbriggan	**12**	St. Stephen’s Green	**17**	Blanchardstown
3	Sandyford	**8**	Drogheda	**13**	Red Cow	**18**	Donabate
4	Finglas	**9**	O’Connell Street	**14**	Rathgar Road	**19**	Coolock
5	Ballymun	**10**	Sword East	**15**	DCU	**20**	Glasnevin

Comparisons between Do Minimum and Do Scheme scenarios in both the AM and PM peak periods are presented in Table 6-9 to Table 6-14 for 2030, 2045 and 2060.

Table 6-9: 2030 AM Peak - Journey Time Comparisons (minutes) between Do Minimum and Do Scheme

Journey Time 2030 DS - 2030 DM Business Case AM Peak Period	O'Connell Street	St. Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	-0.2	-7.4	0.1	0.0	-11.7	-0.4	0.2	0.0	0.0	-0.8	-1.1	0.0	0.0	0.0	-26.1	0.9	-13.7
St. Stephen's Green	0.1	0.0	0.1	-3.0	-10.9	0.0	-0.3	-14.1	-2.9	0.0	0.0	0.0	-2.2	-3.5	0.0	0.0	0.0	-33.0	-0.8	-13.1
College Street (Trinity)	0.0	0.0	0.0	0.1	-8.2	0.0	0.0	-10.7	-0.2	0.1	0.0	0.0	-0.1	-0.8	0.0	0.0	0.0	-27.0	5.4	-6.8
Glasnevin	-2.7	-9.0	-1.2	0.0	-0.1	-6.1	-9.0	2.2	-0.1	-16.6	0.5	0.5	-11.7	-0.8	-5.7	-6.5	-0.1	-29.2	-8.8	-24.0
DCU	-4.4	-9.7	-4.3	0.0	0.0	-10.0	0.0	0.0	0.0	-16.3	-3.5	-3.5	-13.2	-0.8	-22.8	-11.1	-0.1	-13.1	-12.4	-9.6
Rathgar Road	0.1	0.0	0.2	-5.7	-15.0	0.0	0.0	-18.6	-1.5	0.0	0.1	0.4	-6.3	-5.9	-0.8	-0.8	0.3	-34.8	-1.7	-20.8
Coolock	-0.1	-0.1	-0.2	-7.3	0.2	-0.3	0.0	0.0	-0.1	-1.2	0.1	-0.1	0.0	-0.8	0.0	0.0	-0.1	-0.8	0.1	0.1
Ballymun	-9.3	-14.7	-8.7	2.3	0.0	-15.6	-0.1	0.0	0.0	-20.6	-0.2	-0.2	-20.0	-0.8	-12.5	-15.7	-0.1	-10.9	-10.2	-7.9
Finglas	-0.2	-5.9	-0.4	0.9	-0.1	-0.8	-0.2	-0.1	0.0	-10.9	2.9	2.9	0.0	-0.7	1.4	0.3	0.4	-10.4	-10.8	-0.7
Sandyford	0.0	0.0	0.0	-8.6	-15.3	0.0	-1.2	-18.8	-2.7	0.0	0.0	0.0	-3.5	-6.7	-0.3	-0.3	0.2	-35.4	-2.4	-21.8
Tallaght	0.0	0.0	0.0	1.3	-6.6	0.0	0.0	-10.5	-1.1	0.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-23.3	5.3	-15.3
Red Cow	0.0	0.0	0.0	1.2	-6.5	0.0	0.0	-10.5	0.4	0.2	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-22.4	7.0	9.1
Blanchardstown	1.7	0.1	0.7	-12.1	-4.4	-1.2	0.0	-9.8	0.0	-1.6	0.0	0.1	0.0	-6.0	0.0	0.0	-0.1	-22.7	-1.9	-20.9
Ashbourne	-0.8	-0.8	-0.8	-0.8	-0.3	-0.8	-0.6	1.7	-0.8	-2.1	-0.1	-0.1	-9.0	0.0	-7.2	-9.0	5.1	-11.1	-13.0	4.1
Donabate	0.0	0.0	0.0	1.1	-14.1	0.9	0.0	-13.7	-16.7	-1.7	0.0	0.0	0.0	-17.8	0.0	0.0	0.0	1.0	0.4	-8.4
Balbriggan	-7.8	0.0	0.0	-15.5	-5.6	0.9	-7.8	-6.2	-6.3	-1.7	-7.8	-7.8	-7.8	0.2	0.0	0.0	-0.1	4.3	-9.6	2.2
Drogheda	0.0	0.0	0.0	-3.1	2.7	1.3	2.7	5.8	-11.3	-1.9	0.0	0.0	0.0	0.3	0.0	0.2	0.0	-8.9	0.0	1.6
Swords Pavilion	-16.3	-17.4	-7.3	-40.9	-17.1	-13.7	0.6	-17.0	-18.3	-19.6	-7.2	-7.1	-24.2	-31.8	0.4	6.5	-7.8	0.0	0.1	-8.5
Swords East	2.6	3.7	5.4	-14.4	-15.3	3.0	-1.4	-15.3	-16.6	-3.7	5.1	4.6	-7.2	-31.1	0.5	6.5	-5.5	-0.9	0.0	-5.0
Airport	-13.3	-11.5	-7.3	-25.3	-6.9	-20.7	0.1	-5.7	-7.0	-25.1	8.9	11.9	-19.7	-13.0	-2.0	5.9	-0.6	3.2	3.5	0.0

Table 6-10: 2030 PM Peak – Journey Time Comparisons (minutes) between Do Minimum and Do Scheme

Journey Time 2030 DS - 2030 DM Business Case PM Peak Period	O'Connell Street	St. Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	-0.2	-9.2	0.1	-0.3	-13.4	-1.1	0.1	0.0	0.0	-0.9	0.9	0.0	9.4	0.0	-19.5	-2.3	-13.8
St. Stephen's Green	0.2	0.0	0.1	-2.1	-12.3	0.0	-0.2	-16.9	-6.0	0.0	0.0	0.0	-0.1	-0.4	0.0	0.0	0.0	-10.9	-2.0	-18.3
College Street (Trinity)	0.0	0.0	0.0	0.2	-9.2	0.1	-0.1	-13.8	-0.1	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	-12.9	4.8	-7.0
Glasnevin	-1.2	-7.4	-0.3	0.0	-0.2	-7.8	-23.4	1.5	-0.1	-14.8	0.2	0.2	-11.2	0.9	-6.4	0.6	-11.0	-35.0	-19.7	-21.3
DCU	-3.2	-7.1	-3.9	0.0	0.0	-9.3	0.0	0.0	-0.1	-13.7	5.8	5.8	-12.9	1.1	-11.1	-10.8	0.1	-18.0	-9.8	-9.3
Rathgar Road	0.2	0.0	0.1	-4.6	-17.5	0.0	-0.6	-20.9	-4.2	0.0	0.2	0.2	-7.4	1.6	-0.7	-0.4	-3.1	-21.2	3.0	-20.8
Coolock	0.0	0.0	0.0	-10.2	-0.3	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.8	0.0	9.4	0.0	0.2	0.2	-0.5
Ballymun	-8.5	-13.7	-7.9	2.5	0.0	-15.1	0.0	0.0	-0.1	-19.4	0.1	0.1	-11.4	1.1	-16.5	-14.9	-4.9	-14.2	-1.4	-7.4
Finglas	-0.8	-6.8	-0.5	0.0	-0.6	-6.7	-0.5	-0.6	0.0	-13.0	2.6	2.6	0.0	1.0	3.8	-8.4	18.0	-13.7	-11.7	-6.9
Sandyford	0.0	0.0	-0.2	-8.6	-17.2	-0.1	-2.5	-20.6	-6.4	0.0	0.0	0.0	-2.3	-3.6	-0.7	-0.7	-2.5	-17.4	-8.2	-21.5
Tallaght	0.0	0.0	0.0	3.5	-8.0	0.1	-0.1	-12.0	-0.2	0.3	0.0	0.0	0.0	2.9	0.0	9.4	0.0	-8.4	1.1	-10.8
Red Cow	0.0	0.0	0.0	3.2	-8.0	0.0	-0.4	-11.9	0.0	0.7	0.0	0.0	0.0	3.1	0.0	9.4	0.0	-8.4	1.4	7.4
Blanchardstown	1.6	0.0	0.7	-12.0	-3.6	-0.7	-0.1	-8.2	0.0	-1.8	-0.1	-0.1	0.0	0.0	0.0	9.4	0.0	-27.7	-6.6	-17.6
Ashbourne	0.1	0.1	0.0	0.1	0.3	0.0	0.8	2.9	0.1	-0.7	0.6	0.7	-7.0	0.0	-0.7	-0.6	0.2	9.2	12.4	-0.4
Donabate	0.0	0.0	0.0	-6.4	-8.1	1.0	-0.1	10.1	-4.3	-1.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.4	0.4	-24.5
Balbriggan	-0.7	0.1	0.0	-9.4	-14.2	0.3	-0.4	-21.1	-19.1	-8.1	1.9	1.7	0.1	0.4	0.0	0.0	0.0	0.3	6.4	0.4
Drogheda	-5.8	0.0	0.0	-13.6	21.7	-3.6	-9.2	-11.7	-21.9	-12.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-17.1	2.8	0.0
Swords Pavilion	-21.9	-21.5	-12.5	-39.8	-16.0	-21.7	1.4	-14.9	-12.1	-42.8	-12.4	14.1	-32.8	-2.1	1.1	3.7	-14.0	0.0	0.1	-2.9
Swords East	1.2	-1.9	3.2	-11.3	-0.6	-1.8	0.2	-0.3	2.6	-10.5	3.5	3.6	-1.8	-3.7	0.0	1.2	0.0	-0.1	0.0	0.7
Airport	-15.5	-14.0	-5.6	-21.4	-7.0	-23.2	2.0	-5.8	-3.0	-27.4	20.2	9.7	-21.5	10.9	-0.5	3.7	1.5	0.6	1.8	0.0

Table 6-11: 2045 AM Peak - Journey Time Comparisons (minutes) between Do Minimum and Do Scheme

Journey Time 2045 DS - 2045 DM Business Case AM Peak Period	O'Connell Street	St. Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.0	-7.5	0.2	0.2	-12.1	0.3	0.2	0.0	0.0	-0.8	-1.1	0.0	0.0	0.0	-26.0	0.8	-23.0
St. Stephen's Green	0.0	0.0	0.1	-2.9	-11.3	0.1	0.2	-14.5	-2.0	0.0	0.0	0.0	-2.2	-3.4	0.0	0.0	0.0	-32.7	-0.9	-14.3
College Street (Trinity)	0.0	0.0	0.0	0.2	-8.3	0.2	0.2	-12.7	0.4	0.1	0.0	0.0	-0.2	-0.9	0.0	0.0	0.0	-27.3	5.3	-8.7
Glasnevin	-3.8	-9.3	-2.1	0.0	-0.1	-6.4	-8.5	2.1	0.2	-16.8	0.4	0.4	-11.7	-0.9	-5.5	-8.7	0.1	-28.7	-14.1	-24.5
DCU	-4.8	-9.9	-4.7	0.1	0.0	-9.9	0.0	0.0	0.3	-16.5	-3.2	-3.2	-12.5	-1.3	-23.0	-15.4	-0.8	-13.5	-12.8	-9.7
Rathgar Road	0.1	0.1	0.2	-4.6	-15.6	0.0	0.3	-18.9	-0.4	0.0	0.2	0.5	-6.6	-5.8	-0.8	-2.9	0.0	-34.3	-1.8	-22.4
Coolock	0.3	0.3	0.2	-7.0	0.2	0.3	0.0	-0.1	0.2	-0.8	0.5	0.3	0.3	-1.0	0.3	0.3	-3.9	0.0	0.3	0.3
Ballymun	-9.3	-14.7	-8.6	2.4	0.0	-15.6	-0.5	0.0	0.3	-20.5	-0.2	-0.2	-21.5	-1.2	-12.4	-18.0	-0.8	-11.1	-10.4	-8.1
Finglas	0.2	-6.2	0.1	-1.0	0.0	-0.7	-0.6	0.0	0.0	-11.7	2.3	2.3	0.0	-1.1	-0.9	-15.5	7.9	-10.3	-11.2	-7.3
Sandyford	0.0	0.0	0.0	-8.2	-15.8	-0.1	-1.2	-18.7	-1.7	0.0	0.0	0.0	-4.1	-6.4	-0.4	-0.3	-0.1	-35.0	-2.3	-23.7
Tallaght	0.0	0.0	0.0	1.7	-6.3	-0.1	0.2	-10.4	1.9	0.1	0.0	0.0	0.2	1.2	0.0	0.0	0.0	-23.6	5.4	-18.5
Red Cow	0.0	0.0	0.0	1.6	-6.2	-0.1	0.2	-10.4	1.4	0.2	0.0	0.0	0.2	1.2	0.0	0.0	0.0	-22.5	7.1	1.8
Blanchardstown	1.6	0.0	0.7	-12.1	-3.5	-1.0	0.1	-8.4	0.0	-1.6	0.2	0.2	0.0	-2.1	0.0	0.0	0.0	-22.3	-2.0	-21.3
Ashbourne	-0.5	-0.5	-0.5	-0.5	-0.2	-0.5	0.0	1.7	-0.7	-2.0	0.3	0.3	-9.3	0.0	-6.9	-14.3	1.2	-18.4	-16.7	3.7
Donabate	5.5	0.0	0.0	7.3	-13.9	1.0	5.6	-14.1	-8.2	-1.8	5.5	5.5	5.5	-17.2	0.0	0.0	0.0	1.0	0.2	-9.1
Balbriggan	0.0	7.8	7.8	-7.7	6.8	8.8	0.2	-16.2	3.6	6.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	3.4	-0.3	2.0
Drogheda	0.0	0.0	0.0	-5.2	0.8	1.0	0.8	4.8	-12.9	-1.7	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	4.1	-0.3	1.1
Swords Pavilion	-15.4	-17.9	-7.7	-40.6	-17.4	-14.1	2.1	-17.3	-18.3	-20.0	-7.6	-7.5	-24.3	-33.3	0.7	0.3	-8.4	0.0	0.0	-9.3
Swords East	2.4	3.5	4.4	-14.6	-15.9	2.7	-0.4	-15.9	-16.9	-4.0	4.2	3.6	-7.4	-25.0	0.8	0.3	0.2	-0.3	0.0	-5.9
Airport	-13.7	-11.8	-7.8	-24.8	-6.9	-21.0	-0.3	-5.7	-6.7	-25.6	-3.6	13.0	-20.4	-14.0	-2.3	0.3	-0.2	3.1	3.5	0.0

Table 6-12: 2045 PM Peak – Journey Time Comparisons (minutes) between Do Minimum and Do Scheme

Journey Time 2045 DS - 2045 DM Business Case PM Peak Period	O'Connell Street	St. Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.0	-9.0	0.0	-0.2	-13.3	-0.5	0.2	0.0	0.0	-0.9	0.5	0.0	0.0	0.0	-18.7	-4.5	-18.3
St. Stephen's Green	0.1	0.0	0.1	-1.9	-12.2	0.0	0.1	-16.9	-5.3	0.0	0.0	0.0	-0.1	-1.1	0.0	0.0	0.0	-14.8	-6.4	-22.9
College Street (Trinity)	0.0	0.0	0.0	0.4	-9.2	0.1	0.1	-13.7	0.4	0.1	0.0	0.0	0.2	1.2	0.0	0.0	0.0	-12.1	0.5	-8.2
Glasnevin	-1.4	-7.2	-0.1	0.0	-0.1	-7.5	-24.4	1.5	0.2	-15.0	0.3	0.3	-11.2	0.6	-6.5	-4.8	-9.1	-36.6	-20.7	-24.6
DCU	-3.2	-7.2	-4.0	0.1	0.0	-9.5	-0.1	0.0	0.5	-13.9	5.8	5.8	-13.0	-0.1	-10.8	-17.2	-1.5	-20.4	-12.6	-10.7
Rathgar Road	0.2	0.0	0.2	-4.4	-17.3	0.0	-0.7	-20.9	-3.4	0.0	-6.2	-6.7	-7.6	0.6	0.3	0.3	-0.8	-26.0	-1.4	-25.7
Coolock	0.3	0.4	0.4	-10.1	-0.3	0.5	0.0	0.0	0.5	0.3	0.4	0.3	0.3	0.2	0.3	0.3	0.3	-0.1	0.0	-1.6
Ballymun	-8.6	-13.8	-8.5	2.6	0.0	-15.2	-0.4	0.0	0.5	-19.5	0.1	0.1	-11.2	-0.1	-16.5	-21.1	-8.3	-16.2	-3.7	-8.9
Finglas	-0.5	-6.5	-0.2	0.2	-0.1	-6.7	-0.3	-0.1	0.0	-13.1	2.9	2.8	0.0	0.3	3.9	-7.8	17.1	-15.9	-13.7	-8.6
Sandyford	-0.1	0.0	-0.2	-8.3	-17.0	-0.1	-2.2	-20.5	-5.5	0.0	-0.1	-0.1	-2.5	-5.5	-0.7	-0.7	-1.4	-21.8	-12.2	-25.9
Tallaght	0.0	0.0	0.0	7.2	-8.0	-3.0	0.2	-12.2	0.1	0.8	0.0	0.0	7.9	2.8	0.0	0.0	0.0	-11.9	-0.2	-15.3
Red Cow	0.0	0.0	0.0	3.4	-8.1	-0.2	-0.1	-12.1	0.3	1.2	0.0	0.0	-1.3	2.8	0.0	0.0	0.0	-11.9	1.2	10.8
Blanchardstown	1.6	0.0	0.7	-12.0	-3.5	-0.7	-0.1	-7.7	0.0	-1.9	0.1	0.1	0.0	1.1	0.0	0.0	0.0	-30.1	-7.3	-20.7
Ashbourne	0.3	0.3	0.3	0.2	1.0	0.2	1.2	3.3	0.0	-0.6	0.9	0.9	-6.8	0.0	-0.5	0.2	-0.2	4.1	7.2	14.1
Donabate	0.0	0.0	0.0	-6.3	-8.1	0.6	0.1	9.1	-3.2	-2.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.2	0.2	-24.9
Balbriggan	-0.4	0.1	0.0	-9.0	-12.0	0.2	-0.2	-23.7	-17.4	-7.7	1.7	1.5	0.3	0.5	0.0	0.0	0.0	0.0	6.8	0.0
Drogheda	-5.1	0.0	0.0	-13.1	21.2	-3.6	-0.1	-13.5	-20.0	-11.5	0.0	0.0	0.0	-0.3	0.0	-0.1	0.0	-17.5	2.0	-0.5
Swords Pavilion	-23.7	-23.8	-14.8	-38.5	-16.3	-29.0	2.0	-15.4	-11.8	-47.9	-14.7	9.3	-31.1	-6.5	0.7	-0.5	-13.7	0.0	0.5	-3.2
Swords East	1.1	-2.4	2.6	-12.0	-1.1	-2.7	0.4	-0.6	3.1	-11.2	2.9	3.0	-2.3	-4.7	0.1	-0.5	0.1	-0.1	0.0	0.4
Airport	-15.8	-16.2	-6.1	-24.6	-7.1	-24.4	-0.7	-5.8	-2.1	-28.8	3.9	7.6	-21.2	6.9	-2.9	-0.5	-0.5	-0.3	1.9	0.0

Table 6-13: 2060 AM Peak – Journey Time Comparisons (minutes) between Do Minimum and Do Scheme

Journey Time 2060 DS - 2060 DM Business Case AM Peak Period	O'Connell Street	St. Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.0	-7.9	0.0	0.4	-12.7	0.4	0.2	0.0	0.0	-0.9	-0.7	0.0	0.0	0.0	-27.5	-0.6	-22.8
St. Stephen's Green	0.0	0.0	0.0	-2.8	-11.8	0.0	0.5	-14.9	-2.0	0.0	0.0	0.0	-2.3	-2.9	0.0	0.0	0.0	-33.4	-1.1	-16.3
College Street (Trinity)	0.0	0.0	0.0	0.3	-8.6	0.1	0.4	-13.0	0.5	0.1	0.0	0.0	-0.2	-0.4	0.0	0.0	0.0	-28.7	5.2	-10.8
Glasnevin	-4.1	-9.5	-3.2	0.0	0.0	-9.5	-7.9	2.0	0.3	-17.8	0.4	0.6	-11.7	-0.5	-4.9	-6.9	-7.3	-30.1	-10.7	-24.4
DCU	-5.4	-10.3	-5.3	0.1	0.0	-11.1	0.0	0.0	-0.1	-17.2	-3.2	-3.2	-12.6	-2.6	-23.0	-18.0	-2.1	-15.8	-15.6	-10.1
Rathgar Road	0.1	0.1	0.1	-4.6	-16.1	0.0	0.6	-19.4	-0.6	0.0	0.0	0.6	-6.9	-5.3	0.3	0.2	0.8	-34.3	-2.0	-24.2
Coolock	0.5	0.5	0.4	-6.8	-0.1	0.6	0.0	-0.7	-0.7	-1.0	0.7	0.6	0.5	-14.3	0.5	0.5	0.5	-0.3	0.4	-2.1
Ballymun	-9.6	-15.0	-8.9	2.6	0.0	-16.6	0.0	0.0	0.0	-20.8	-0.6	-0.6	-22.4	-2.3	-12.3	-22.2	-2.1	-12.5	-12.0	-8.2
Finglas	0.9	-4.1	1.1	2.1	0.0	-3.0	-0.1	0.0	0.0	-9.7	4.8	4.2	0.0	-0.8	0.5	-8.0	-10.5	-12.9	-13.6	-1.0
Sandyford	0.0	0.0	0.0	-7.7	-15.7	-0.1	-0.2	-18.4	-0.7	0.0	0.0	0.0	-4.6	-5.7	-0.3	-0.3	-0.1	-35.1	-2.3	-25.2
Tallaght	0.0	0.0	0.0	2.0	-5.9	0.0	0.4	-10.8	1.4	0.1	0.0	0.0	0.0	1.9	0.0	0.0	0.0	-24.4	6.1	-19.7
Red Cow	0.0	0.0	0.0	1.9	-5.8	0.0	0.4	-9.2	1.3	0.3	0.0	0.0	0.0	2.0	0.0	0.0	0.0	-23.1	7.3	-19.1
Blanchardstown	1.6	0.0	-0.4	-12.1	-2.6	-1.0	0.3	-8.2	0.0	-1.7	0.4	0.4	0.0	0.1	0.0	0.0	0.0	-23.7	-2.2	-21.3
Ashbourne	-2.7	-2.7	-2.7	-2.9	-2.5	-3.3	-1.8	-0.6	-3.2	-4.8	-1.8	-1.8	-18.0	0.0	-9.7	-16.4	23.6	-22.5	-18.5	3.1
Donabate	0.0	0.0	0.0	7.3	-6.8	1.1	0.3	-16.9	-7.8	-2.1	0.0	0.0	0.0	-17.3	0.0	0.0	0.0	-0.4	-1.1	-9.8
Balbriggan	0.0	0.0	0.0	-7.5	-6.1	1.1	0.3	-21.3	-4.1	-2.0	0.0	0.0	0.0	-0.9	0.0	0.0	-0.1	-7.9	-1.4	1.0
Drogheda	0.0	0.0	0.0	-5.8	2.0	1.1	2.0	4.6	-8.4	-1.8	-0.1	-0.1	0.0	-0.7	0.0	2.5	0.0	5.0	-1.4	1.8
Swords Pavilion	-19.3	-20.5	-11.6	-38.8	-15.4	-18.5	1.2	-15.7	-17.0	-23.7	-11.4	-11.4	-27.9	-33.5	0.6	0.8	-9.0	0.0	-0.1	-11.3
Swords East	1.5	2.6	7.8	-15.4	-14.2	1.6	-1.7	-14.3	-15.7	-4.9	5.9	5.6	-8.3	-24.6	0.7	0.9	0.6	-0.7	0.0	-6.4
Airport	-16.9	-9.7	-8.8	-29.0	-6.9	-27.7	0.2	-5.6	-7.0	-29.5	-5.4	17.5	-23.9	-18.0	-9.2	-1.1	-2.2	-0.4	1.0	0.0

Table 6-14: 2060 PM Peak – Journey Time Comparisons (minutes) between Do Minimum and Do Scheme

Journey Time 2060 DS - 2060 DM Business Case PM Peak Period	O'Connell Street	St. Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.1	-8.6	-0.1	0.2	-12.9	-0.4	0.2	0.0	0.0	-0.9	1.5	0.0	0.0	0.0	-21.3	-5.4	-14.9
St. Stephen's Green	0.0	0.0	0.1	-1.9	-11.7	0.1	0.5	-16.6	-5.2	0.0	0.0	0.0	-0.1	-1.0	0.0	0.0	0.0	-17.7	-9.0	-24.0
College Street (Trinity)	0.0	0.0	0.0	0.5	-8.7	0.4	0.5	-13.4	0.5	0.1	0.0	0.0	-0.1	1.0	0.0	0.0	0.0	-19.3	-2.0	-8.3
Glasnevin	-1.4	-7.3	-0.2	0.0	0.2	-7.7	-15.4	1.8	0.2	-15.3	0.1	0.5	-11.2	1.0	-4.2	-6.5	-6.5	-36.4	-28.0	-28.5
DCU	-3.6	-7.9	-3.5	0.2	0.0	-9.4	-0.4	0.0	-0.8	-14.6	-7.3	5.6	-10.8	-14.5	-11.0	-16.5	-6.9	-20.5	-16.6	-10.7
Rathgar Road	0.2	0.1	0.2	-4.4	-16.8	0.0	0.8	-20.4	-3.1	0.0	0.3	0.4	-7.8	1.7	-0.3	-0.3	-0.2	-28.1	-4.0	-27.1
Coolock	0.5	0.7	0.5	-10.2	-0.5	1.0	0.0	-0.6	-1.3	0.6	0.6	0.5	0.6	1.2	0.5	0.5	0.6	0.0	0.1	-1.3
Ballymun	-8.5	-13.8	-8.6	2.9	0.1	-15.1	-2.5	0.0	-0.7	-19.5	-7.0	-0.1	-10.5	-1.5	-16.8	-20.5	-7.8	-16.3	-15.5	-9.0
Finglas	-0.4	-6.5	-0.1	0.2	-0.1	-6.7	-0.5	-0.2	0.0	-13.3	3.0	3.0	0.0	0.6	11.1	-6.7	-14.6	-16.5	-15.7	-9.2
Sandyford	-0.1	0.0	-0.1	-8.2	-16.6	-0.1	-1.6	-20.0	-5.5	0.0	-0.1	-0.1	-2.9	-5.4	-0.6	-0.6	-0.6	-24.1	-14.1	-28.4
Tallaght	0.0	0.0	0.0	7.5	-7.8	-3.8	0.5	-12.1	0.4	0.8	0.0	0.0	-0.4	3.3	0.0	0.0	0.0	-13.8	-1.1	-16.8
Red Cow	0.0	0.0	0.0	3.7	-7.8	-0.2	0.2	-12.1	0.4	0.8	0.0	0.0	-0.5	3.3	0.0	0.0	0.0	-13.8	0.2	8.0
Blanchardstown	1.7	0.0	0.7	-12.0	-3.3	-0.7	1.9	-7.5	0.0	-2.2	-0.2	-0.2	0.0	0.6	0.0	0.0	0.0	-30.0	-7.7	-24.2
Ashbourne	0.4	0.4	0.4	0.2	1.3	0.4	1.9	3.7	0.1	-0.7	0.9	0.9	-6.9	0.0	-0.1	0.3	0.0	2.2	5.5	12.0
Donabate	0.0	0.0	0.0	-6.0	-8.0	0.8	0.5	-2.9	-2.7	-2.2	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.3	0.3	-25.1
Balbriggan	-0.2	0.1	0.0	-8.4	-12.7	0.8	0.3	-24.2	-15.5	-7.0	1.2	0.8	0.3	1.4	0.0	0.0	0.0	-0.2	6.7	0.0
Drogheda	0.0	0.0	0.0	-12.2	20.4	-1.4	0.1	-14.6	-17.7	-4.6	0.0	0.0	0.0	-0.4	0.0	0.1	0.0	-17.6	0.5	-1.3
Swords Pavilion	-34.7	-28.4	-19.1	-39.1	-18.5	-43.2	3.2	-16.2	-13.5	-48.6	-19.0	5.8	-31.8	-10.3	1.2	1.7	-12.5	0.0	0.9	-3.5
Swords East	0.3	-2.8	2.2	-12.4	-2.8	-3.1	0.1	-1.2	1.6	-11.6	2.6	2.6	-2.7	-4.1	0.1	-2.0	0.1	-0.1	0.0	0.1
Airport	-17.3	-18.8	-7.8	-27.6	-7.8	-26.3	1.1	-5.9	-3.2	-31.9	-5.1	10.0	-22.9	3.3	-1.9	1.7	0.2	-0.2	1.0	0.0

The implementation of MetroLink provides substantial time savings in 2030, 2045 and 2060, from a range of locations in north Dublin, the city centre, and south Dublin. In 2045 AM, the largest journey time savings can be seen in journeys to and from Dublin Airport and Swords Pavilion. The largest journey time saving occurs from Swords Pavilion to Glasnevin, with a saving of approximately 40 minutes in all three years. This is due to the presence of the interchange with the heavy rail network at Glasnevin station, contributing to an overall public transport journey time saving. A saving of approximately 26 minutes can be seen from Dublin Airport to Sandyford at the south of the city in 2045, as a result of the MetroLink interchange with the Luas Green Line at Charlemont station, increasing to a saving of 30 minutes in 2060, in the AM period. Similar journey time savings can also be seen from Swords Pavilion to Blanchardstown.

Overall, in the AM period, journeys to the north (to Swords Pavilion and Swords East) and Dublin Airport see widespread journey time reductions, of up to 35 minutes from Sandyford and Rathgar Road to Swords Pavilion, as a result of the interchange with Luas Green Line. The journey from O’Connell Street to Dublin Airport sees a reduction of approximately 14 minutes in 2030, jumping to a reduction of 23 minutes in 2045 between these key locations. Improvements can also be seen along the MetroLink corridor, with time savings of up to 20 minutes to and from DCU and Ballymun.

In the PM period, the largest reduction in journey time in 2030 is from Swords Pavilion to Sandyford, which sees a reduction of approximately 43 minutes in journey time when MetroLink is in place. This increases to a saving of approximately 50 minutes in 2045 and 2060, respectively. As with the AM period, large journey time savings can also be seen to and from Swords Pavilion and Glasnevin as a result of the interchange with the rail network at Glasnevin station. The Fingal Metro corridor sees consistent journey time savings to and from key locations such as O’Connell Street and St Stephen’s Green, with journey time savings of 15 minutes and 25 minutes respectively in 2060.

6.6.3 Transfers to and from MetroLink

Table 6-15, Table 6-16, and Table 6-17 show the volume of 12hr transfers to and from MetroLink, either walking or cycling to/from the surrounding zones, or using other forms of public transport to interchange, in 2030, 2045 and 2060 respectively.

A ‘**First Boarder’** refers to a passenger who first accesses the public transport network via MetroLink. Therefore, passengers who transfer from bus/rail/Luas to MetroLink are not considered ‘First Boarders’.

A ‘**Final Destinations’** passenger is someone who exits the public transport network via MetroLink. Therefore, passengers who transfer to bus/rail/Luas from MetroLink to continue their journey are not considered to be ‘Final Destinations’ passengers.

In all scenarios, the majority of transfers from ‘First Boarders’ and ‘Final Destination’ at Estuary are to/from the Estuary Park and Ride. For all other stations, ‘First Boarder’ and ‘Final Destination’ passengers are predominantly in relation to those living within the walking catchments of the stations.

Table 6-15: Transfers to/From MetroLink Stations – 12hr period in 2030

Transfers To/From MetroLink Stations - 12hr Period								
Station	Transfers to MetroLink				Transfers from MetroLink			
	First Boarders	From Bus	From Rail/DART	From Luas	Final Destination	To Bus	To Rail/DART	To Luas
Estuary Park-and-Ride	7,567	3,730	-	-	7,462	2,202	-	-
Seatown	4,240	485	-	-	4,005	70	-	-
Swords Central	4,582	702	-	-	4,211	2,023	-	-
Fosterstown	4,136	1,621	-	-	3,620	670	-	-
Dublin Airport	22,377	661	-	-	20,606	764	-	-
Dardistown	-	-	-	-	-	-	-	-
Northwood	2,786	94	-	-	2,776	405	-	-
Ballymun	5,627	727	-	-	5,145	901	-	-
Collins Avenue	5,975	652	-	-	5,519	1,806	-	-
Griffiths Park	2,161	3	-	-	2,425	15	-	-
Glasnevin	1,671	3,029	2,513	-	1,899	1,978	2,315	-
Mater	2,736	1,345	-	-	2,845	1,063	-	-
O'Connell Street	4,768	979	-	3,696	4,876	150	-	4,134
Tara	7,609	4,369	3,323	11	8,802	6,559	3,536	4
St Stephen's Green	8,003	540	-	-	8,809	3,904	-	-
Charlemont	5,536	3,942	-	5,986	5,744	2,098	-	4,837

Table 6-16: Transfers to/From MetroLink Stations-12hr period in 2045

Transfers To/From MetroLink Stations - 12hr Period								
Station	Transfers to MetroLink				Transfers from MetroLink			
	First Boarders	From Bus	From Rail/DART	From Luas	Final Destination	To Bus	To Rail/DART	To Luas
Estuary Park-and-Ride	6,027	3,690	-	-	5,921	2,594	-	-
Seatown	4,995	427	-	-	4,665	108	-	-
Swords Central	5,622	840	-	-	5,183	2,435	-	-
Fosterstown	5,263	1,538	-	-	4,401	715	-	-
Dublin Airport	31,146	725	-	-	28,976	877	-	-

Dardistown	-	-	-	-	-	-	-	-
Northwood	3,641	97	-	-	3,569	465	-	-
Ballymun	7,599	865	-	-	6,826	1,016	-	-
Collins Avenue	6,530	690	-	-	6,170	2,097	-	-
Griffiths Park	2,445	4	-	-	2,787	19	-	-
Glasnevin	1,980	3,568	3,538	-	2,255	2,354	3,343	-
Mater	3,323	1,659	-	-	3,402	1,361	-	-
O'Connell Street	5,717	1,392	-	5,330	5,758	183	-	5,717
Tara	9,226	5,681	4,129	17	10,425	8,240	4,469	6
St Stephen's Green	9,060	621	-	-	9,866	4,480	-	-
Charlemont	6,646	4,696	-	7,363	6,905	2,431	-	6,071

Table 6-17:Transfers to/from MetroLink Stations – 12hr period in 2060

Transfers To/From MetroLink Stations - 12hr Period								
Station	Transfers to MetroLink				Transfers from MetroLink			
	First Boarders	From Bus	From Rail/DART	From Luas	Final Destination	To Bus	To Rail/DART	To Luas
Estuary Park-and-Ride	8,625	4,564	-	-	8,542	3,528	-	-
Seatown	6,326	614	-	-	6,171	120	-	-
Swords Central	7,964	1,203	-	-	7,384	3,187	-	-
Fosterstown	6,863	2,092	-	-	5,860	874	-	-
Dublin Airport	45,637	779	-	-	42,199	1,115	-	-
Dardistown	-	-	-	-	-	-	-	-
Northwood	4,781	118	-	-	4,595	590	-	-
Ballymun	9,893	998	-	-	8,765	1,167	-	-
Collins Avenue	7,379	855	-	-	7,014	2,447	-	-
Griffiths Park	2,915	6	-	-	3,265	23	-	-
Glasnevin	2,428	4,395	5,452	-	2,767	3,009	5,240	-
Mater	4,285	2,005	-	-	4,351	1,844	-	-
O'Connell Street	7,640	1,934	-	7,540	7,654	221	-	7,990
Tara	12,546	7,716	5,482	29	13,919	11,238	6,047	11
St Stephen's Green	11,379	757	-	-	12,437	5,483	-	-

Charlemont	8,451	5,809	-	9,353	8,838	3,013	-	7,905

Dublin Airport sees the largest number of transfers to/from zone across all years. After Dublin Airport, stations in the city centre, such as Tara and St Stephen’s Green, see significant volumes of transfers to/from zone. Stations such as Collins Avenue and Ballymun, and along the R132, see large numbers of transfers to/from zone due to the surrounding residential catchments of the stations.

Tara sees the largest volume of transfers to/from bus in both scenarios. Estuary and Charlemont also see large volumes of bus transfers both to and from MetroLink.

Interchange with the heavy rail network is also possible at Glasnevin and Tara stations, however Tara sees a higher volume of transfers to and from this mode.

There is a large volume of transfers to/from Luas at Charlemont and O’Connell Street, as these stations are in close proximity to Luas services (Green Line at Charlemont and both Red and Green lines at O’Connell Street). In terms of transfers at O’Connell Street, Luas Green line has more transfers than Luas Red Line.

6.7 Road Network Analysis

6.7.1 Link Flows

In comparing the Do Minimum Scenario to the Do Scheme Scenarios, decreases and increases can be seen both in actual and Demand flows on the strategic road network throughout the area of interest.

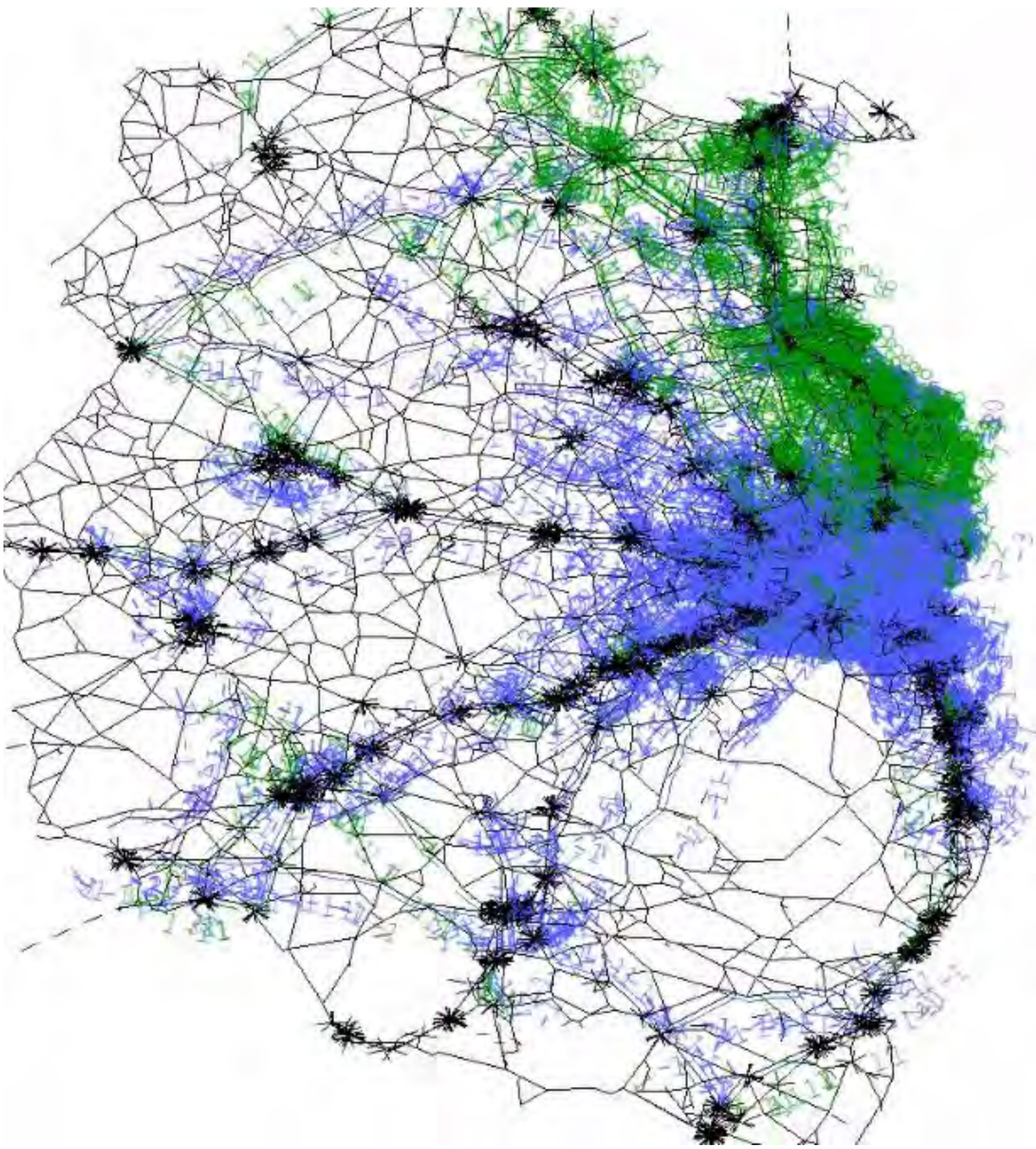


Figure 6-21: Saturn Highway Model - Flow Changes AM Peak

Figure 6-21 displays the difference in traffic flows on the highway network with the MetroLink scheme in place, the blue shows an increase in flows and the green shows a decrease in flows. The plot shows the increases in traffic flows to the north of the Estuary Park and Ride and decreases in traffic flow south of the Airport and along most of the radial routes into Dublin city.

Figure 6-22 shows local changes in traffic flow around the M1 and M50. There are increases in flows on the main roads to the north of the Estuary Park and Ride and there are decreases in flows south of the Airport and along the M50. These decreases in flows along the M50 result in journey time benefits for the significant number of users of the M50, which has an AADT of close to 150,000 vehicles.

Figure 6-22: Saturn Highway Model - Flow Changes (M1/M50)

Figure 6-23 and Figure 6-24 below shows the AADT traffic flow differences between the Do Scheme and Do Minimum scenario in 2030, with Figure 6-25 and Figure 6-26 illustrating the same for 2045, and Figure 6-27 and Figure 6-28 illustrating the same for 2060.

There are increases in traffic flow in both directions to the North of Swords in all future years. This can be expected due to traffic travelling to the Strategic Park and Ride site at Estuary. As a result of the Park and Ride, there is a general decrease in traffic between Swords and the City Centre

In 2045, reductions in AADT traffic flow can be seen on key national routes such as the M3, M4, M7/M9, M11 and M50. This relates to the transfer of road passengers onto the public transport network, utilising the Maynooth, Kildare and Cork rail lines.

In 2060, reductions in AADT traffic flow can be seen on national routes such as the M1, M3 and M4, as well as throughout the City Centre and Port Tunnel. The largest reduction of up to 15,000 vehicles is on the M1, where it joins the M50, which can be attributed to the presence of the Park and Ride facility.

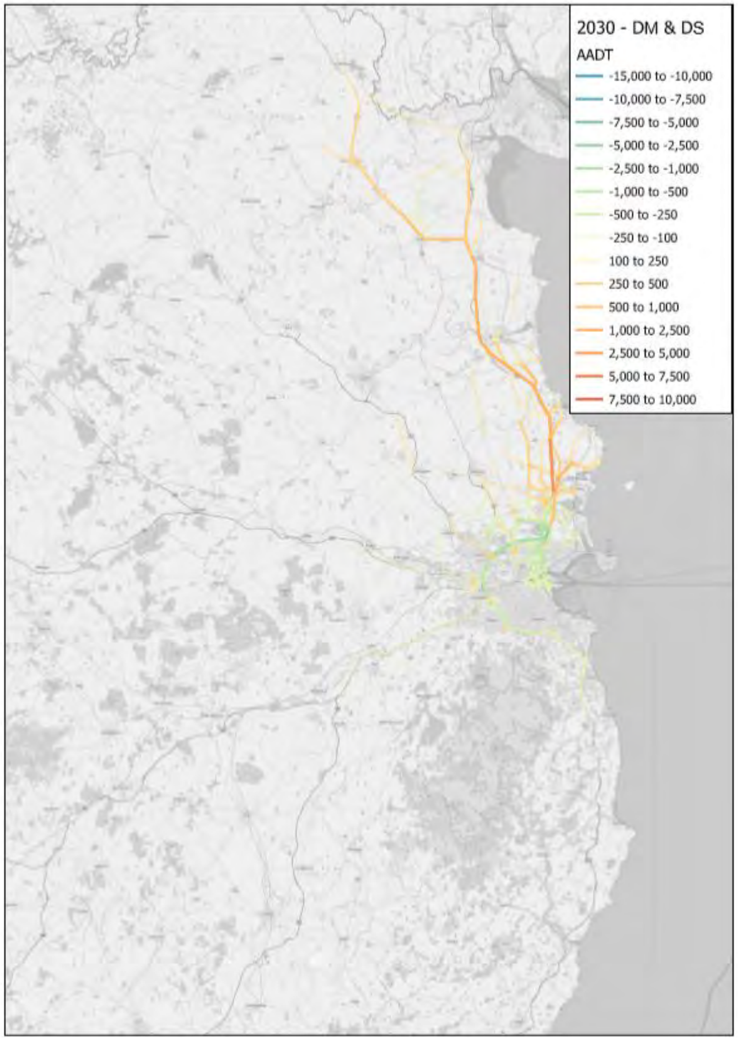


Figure 6-23 Overview 2030 DS – DM AADT Traffic Flow

Figure 6-24: 2030 DS-DM AADT Traffic Flow along Scheme

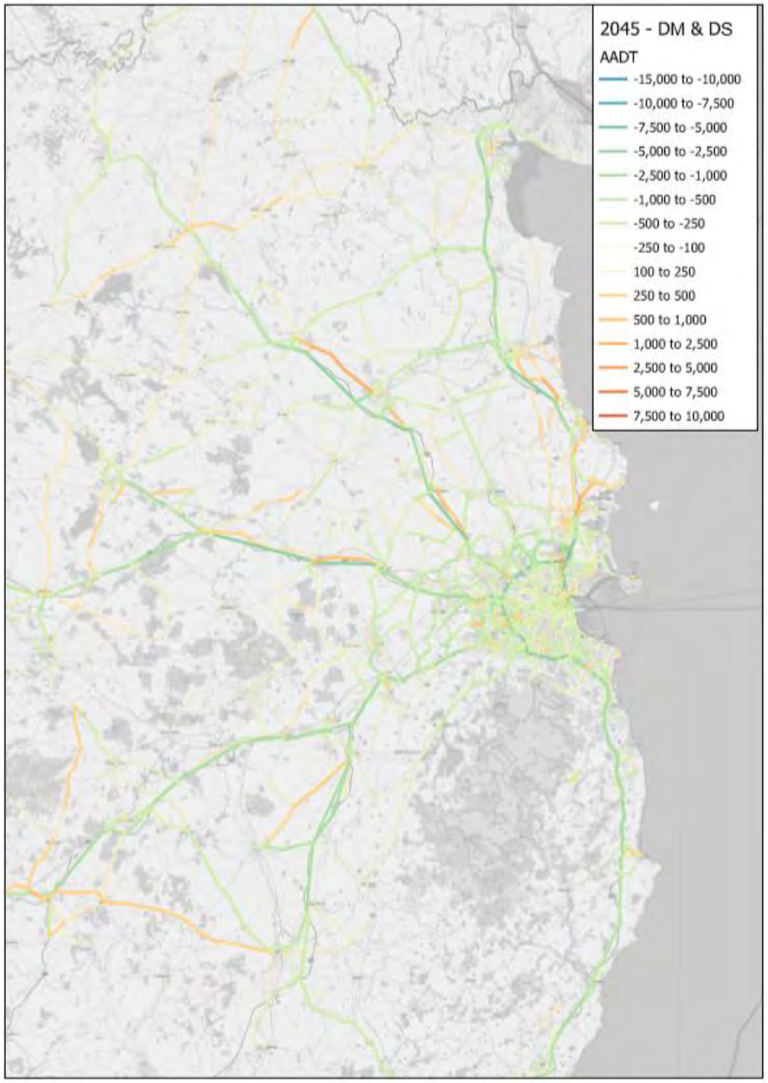
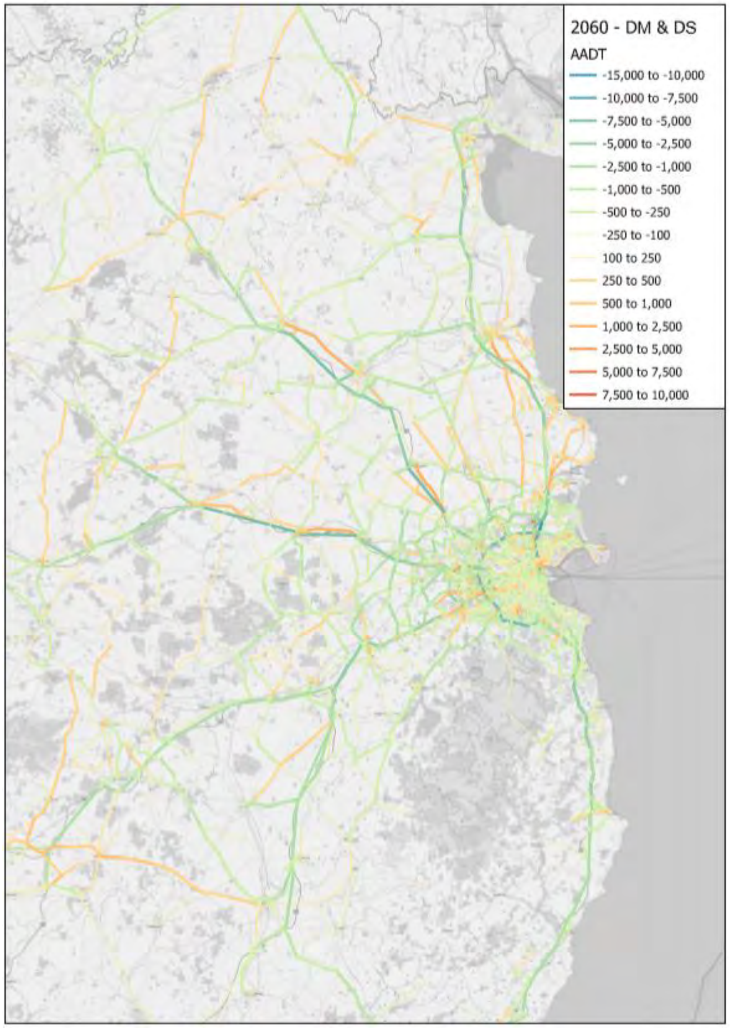


Figure 6-25: Overview 2045 DS-DM AADT Traffic Flow

Figure 6-26: 2045 DS-DM AADT Traffic Flow along Scheme



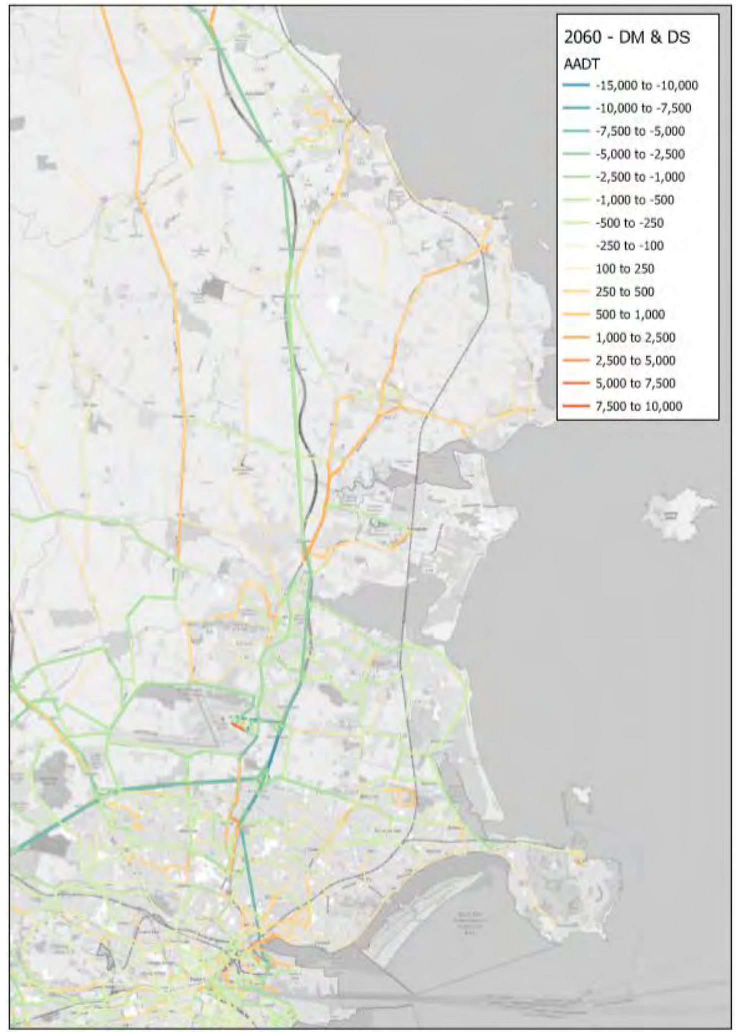


Figure 6-27: Overview 2060 DS-DM AADT Traffic Flow

Figure 6-28: Overview 2060 DS-DM AADT Traffic Flow along Scheme

6.7.2 Volume Capacity Ratio

Figure 6-29 to Figure 6-34 shows links with Volume to Capacity ratios greater than 85% without the Project in place, that are reduced to be less than 85% with the Project in place (shown in green), as well as links that would have Volume to Capacity ratios less than 85% without the Project in place that now have Volume to Capacity ratio's greater than 85% with the Project in place (shown in red) in the AM and PM peaks in 2030, 2045 and 2060.

The figures show that there are a number of links to the North of Estuary Park and Ride Site that result in increases in Volume to Capacity to values greater than 85% as a result of the impact of the scheme. These can be expected with the implementation of the Park and Ride scheme, and as shown with the traffic flow increases in the section above. In 2030 AM period, a number of links reduce by between 20%-30%, such as the Swords Bypass, and R125 between Swords Bypass and Lissenhall. In 2030 AM and PM most increases in VC to >85% are minimal, with the Dublin Airport car park complex and N7 Naas Road towards M50 J9 increasing by 8% to 89% and 87% respectively.

Similarly, there are congested links without the scheme in place that are relieved and have resultant Volume to Capacity ratios less than 85% with the scheme in place. In 2045, links near Dublin Airport see a decrease in Volume to Capacity to values less than 85% due to the implementation of MetroLink, such as the South Parallel Road (near Long Term Car Park), which decreases from a 100% to 49% Volume to Capacity ratio. As with 2030, most increases to Volume to Capacity ratios greater than 85% are minimal, with the largest increase occurring at M1 J4, which can be attributed to the attraction of the Park and Ride facility at Estuary station.

In 2060, links with Volume to Capacity Rations that are reduced to less than 85% can be seen along the R132, and Port Tunnel.

In 2045 and 2060, increases in Volume to Capacity ratios can be seen at the M50/N7 junction, however the N7 as a whole shows a reduction in AADT in all years.

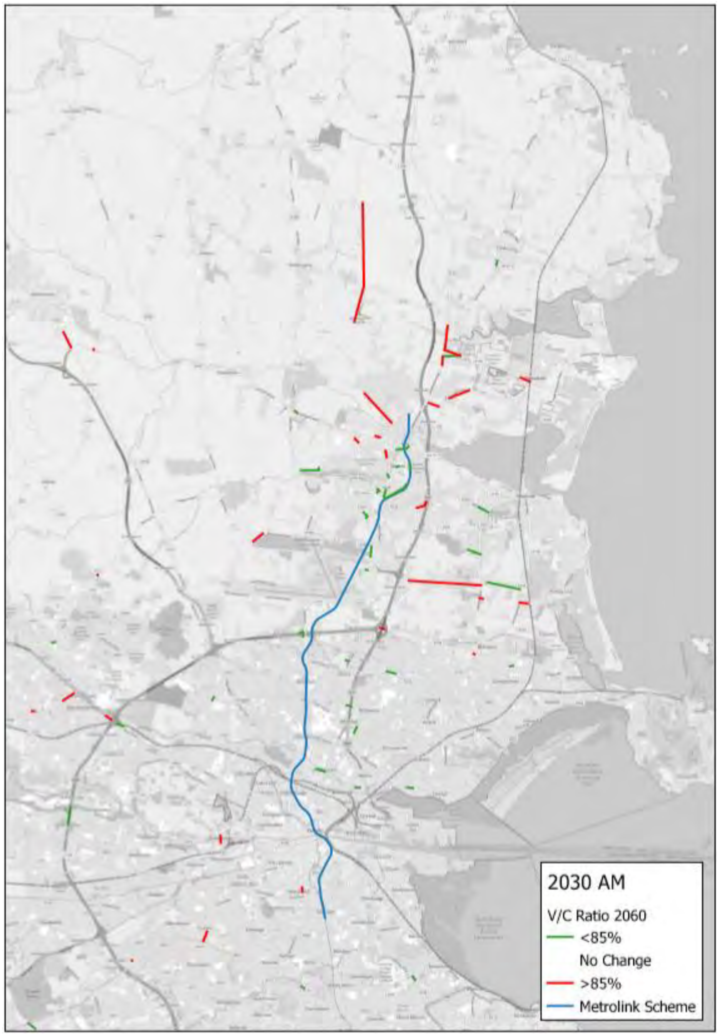


Figure 6-29 - Change in VC Ratios in 2030 AM Peak Period DS

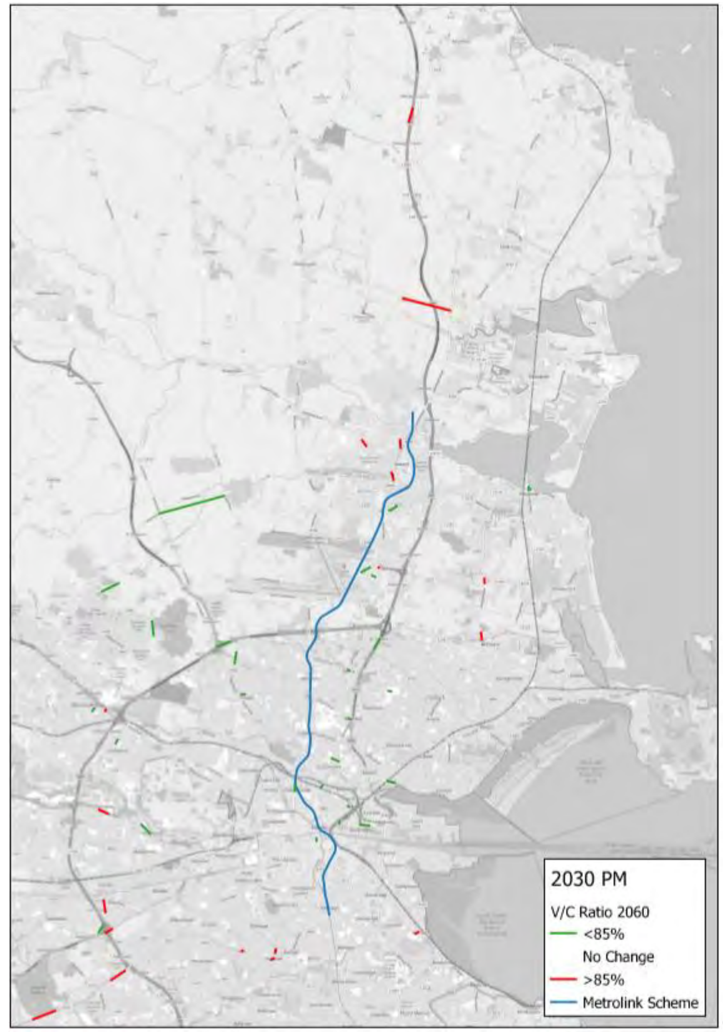


Figure 6-30 - Change in VC Ratios in 2030 PM Peak Period DS

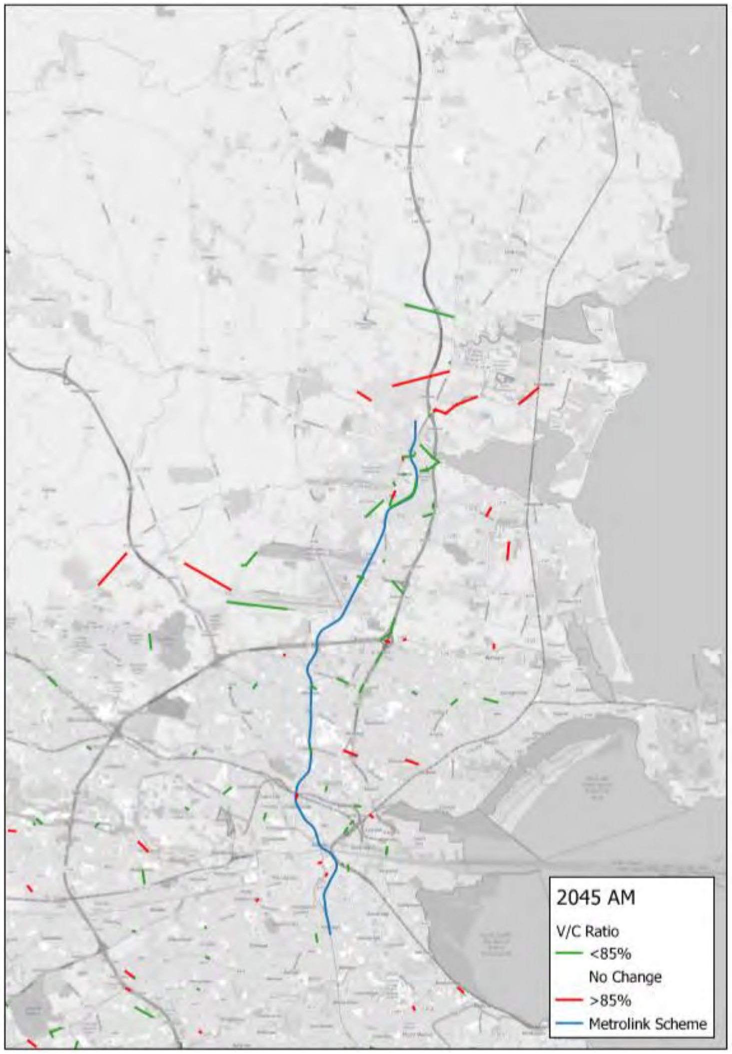


Figure 6-31: Change in VC Ratios in 2045 AM Peak Period DS

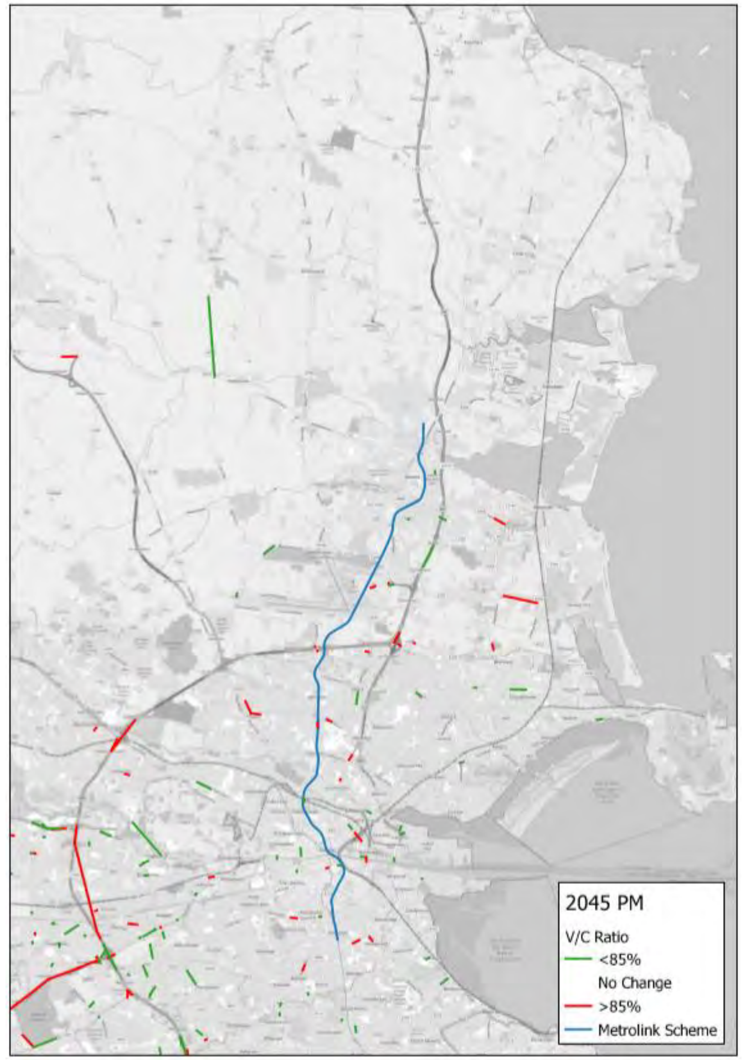


Figure 6-32: Change in VC Ratios in 2045 PM Peak Period DS

Figure 6-33: Changes in VC Ratios in 2060 AM Peak Period DS

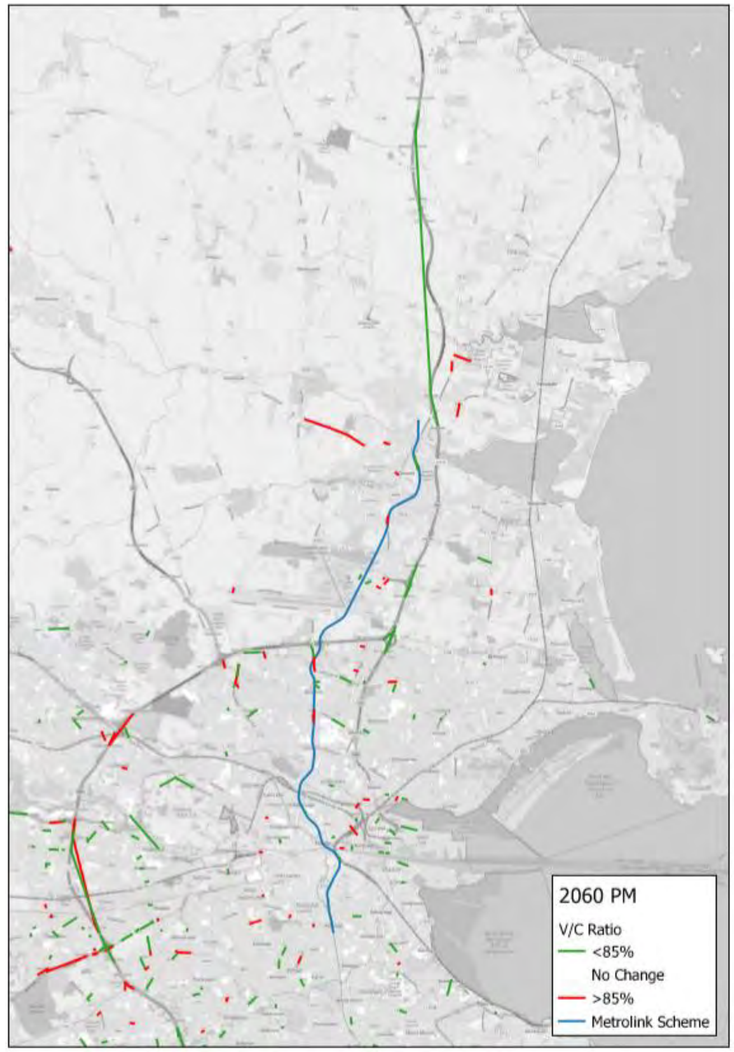


Figure 6-34: Changes in VC Ratios in 20600 PM Peak Period DS

6.7.3 Delay

Figure 6-35 to Figure 6-40 shows the changes in delays with the scheme in place in the AM and PM peaks in 2030, 2045 and 2060.

As would be expected, and as in line with the Volume to Capacity ratio plots, there are increases in delays on links to the North of Estuary Park and Ride, due to the increase in traffic travelling to and from the Park and Ride Sites in the respective AM and PM Peaks. There are also decreases in delays between Estuary and the City Centre, due to a reduction in traffic on the road network, as a result of previous highway trips using the MetroLink instead.

The 2030 PM peak illustrates a number of delay impacts within the City Centre, however these delays are not present in the 2045 and 2060 scenarios, so may be attributed to variances within the model.

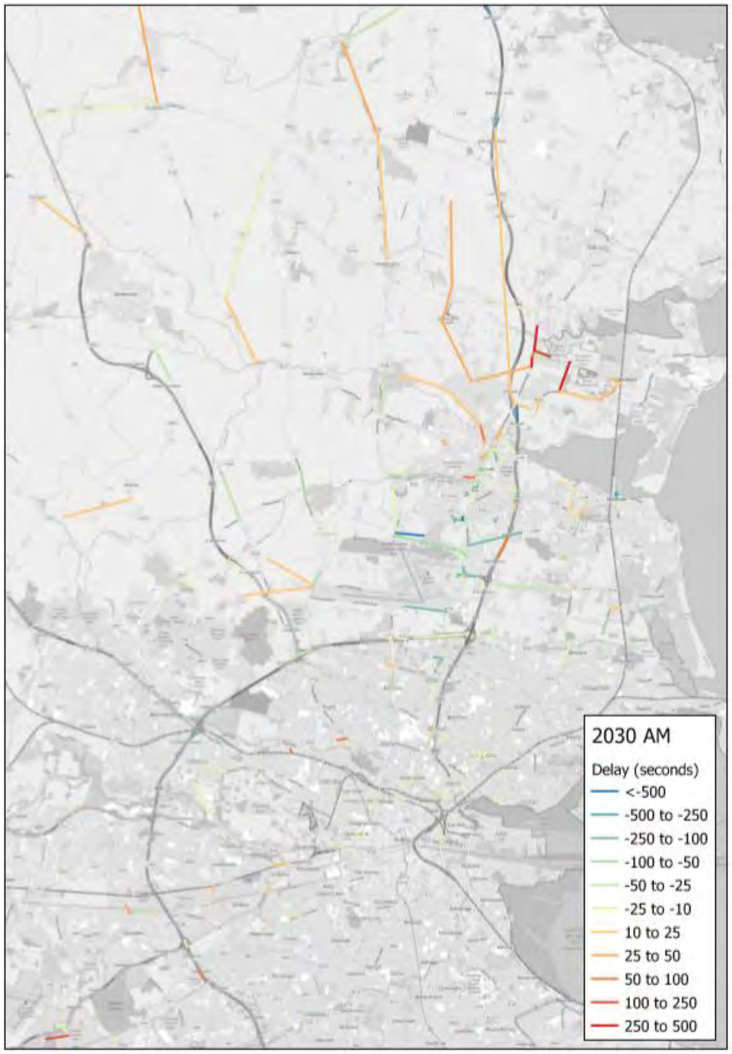


Figure 6-35 - Change in Delay in 2030 AM Peak Period DS

Figure 6-36 - Change in Delay in 2030 PM Peak Period DS

Figure 6-37: Change in Delay in 2045 AM Peak Period DS

Figure 6-38: Change in Delay in 2045 PM Peak Period DS

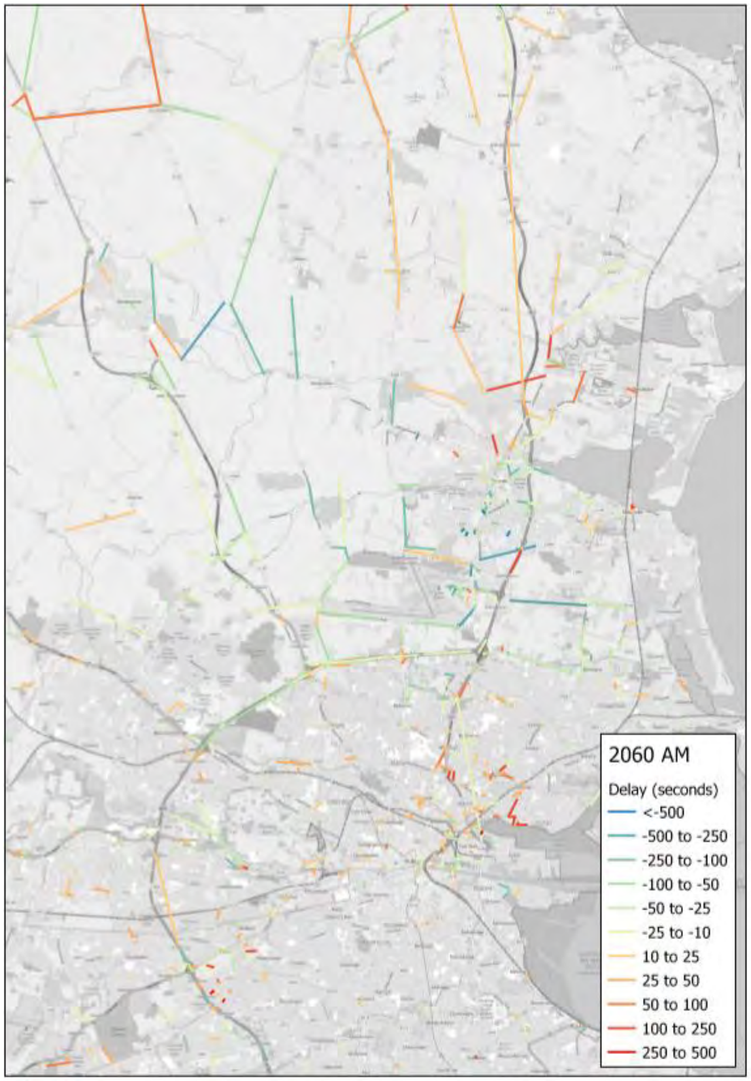


Figure 6-39: Changes in Delay in 2060 AM Peak Period DS

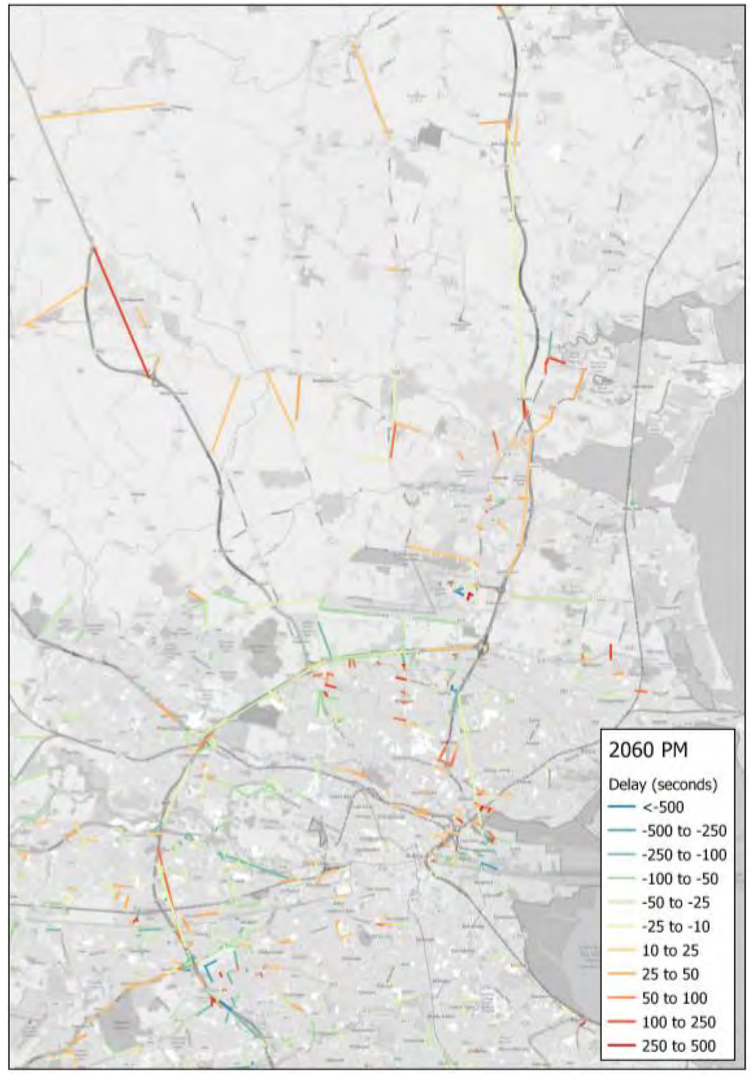


Figure 6-40: Changes in Delay in 2060 PM Peak Period DS

7. MetroLink Modelling Results: Sensitivity Analysis

7.1 Introduction

Five sets of Sensitivity Tests have been undertaken for the MetroLink appraisal. These are:

- Slow Growth;
- Low Frequency;
- Alternative Demand;
- Enhanced Transport Network: National Development Plan;
- Enhanced Transport Network: National Development Plan + Alternative Demand; and
- Enhanced Transport Network: NTA Greater Dublin Area Strategy.

Each of the above scenarios were assessed for the forecast years of 2030, 2045 and 2060, or in the cases of the Enhanced Transport Network two of these years, (exception of National Development Plan + Alternative Demand Scenario, which was assessed for all three years). These were then compared with the Business Case Core Run Do Something results for the corresponding year. The results are presented in this section. Model outputs for all time periods can be found in Appendix B.

7.2 Slow Growth

7.2.1 Description

The Slow Growth scenario has been undertaken to help understand the impact of population and jobs growth on the MetroLink scheme. The slower growth scenario assumes that growth in population and jobs follows the same pattern as the Business Case Core runs but happens at a slower pace, such that the difference increases as the forecast years get closer to 2060. The forecasts have been developed by taking a planning datasheet from an earlier year and using that for the forecast years, as summarized within Table 7-1.

Table 7-1:Slow Growth Forecast

Forecast Year	Planning Datasheet Year used for Slow Growth
2030	2028
2045	2040
2060	2052

Analysis of peak hour passenger loading and 12-hour total boarding and alighting model results are presented here, with more detailed results of boarding, alighting and load by period and direction provided in Appendix A.

7.2.2 Loading Profile

The loading results for the Slow Growth runs are summarised in Table 7-2. Line loading by station is presented in detail with charts for each peak period and direction. This section also compares the results with those from the corresponding Business Case (BC) Core runs.

Table 7-2: Maximum Loading in Peak Periods for Slow Growth runs

Direction	Year	Max Loading		Difference from Business Case	
		AM	PM	AM	PM
Northbound	2030	4,860	7,271	-3%	-5%
	2045	5,744	7,758	-7%	-6%
	2060	6,950	9,518	-16%	-14%
Southbound	2030	10,096	3,827	-3%	-4%
	2045	11,028	4,049	-6%	-12%
	2060	13,560	5,273	-9%	-19%

Figure 7-1 to Figure 7-4 show the load for each year across stations for each peak period and direction. In the Northbound AM peak, shown in Figure 7-1, the maximum load in 2030 is 4,860, which is 3% lower than the corresponding BC Core Run maximum load (5,024). For 2045 it is 5,744, which is 7% lower than in the BC Core Run (6,167). In 2060, the maximum load of 6,950 is 16% lower than the BC Core Run 2060 maximum load (8,243).

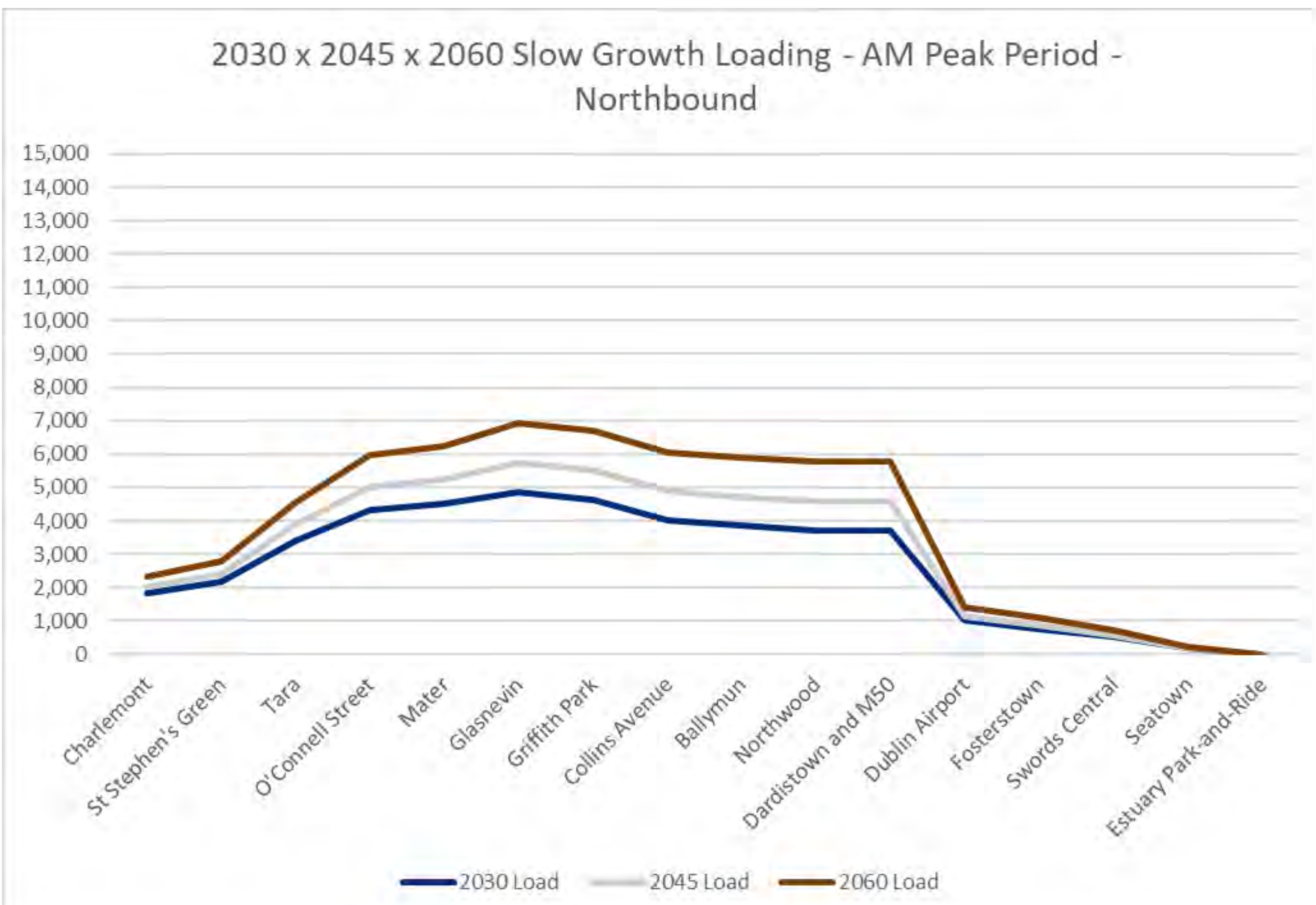


Figure 7-1: Slow Growth Sensitivity Test – AM Peak loading in Northbound direction

In the Southbound direction, loading results for the AM peak are shown in Figure 7-2. The 2030 maximum load here is 10,096, a 3% decrease from the BC Core Run (10,412). 2045 maximum loading is 11,028 which is 6% lower than in the BC Core Run (11,765). For 2060, the maximum load is 13,560, 9% lower than the BC Core Run (14,859).

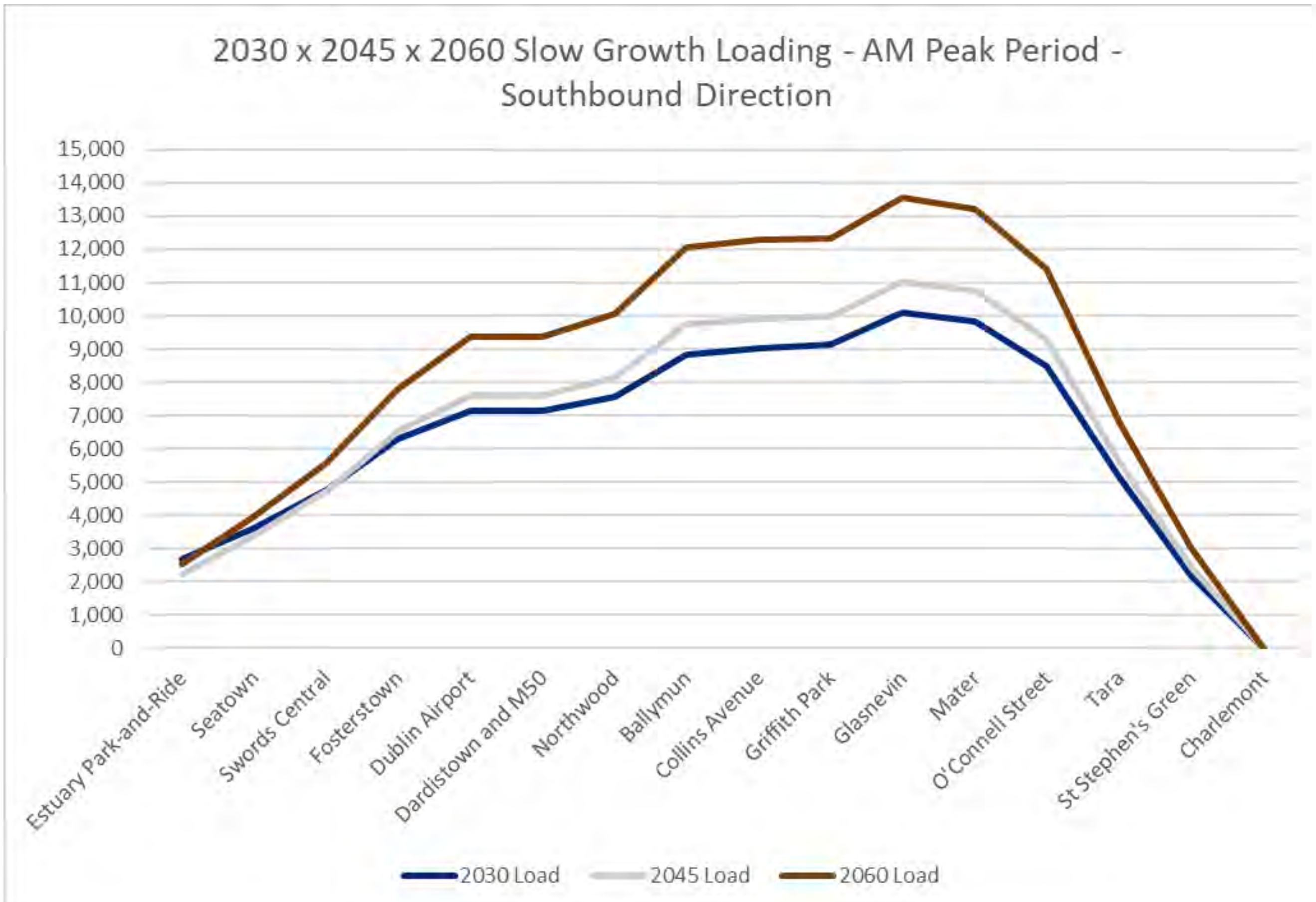


Figure 7-2: Slow Growth Sensitivity Test – AM Peak loading in Southbound direction

Figure 7-3 presents the PM peak loading in the Northbound direction. The 2030 Slow Growth maximum PM loading for this direction is 7,271. This is 5% lower than the BC Core Run value (7,616). The 2045 maximum load is 7,758, which is 6% lower than in the BC Core Run (8,280). The 2060 maximum load is again lower than the BC Core Run, at 9,518; 14% lower than the BC Core Run (11,006).

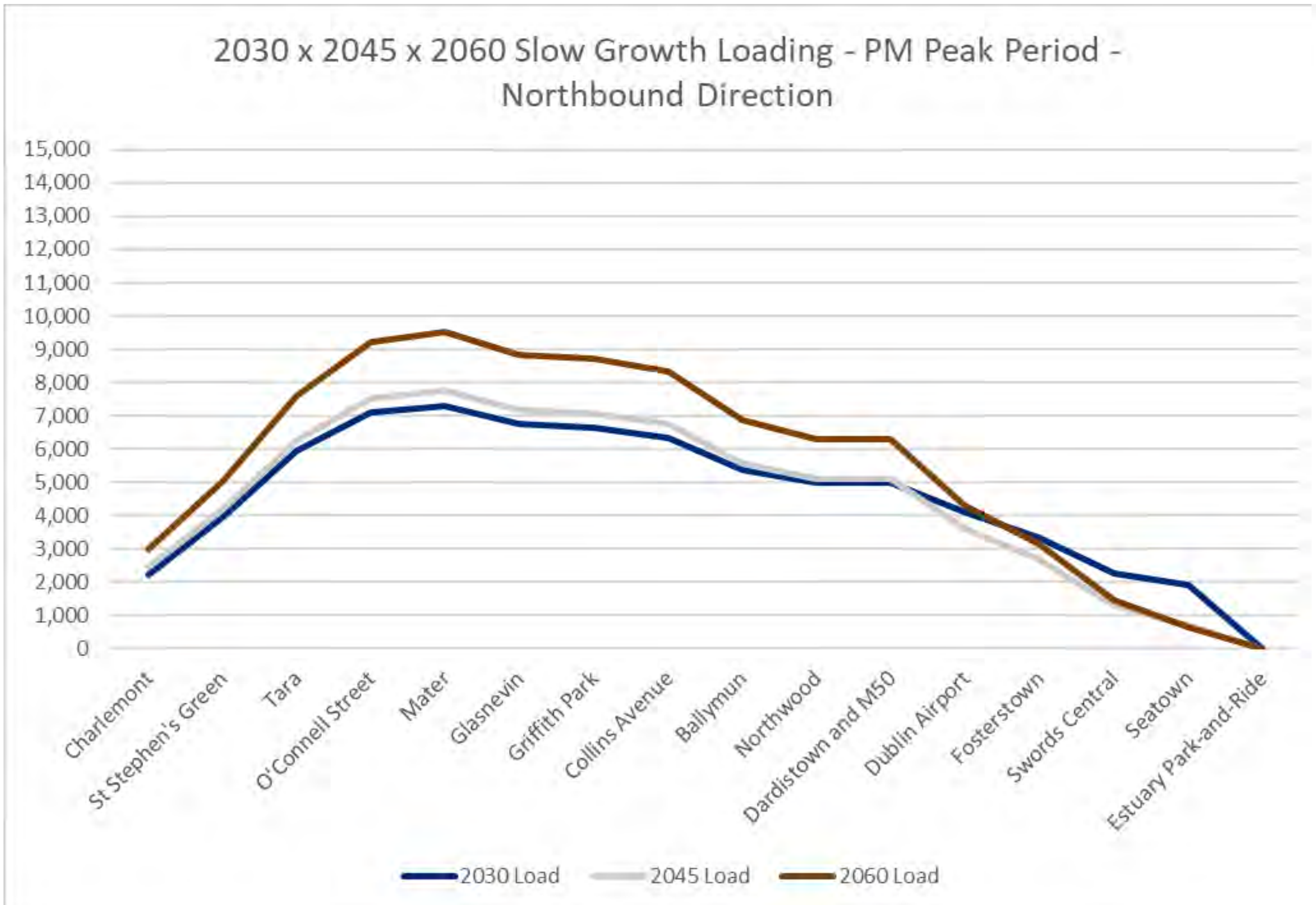


Figure 7-3: Slow Growth Sensitivity Test – PM Peak loading in Northbound direction

Figure 7-4 provides the PM peak loading results in the Southbound direction. In 2030, the maximum load is 3,827, which is 4% smaller than the BC Core Run (3,999). The 2045 maximum load is 4,049, 12% lower than the BC Core Run (4,619). In 2060 with a value of 5,273, the maximum load is 19% smaller than the Core BC Run (6,529).

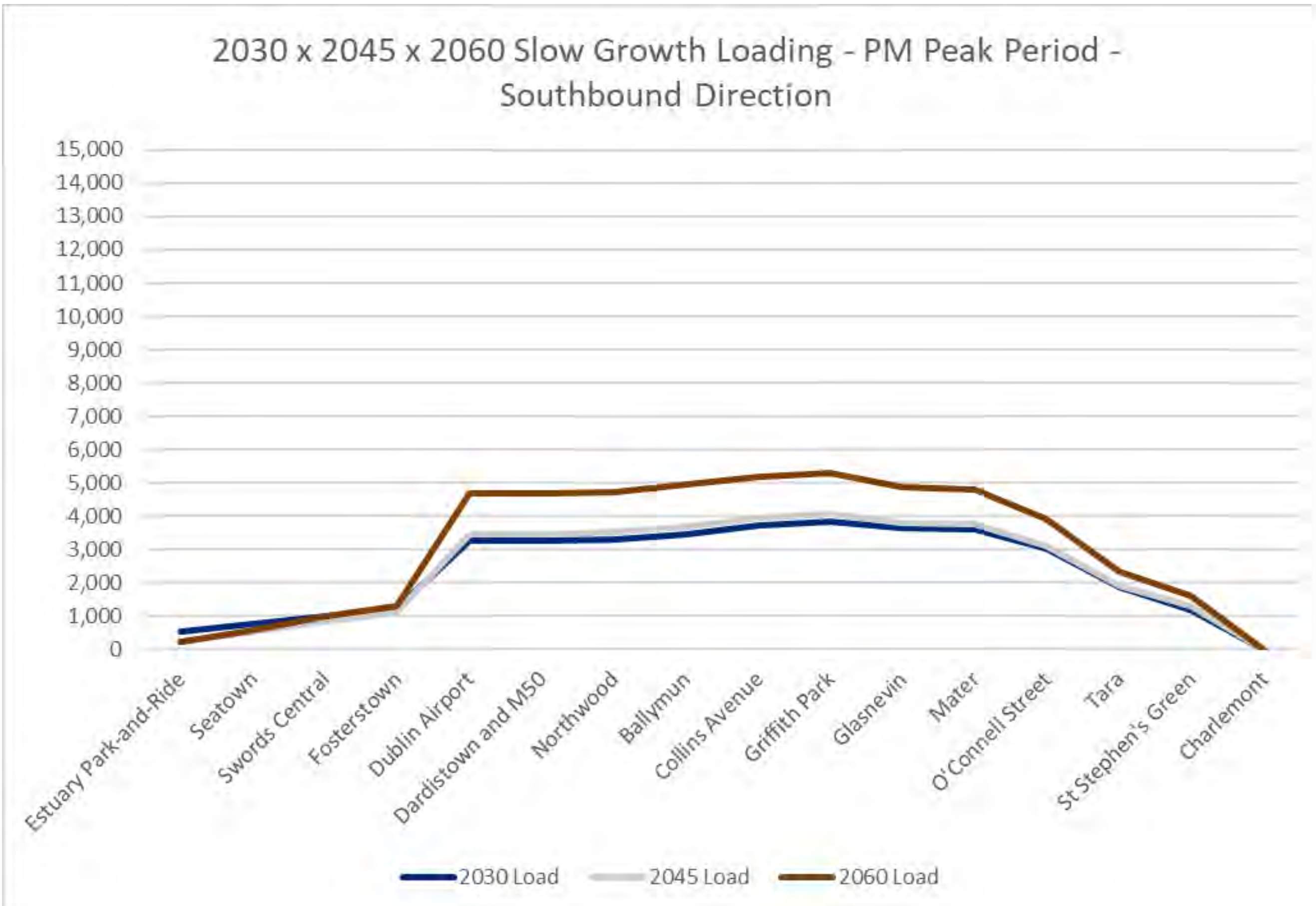


Figure 7-4: Slow Growth Sensitivity Test – PM Peak loading in southbound direction

7.2.3 Boarding and Alighting Numbers

The 12-hour boarding and alighting totals on the MetroLink line for the Slow Growth runs are shown in Figure 7-5. The boardings and alightings at each station generally increase across the modelled years. Total 12-hour boardings go from 123,396 in 2030 to 142,033 in 2045 (an increase of 15% between these years), then to 177,755 in 2060 (an increase of 25% between 2045 and 2060). Dublin Airport shows the largest increase in both boardings and alightings in 2060. The Estuary Park-and-Ride station is the only station showing a decrease in boardings and alightings across the years.

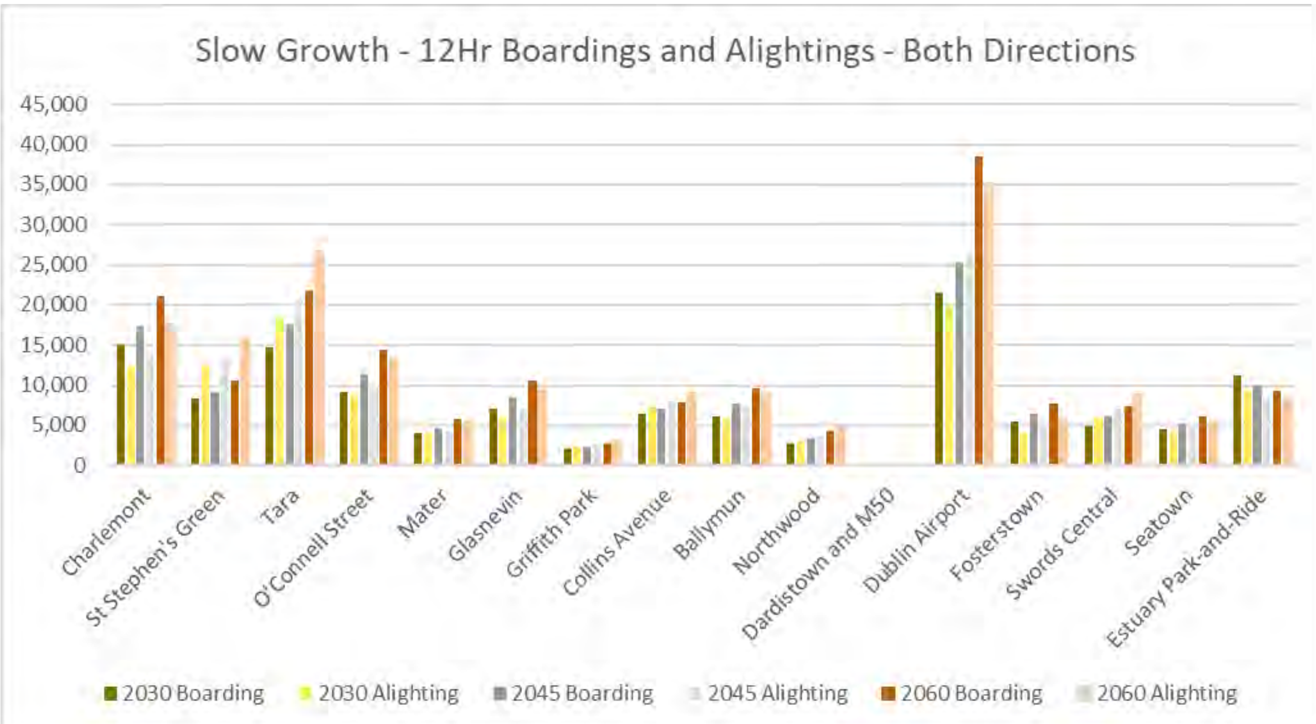


Figure 7-5: Slow Growth Sensitivity Test – 12hr Boardings and Alightings Both Directions

Slow Growth results for each year are provided in Table 7-4. The Slow Growth boardings and alightings at each station are compared with the BC Core run results in Figure 7-6 to Figure 7-8. “SG” in the charts refers to Slow Growth runs, and “BC Core” refers to the Business Case Core runs.

Table 7-3: 12-Hour Boarding and Alighting in Peak Periods for Slow Growth runs

Year	Boarding	Difference from Core BC
2030	123,396	-4%
2045	142,033	-9%
2060	177,755	-15%

Figure 7-6 shows a comparison of boarding and alighting totals for the 2030 Slow Growth run. The overall boardings are 4% less than the Business case boardings, with 123,396 boardings in the 2030 Slow Growth results compared to 128,182 boardings in the Business Case.

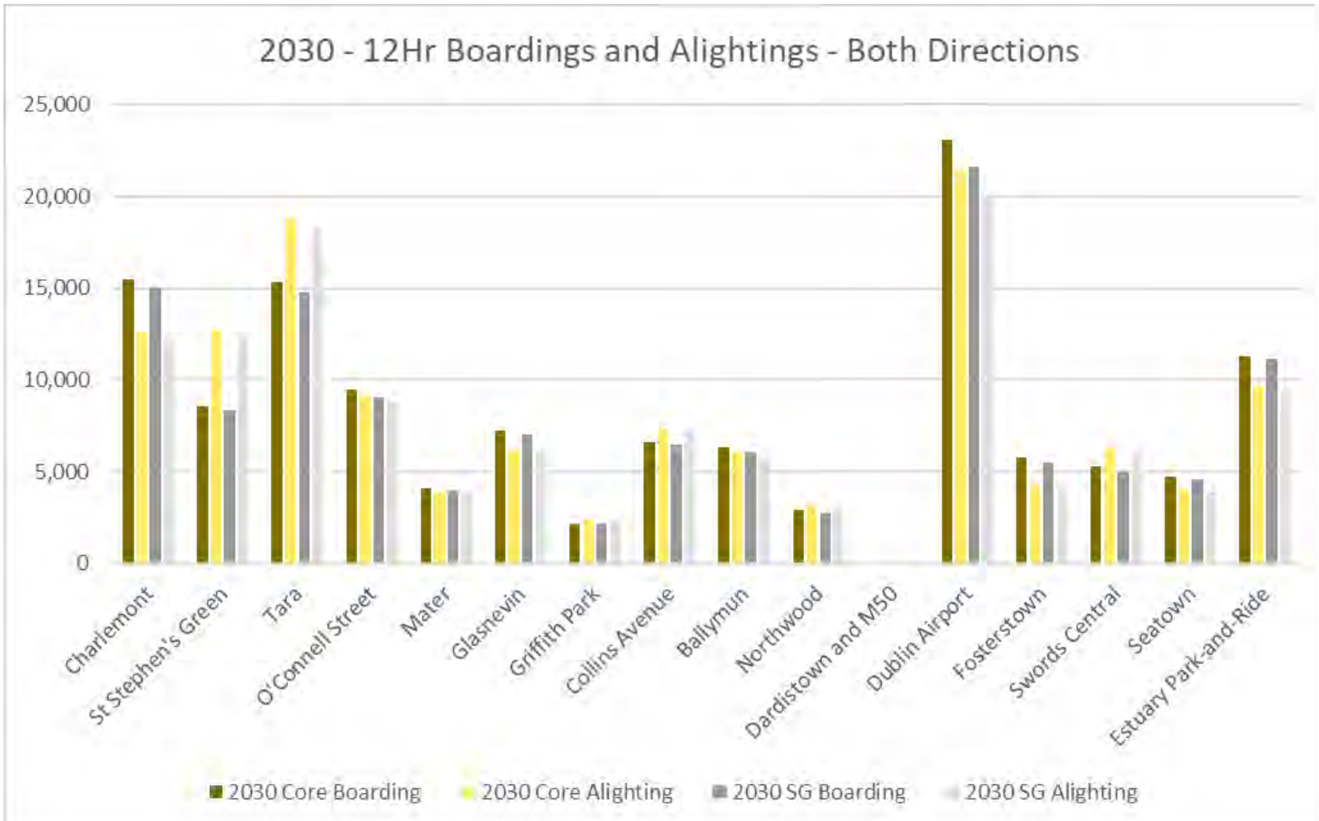


Figure 7-6: 2030 Slow Growth Sensitivity Test x Business Case Scenario – 12hr Boardings and Alightings Both Directions

In 2045, the 12-hour Slow Growth boarding and alighting are also lower than in the Business Case run, as shown in Figure 7-7. Overall, the 2045 Slow Growth run results showed 142,033 boardings. This is 9% less boardings than the Business Case 2045, which showed 156,091 boardings. The station with the largest difference is Dublin Airport. The 2045 Slow Growth run has 21% less boardings and 12% less alightings at Dublin Airport than the BC Core run.

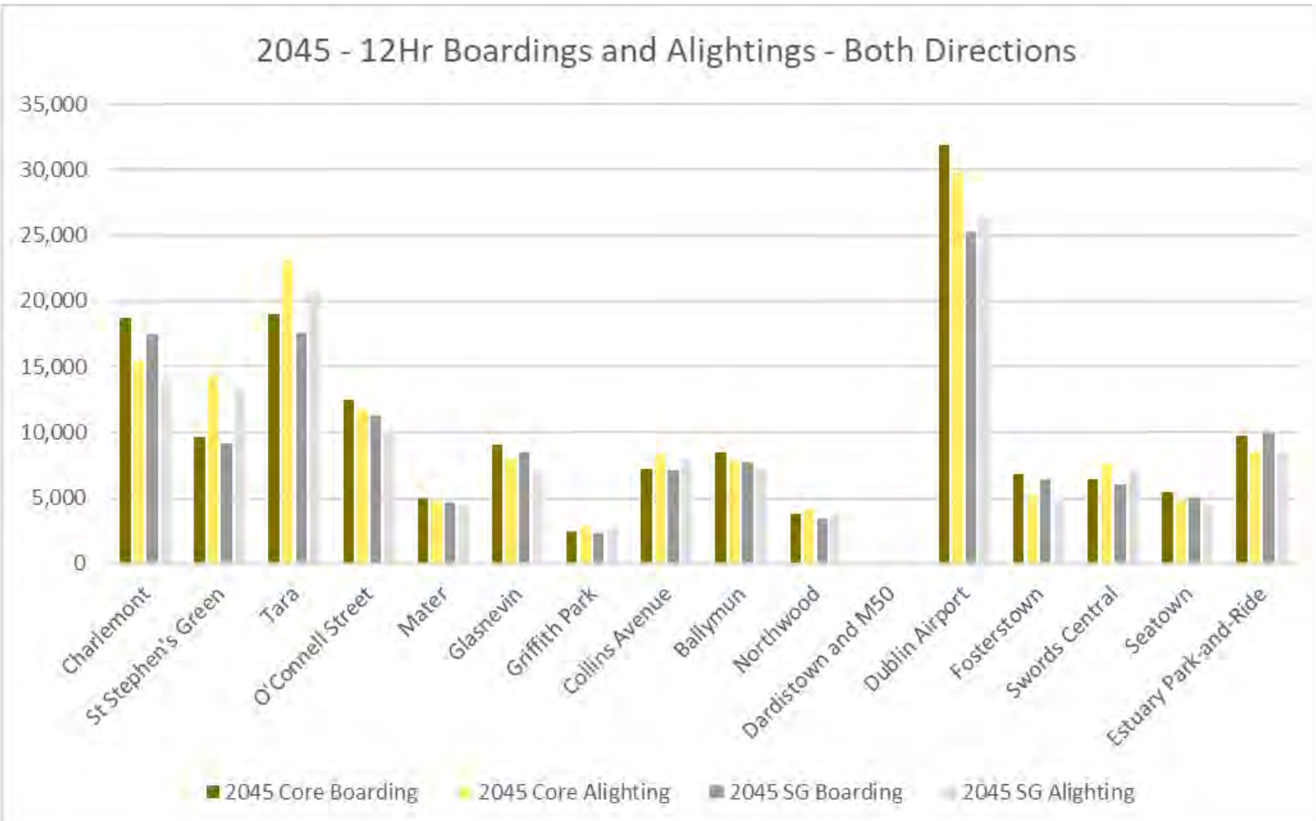


Figure 7-7: 2045 Slow Growth Sensitivity Test x Business Case scenario – 12hr Boardings and Alightings Both Directions

The 2060 Slow Growth results are shown in Figure 7-8. This Scenario has 15% less boardings and alightings than the BC Core run. The Estuary Park-and-Ride station shows the largest difference in 2060, with 29% less boardings and 30% less alightings in the Slow Growth than the BC Core run.

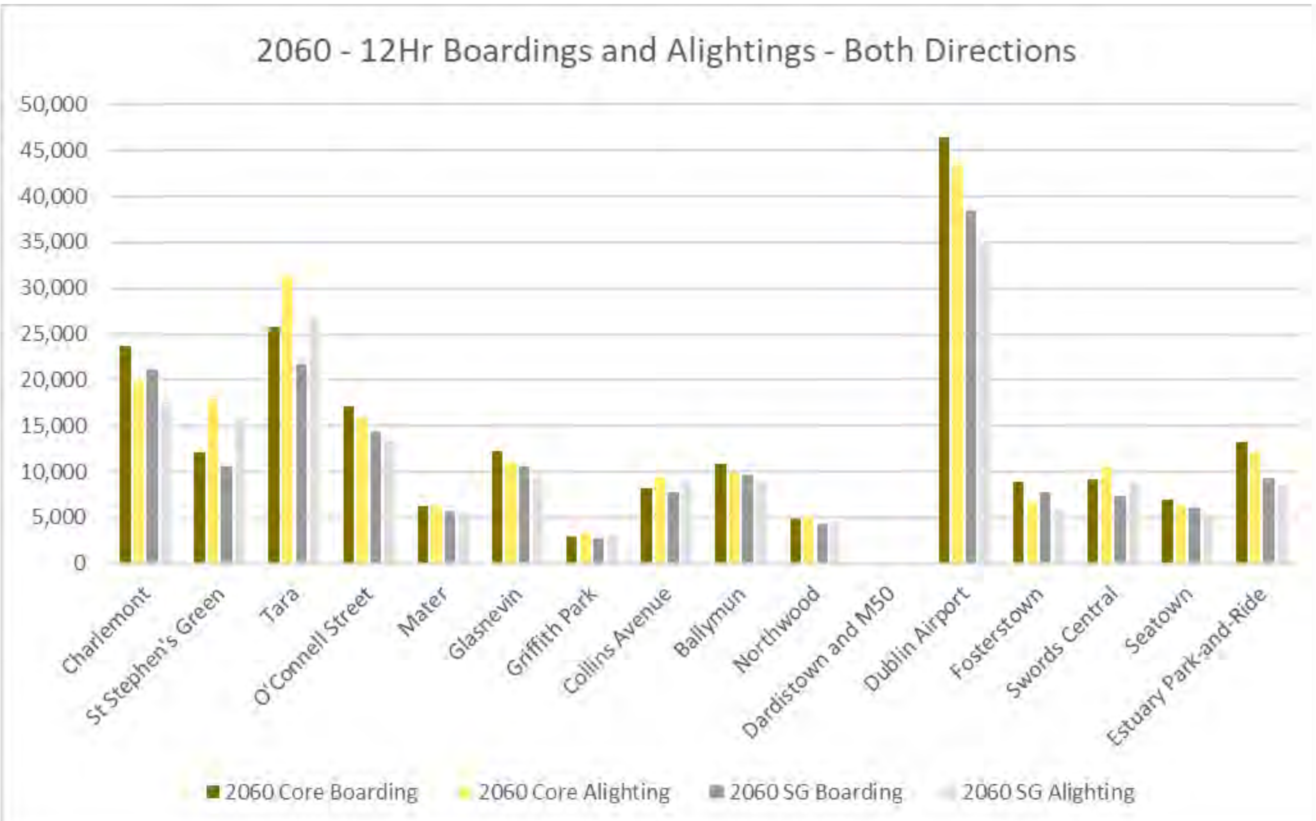


Figure 7-8: 2060 Slow Growth Sensitivity Test x Business Case scenario – 12hr Boardings and Alightings Both Directions

7.3 Low Frequency

7.3.1 Description

In the Low Frequency sensitivity test, the core population, job forecasts and travel patterns have been assumed to remain in place, but the frequency of trains on the MetroLink has been reduced. This sensitivity test has been undertaken to understand how the MetroLink may perform if it was operated with a lower frequency, i.e., with less trains.

Table 7-4 details the lower frequencies assessed in comparison with the Business Case runs.

Table 7-4: Headways in the Low Frequency Sensitivity Test

Forecast Year	Business Case Core Run Headways	Low Frequency Headways
2030	All Periods: 2 minutes	All Periods: 5 minutes
2045	All Periods: 2 minutes	All Periods: 3.5 minutes
2060	All Periods: 1.5 minutes	All Periods: 3 minutes

7.3.2 Loading Profile

The loading results for the Low Frequency runs are summarised in Table 7-5. Line loading by station is presented in detail with charts for each peak period and direction. This section also compares the results with those from the corresponding Business Case (BC) Core runs.

Table 7-5: Maximum Loading in Peak Periods for Low Frequency runs

Direction	Year	Max Loading		Difference from Business Case	
		AM	PM	AM	PM
Northbound	2030	4,427	6,204	-12%	-19%
	2045	5,809	7,617	-6%	-8%
	2060	7,429	9,615	-10%	-13%
Southbound	2030	8,723	3,387	-16%	-15%
	2045	10,760	4,354	-9%	-6%
	2060	13,581	5,674	-9%	-13%

The load for each year across stations for each peak period and direction is shown in Figure 7-9 to Figure 7-12.

Figure 7-9 shows the Northbound AM peak loading. The maximum load in 2030 is 4,427, which is 12% lower than the corresponding BC Core Run maximum load (5,024). For 2045 it is 5,809, which is 6% lower than in the BC Core Run (6,167). In 2060, the maximum load is 7,429, 10% lower than the BC Core Run 2060 maximum load (8,243).

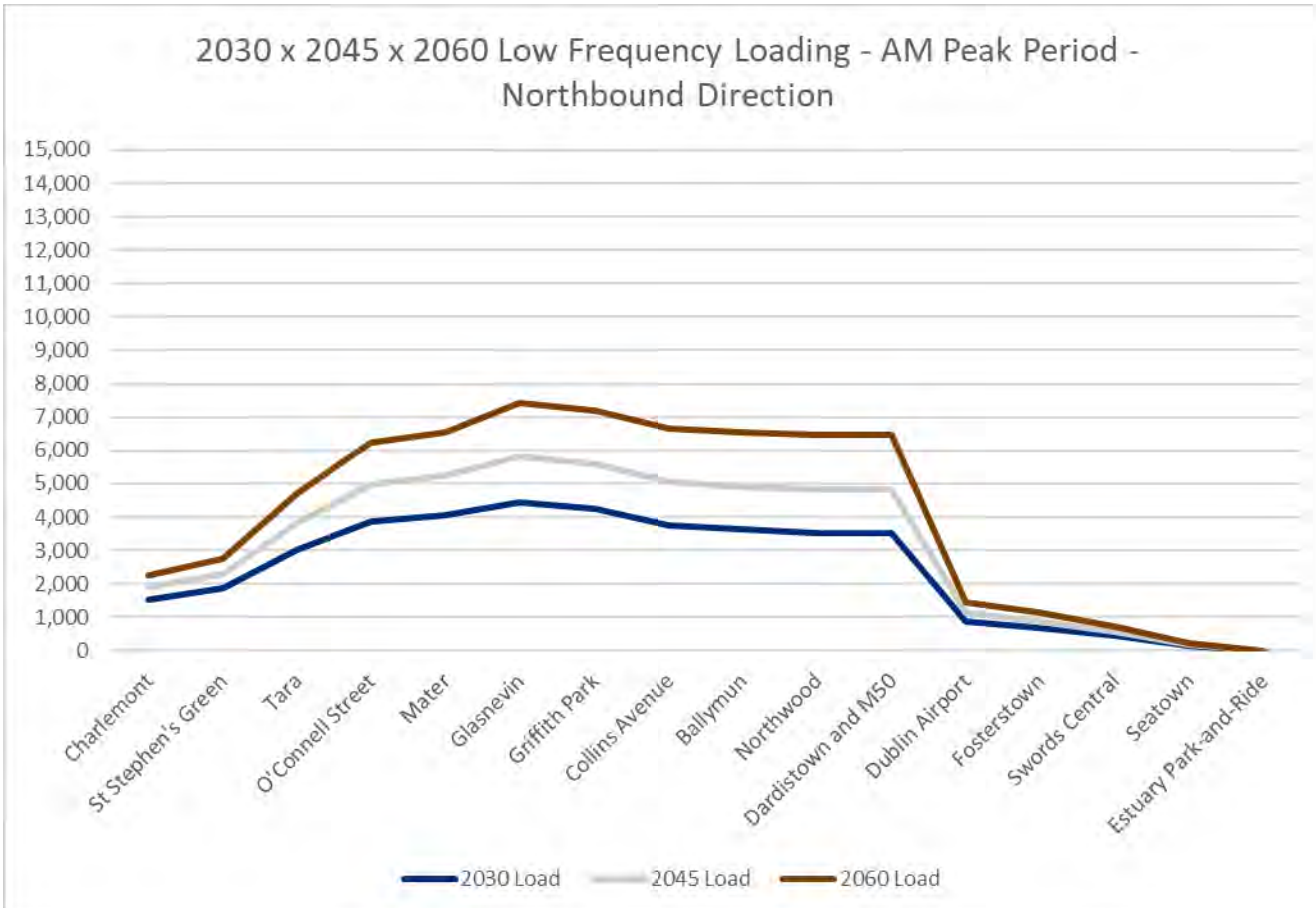


Figure 7-9: Low Frequency Sensitivity Test – AM Peak loading in Northbound direction

Figure 7-10 presents the AM peak loading in the Southbound direction. The 2030 Slow Growth maximum PM loading for this direction is 8,723. This is 16% lower than the BC Core Run value (10,412). The 2045 maximum load is 10,760, which is 9% lower than in the BC Core Run (11,765). The 2060 maximum load is again lower than the BC Core Run, at 13,581; 9% lower than the BC Core Run (14,859).

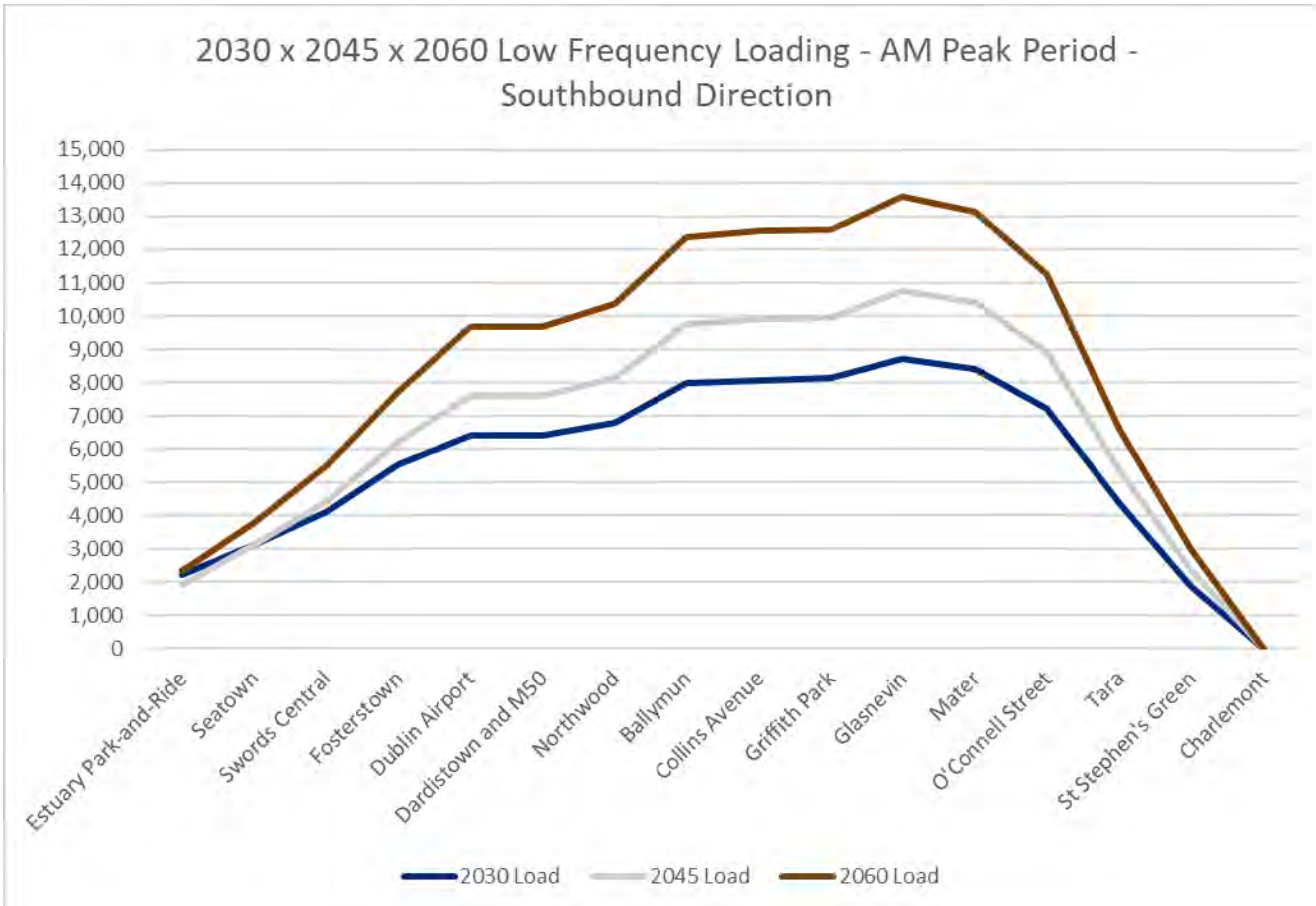


Figure 7-10: Low Frequency Sensitivity Test – AM Peak loading in Southbound direction

Loading results for the PM peak travelling Northbound are shown in Figure 7-11. In 2030, the maximum load is 6,204, which is 19% lower than the BC Core Run (7,616). The 2045 maximum load is 7,617, 8% smaller than the BC Core Run (8,280). In 2060 with a value of 9,615, the maximum load is 13% smaller than the Core BC Run (11,006).

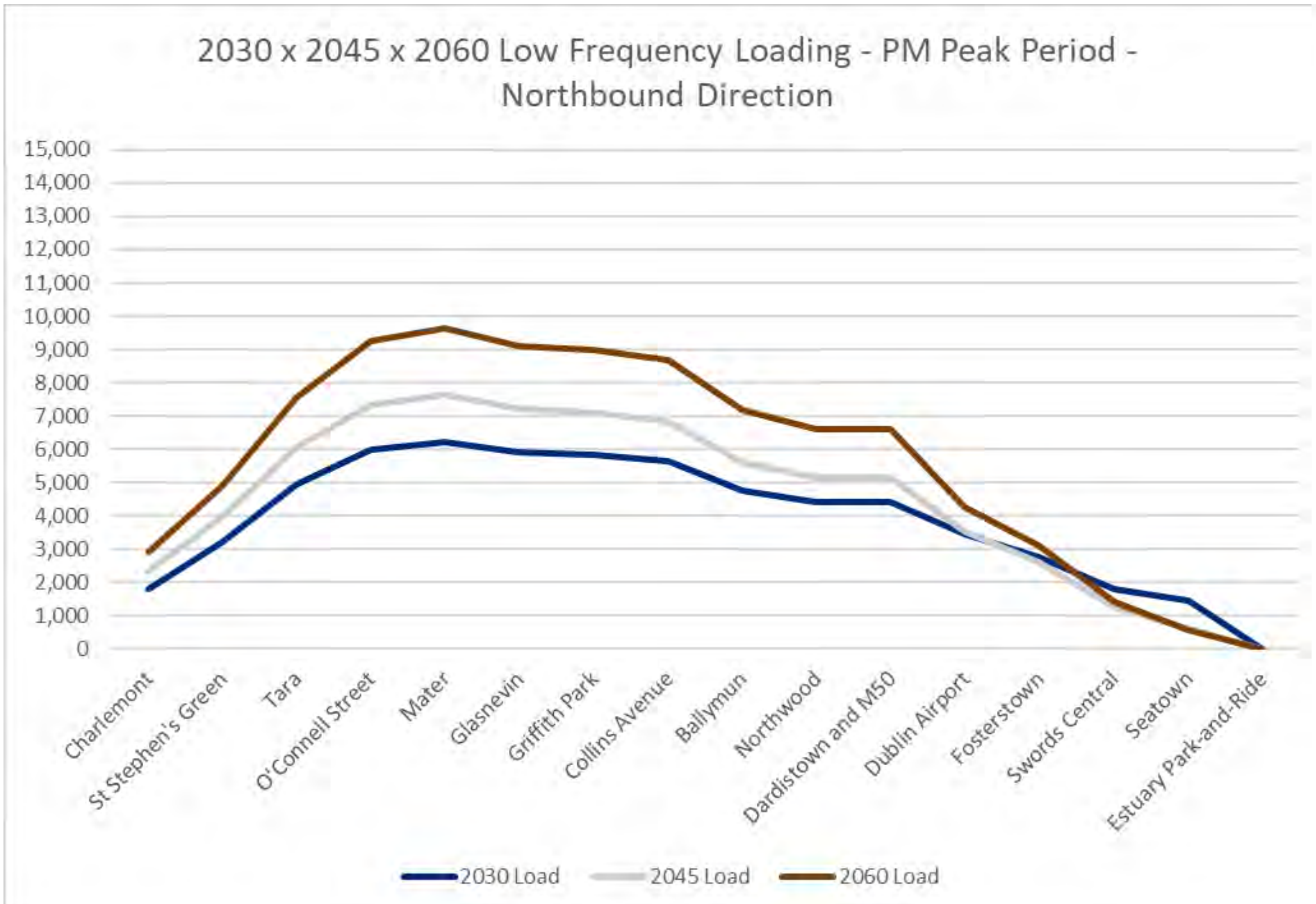


Figure 7-11: Low Frequency Sensitivity Test – PM Peak loading in Northbound direction

Figure 7-12 provides the PM peak loading results in the Southbound direction. The 2030 maximum load here is 3,387, a decrease of 15% from the BC Core Run (3,999). 2045 maximum loading is 4,354 which is 6% lower than the BC Core Run (4,619). For 2060, the maximum load is 5,674, 13% lower than in the BC Core Run (6,529).

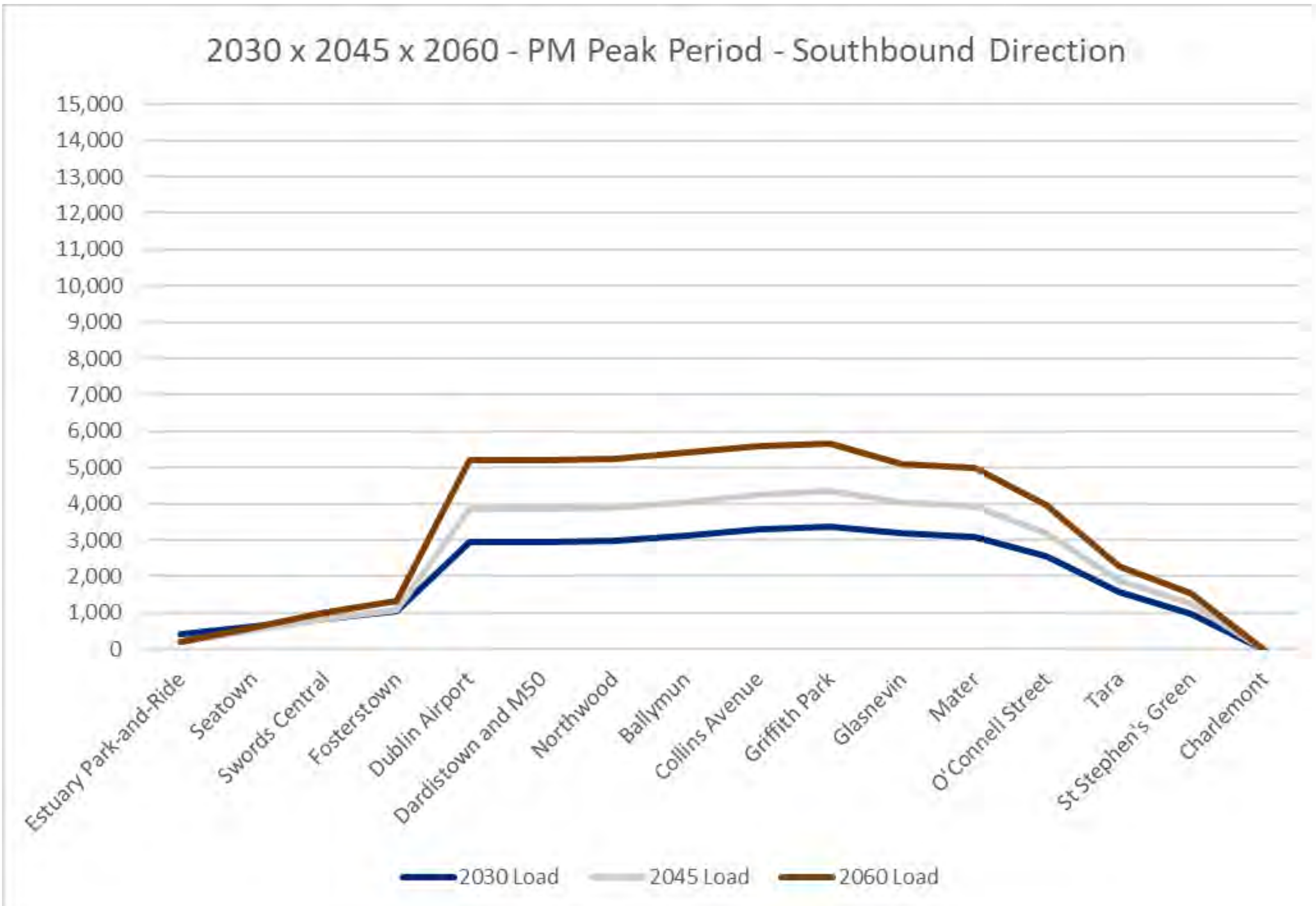


Figure 7-12: Low Frequency Sensitivity Test – PM Peak loading in Southbound direction

7.3.3 Boarding and Alighting Numbers

The 12-hour boarding and alighting totals on the MetroLink line, as modelled in the three Low Frequency runs, are shown in Figure 7-13. Total 12-hour boardings are 108,160 in 2030, rising to 143,539 in 2045 (an increase of 32.7%), then to 184,696 in 2060 (an increase of (28.7%). Boardings and alightings at each station generally increase across the modelled years, apart from the Estuary Park-and-Ride station, for which usage decreases in 2045 then increases again slightly in 2060. The Dublin Airport station shows the steepest absolute increase across the three years. Low Frequency run results for each year are compared with the Business Case run results in this section.

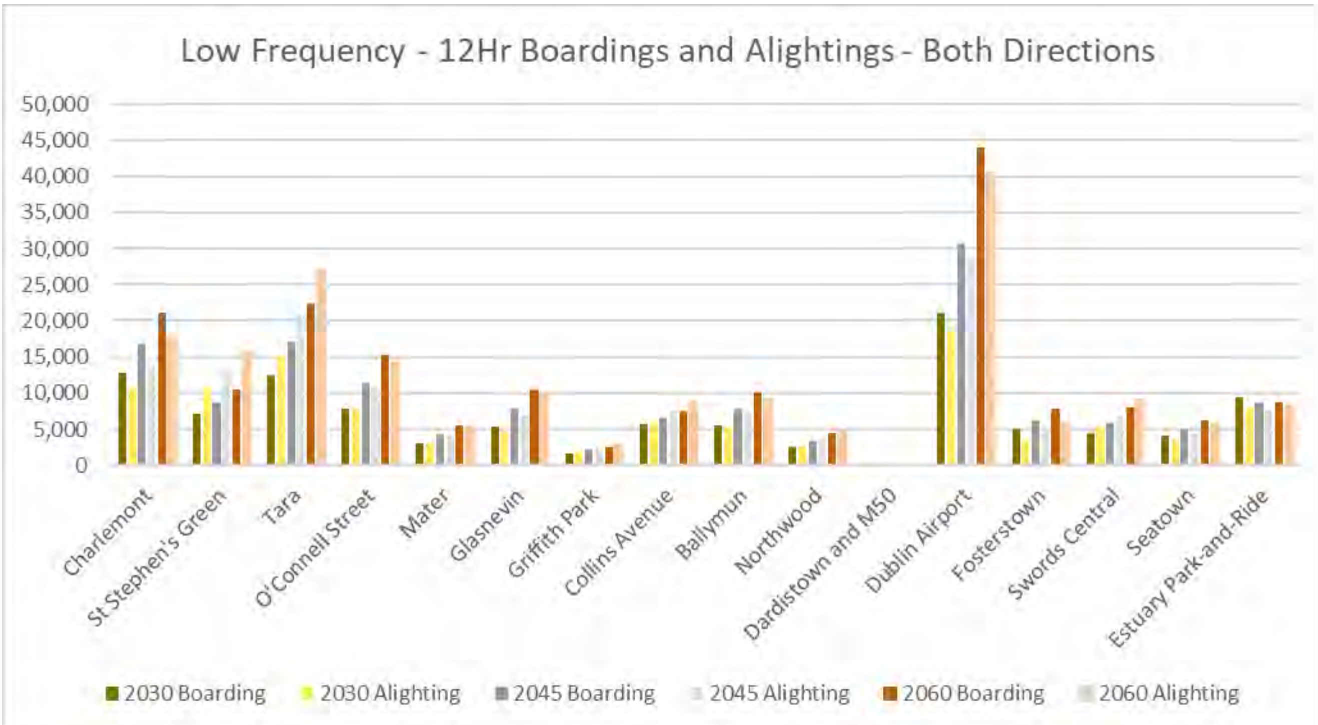


Figure 7-13: Low Frequency Sensitivity Test – 12hr Boardings and Alightings Both Directions

Table 7-6 shows Low Frequency 12-hour boarding results for each year. The Low Frequency results at each station are compared with the BC Core run results in Figure 7-14 to Figure 7-16. “LF” in the charts refers to Low Frequency runs, and “BC Core” refers to the Business Case Core runs.

Table 7-6: 12-Hour Boarding and Alighting in Peak Periods for Low Frequency runs

Year	Boarding	Difference from Core BC
2030	108,160	-16%
2045	143,539	-8%
2060	184,696	-12%

Figure 7-14 shows a comparison of 12-hour boarding and alighting totals for the 2030 Low Frequency run, alongside the Business Case run results. In this Low Frequency run, boardings and alightings are 16% lower than those in the Business Case run. There are 108,160 boardings and alightings in the 2030 Low Frequency results compared to 128,182 boardings and alightings in the Business Case. The Glasnevin station shows the largest difference between the runs, with 25% less boardings and 26% less alightings in the Low Frequency than the BC Core run. At Mater, there are 24% less boardings and 23% less alightings in the Low Frequency than the BC Core run.

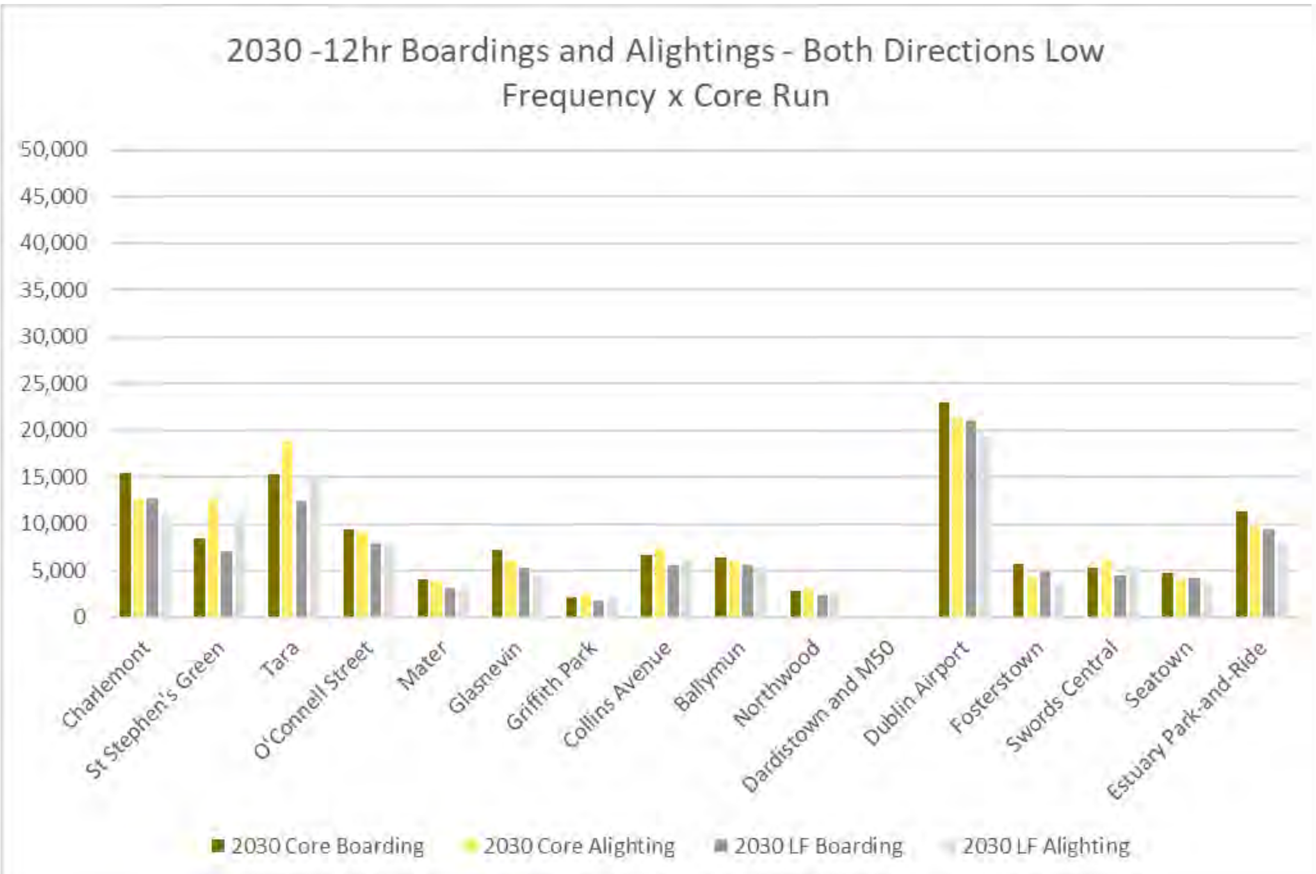


Figure 7-14: 2030 Low Frequency Sensitivity Test x Business Case Scenario – 12hr Boardings and Alightings Both Directions

In 2045, shown in Figure 7-15, the 12-hour Low Frequency boarding and alighting are 8% lower than in the Business Case run. Overall, the 2045 Low Frequency run results showed 143,539 boardings, compared to the BC Core Run which showed 156,091.

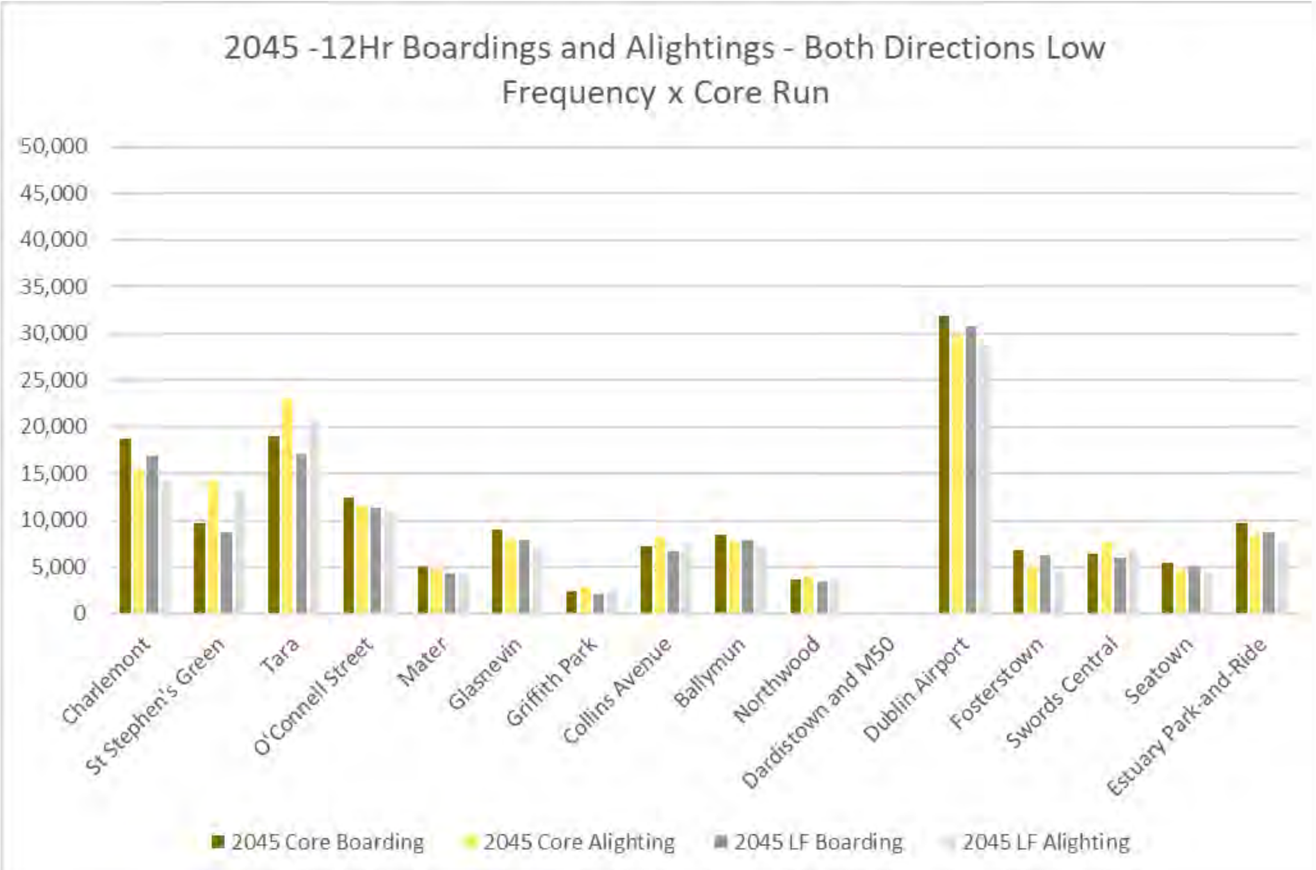


Figure 7-15: 2045 Low Frequency Sensitivity Test x Business Case Scenario – 12hr Boardings and Aligtings Both Directions

The 2060 Low Frequency results are shown in Figure 7-16. This Scenario has 12% less boardings and alightings than the BC Core Run. There are 184,696 boardings and alightings in the 2060 Low Frequency run and 208,815 in the BC Core Run. At the Estuary Park-and-Ride station, the Low Frequency run shows 33% less boardings and 32% less alightings than the BC Core Run.

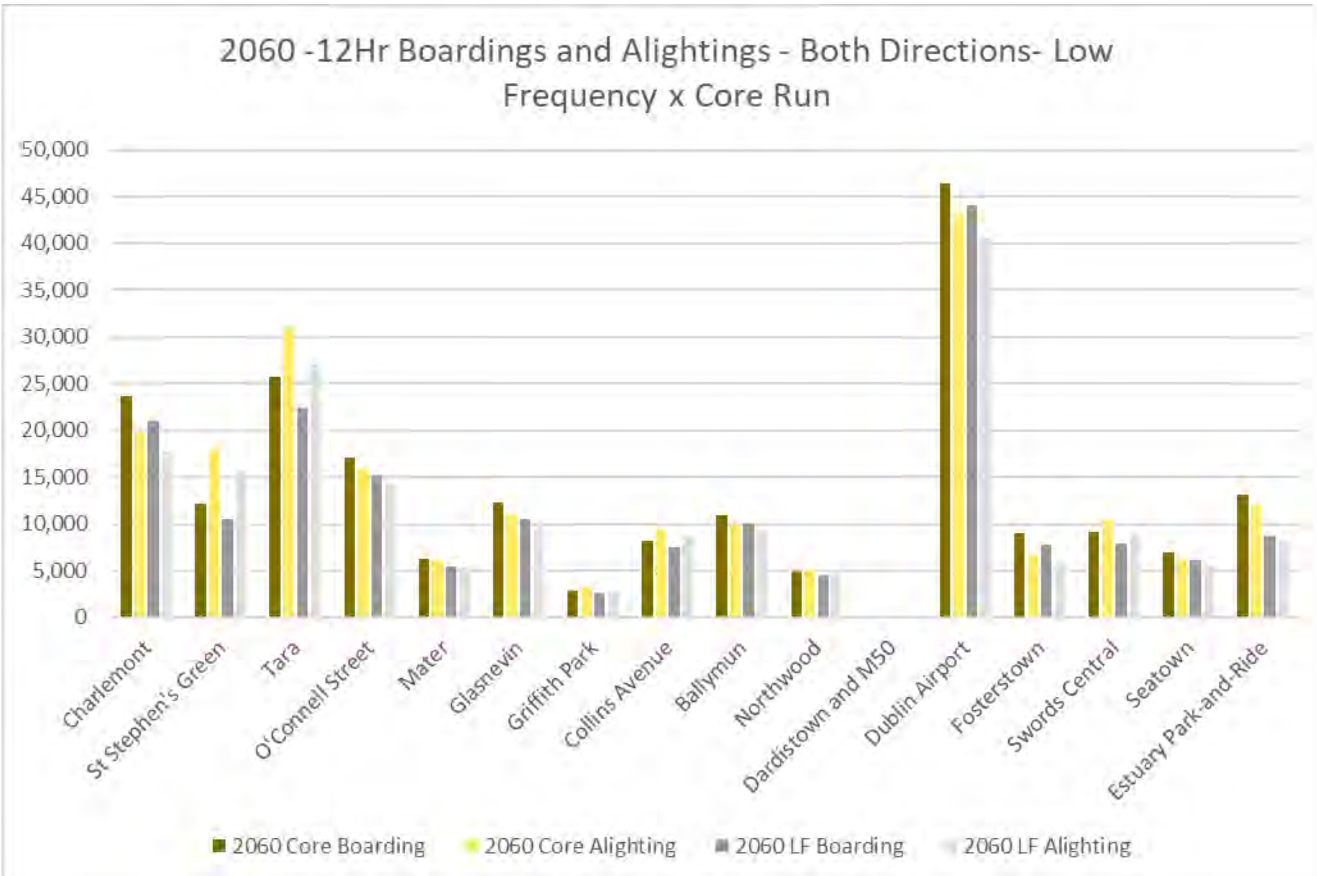


Figure 7-16: 2060 Low Frequency Sensitivity Test x Business Case Scenario – 12hr Boardings and Alightings Both Directions

7.4 Alternative Demand

7.4.1 Description

This Alternative Demand scenario has been developed by the NTA to consider the impact that the Covid-19 pandemic may have on future trip patterns, including a reduction in some types of Commute to Work and Education trips. The Alternative Demand has been assessed for a 2030, 2045 and a 2060 forecast scenario.

An explanatory note has been prepared by the NTA, *Alternative Future Scenario for Travel Demand*. The Alternative Demand scenario represents a reduction of approximately 8% in the total number of trips on the transport network. The adjustments made to trip rates for different user classes as part of this scenario are listed in Table 7-7.

Table 7-7: Alternative Demand Scenario: Adjustments to trip rates provided by NTA

User Class	Adjustment to Trip Rates
Commute to Work	No change to Blue-Collar Worker trip rates 25% reduction in White-Collar Worker trip rates
Journeys to Education (Including Escorted)	No change to Primary Education trip rates 10% reduction in Secondary Education trip rates 25% reduction in Tertiary Education trip rates
Shopping - Food	10% increase
Shopping – Non-Food	20% reduction
Leisure and Social	10% increase
Business Trips (White-Collar)	20% reduction
Goods and Freight	No change
Airport	20% reduction in business travel No change to leisure travel

Figure 7-17, an extract from the NTA report, shows the total number of trips per day for the Alternative Demand scenario compares to the reference case forecasts and a typical slower growth scenario.

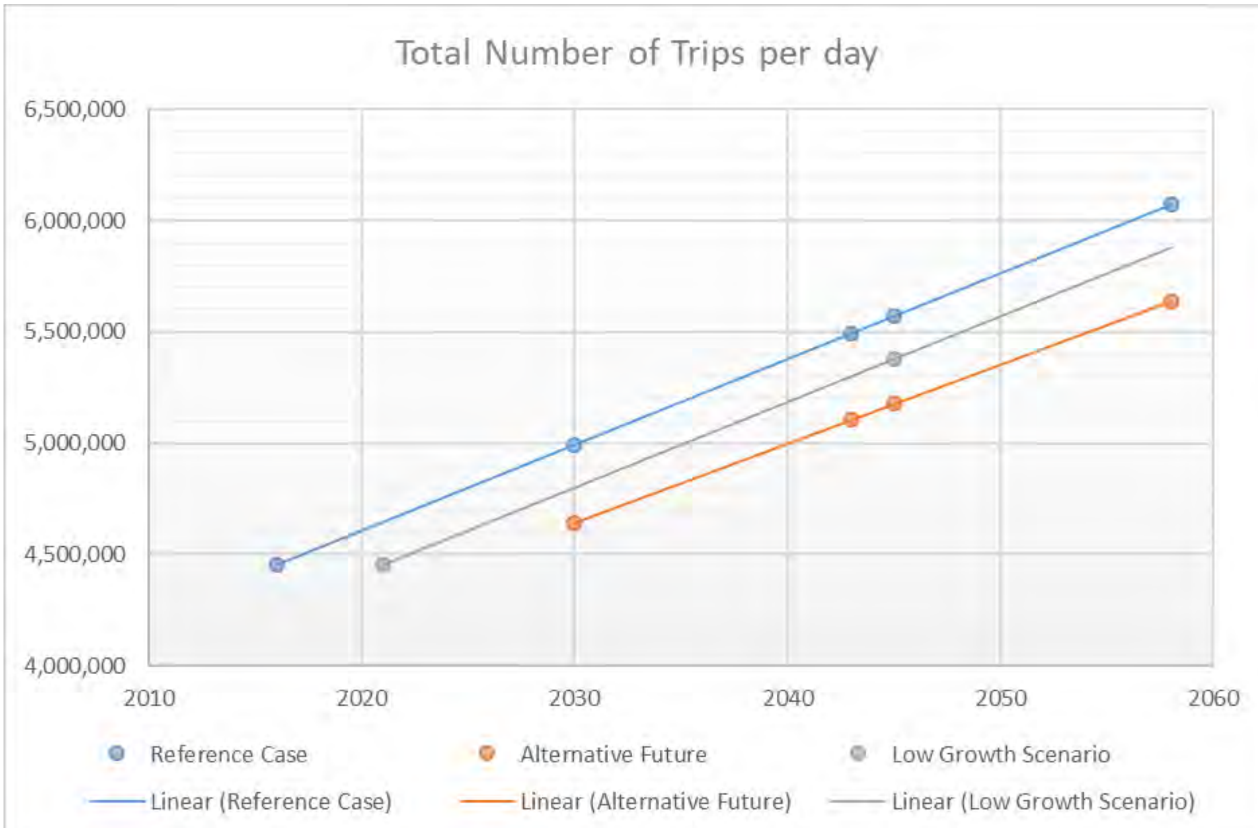


Figure 7-17: Trips per day for Reference Case, Alternative Demand and Slow Growth scenario (source NTA)

7.4.2 Loading Profile

The loading results for the Alternative Demand runs are summarised in Table 7-8. Line loading by station is presented in detail with charts for each peak period and direction. In this section, results are also compared with those from the corresponding Business Case (BC) Core runs.

Table 7-8: Maximum Loading in Peak Periods for Alternative Demand runs

Direction	Year	Max Loading		Difference from Business Case	
		AM	PM	AM	PM
Northbound	2030	4,582	6,169	-9%	-19%
	2045	5,797	7,764	-6%	-6%
	2060	6,958	8,647	-16%	-21%
Southbound	2030	8,573	3,501	-18%	-12%
	2045	10,450	4,645	-11%	1%
	2060	12,123	5,345	-18%	-18%

Figure 7-18 to Figure 7-21 show the load for each year across stations for each peak period and direction. In the Northbound AM peak, shown in Figure 7-18, the maximum load in 2030 is 4,582, which is 9% lower than the corresponding BC Core Run maximum load (5,024). For 2045 it is 5,797, which is 6% lower than in the BC Core Run (6,167). In 2060, the maximum load of 6,958 is 16% lower than the BC Core Run 2060 maximum load (8,243).

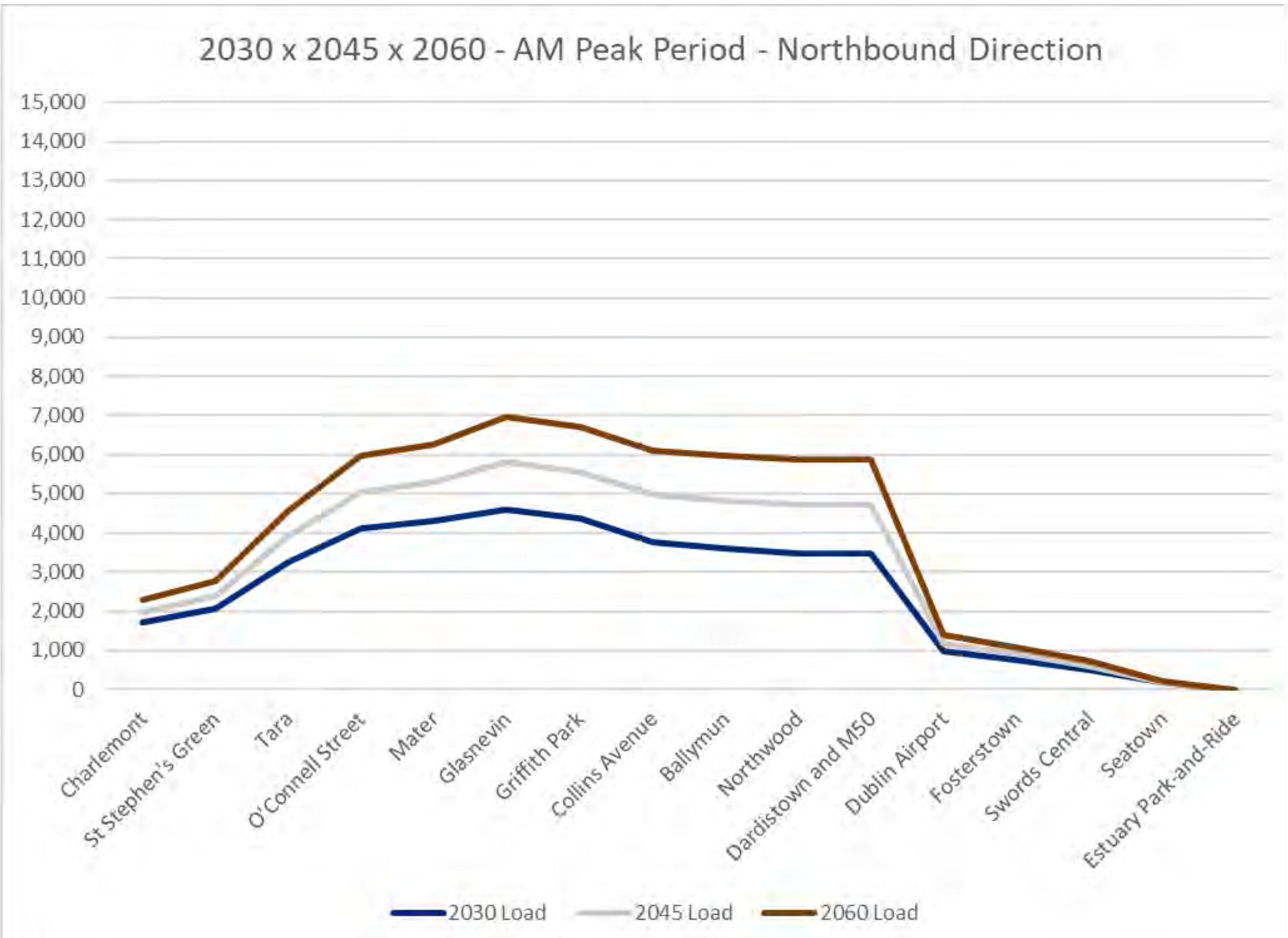


Figure 7-18: Alternative Demand Sensitivity Test – AM Peak loading in Northbound direction

Loading results for the AM peak in the Southbound direction are shown in Figure 7-19. The 2030 maximum load here is 8,573, a 18% decrease from the BC Core Run (10,412). 2045 maximum loading is 10,450 which is 11% lower than in the BC Core Run (11,765). For 2060, the maximum load is 12,123, 18% lower than the BC Core Run (14,859).

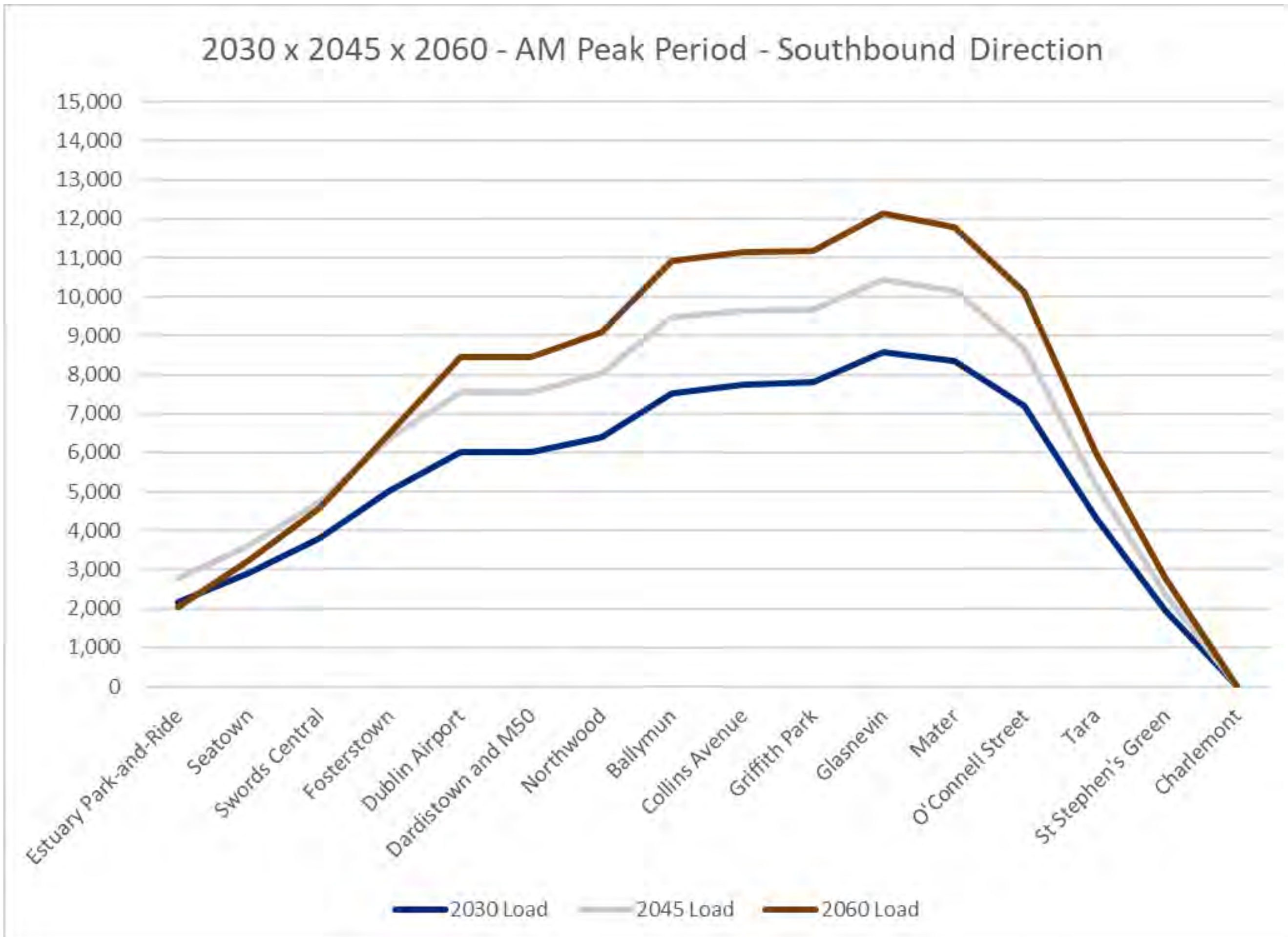


Figure 7-19: Alternative Demand Sensitivity Test – AM Peak loading in Southbound direction

Figure 7-20 presents the PM peak loading in the Northbound direction. The 2030 Alternative Demand maximum PM loading for this direction is 6,169. This is 19% lower than the BC Core Run value (7,616). The 2045 maximum load is 7,764, which is 6% lower than in the BC Core Run (8,280). The 2060 maximum load is again lower than the BC Core Run, at 8,647; 21% lower than the BC Core Run (11,006).

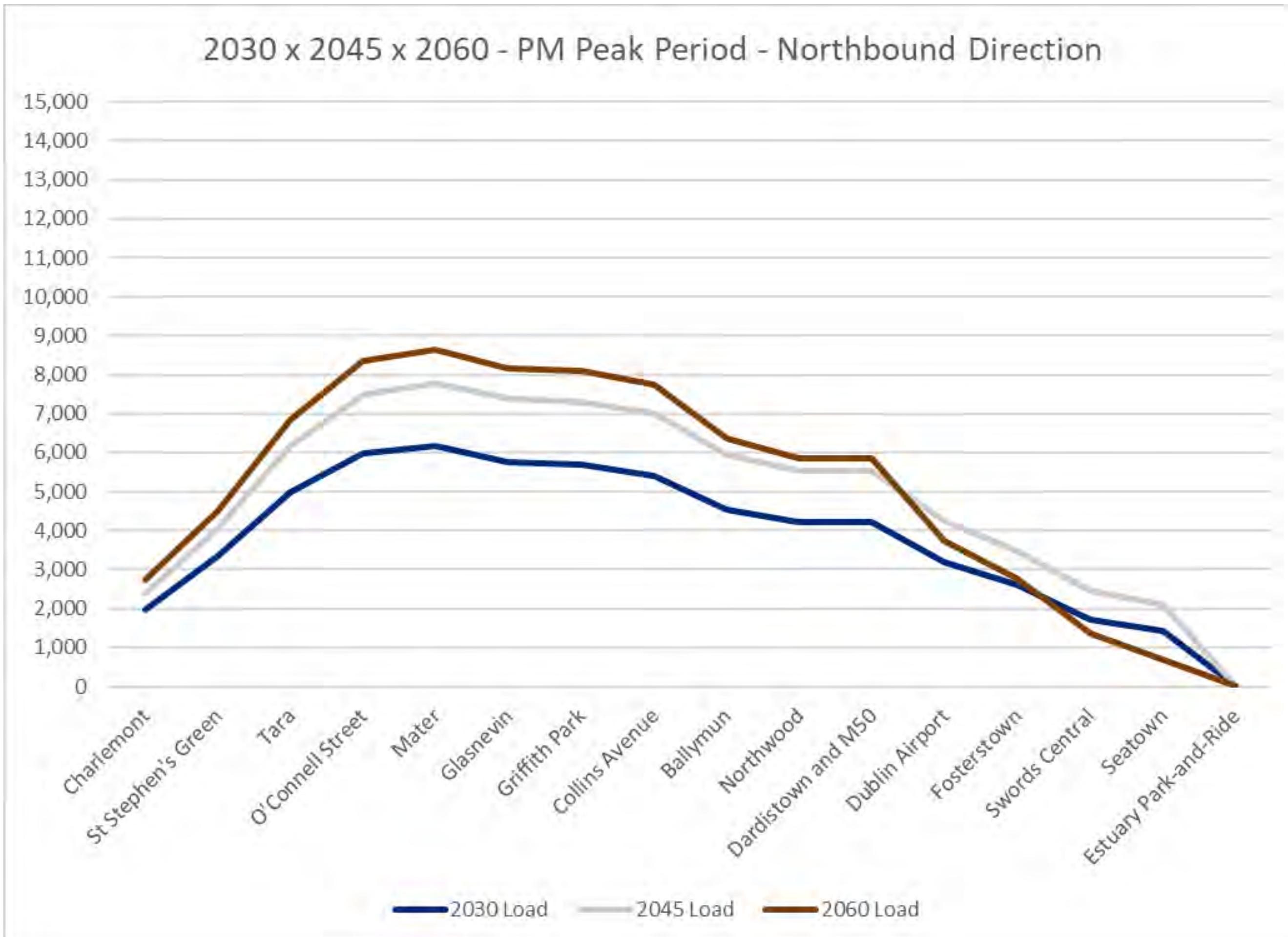


Figure 7-20: Alternative Demand Sensitivity Test – PM Peak loading in Northbound direction

Figure 7-21 provides the PM peak loading results in the Southbound direction. In 2030, the maximum load is 3,501, which is 12% smaller than the BC Core Run (3,999). The 2045 maximum load is 4,645, 1% lower than the BC Core Run (4,619). In 2060 with a value of 5,245, the maximum load is 18% smaller than the Core BC Run (6,529).

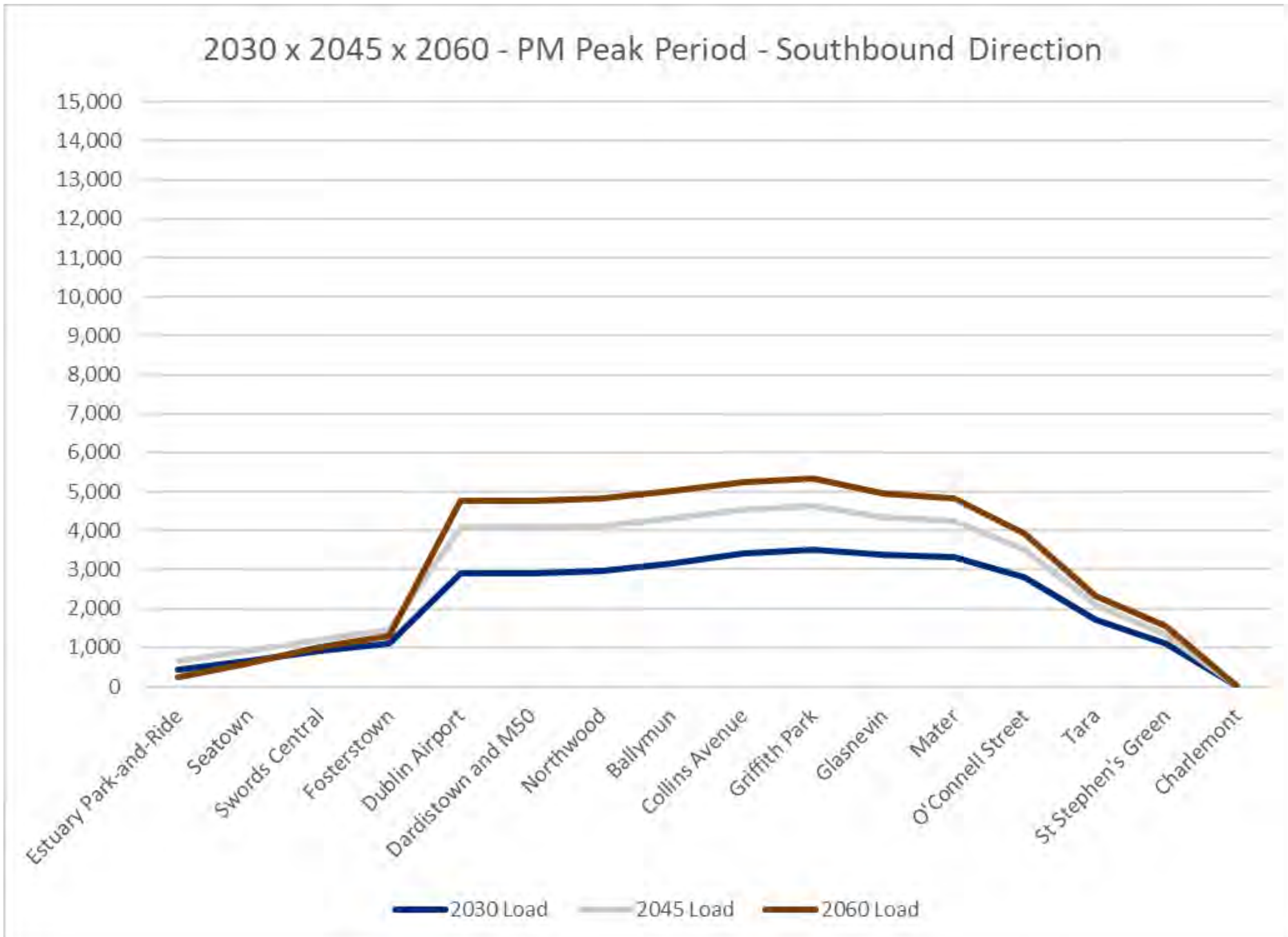


Figure 7-21: Alternative Demand Sensitivity Test – AM Peak loading in Southbound direction

7.4.3 Boarding and Alighting Numbers

The 12-hour boarding and alighting totals on the MetroLink line for the Alternative Demand runs are shown in Figure 7-22. Total 12-hour boardings increase from 111,507 in 2030 to 141,998 in 2045 (an increase of 27% between these years), then to 176,353 in 2060 (an increase of 24% between 2045 and 2060).

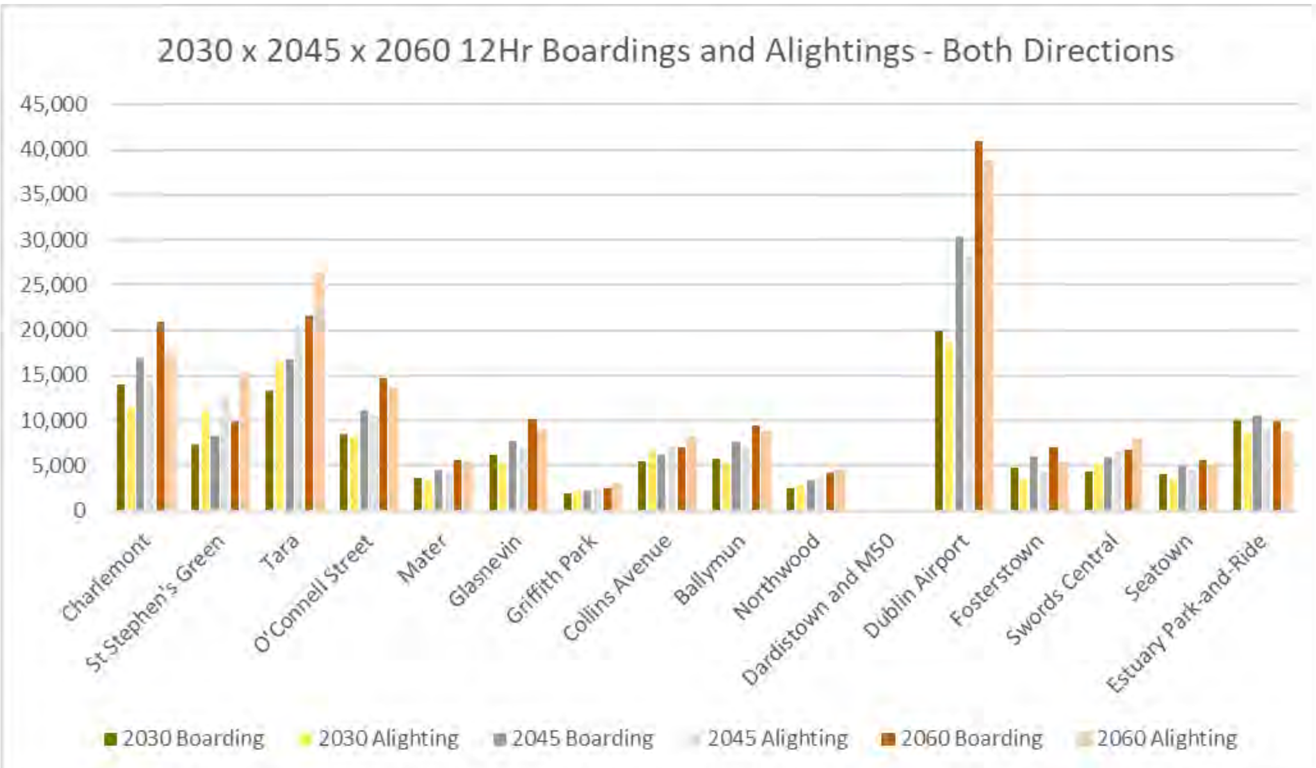


Figure 7-22 Alternative Demand Sensitivity Test – 12hr Boardings and Alightings Both Directions

Alternative Demand results for each year are provided in Table 7-9. The Alternative Demand boardings and alightings at each station are compared with the BC Core run results in Figure 7-23 to Figure 7-25. “AD” in the charts refers to Alternative Demand runs, and “BC Core” refers to the Business Case Core runs.

Table 7-9: 12-Hour Boarding and Alighting in Peak Periods for Alternative Demand runs

Year	Boarding	Difference from Core BC
2030	111,507	-13%
2045	141,998	-9%
2060	176,353	-16%

Figure 7-23 shows a comparison of boarding and alighting totals for the 2030 Alternative Demand run. The overall boardings are 13% less than the BC Core boardings, with 111,507 boardings in the 2030 Alternative Demand results compared to 128,182 boardings in the BC.

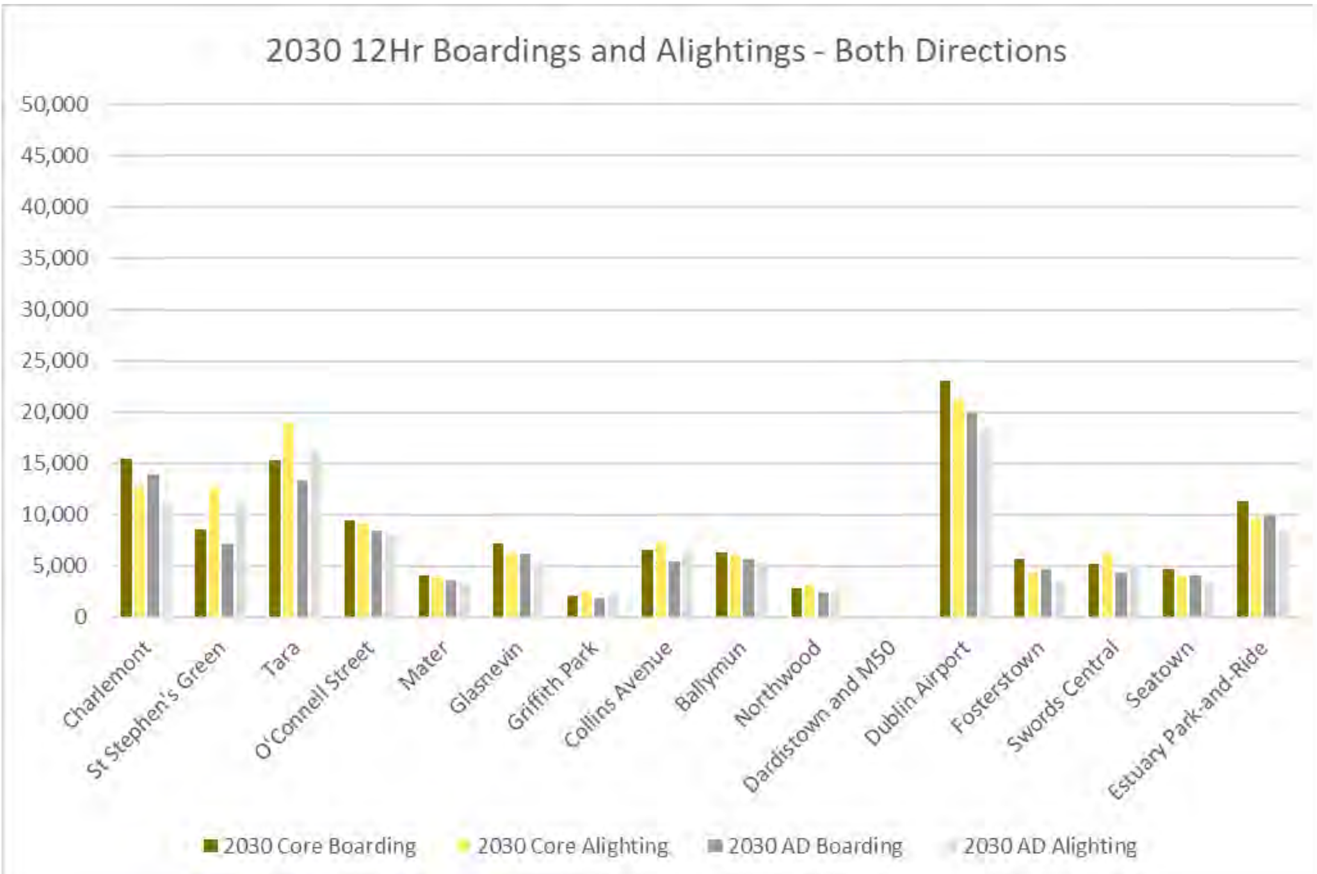


Figure 7-23: 2030 Alternative Demand Sensitivity Test x Business Case – 12hr Boardings and Alightings

The Alternative Demand 12-hour boarding and alighting in 2045 are also lower than in the BC Core Run, as shown in Figure 7-24. Overall, the 2045 Alternative Demand run results showed 9% less boardings than the BC Core 2045, with 141,998 boardings in the Alternative Demand and 156,091 in the BC Core Run.

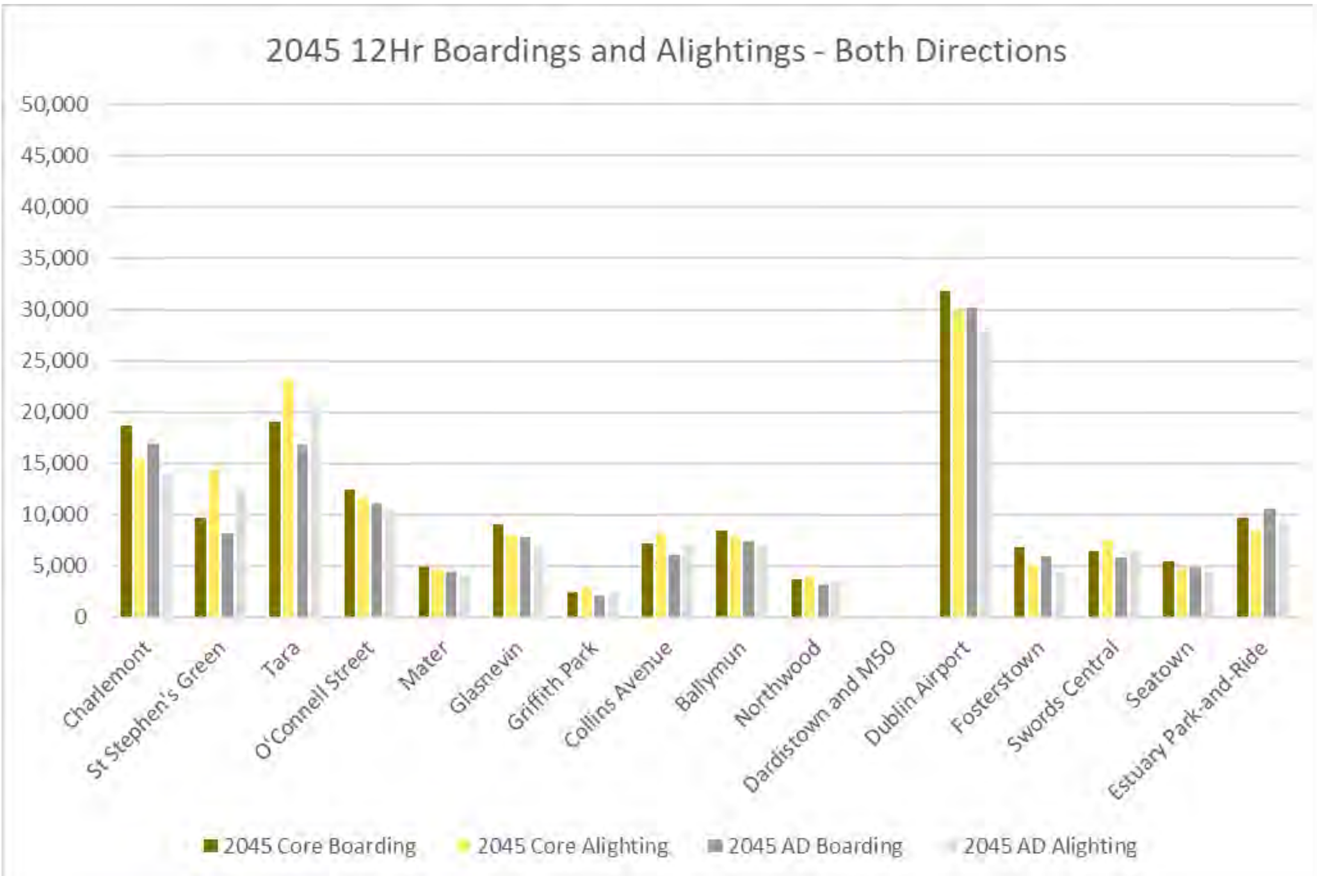


Figure 7-24: 2045 Alternative Demand Sensitivity Test x Business Case – 12hr Boardings and Alightings Both Direction

The 2060 Alternative Demand results are shown in Figure 7-25. There are 16% less boardings and alightings than the BC Core run. The Swords Central station shows the largest difference in boardings in 2060, with 26% less boardings and 25% less alightings in the Alternative Demand than the BC Core run. The Estuary Park-and-Ride station in 2060 has 25% less boardings and 29% less alightings than the BC Core run.

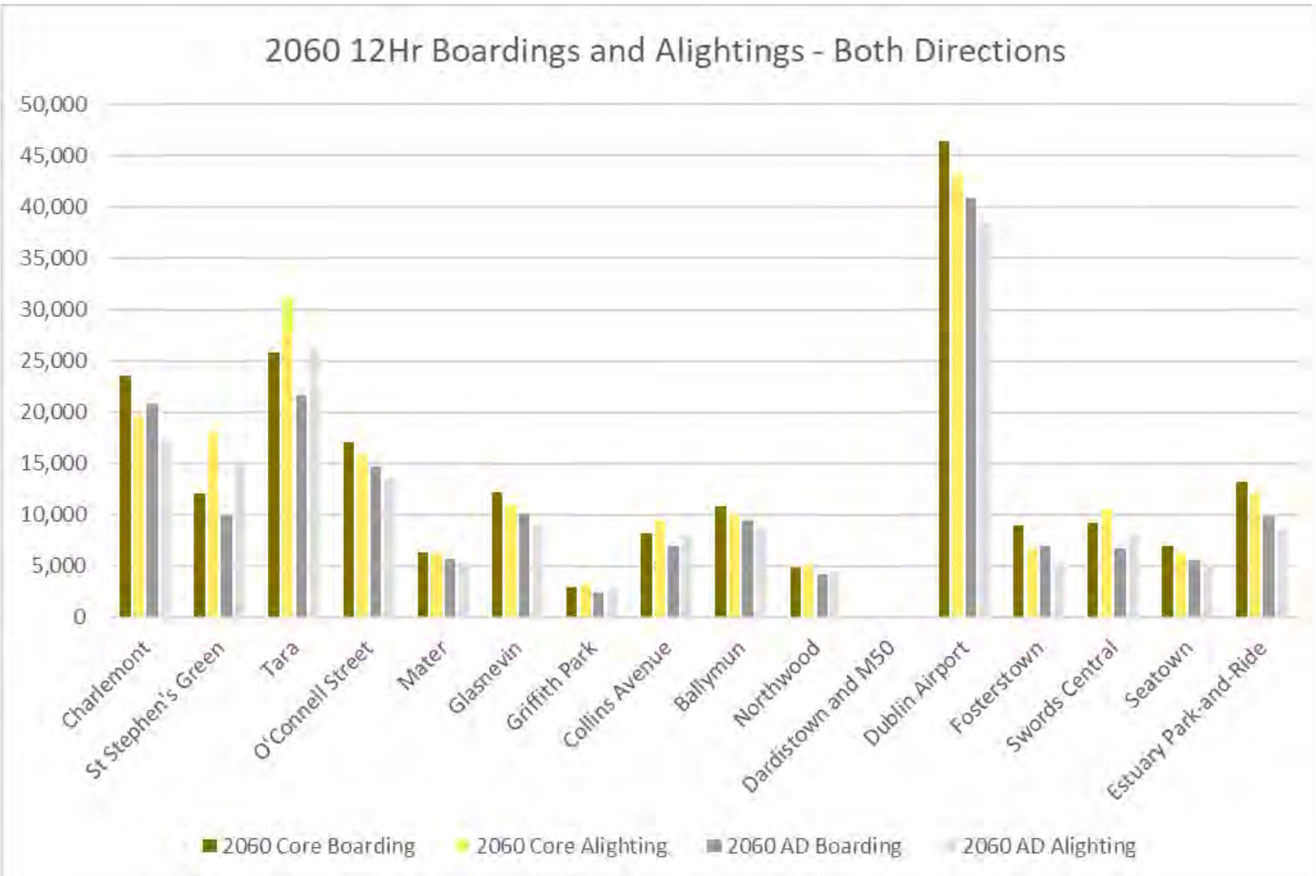


Figure 7-25: 2060 Alternative Demand Sensitivity Test x Business Case – 12hr Boardings and Alightings Both Directions

7.5 Enhanced Transport Network – National Development Plan

7.5.1 Description

The Enhanced Transport Network sensitivity tests have been developed to understand how usage of the MetroLink and how user and non-user benefits may change if other planned infrastructure schemes are delivered during the appraisal period.

A scheme bundle approach has been developed to examine the impacts of the enhanced network, with one bundle representing the schemes within the National Development Plan (2018-2027) and the other bundle representing the full build out of the infrastructure and initiatives contained within the NTA's Transport Strategy for the Greater Dublin Area (2016-2035); these are generally referred to as the DoNDP and the DoGDA model runs respectively The DoGDA results will be discussed in section 7.6.

Each of these model runs has been done both with and without the MetroLink in place. The runs without MetroLink are referred to as DM and the runs with MetroLink are referred to as DS. Full details of the schemes contained within the DoNDP and the DoGDA are contained within the TMP. A summary of the Enhanced Transport Network scenarios assessed are contained within Table 7-10.

Table 7-10: Enhanced Transport Network Sensitivity Tests- Do NDP

Forecast Year	2030	2045	2060
Scenario	Do NDP	Do NDP	-

The results from the Do NDP scenarios have been used within the Business Case for MetroLink and full TUBA analysis has been undertaken using the results from the runs.

The results for each Enhanced Transport Network test are presented below, along with a comparison against the Business Case Core runs.

7.5.2 Loading Profile

For the Enhanced Transport Network Do NDP runs, loading results are summarised in Table 7-11. Line loading by station is presented in detail with charts for each peak period and direction. This section also compares the results with those from the corresponding Business Case (BC) Core runs.

Table 7-11: Maximum Loading in Peak Periods for DoNDP runs

Direction	Year	Max Loading		Difference from Business Case	
		AM	PM	AM	PM
Northbound	2030	5,077	7,110	1%	-7%
	2045	6,570	8,807	7%	6%
Southbound	2030	9,302	4,376	-11%	9%
	2045	11,227	5,835	-5%	26%

Figure 7-26 to Figure 7-29 show the load for each year across stations for each peak period and direction. Figure 7-26 shows the Northbound AM peak loading. The maximum load in the 2030 DoNDP is 5,077, which is 1% higher than the corresponding BC Core Run maximum load (5,024). For the 2045 DoNDP it is 6,570, which is 7% higher than in the BC Core Run (6,167).

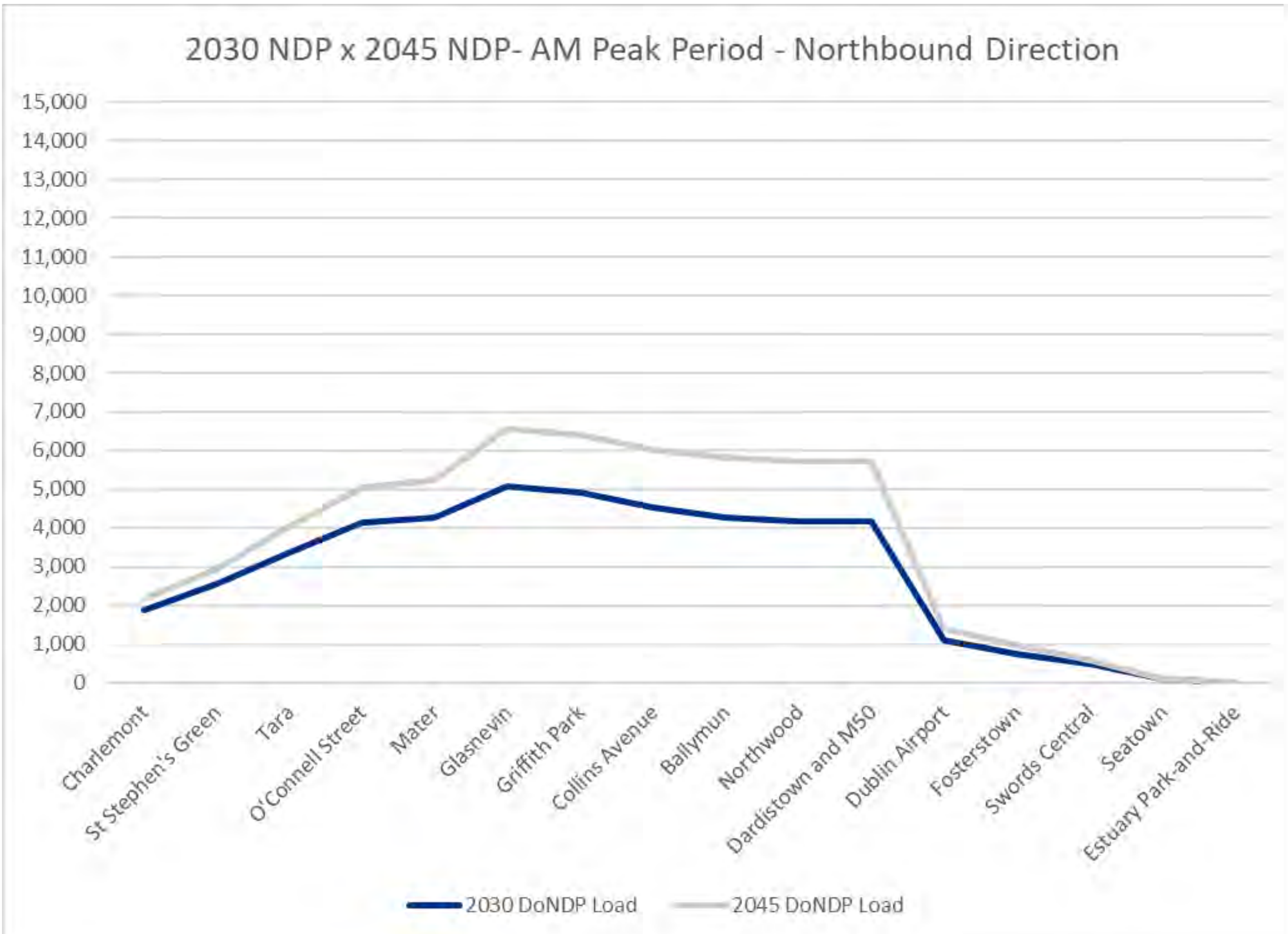


Figure 7-26: 2030 DoNDP x 2045 Do NDP Loading Profiles -AM Northbound

Figure 7-27 presents the AM peak loading in the Southbound direction. The 2030 DoNDP maximum PM loading for this direction is 9,302. This is 11% lower than the BC Core Run value (10,412). The 2045 DoNDP maximum load is 11,227, which is 5% lower than in the BC Core Run (11,765).

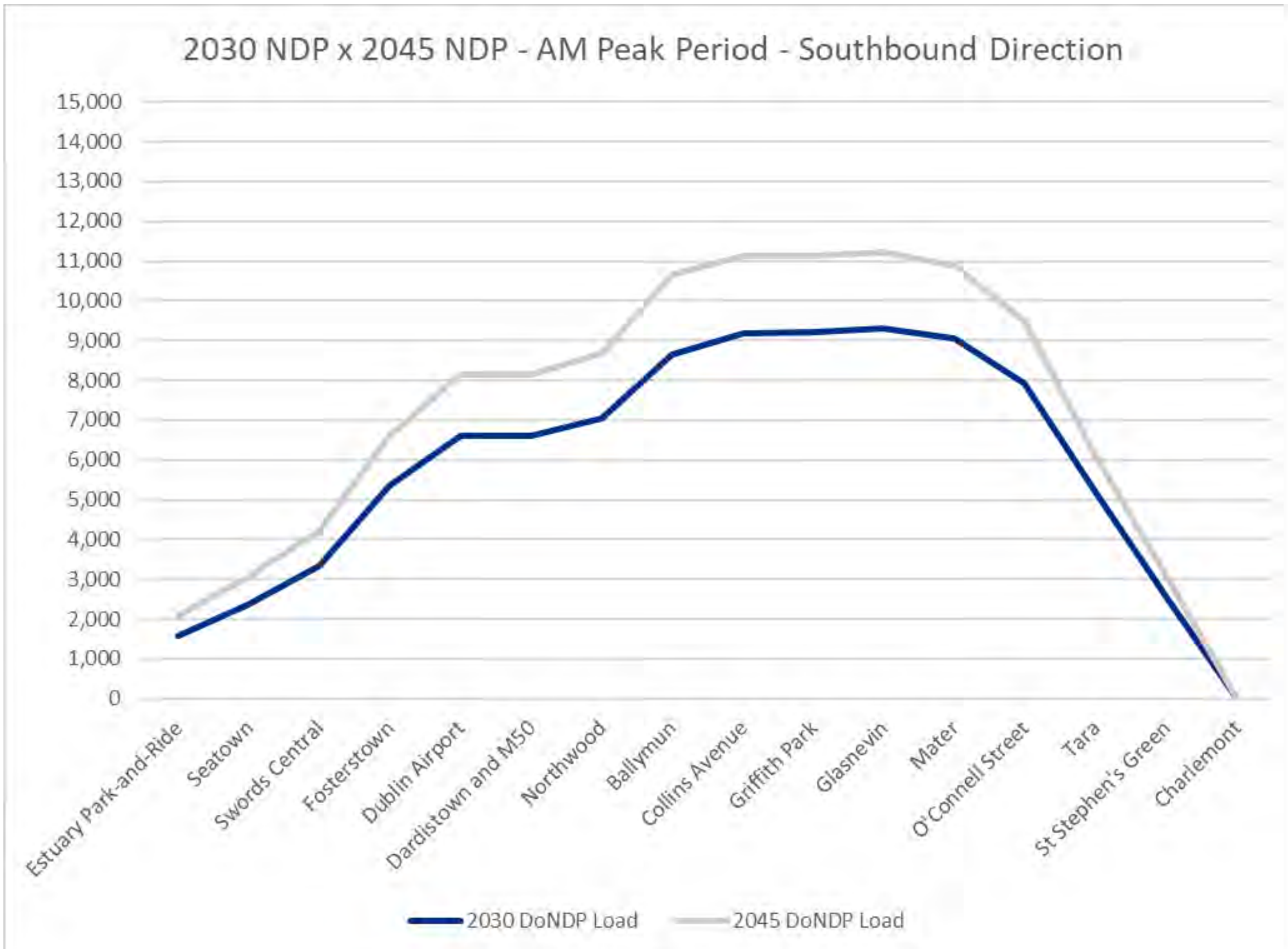


Figure 7-27: 2030 DoNDP x 2045 Do NDP Loading Profiles -AM Southbound

Loading results for the PM peak travelling Northbound are shown in Figure 7-28. In the 2030 DoNDP, the maximum load is 7,110, which is 7% lower than the BC Core Run (7,616). For the 2045 DoNDP it is 8,807, which is 6% higher than in the BC Core Run (8,280).

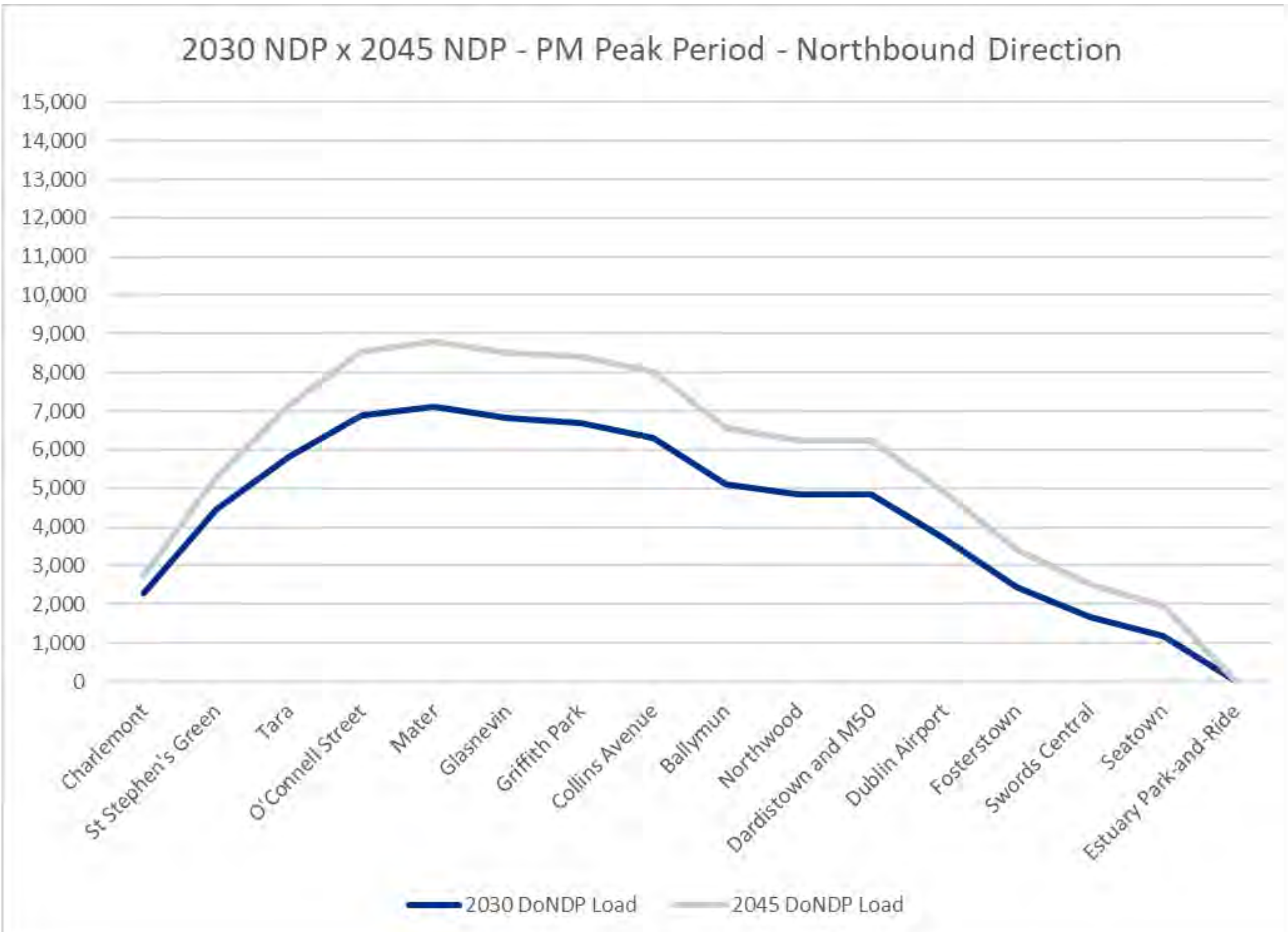


Figure 7-28: 2030 DoNDP x 2045 Do NDP Loading Profiles -PM Northbound

Figure 7-29 provides the PM peak loading results in the Southbound direction. The 2030 DoNDP maximum load here is 4,376, an increase of 9% from the BC Core Run (3,999). 2045 DoNDP maximum loading is 5,835 which is 26% higher than the BC Core Run (4,619).

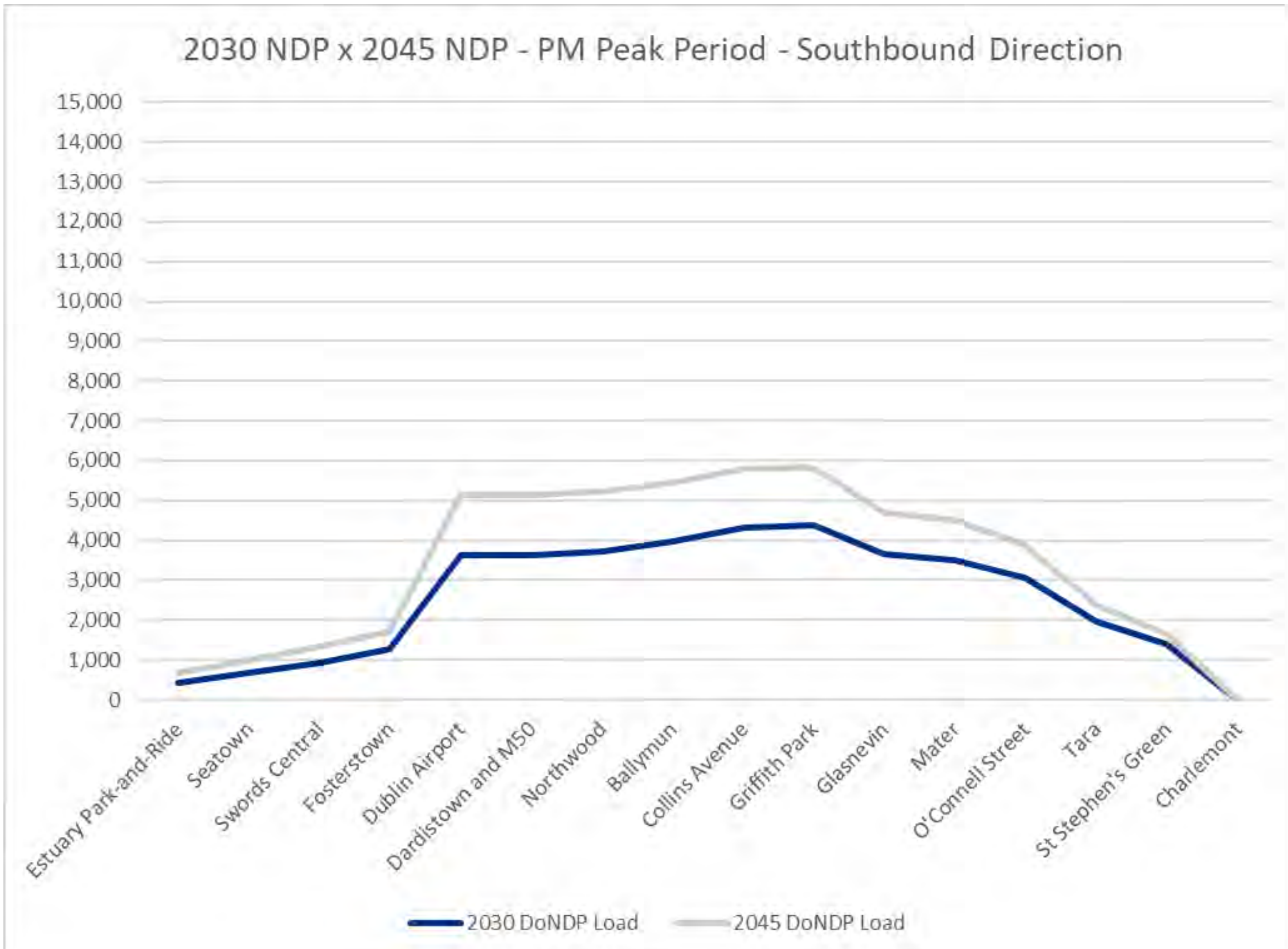


Figure 7-29: 2030 DoNDP x 2045 Do NDP Loading Profiles -PM Southbound

7.5.3 Boarding and Alighting Numbers

The 12-hour boarding and alighting totals on the MetroLink line as modelled in the two National Development Plan runs are shown in Figure 7-30. Total 12-hour boardings are 126,647 in the 2030 DoNDP and 163,318 in the 2045 DoNDP.

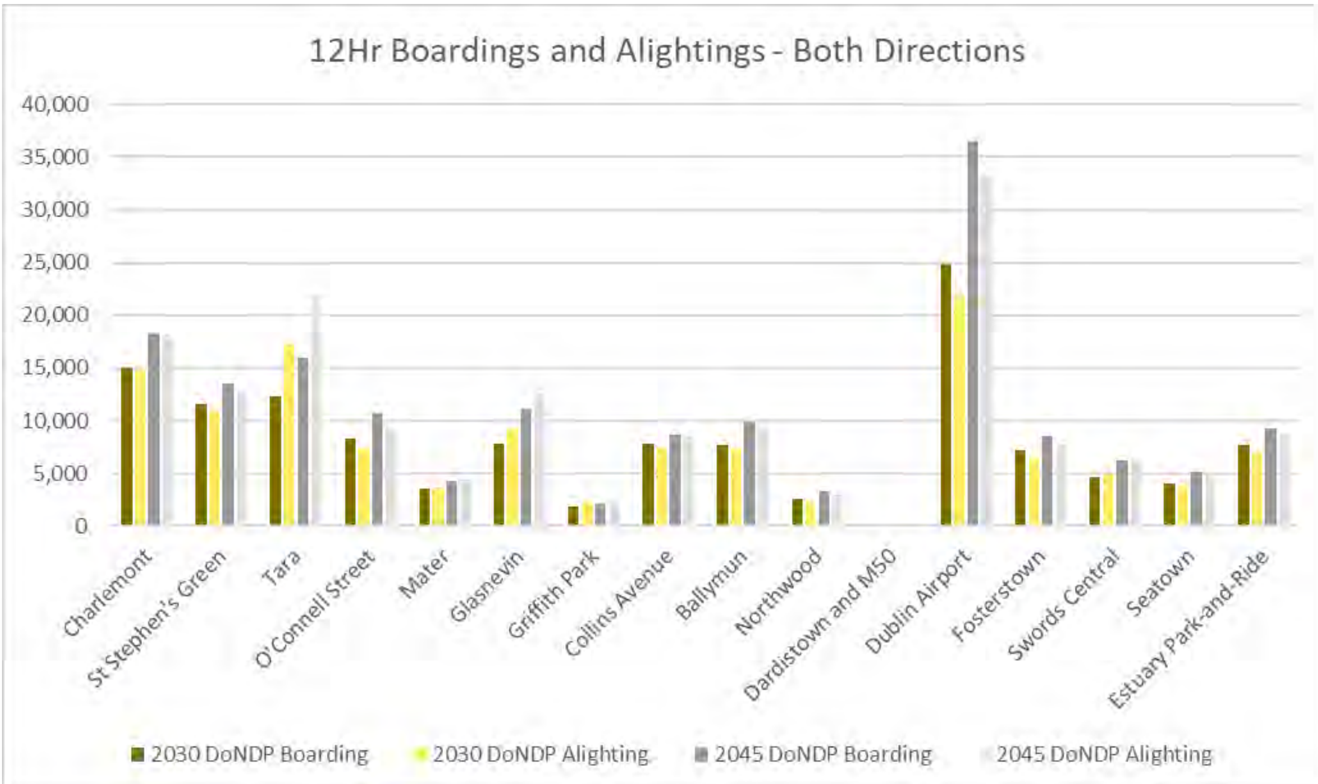


Figure 7-30: 2030 DoNDP x 2045 Do NDP Boarding and Alighting – 12hr Both Direction

Table 7-12 shows the NDP 12-hour boarding results for each year. The NDP results at each station are compared with the BC Core run results in Figure 7-31 and Figure 7-32. “DoNDP” in the charts refers to the NDP runs, and “BC Core” refers to the Business Case Core runs.

Table 7-12: 12-Hour Boarding and Alighting in Peak Periods for DoNDP runs

Year	Boarding	Difference from Core BC
2030	126,647	-1%
2045	163,318	5%

Figure 7-31 shows a comparison of 12-hour boarding and alighting totals for the 2030 DoNDP run alongside the Business Case run results. In this DoNDP run, boardings and alightings are 1% lower than those in the Business Case run. There are 126,647 boardings and alightings in the 2030 DoNDP results compared to 128,182 boardings and alightings in the Business Case. The St Stephen’s Green station shows the largest difference between the runs, with 35% more boardings and 15% less alightings in the DoNDP than the BC Core run. At Estuary Park-and-Ride, there are 32% less boardings and 28% less alightings in the Low Frequency than the DoNDP run.

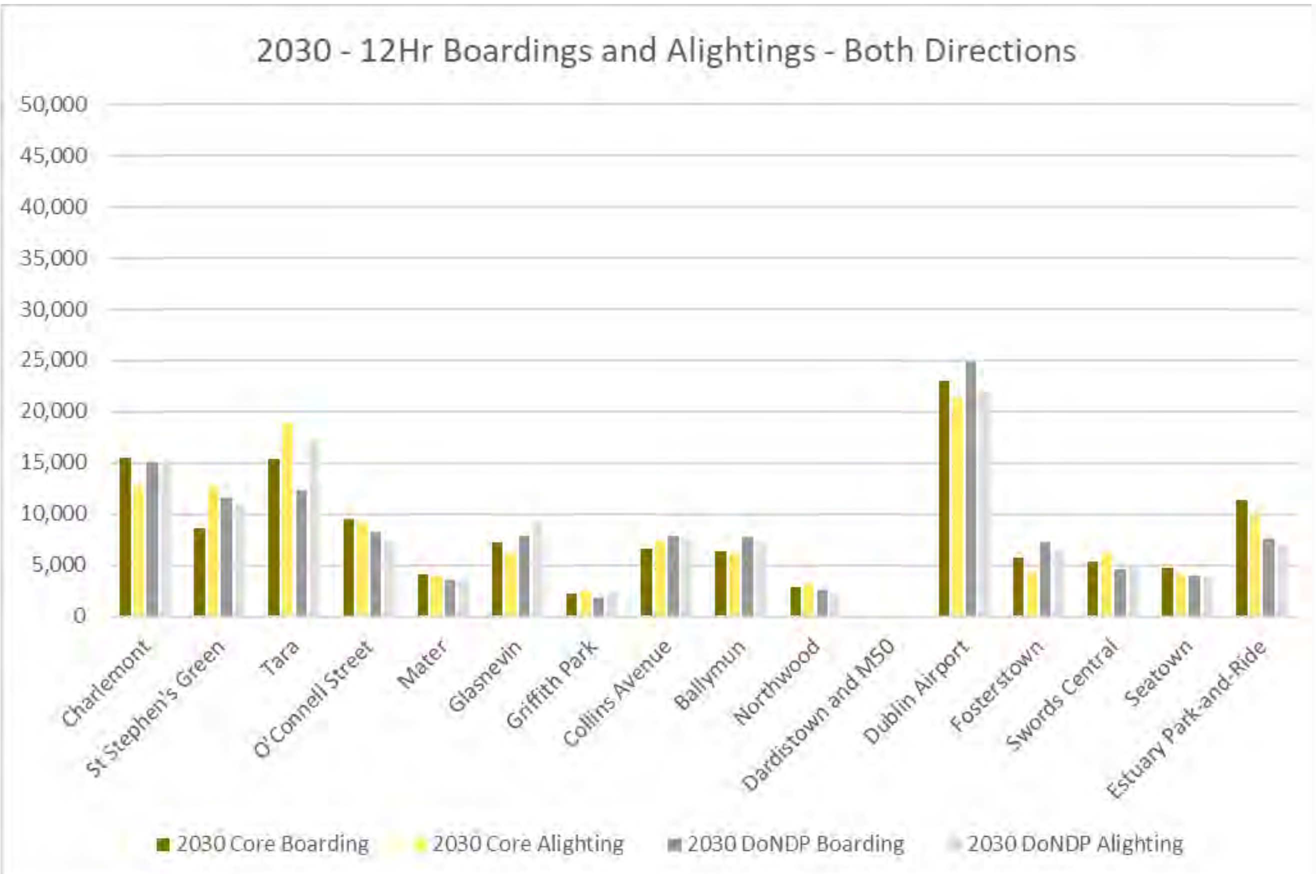


Figure 7-31: 2030 Core x 2030 Do NDP Boarding and Alighting -12hr Both Directions

In 2045, shown in Figure 7-32, the 12-hour DoNDP boarding and alighting are 5% higher than in the Business Case run. Overall, the 2045 DoNDP run results showed 163,318 boardings, compared to the BC Core Run which showed 156,091. At Glasnevin, there are 22% more boardings and 58% more alightings in the DoNDP than the BC Core run.

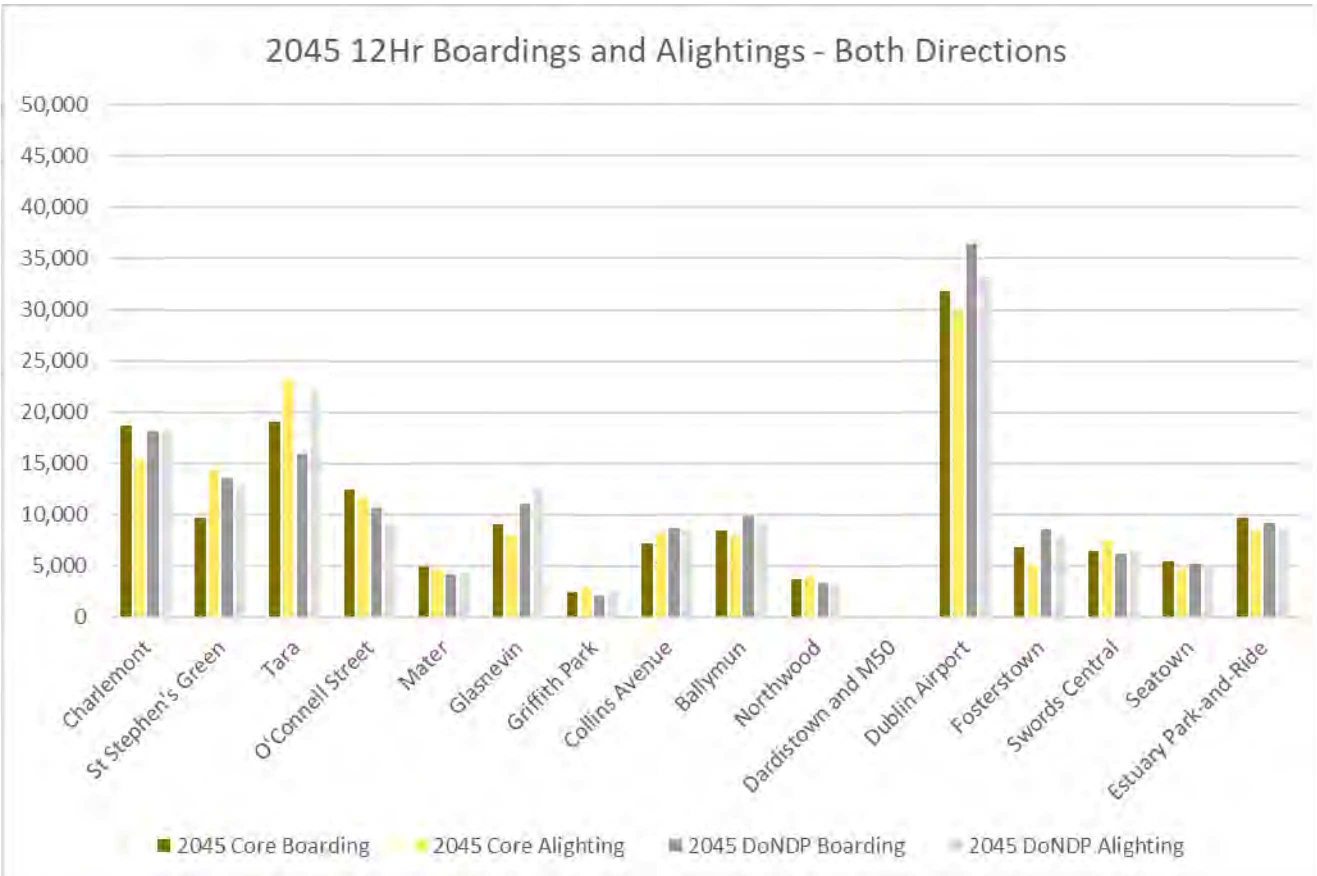


Figure 7-32:2045 Core x 2045 Do NDP Boarding and Alighting – 12hr Both Directions

7.6 Enhanced Transport Network – National Development Plan +Alternative Demand

7.6.1 Description

As detailed, a scheme bundle approach has been developed to examine the impacts of the enhanced network, with one bundle representing the schemes within the National Development Plan (2018-2027), in conjunction with the Alternative Demand scenario (presented in section 7.4). Each of these model runs has been done both with and without the MetroLink in place (Do Minimum and Do Scheme).

The Alternative Demand scenario has been developed by the NTA to consider the impact that the Covid-19 pandemic may have on future trip patterns, including a reduction in some types of Commute to Work and Education trips.

This scenario has been assessed for 2030, 2045 and 2060.

7.6.2 Loading Profile

For the Enhanced Transport Network Do NDP +Alternative Demand runs, loading results are summarised in Table 7-13. Line loading by station is presented in detail with charts for each peak period and direction. This section also compares the results with those from the corresponding Business Case (BC) Core runs.

Table 7-13: Maximum Loading in Peak Periods for NDP + Alternative Demand runs

Direction	Year	Max Loading		Difference from Business Case	
		AM	PM	AM	PM
Northbound	2030	4,555	6,134	-9%	-19%
	2045	5,843	7,134	-5%	-14%
	2060	7,200	8,890	-13%	-19%
Southbound	2030	7,871	3,860	-24%	-3%
	2045	9,417	4,941	-20%	7%
	2060	11,523	6,329	-22%	-3%

Figure 7-33 to Figure 7-36 show the load for each year across stations for each peak period and direction. In the Northbound AM peak, shown in Figure 7-33, the maximum load in 2030 is 4,555, which is 9% lower than the corresponding BC Core Run maximum load (5,024). For 2045 it is 5,843, which is 5% lower than in the BC Core Run (6,167). In 2060, the maximum load of 7,200 is 13% lower than the BC Core Run 2060 maximum load (8,243).

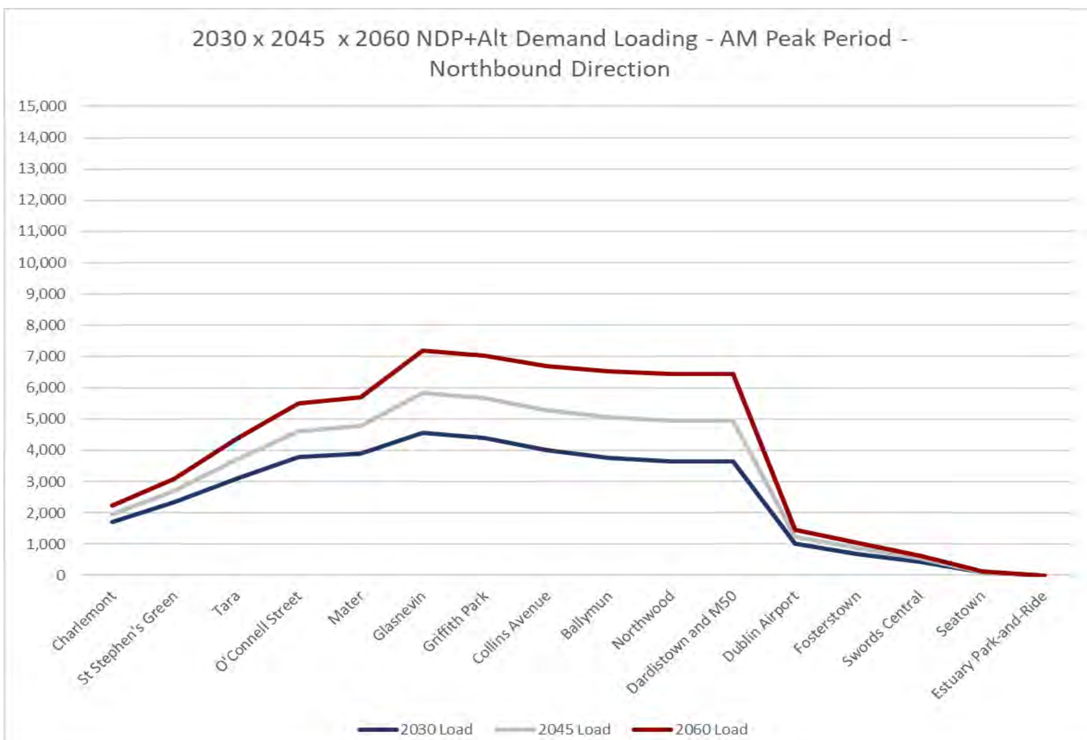


Figure 7-33: **2030 NDP+AD x 2045 NDP+AD x 2060 NDP+AD Loading Profiles -AM Northbound**

Loading results for the AM peak in the Southbound direction are shown in Figure 7-34. The 2030 maximum load here is 7,871, a 24% decrease from the BC Core Run (10,412). 2045 maximum loading is 9,417 which is 20% lower than in the BC Core Run (11,765). For 2060, the maximum load is 11,523, 22% lower than the BC Core Run (14,859).

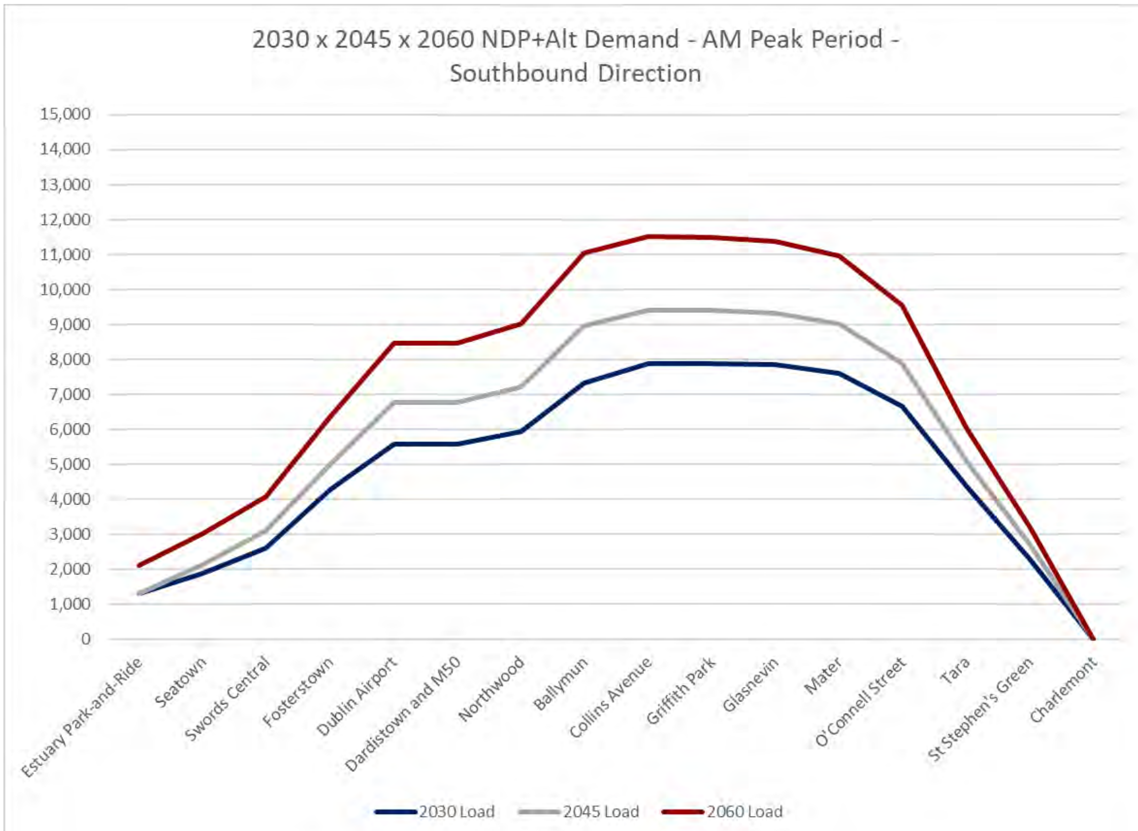


Figure 7-34: 2030 NDP+AD x 2045 NDP+AD x 2060 NDP+AD Loading Profiles – AM Southbound

Figure 7-35 presents the PM peak loading in the Northbound direction. The 2030 NDP+Alternative Demand maximum PM loading for this direction is 6,134. This is 19% lower than the BC Core Run value (7,616). The 2045 maximum load is 7,134, which is 14% lower than in the BC Core Run (8,280). The 2060 maximum load is again lower than the BC Core Run, at 8,890; 19% lower than the BC Core Run (11,006).

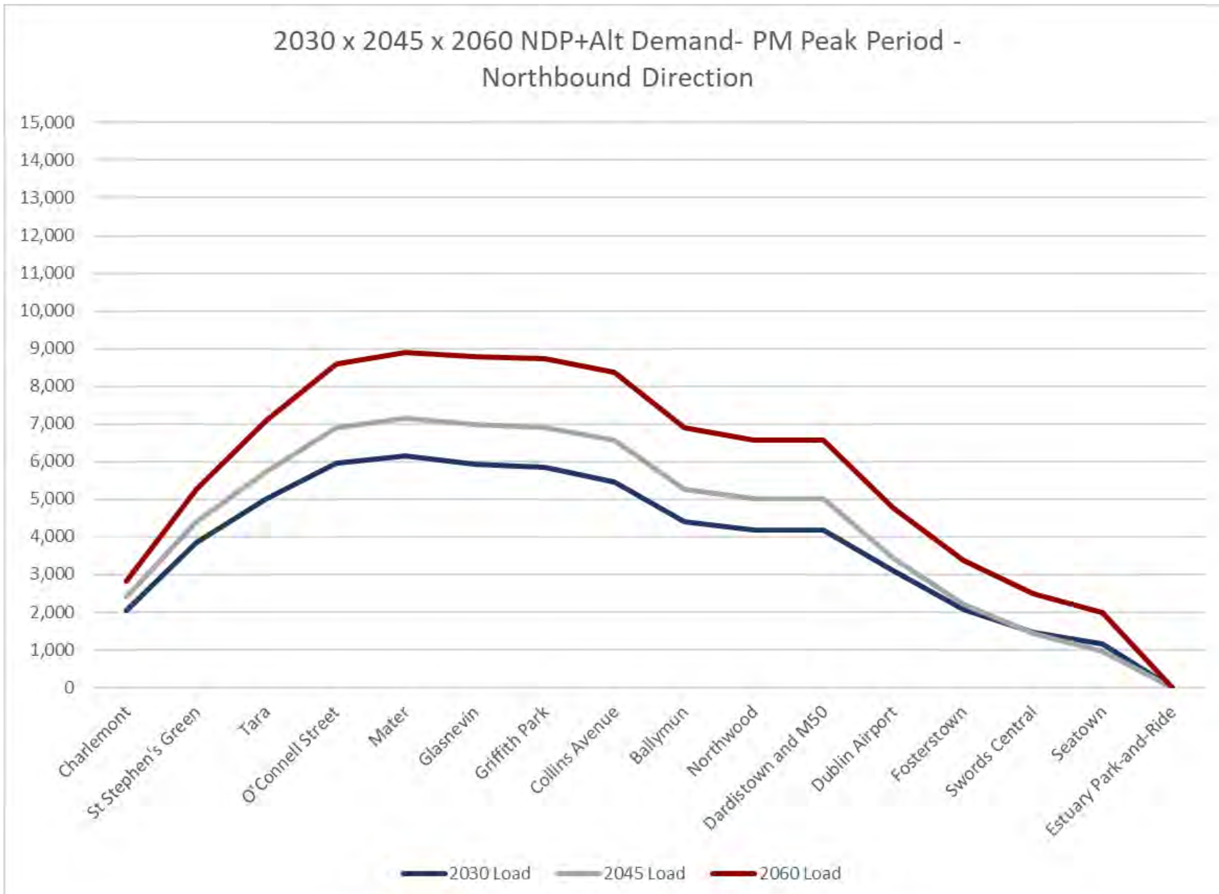


Figure 7-35: 2030 NDP+AD x 2045 NDP+AD x 2060 NDP+AD – PM Northbound

Figure 7-36 provides the PM peak loading results in the Southbound direction. In 2030, the maximum load is 3,860, which is 3% smaller than the BC Core Run (3,999). The 2045 maximum load is 4,941, 7% higher than the BC Core Run (4,619). In 2060 with a value of 6,329, the maximum load is 3% smaller than the Core BC Run (6,529).

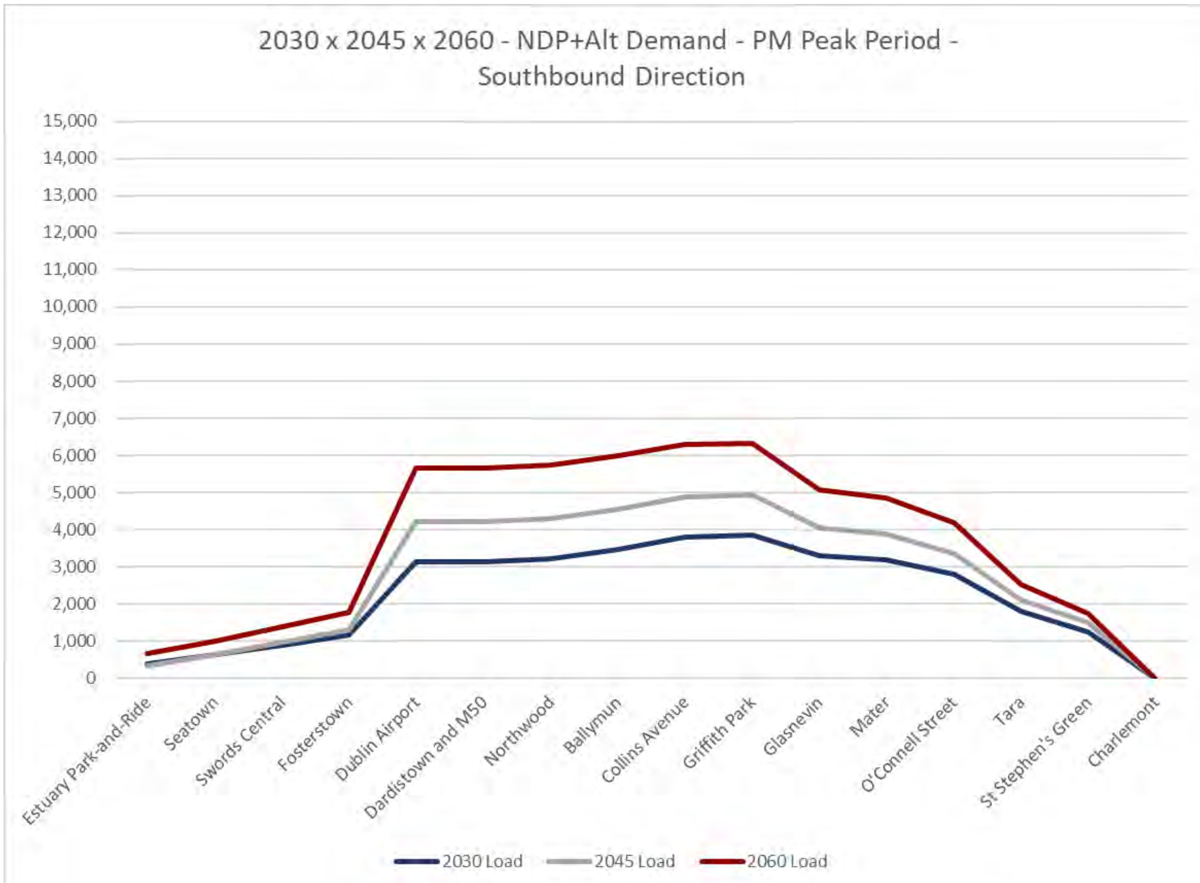


Figure 7-36: 2030 NDP+AD x 2045 NDP+AD x 2060 NDP+AD – PM Southbound

7.6.3 Boarding and Alighting Numbers

The 12-hour boarding and alighting totals on the MetroLink line as modelled in the three National Development Plan + Alternative Demand runs are shown in Figure 7-30. Total 12-hour boardings are 112,166 in the 2030 DoNDP +Alternative Demand, 143, 913 in the 2045 scenario, and 183,370 in 2060.

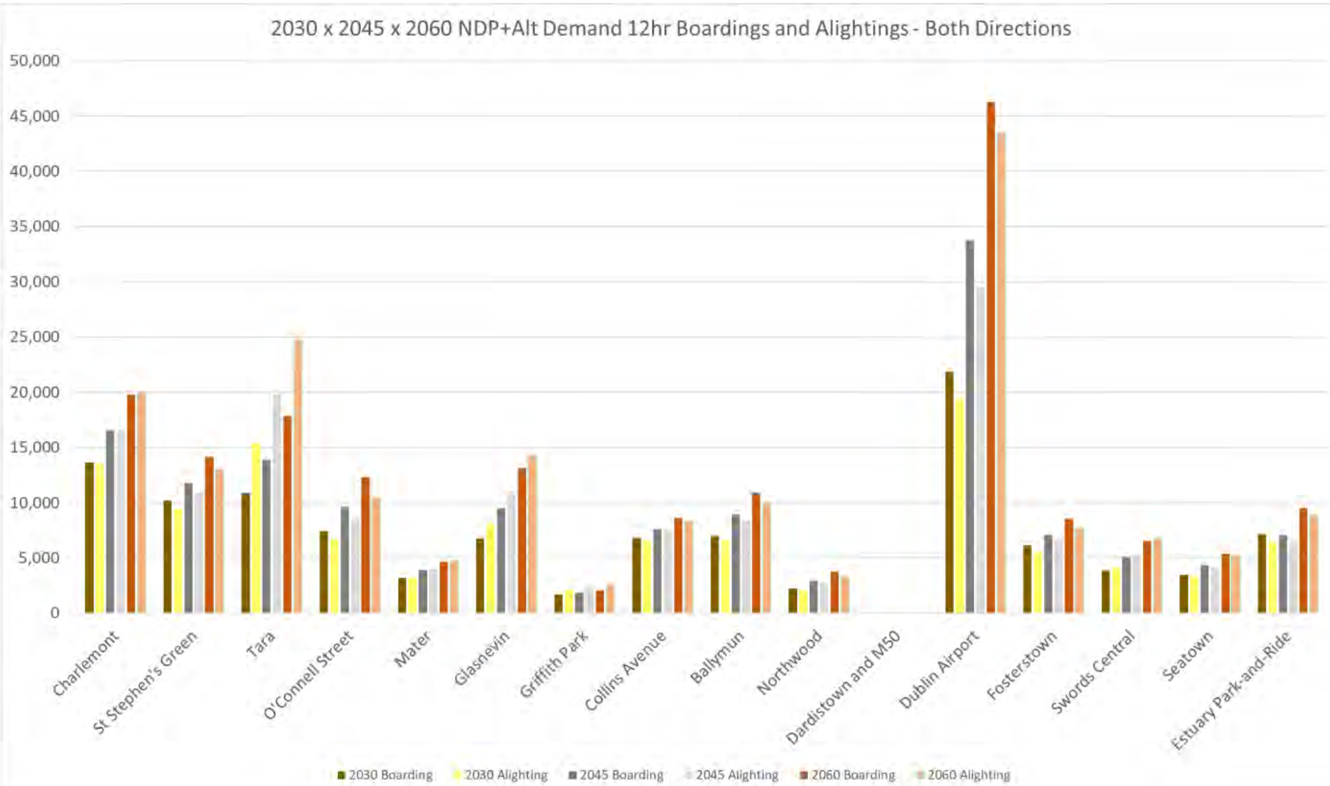


Figure 7-37: 2030 DoNDP+AD x 2045 Do NDP+AD x 2060 Do NDP+AD Boarding and Alighting – 12hr Both Directions

Do NDP+Alternative Demand results for each year are provided in Table 7-14. The Alternative Demand boardings and alightings at each station are compared with the BC Core run results in Figure 7-38 to Figure 7-40. "NDP+AD" in the charts refers to Do NDP+ Alternative Demand runs, and "BC Core" refers to the Business Case Core runs.

Table 7-14: 12-Hour Boarding and Alighting in Peak Periods for NDP+ Alternative Demand runs

Year	Boarding	Difference from Core BC
2030	112,166	-13%
2045	143,913	-8%
2060	183,370	-12%

Figure 7-38 shows a comparison of boarding and alighting totals for the 2030 NDP+ Alternative Demand run. The overall boardings are 13% less than the BC Core boardings, with 112, 166 boardings in the 2030 Alternative Demand results compared to 128,182 boardings in the BC.

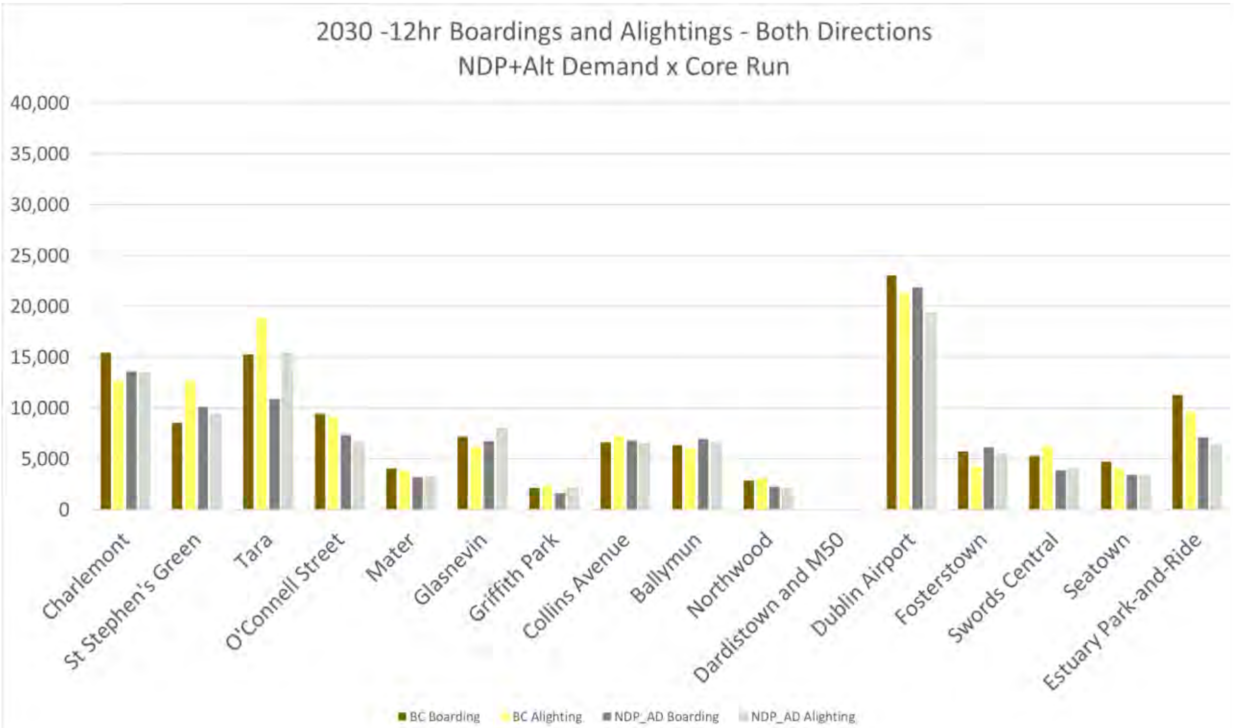


Figure 7-38: **2030 Core x 2030 Do NDP+ Alternative Demand Boarding and Alighting – 12hr Both Directions**

The NDP+ Alternative Demand 12-hour boarding and alighting in 2045 are also lower than in the BC Core Run, as shown in Figure 7-39. Overall, the 2045 NDP +Alternative Demand run results showed 8% less boardings than the BC Core 2045, with 143,913 boardings in the NDP + Alternative Demand and 156,091 in the BC Core Run.

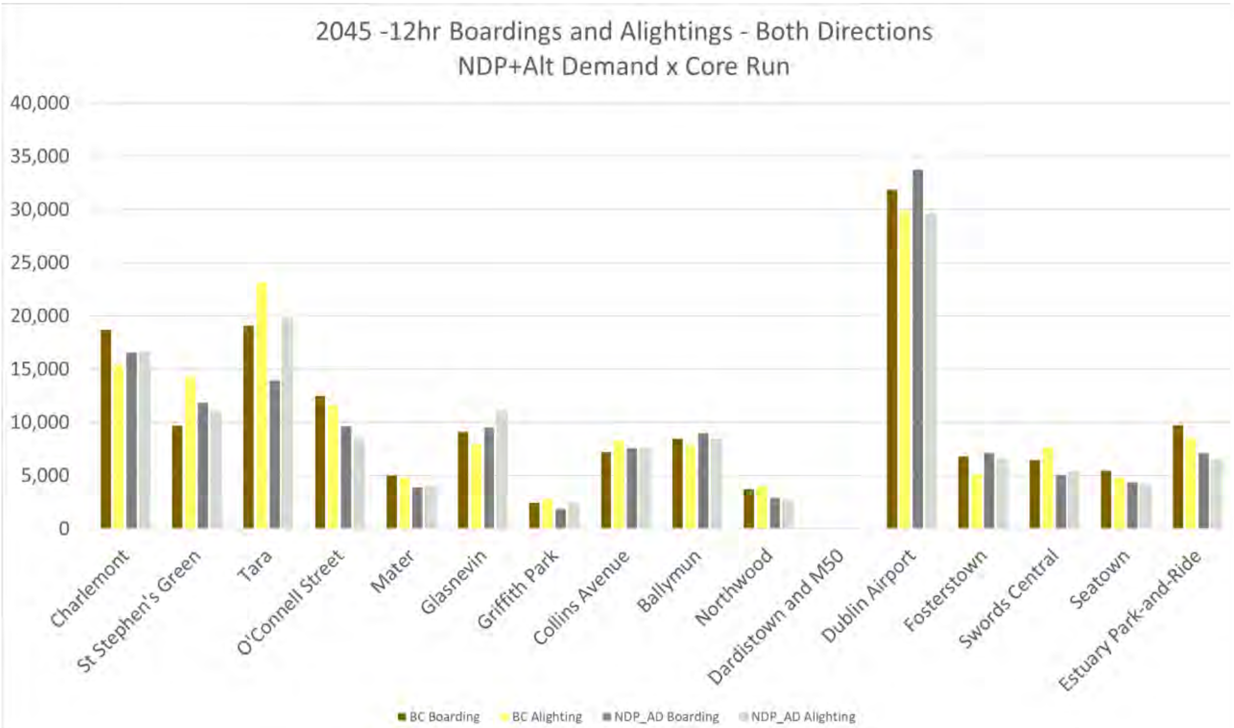


Figure 7-39: **2045 Core x 2045 Do NDP+ Alternative Demand Boarding and Alighting – 12hr Both Directions**

The 2060 NDP+ Alternative Demand results are shown in Figure 7-40. There are 12% less boardings and alightings than the BC Core run. The Tara Street station shows the largest difference in boardings in 2060, with 31% less boardings, while Swords Central has 36% less alightings in the NDP+ Alternative Demand than the BC Core run.

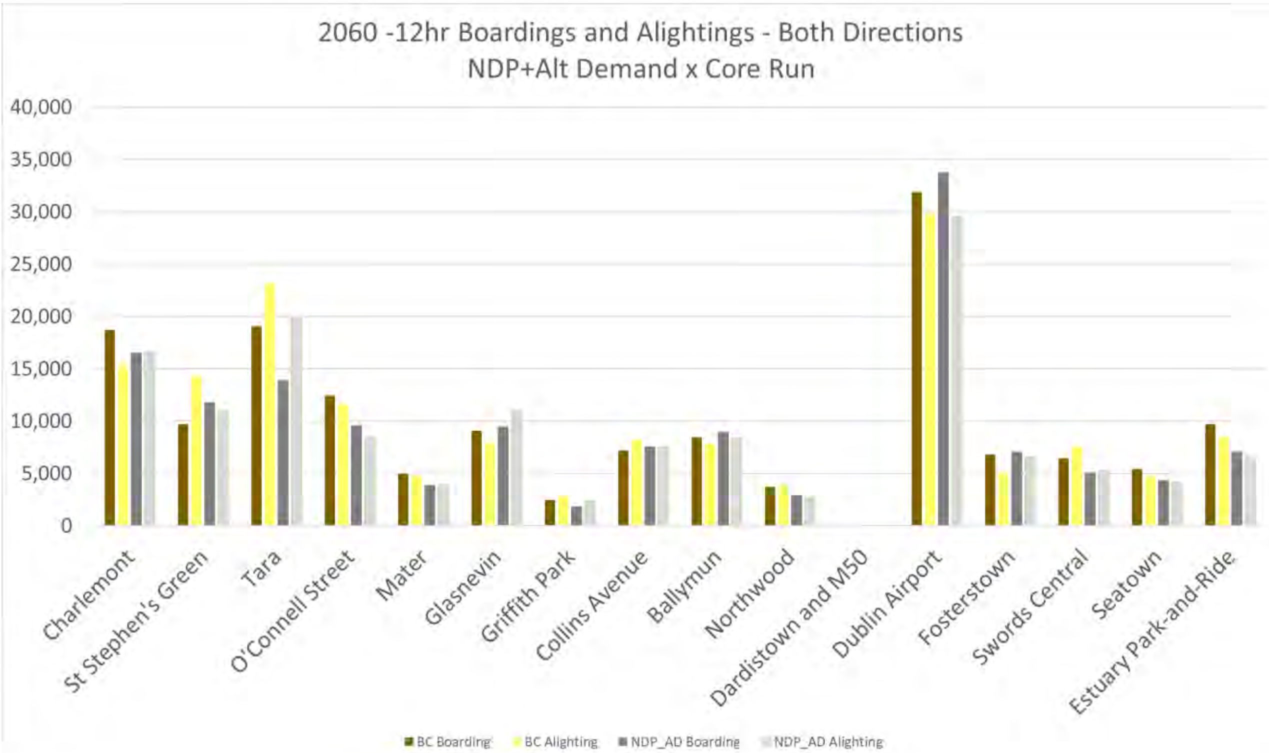


Figure 7-40:**2060 Core x 2060 Do NDP+ Alternative Demand Boarding and Alighting – 12hr Both Directions**

7.7 Enhanced Transport Network – NTA's GDA Strategy

7.7.1 Description

A scheme bundle approach has been developed to examine the impacts of the enhanced network, with one bundle representing the full build out of the infrastructure and initiatives contained within the NTA's Transport Strategy for the Greater Dublin Area (2016-2035); these are generally referred to as the DoNDP and the DoGDA model runs respectively.

Each of these model runs has been done both with and without the MetroLink in place. For the DoGDA strategy, the Metro South scheme was not included in either the Do Minimum or Do Scheme MetroLink runs. Full details of the schemes contained within the DoGDA are contained within the TMP. A summary of the Cumulative Impact Do GDA scenarios assessed are contained within Table 7-15.

Table 7-15: Enhanced Transport Network Tests – Do GDA

Forecast Year	2030	2045	2060
Scenario	-	Do GDA	Do DGA

The results from the Do GDA scenarios have been used to inform potential changes in patronage of the MetroLink, but a full TUBA analysis has not been undertaken on these results.

The results for each Enhanced Transport Network test are presented below, along with a comparison against the Business Case Core runs.

7.7.2 Loading Profile

For the Enhanced Transport Network Do GDA runs, loading results are summarised in Table 7-16. Line loading by station is presented in detail with charts for each peak period and direction. This section also compares the results with those from the corresponding Business Case (BC) Core runs.

Table 7-16: Maximum Loading in Peak Periods for DoGDA runs

Direction	Year	Max Loading		Difference from Business Case	
		AM	PM	AM	PM
Northbound	2045	5,765	8,279	-7%	0%
	2060	7,469	9,927	-9%	-10%
Southbound	2045	12,153	4,632	3%	0%
	2060	14,323	6,261	-4%	-4%

Figure 7-41 to Figure 7-44 show the load for each year across stations for each peak period and direction. Figure 7-41 shows the Northbound AM peak loading. The 2045 DoGDA maximum load of 5,765 is 7% lower than the BC Core Run (6,167). In the 2060 DoGDA, the maximum load is 7,469, 9% lower than the BC Core Run 2060 maximum load (8,243).

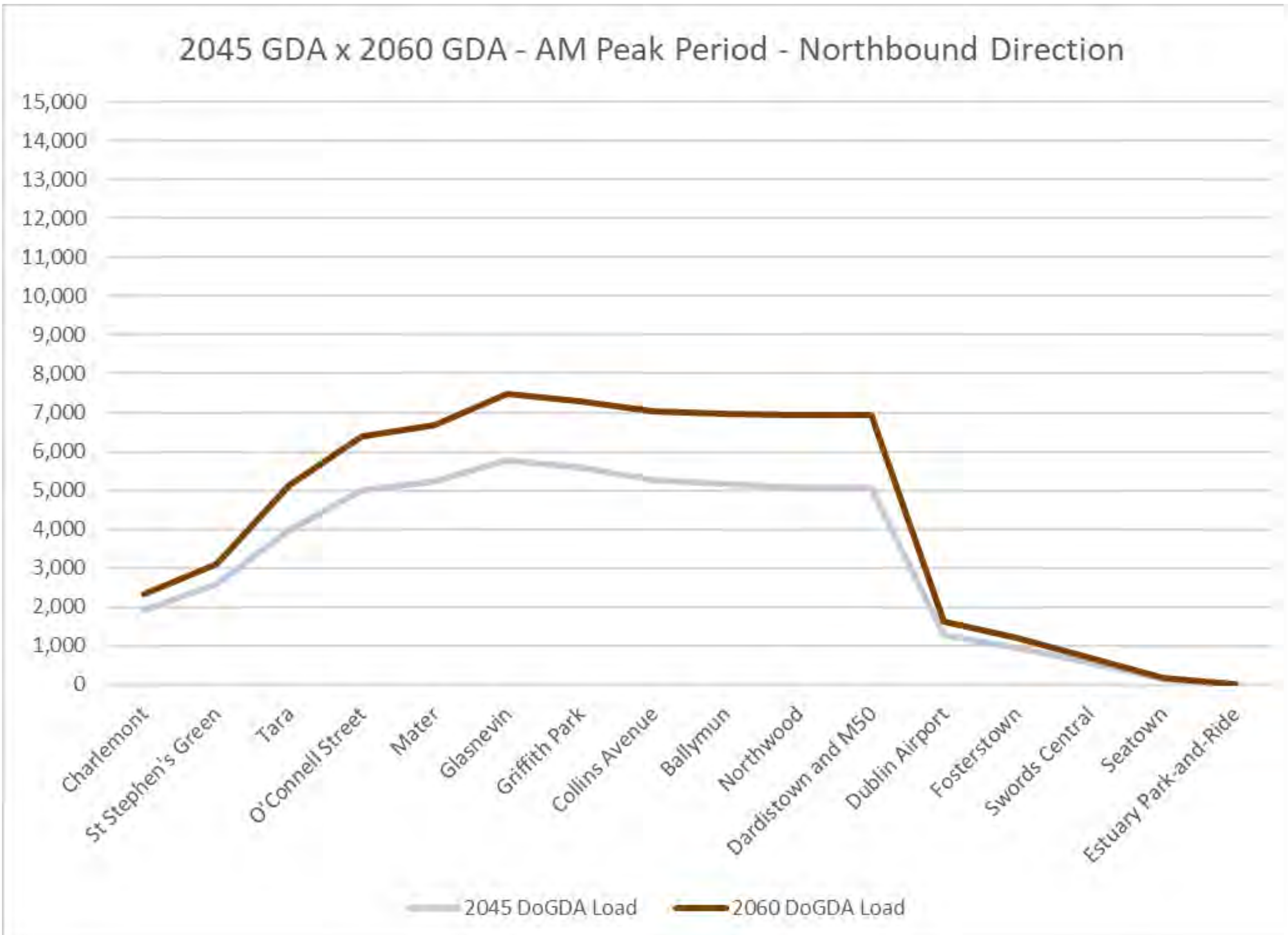


Figure 7-41: 2045 DoGDA x 2060 DoGDA Loading Profiles -AM Northbound

Figure 7-42 presents the AM peak loading in the Southbound direction. The 2045 DoGDA maximum load, 12,153, is 3% higher than in the BC Core Run (11,765). The 2060 DoGDA maximum load is lower than the BC Core Run, at 14,323; 4% less than the BC Core Run (14,859).

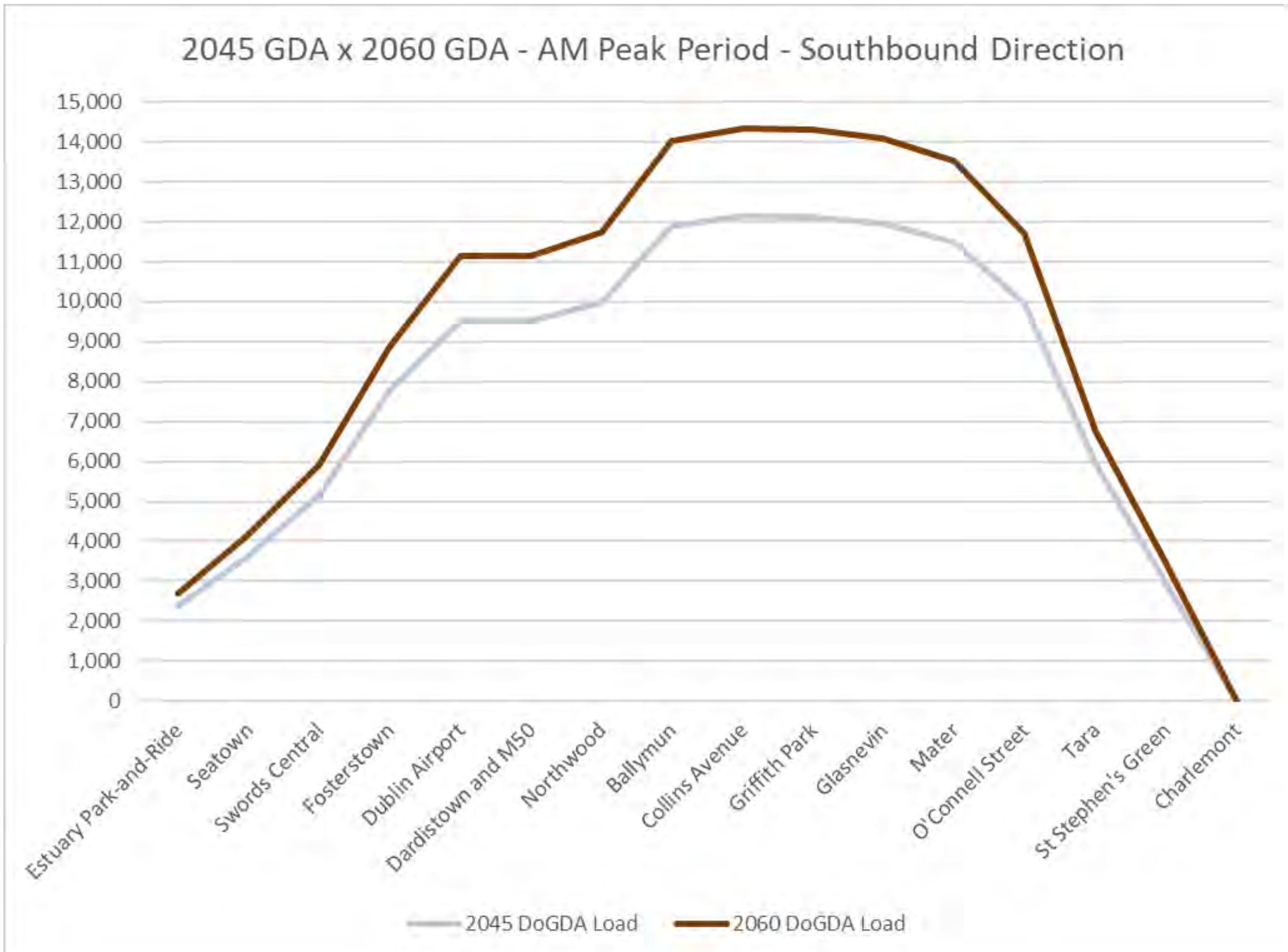


Figure 7-42: 2045 DoGDA x 2060 DoGDA Loading Profiles -AM Southbound

Loading results for the PM peak travelling Northbound are shown in Figure 7-43. The 2045 DoGDA maximum load is 8,279, less than a 0% change from the BC Core Run (8,280). In 2060, with a value of 9,927, the maximum load is 10% smaller than the Core BC Run (11,006).

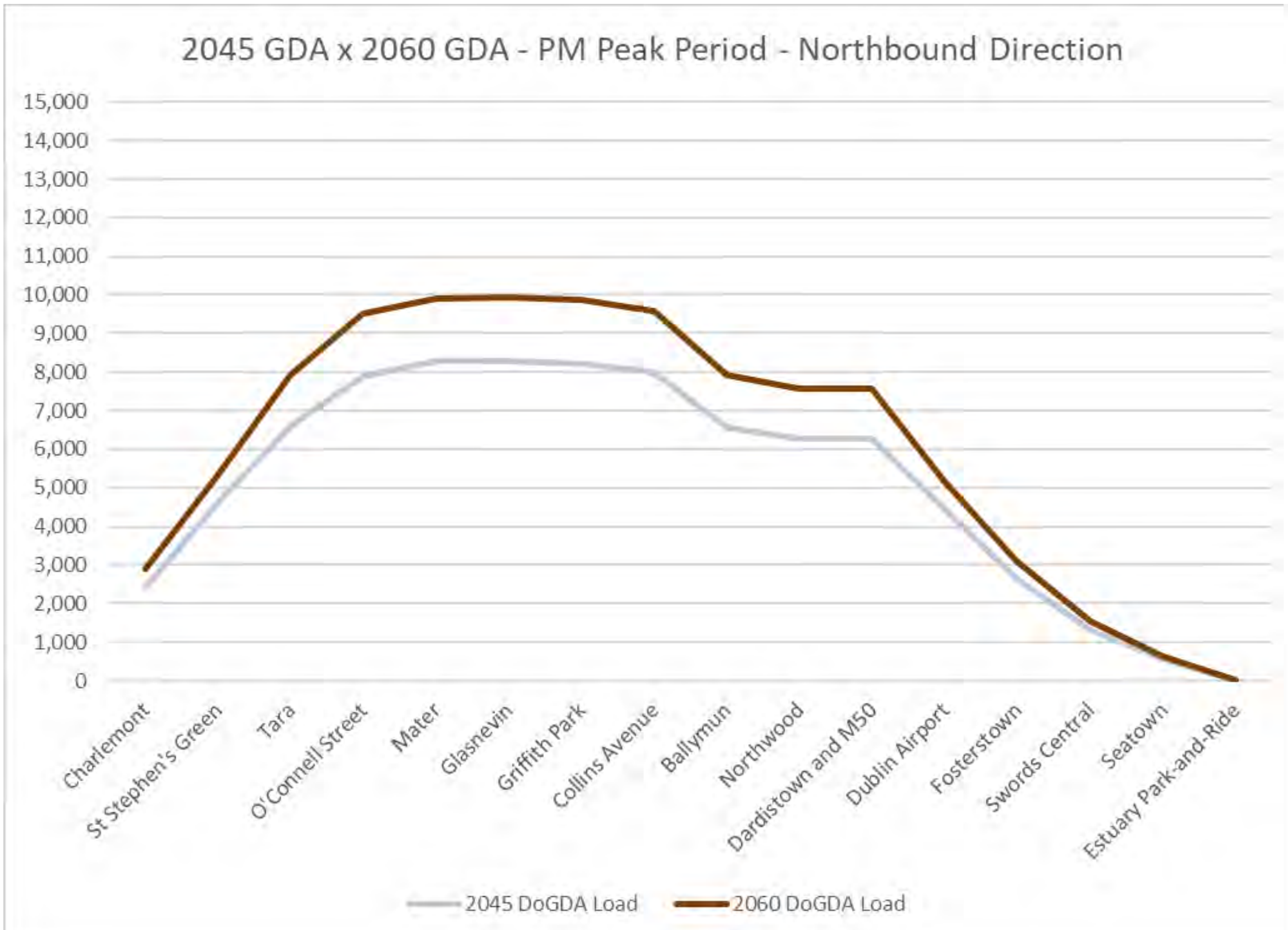


Figure 7-43: 2045 DoGDA x 2060 DoGDA Loading Profiles -PM Northbound

Figure 7-44 provides the PM peak loading results in the Southbound direction. In the 2045 DoGDA the maximum load is 4,632, less than 0% different from the Core BC Run maximum load (4,619). For 2060, the maximum load is 6,261, 4% lower than in the BC Core Run (6,529).

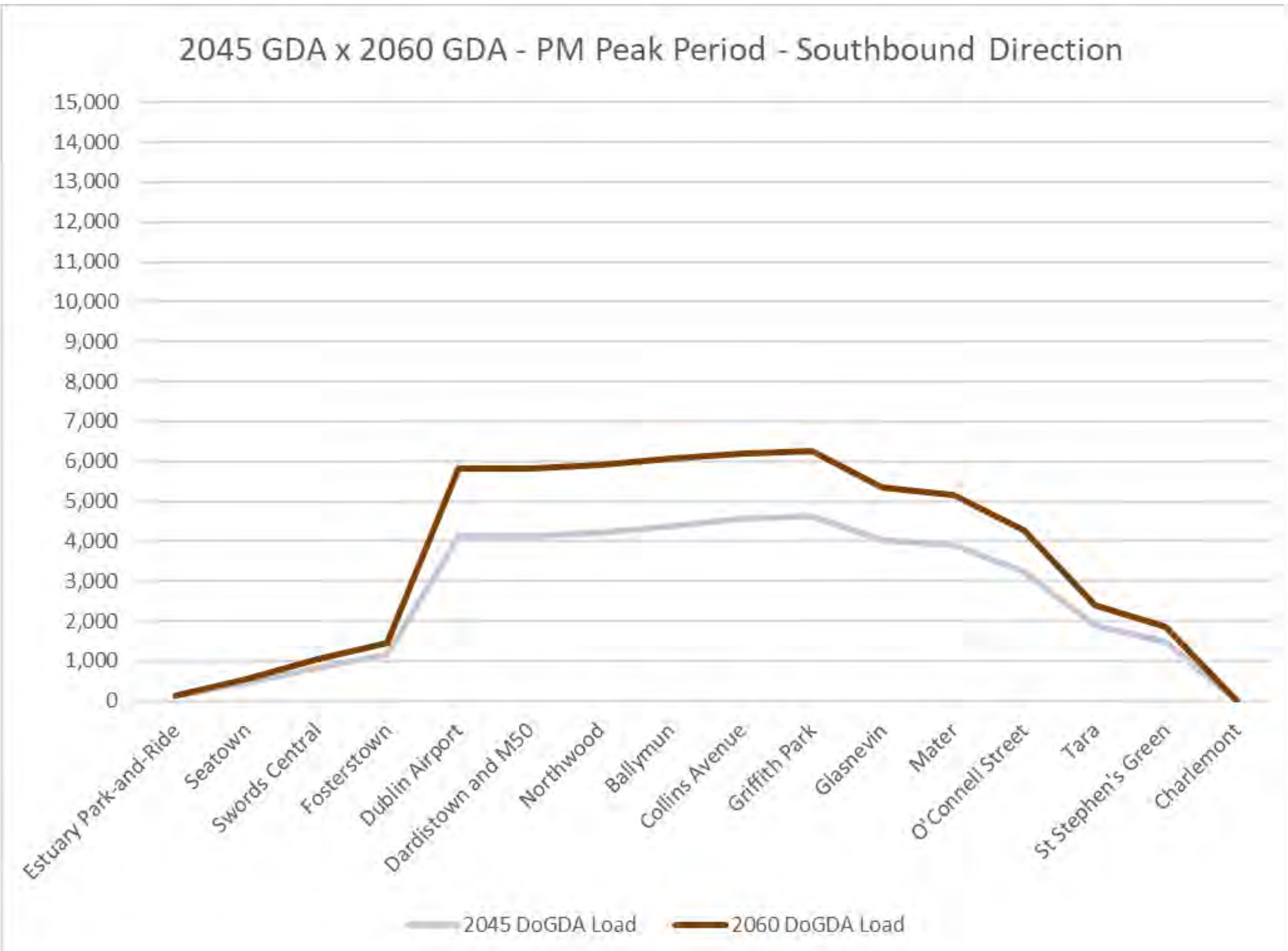


Figure 7-44: 2045 DoGDA x 2060 DoGDA Loading Profiles -PM Southbound

7.7.3 Boarding and Alighting Numbers

The 12-hour boarding and alighting totals on the MetroLink line as modelled in the two Enhanced Transport Network GDA runs are shown in Figure 7-45. Total 12-hour boardings are 151,968 in the 2045 DoGDA, rising to 196,389 in 2060 (an increase of 29%).

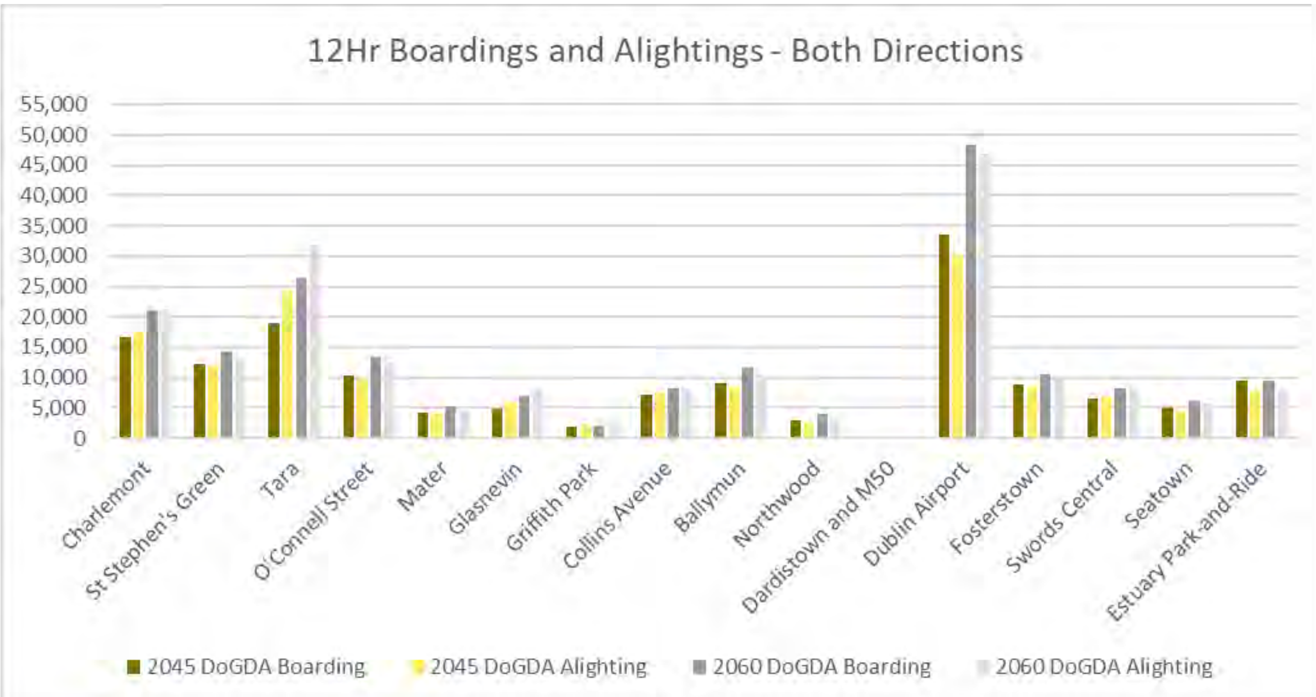


Figure 7-45: 2045 DoGDA x 2060 DoGDA Boarding and Alighting – 12hr Both Directions

GDA boarding results for each year are provided in Table 7-17. The GDA boardings and alightings at each station are compared with the BC Core run results in Figure 7-46 and Figure 7-47. “DoGDA” in the charts refers to GDA runs, and “BC Core” refers to the Business Case Core runs.

Table 7-17: 12-Hour Boarding and Alighting in Peak Periods for DoGDA runs

Year	Boarding	Difference from Core BC
2045	151,968	-3%
2060	196,389	-6%

Figure 7-46 shows a comparison of boarding and alighting totals for the 2045 DoGDA run. The overall boardings are 3% less than the BC Core boardings, with 151,968 boardings in the 2045 DoGDA results compared to 156,091 boardings in the BC.

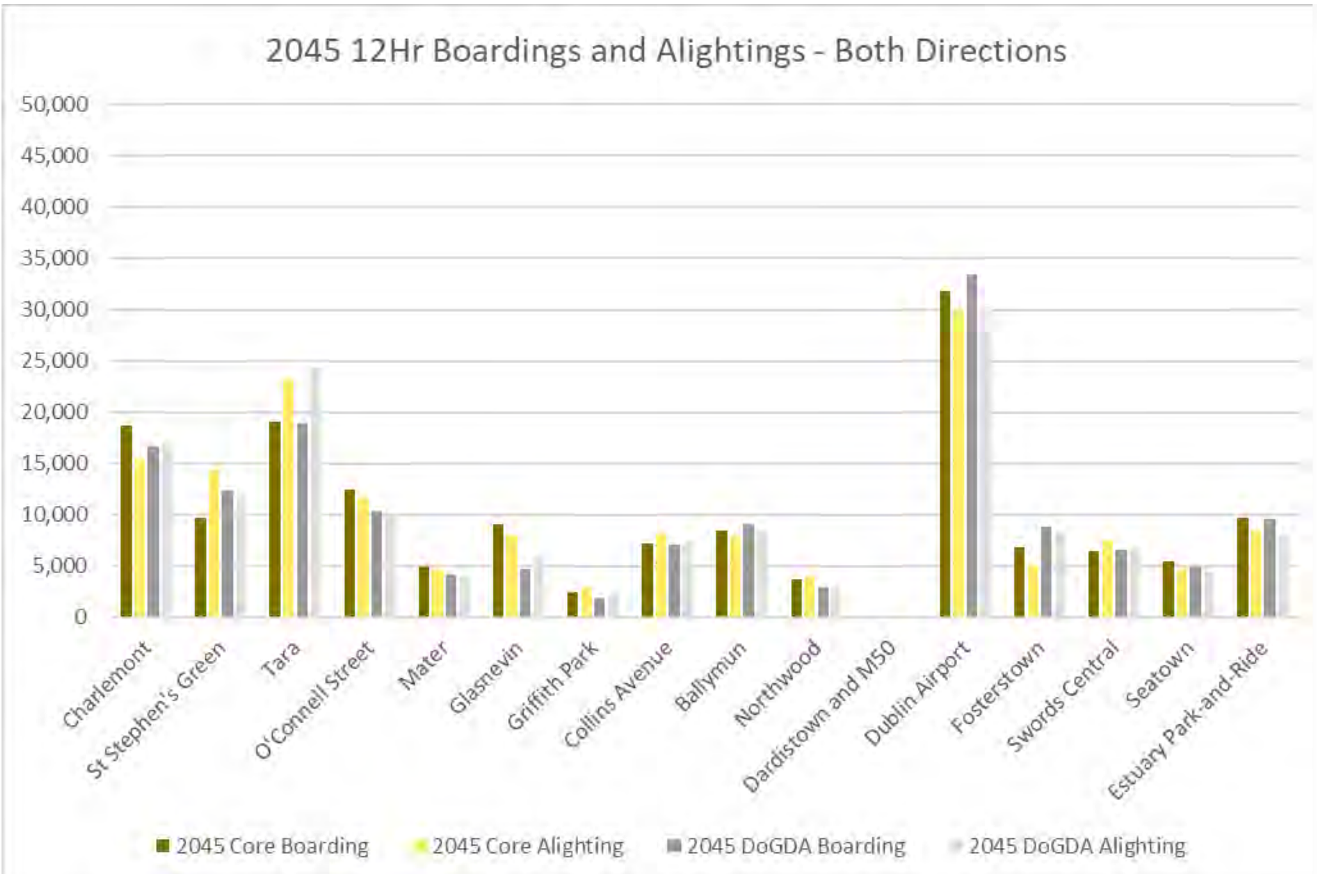


Figure 7-46: 2045 Core x 2045 DoGDA Boarding and Alighting – 12hr Both Directions

The 2060 DoGDA results are shown in Figure 7-47. There are 6% less boardings and alightings than the BC Core run. There are 196,389 boardings in the DoGDA and 208,815 in the BC Core run. The Fosterstown station shows the largest difference in alightings in 2060, with 50% more alightings in the DoGDA than the BC Core run. The Glasnevin station in 2060 has 43% less boardings and 24% less alightings than the BC Core run.

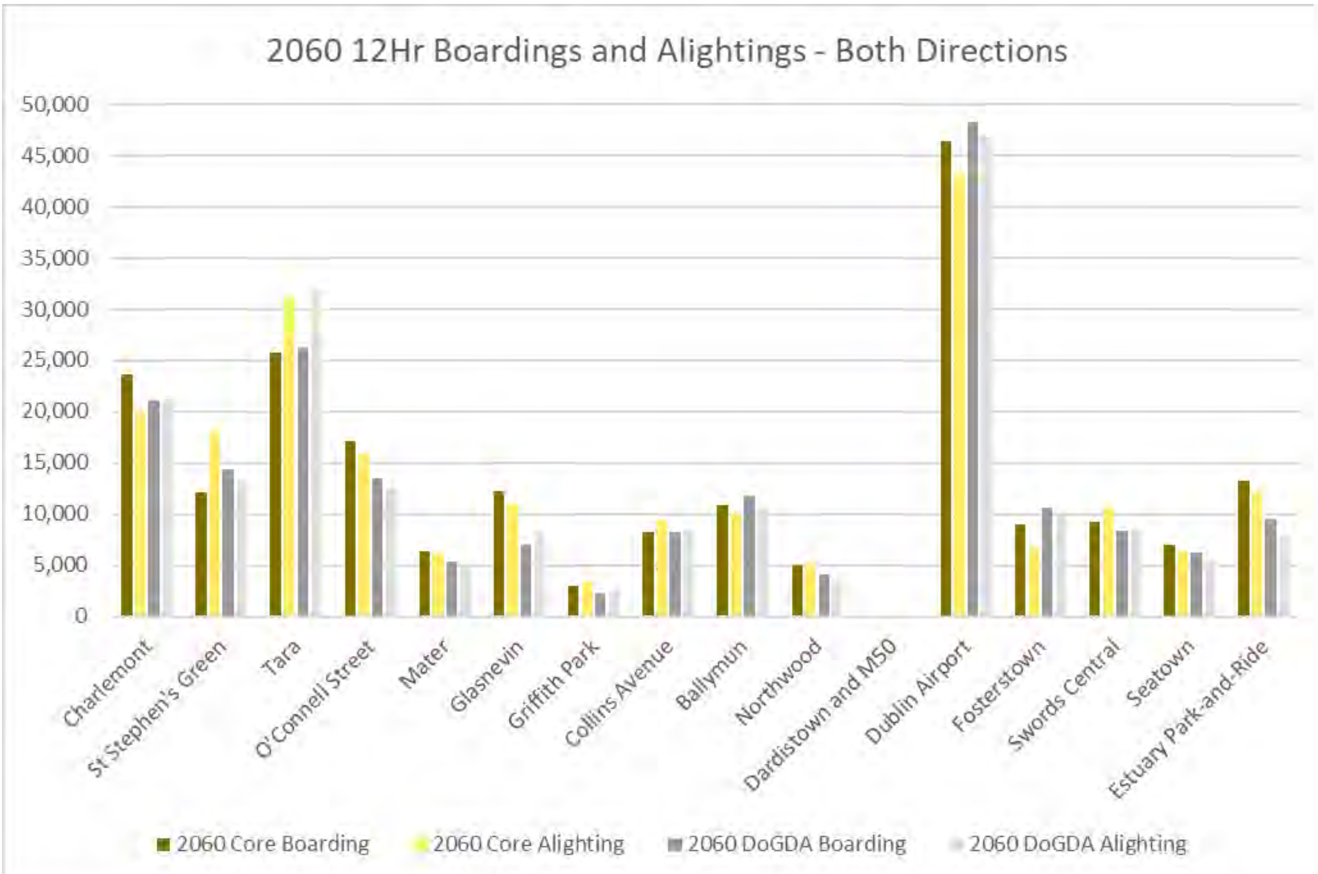


Figure 7-47: 2060 Core x 2060 DoGDA Boarding and Alighting – 12hr Both Directions

7.8 Business Case Core Runs v Sensitivity Tests

A final comparison of the Business Case Core Runs against all sensitivity tests (Slow Growth, Low Frequency, Alternative Demand, Enhanced Transport Network, and Enhanced Transport Network + Alternative Demand) was undertaken for 2030, 2045 and 2060. As expected, the constrained growth of the population in the Slow Growth scenario, and the reduced demand for travel in the Alternative Demand scenario, contributes to the reduced number of boarding passengers in these scenarios, when compared with the Core run. The Low Frequency sensitivity test presents a scenario where MetroLink does not run as often, and as such it cannot carry as many passengers throughout the day. The NDP and GDA scenarios generally see slightly lower boarding passengers due to the presence of other schemes which may attract passengers in place of using MetroLink. The NDP+ Alternative Demand sensitivity test presents the build out of the NDP in conjunction with the alternative demand scenario which sees a reduced number of boarding passengers in line with the Alternative Demand scenario.

Table 7-18 presents the total 12hr boarding figures in each scenario, as well as presenting the percentage difference between the sensitivity tests and their respective Core Run.

Table 7-18: 12hr Boarding Passengers Both Directions – All Scenarios.

Scenario	12hr Boarding	Diff from Core
2030 Core	128,182	-
2030 Low Frequency	108,160	-16%
2030 Slow Growth	123,396	-4%
2030 Alt. Demand	111,507	-13%
2030 NDP	126,647	-1%
2030 NDP+Alt Demand	112,166	-15%
2045 Core	156,091	-
2045 Low Frequency	143,539	-8%
2045 Slow Growth	142,033	-9%
2045 Alt. Demand	141,998	-9%
2045 NDP	163,318	5%
2045 GDA	151,968	-3%
2045 NDP+Alt Demand	143,913	-8%
2060 Core	208,815	-
2060 Low Frequency	184,696	-12%
2060 Slow Growth	177,755	-15%
2060 Alt. Demand	176,353	-16%
2060 GDA	196,389	-6%
2060 NDP+Alt Demand	183,370	-14%

Figure 7-48 to Figure 7-50 present the 12hr boarding figures both directions for the Core Runs and Sensitivity Tests in 2030, 2045 and 2060 respectively.

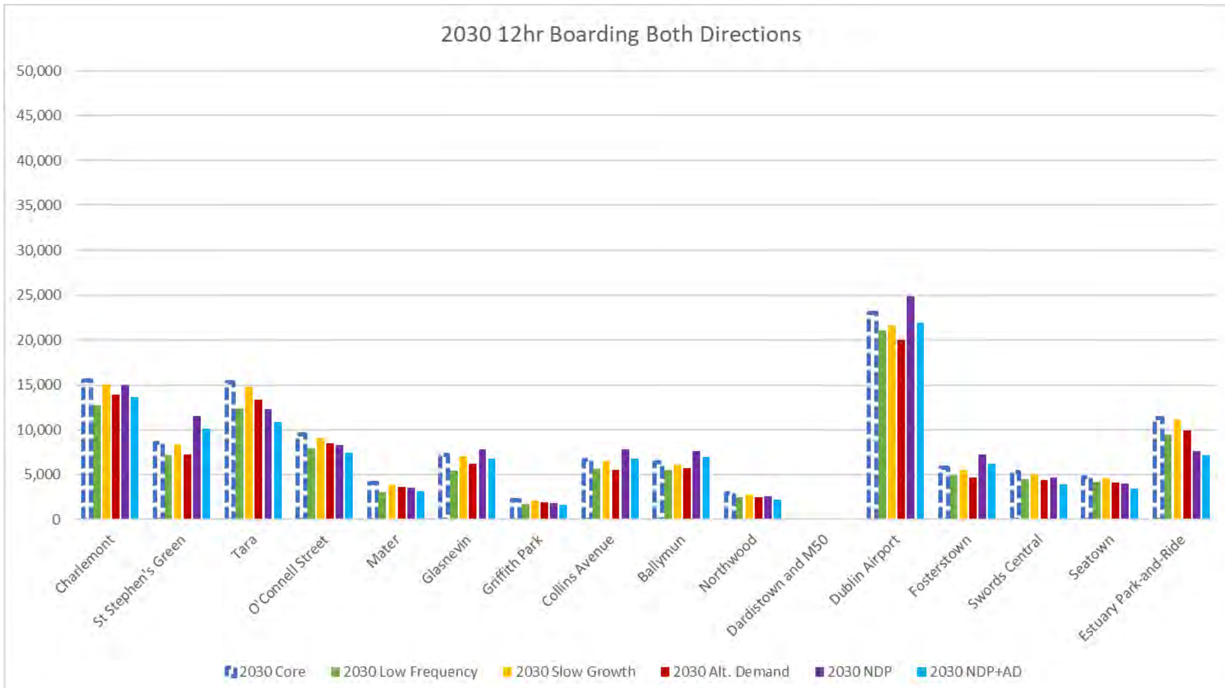


Figure 7-48: 2030 Boarding Passengers – 12hr Both Directions

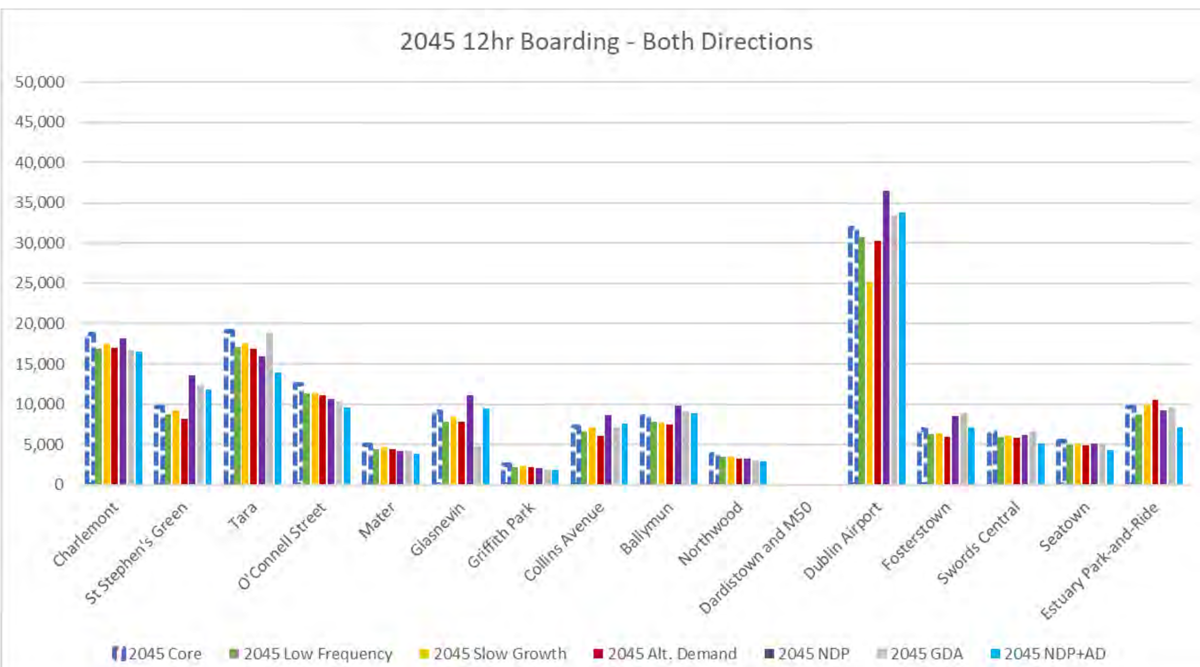


Figure 7-49: 2045 Boarding Passengers – 12hr Both Directions

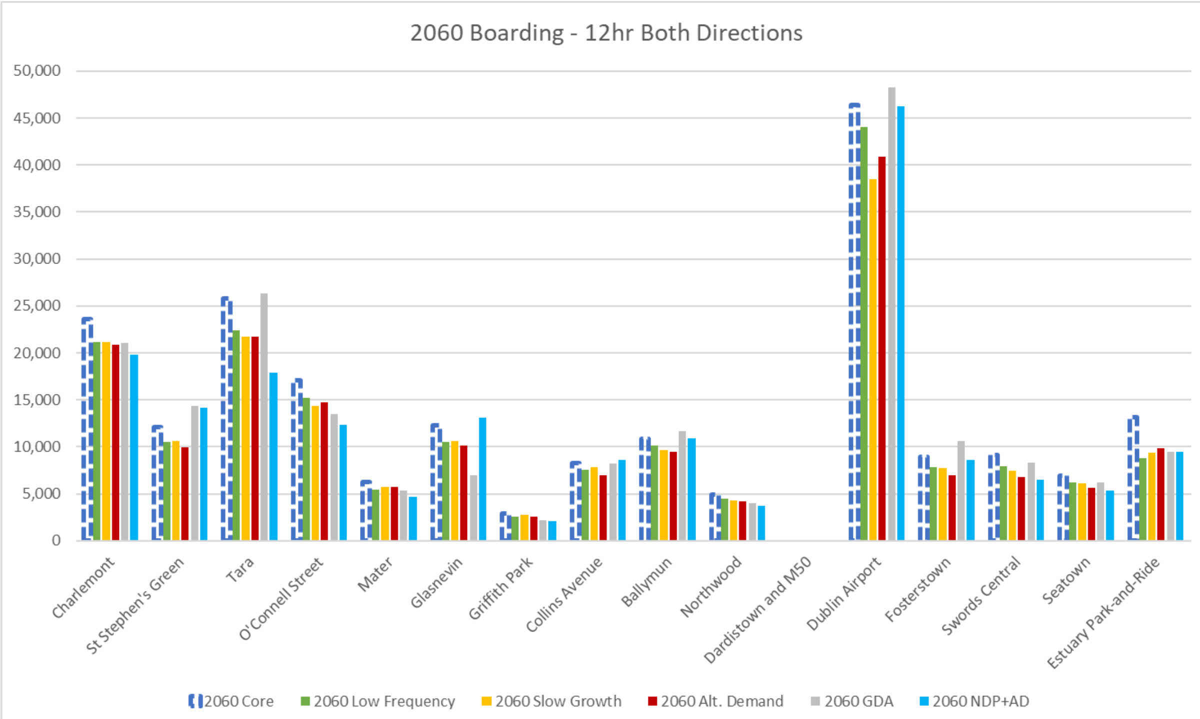


Figure 7-50: 2060 Boarding Passengers – 12hr Southbound

8. Model Assessment

8.1 Model Benefits

In the 12hr period, the total number of boarding passengers increases by 22% from 2030 to 2045, from 128,182 passengers to 156,091 passengers respectively. This further increases to 209,815 boarding passengers in 2060, representing an increase of 34% from 2045 to 2060.

From the modelling results presented, the maximum line flow across all years in the AM peak period southbound is present at Glasnevin station, with approximately 10,400 passengers in 2030, 11,800 passengers in 2045, and 14,900 passengers in 2060. This is as a result of the opportunity of interchange with the rail network. In the PM peak period southbound, the maximum line flow in all years is present at Griffith Park station, with approximately 4,000 passengers in 2030, approximately 4,600 passengers in 2045 and 6,500 passengers in 2060.

The results from the MetroLink modelling exercise indicated the following:

- The strategic park and ride site facilitates significant volumes of people primarily along the M1 corridor (Balbriggan, Drogheda etc.) and to a lesser extent, from towns from the north of Fingal (Skerries, Donabate) and from the N2 corridor to access the MetroLink and reducing the length of their private car trips and removing trips from other parts of the strategic road network;
- Reduces the public transport journey time from Swords, Dublin Airport and Ballymun to/from the City Centre;
- Reduces private car travel along the length of the corridor of the MetroLink, but in particular in areas such as Swords and Dublin Airport;
- Increases in public transport usages along other corridors such as the rail line to/from Cork, Maynooth and the Luas Green and Red Lines, as well as the DART along the southern side of the city; and
- The transfer of people from bus to MetroLink from Swords, Dublin Airport and from the Ballymun areas.

8.1.1 Economic Benefits

TUBA (Transport User Benefit Appraisal) software has been utilised to assess the potential economic benefits to the surrounding Highways (HW) and Public Transport network (PT) when MetroLink is in place. The results of this appraisal have been illustrated per zone in the following figures, showing the PT, HW and Total (PT and HW combined) benefits in both 2030 and 2045.

In terms of PT benefits, zones that see benefits of between €20million and €50million in 2030 and 2045 are located at Dublin Airport and Estuary, where the Park and Ride facility will be situated. In the zones immediately surrounding the scheme alignment, there are PT benefits of between €100,00 and €1million in both 2030 and 2045.

Zones at Estuary and further north along the M1 experience a reduction of up to €5million in HW benefits. This is a result of the presence of the Park and Ride facility at Estuary station which encourages those in the surrounding area to drive to the facility to interchange with MetroLink. As a result, there may be increases in traffic flow and delays experienced. However, these disbenefits decrease in 2045. The zone at Dublin Airport experiences an increase of up to €40million in HW benefits in both 2030 and 2045, as a large volume of people will choose to use MetroLink rather than private vehicles.

In total, Dublin Airport sees an increase of over €50million in benefits, in both 2030 and 2045. A reduction in benefits of up to €100,000 along the DART line to the east of the alignment, when considering Origins, however this improves in 2045. Benefits of up to €20million can also be see in the areas beyond the M50, showing the far-reaching economic benefits of MetroLink.

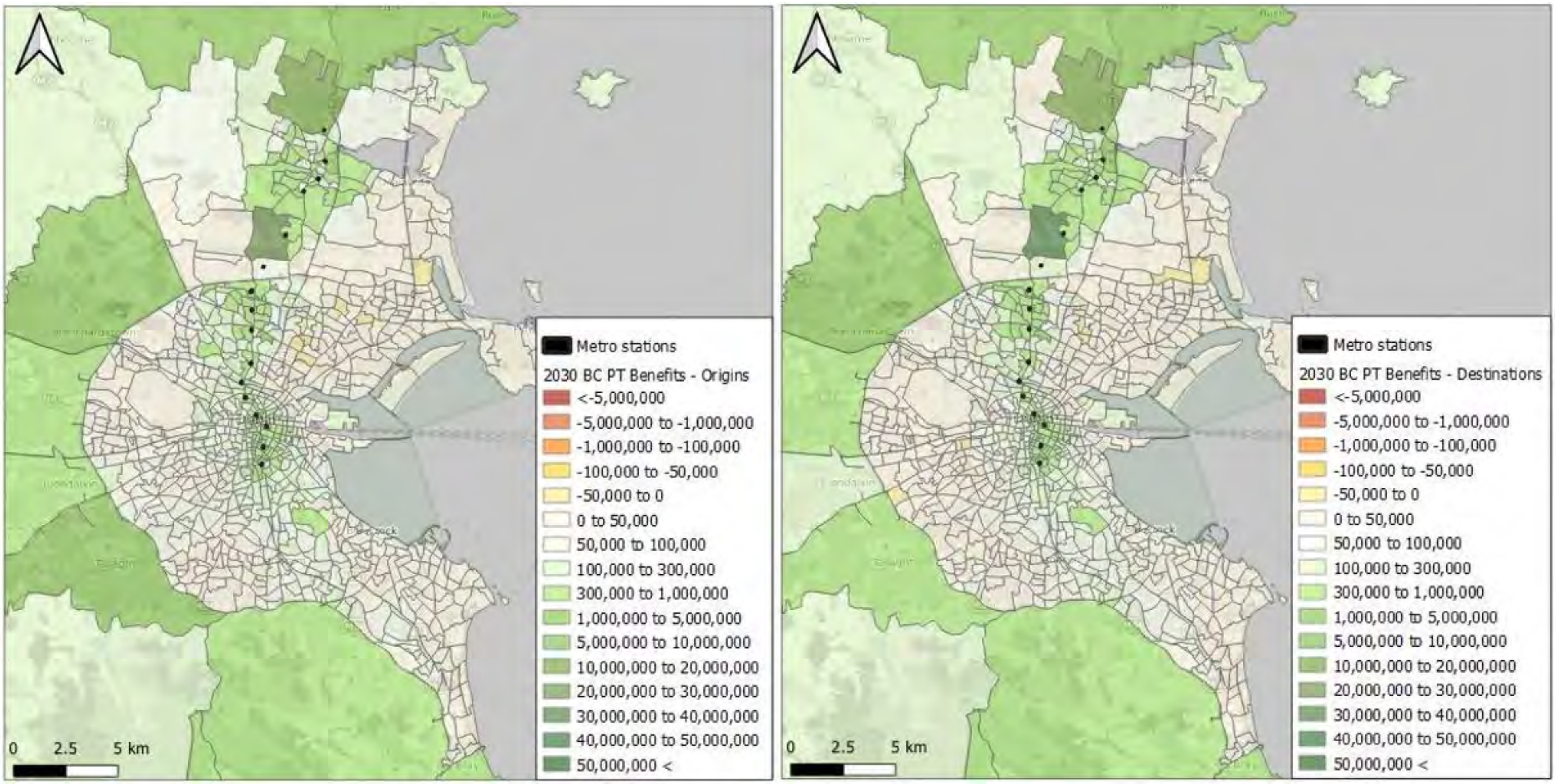


Figure 8-1: 2030 PT Benefits- Origins and Destinations

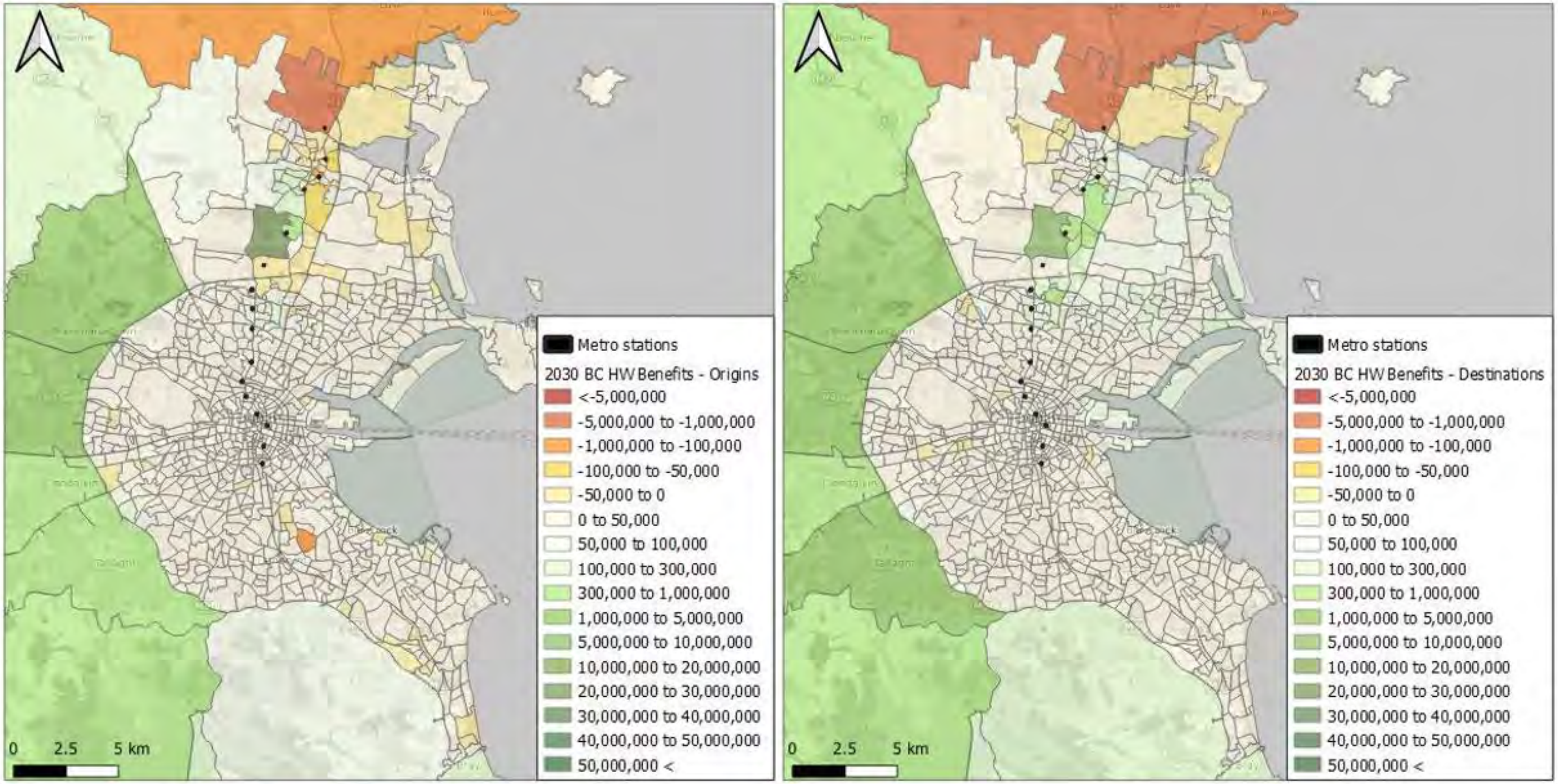


Figure 8-2: 2030 HW Benefits – Origins and Destinations

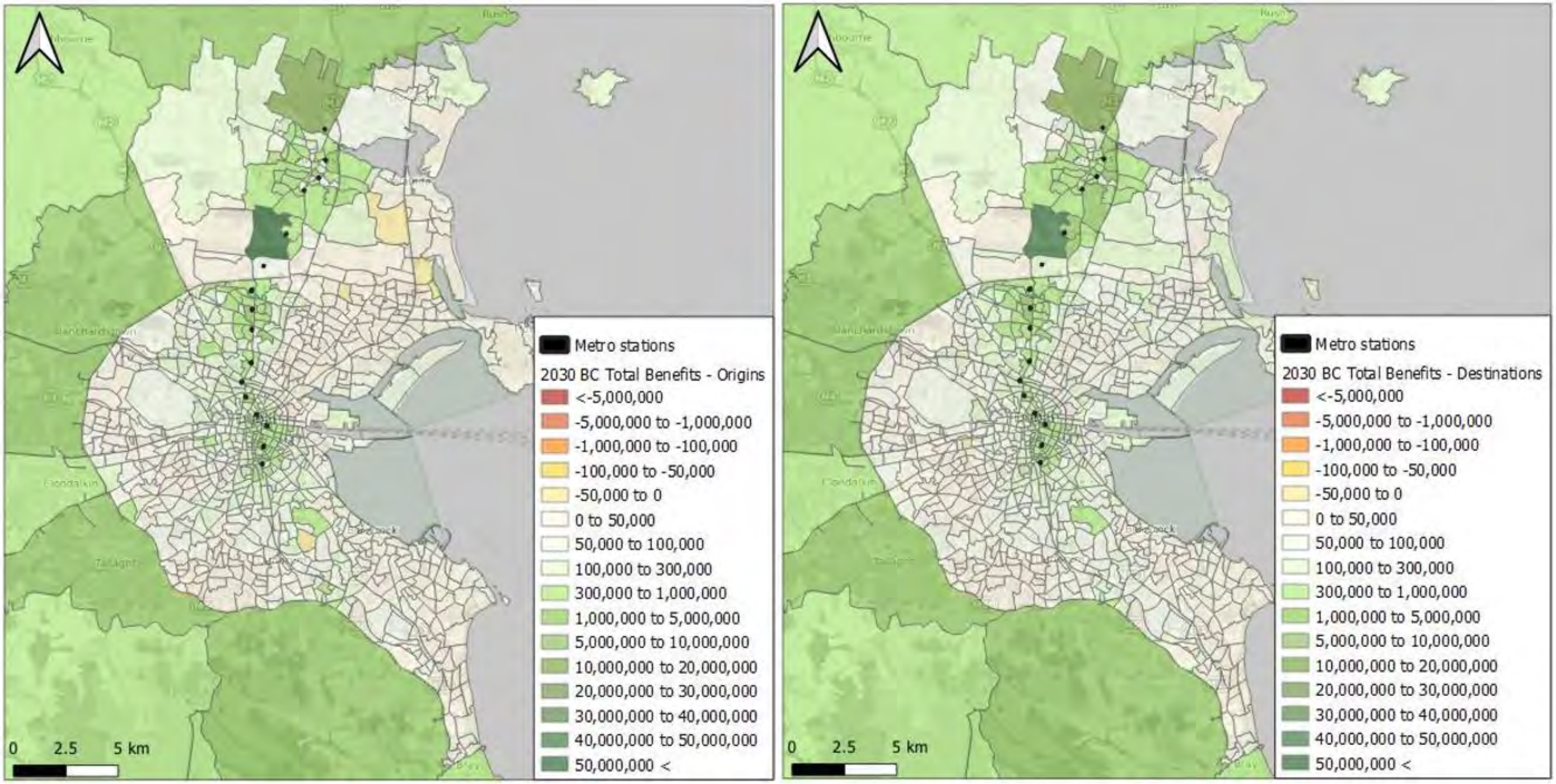


Figure 8-3: 2030 Total Benefits – Origins and Destinations

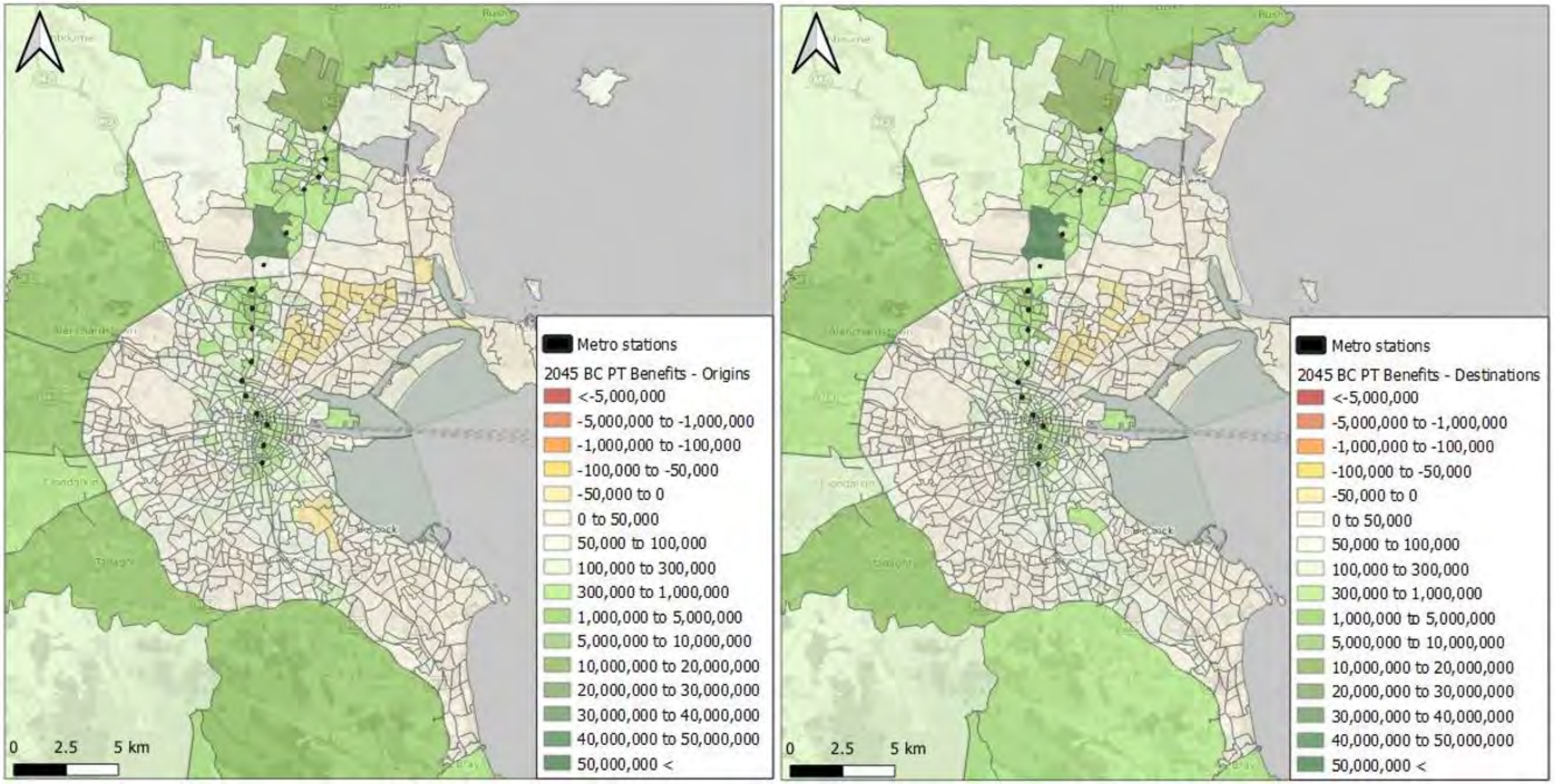


Figure 8-4: 2045 PT Benefits – Origins and Destinations

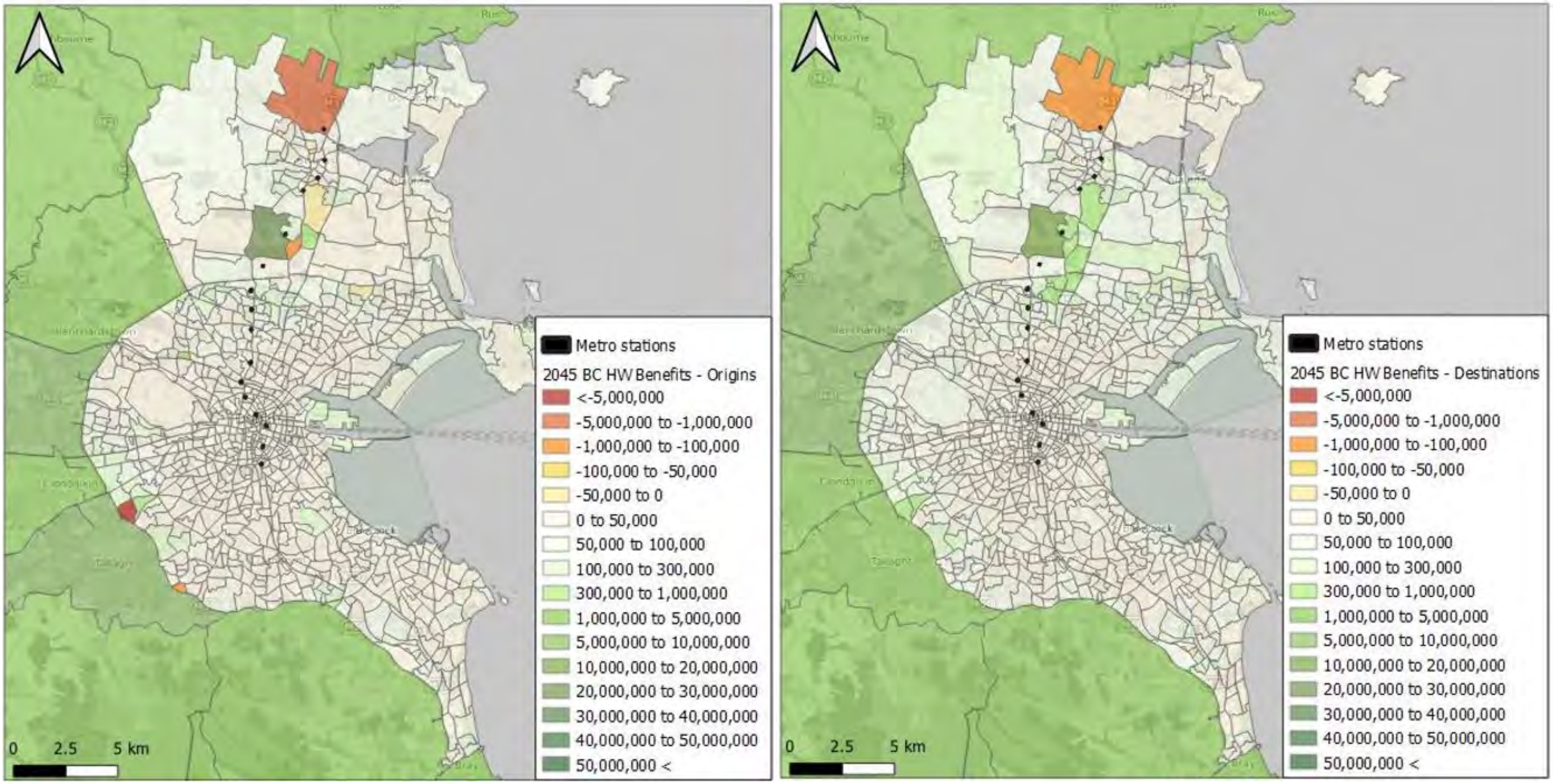


Figure 8-5: 2045 HW Benefits – Origins and Destinations

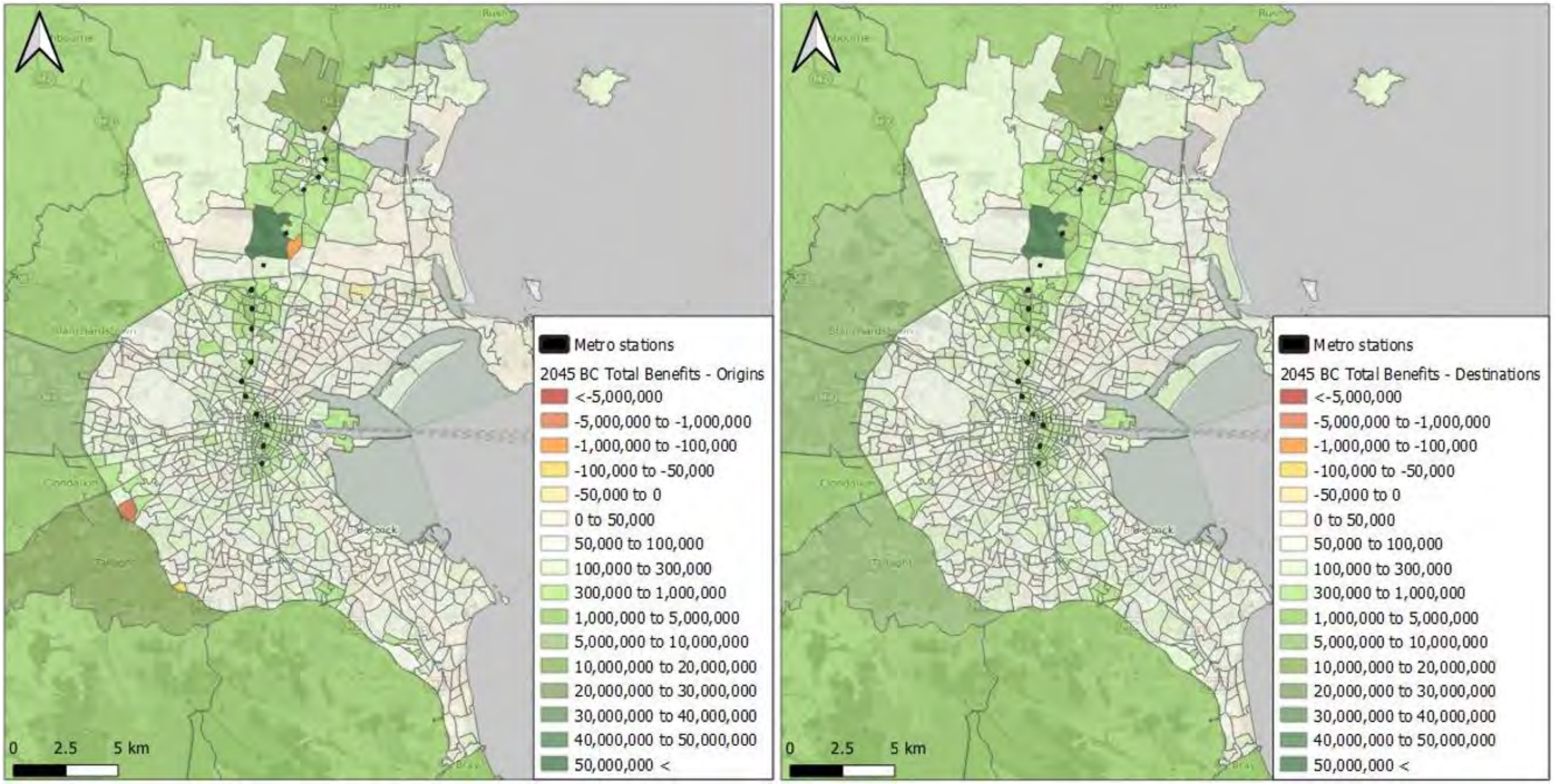


Figure 8-6: 2045 Total Benefits – Origins and Destinations

8.1.2 Health Benefits

The NTA Health Appraisal Module was utilised to monetise the impact of physical activity on premature deaths and absenteeism, which results from changes in the levels of cycling. The tools that it employs are Cube Voyager and Microsoft Excel.

The Cube Voyage element aggregates transport model outputs to 24 hours and calculates the average walking and cycling times and distances, which are then used in Excel spreadsheet. Currently end to end activity mode trips are included in this process with walk leg for public transport mode trips included.

The Excel spreadsheet monetises these impacts based on the relative number of lives saved, in accordance with the HEAT Tool developed by the World Health Organisation (WHO), and reduction in absenteeism as suggested in the Active Travel 'toolkit' developed by the Department for Transport (DfT, UK).

The results outlined below combine both Active Mode travel trips (end to end trips) and walk-leg trips to/from Public Transport.

Table 8-1 summarises the model inputs for the Do Minimum and Do Scheme scenarios for 2030 year. Results for Physical Activity are summarised in Table 8-2 and Table 8-3 presents results for absenteeism.

Model inputs for year 2045 are summarised in Table 8-4. Results for Physical Activity are outlined in Table 8-5 and Table 8-6 presents results for absenteeism.

Table 8-1: 2030 Business Case - Model Inputs

Mode	Model Inputs	Do Minimum Scenario	Do Scheme Scenario
Walking	Journeys per day	2,264,383	2,292,320
	Average Distance (km)	1.56	1.59
	Average Time (mins)	18.59	18.92
Cycling	Journeys per day	157,198	153,203
	Average Distance (km)	4.06	4.02
	Average Time (mins)	14.69	14.49

Table 8-2: 2030 Business Case – Physical Activity Calculations

Impact	Description	Cyclists	Walkers
Impact on New Users	Expected deaths among new users	-4.1745	29.1946
	Relative Risk FY	0.0336	0.0217
	Lives saved FY	-0.1404	0.6332
	Value (€ per year)	**€ -317,054.17**	**€ 1,429,881.90**

Impact on existing users (if route Journey Time changes)	Difference in minutes	-0.092	0.131
	Difference relative risk	0.000	0.000
	Deaths amongst existing users	158.747	2,314.960
	Lives saved FY	-0.074	0.876
	Value (€ per year)	**€ -166,414.89**	**€ 1,977,578.13**
Net Impact per annum		**€ -509,483.89**	**€ 3,407,460.03**

Table 8-3: 2030 Business Case - Absenteeism

Description	Result
Output lost from day leave	€ 193.73
Change in absenteeism (days)	2,537
Monetised costs	€ 491,486.07

Table 8-4 :2045 Business Case - Model Inputs

Mode	Model Inputs	Do Minimum Scenario	Do Scheme Scenario
Walking	Journeys per day	2,591,119	2,633,804
	Average Distance (km)	1.58	1.62
	Average Time (mins)	18.81	19.22
Cycling	Journeys per day	185,718	181,119
	Average Distance (km)	4.23	4.19
	Average Time (mins)	15.09	14.93

Table 8-5: 2045 Business Case - Physical Activity Calculations

Impact	Description	Cyclists	Walkers
Impact on New Users	Expected deaths among new users	-4.8050	44.6062
	Relative Risk FY	0.0347	0.0220
	Lives saved FY	-0.1665	0.9828
	Value (€ per year)	**€ -376,021.31**	**€ 2,219,346.01**

Impact on existing users (if route Journey Time changes)	Difference in minutes	-0.074	0.162
	Difference relative risk	0.000	0.001
	Deaths amongst existing users	187.350	2,648.062
	Lives saved FY	-0.070	1.245
	Value (€ per year)	**€ -157,119.31**	**€ 2,810,530.56**
Net Impact per annum		**€ -573,247.47**	**€ 5,029,876.57**

Table 8-6: 2045 Business Case - Absenteeism

Description	**Result**
Output lost from day leave	€ 193.73
Change in absenteeism (days)	4,052
Monetised costs	€ 784,974.23

The results from the Health Appraisal Tool for the MetroLink opening year 2030 show a combined net impact per annum (physical activity and absenteeism) of approximately €3.41 million. For year 2045, the combined net impact per annum is approximately €5.28 million. It is worth mention that the disbenefit associated to cyclists for both years accounts for end to end trips only. We acknowledge that the Metrolink scheme is likely to reduce, in some level, end to end active mode trips however, we understand that the scheme is also likely to enhance first and last leg active mode trips to and from the stations' catchment area.

8.2 Sensitivity Test Benefits

Table 8-7 presents a comparison of the breakdown of the Present Value of Benefits in the Business Case Core Run and the sensitivity tests that have been undertaken. The benefits received in the Slow Growth and the Alternative Demand scenarios are approximately €2billion less than that of the Core scenario. This is due to the constrained growth of the population in the Slow Growth scenario, and the reduced demand for travel in the Alternative Demand scenario, contributing to the reduced number of boarding passengers in these scenarios, as mentioned in section 7.7.

The Low Frequency sensitivity test was not assessed, however similar levels of benefits can be expected for the Road Network Users, however benefits to Public Transport Users would see a further reduction when compared to the Core scenario.

The Complimentary Infrastructure scenario sees a reduction of approximately €3billion in benefits to Road Network Users as a result of the presence of other schemes in this scenario.

The combined NDP +Alternative Demand scenario has the lowest total benefits of €11.83 billion.

Table 8-7: Comparison of Benefits – Core x Sensitivity Test Scenarios (in Billions)

Scenario	Core	Complimentary Infrastructure	Slow Growth	Alternative Demand	NDP + Alternative Demand
Public Transport Users	9.4	9.4	8.3	8.1	9.1
Road Network Users	5.5	2.7	4.5	4.7	2.7
Safety	0.03	0.03	0.04	0.03	0.03
PV Benefits	**14.93**	**12.13**	**12.84**	**12.83**	**11.83**

8.3 Model Constraints

As highlighted in Section 5 Model Validation/Calibration, there are some constraints present within the model. The NTA model does not achieve the UK TAG recommendation of 0.2% convergence, which can in turn affect convergence levels within the MetroLink model. The following details the constraints present within the MetroLink model, and the solutions provided to improve these.

8.3.1 Park and Ride

The outputs from the ERM v3 suggest that the model does not constrain use of the Estuary Park and Ride site to match the available parking capacity. In many runs the solutions give additional MetroLink demand beyond what the car park capacity supports. Although this happens in some AM peak runs, it also occurs more extensively in LT period runs where arriving demand at the Park and Ride site in that interval exceeds the spare capacity available after AM trips have taken spaces.

This ‘excess demand’ may be unable to use MetroLink as the car park capacity should limit the demand. In order to understand the significance of this we have quantified the extent of that demand and its impact on MetroLink flows. The main model runs (Business Case 2030 and 2045, NDP 2030 and GDA 2045) were analysed.

The Park and Ride model works with tours (outward from home trips in a time period, followed by a return to home later in the day). Any trip which does not fit into the car park capacity will affect both outward and returning time periods, with MetroLink trips from Estuary in the former and back to Estuary in the latter. The number of excess tours is 1,600-1,720 in some runs (for 2030 Core Run and 2045 DoNDP where the AM period overloads the carpark) and about 600 in the other 2 cases (where spare capacity at the end of the AM peak is over-used by LT period outward trips).

The excess trips amount to 1,050 to 3,422 one-way MetroLink trips per day. When set against a daily total of 128,000 to 163,000 trips, the overestimate of usage due to lack of Park and Ride capacity constraint is very small at 0.8%-2.1% of the total MetroLink trips. The low percentage reflects the fact that the majority of MetroLink trips are between Dublin Airport and City Centre.

To improve on this, capped DoGDA scenarios were run, which gave outputs reflecting the correct available capacity of the Park and Ride facility, as well as conducting a penultimate loop analysis, as below.

8.4 Penultimate Loop Analysis

8.4.1 Description

The ERM model goes through various loops as it converges towards an output. There will be differences in the outputs from loop to loop, the smaller the difference in between loops the better the convergence. Section 5.2 details the convergence on the model run. The convergence levels reported are based on the differences between the penultimate and final runs, with the higher differences between the final and the penultimate runs giving a higher GAP number. If the model was run for a large number of loops it should eventually reach a point where the difference between the penultimate and final run is very small, this converged answer lies close to the penultimate and final loop results. In order to understand the potential impact that this range in outputs created by the difference between the penultimate and final loop we have reviewed and assessed the results provided by the penultimate loop model runs for the core business case. Model outputs for all time periods can be found in Appendix C.

8.4.2 Penultimate and Final Loop Comparisons

Line flow differences between the penultimate and final loop runs for the AM and PM peak periods as well as 12hr period boarding and alighting differences for the Business Case Core runs for years 2030 and 2045 are presented below.

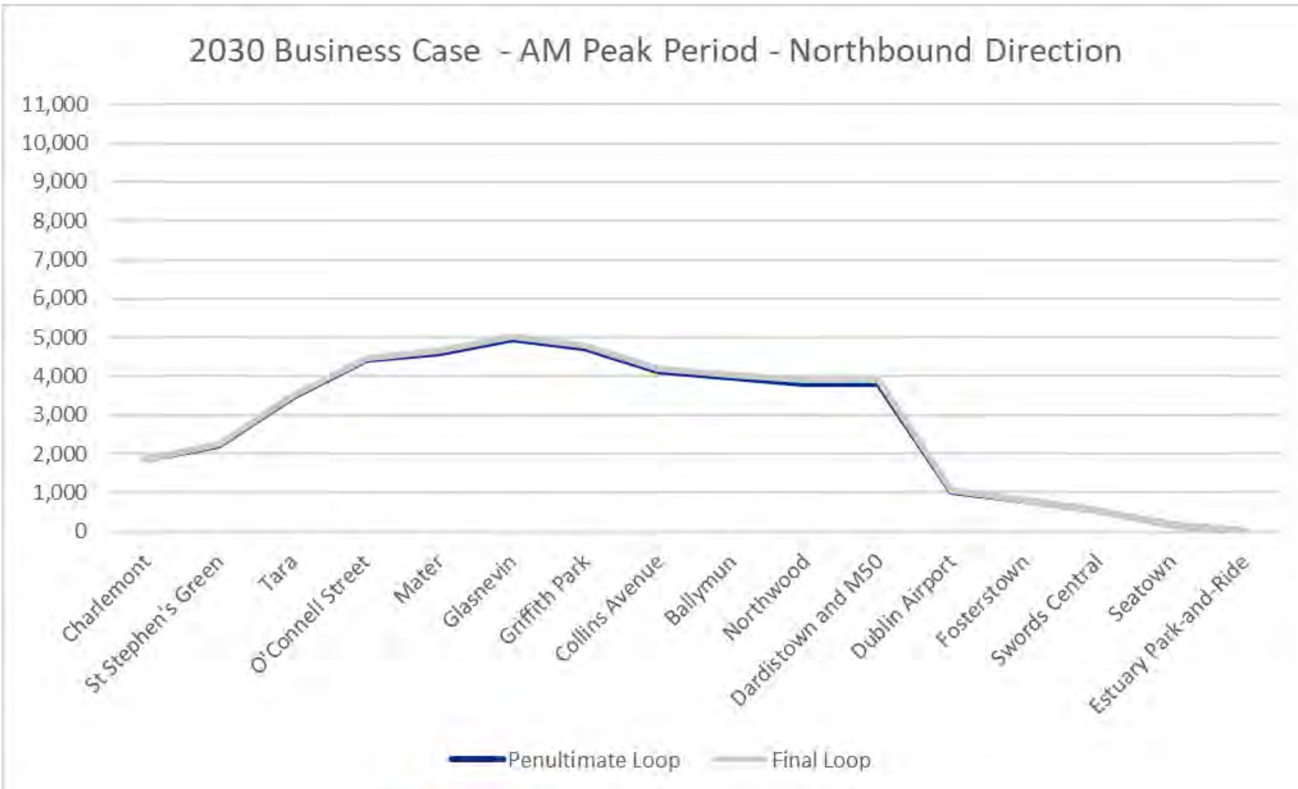


Figure 8-7: Line Flow Comparison, AM Peak 2030 Business Case Northbound Direction

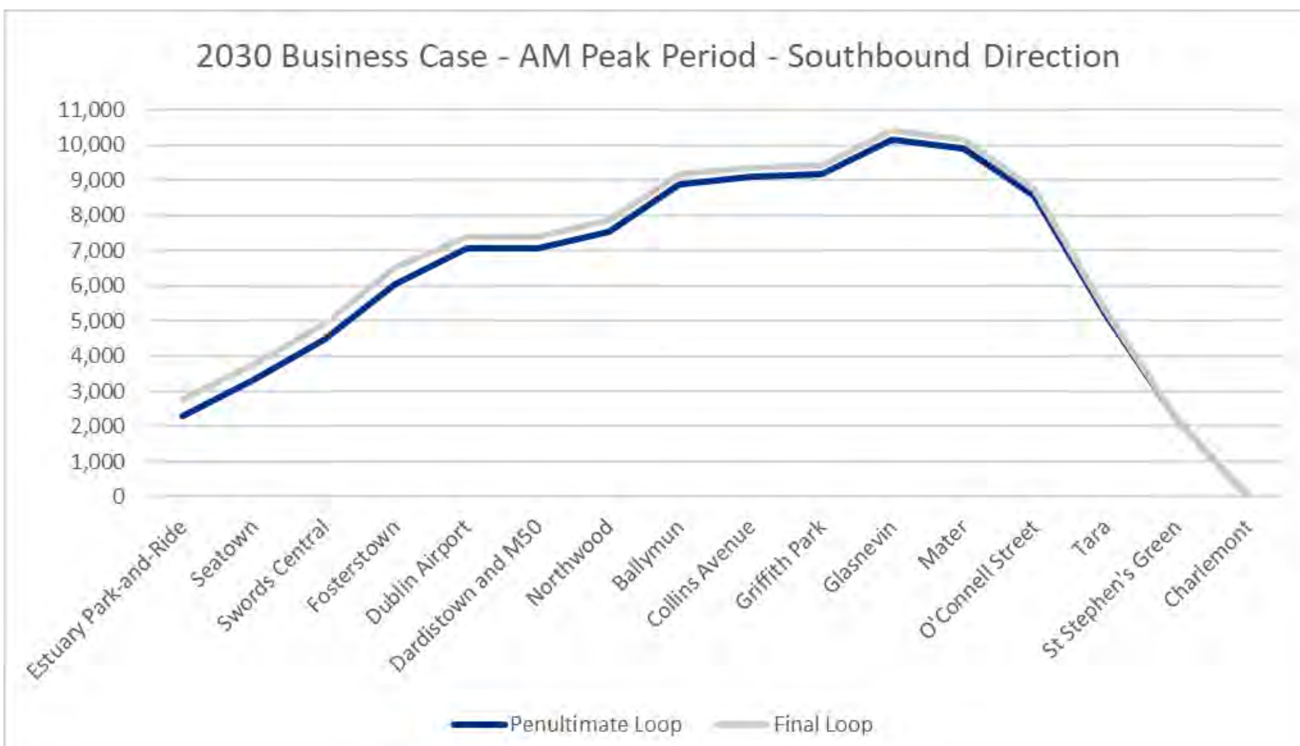


Figure 8-8: Line Flow Comparison, AM Peak 2030 Business Case Southbound Direction

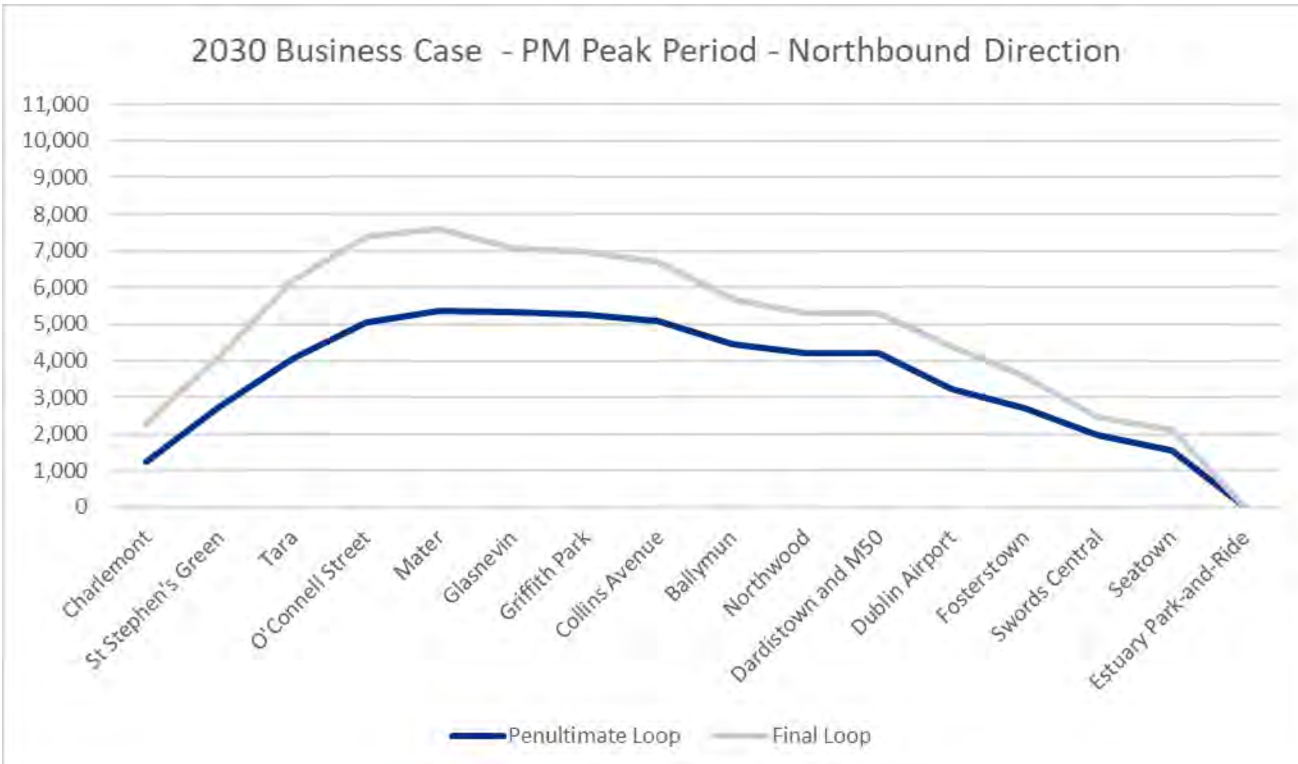


Figure 8-9: Line Flow Comparison, PM Peak 2030 Business Case Northbound Direction

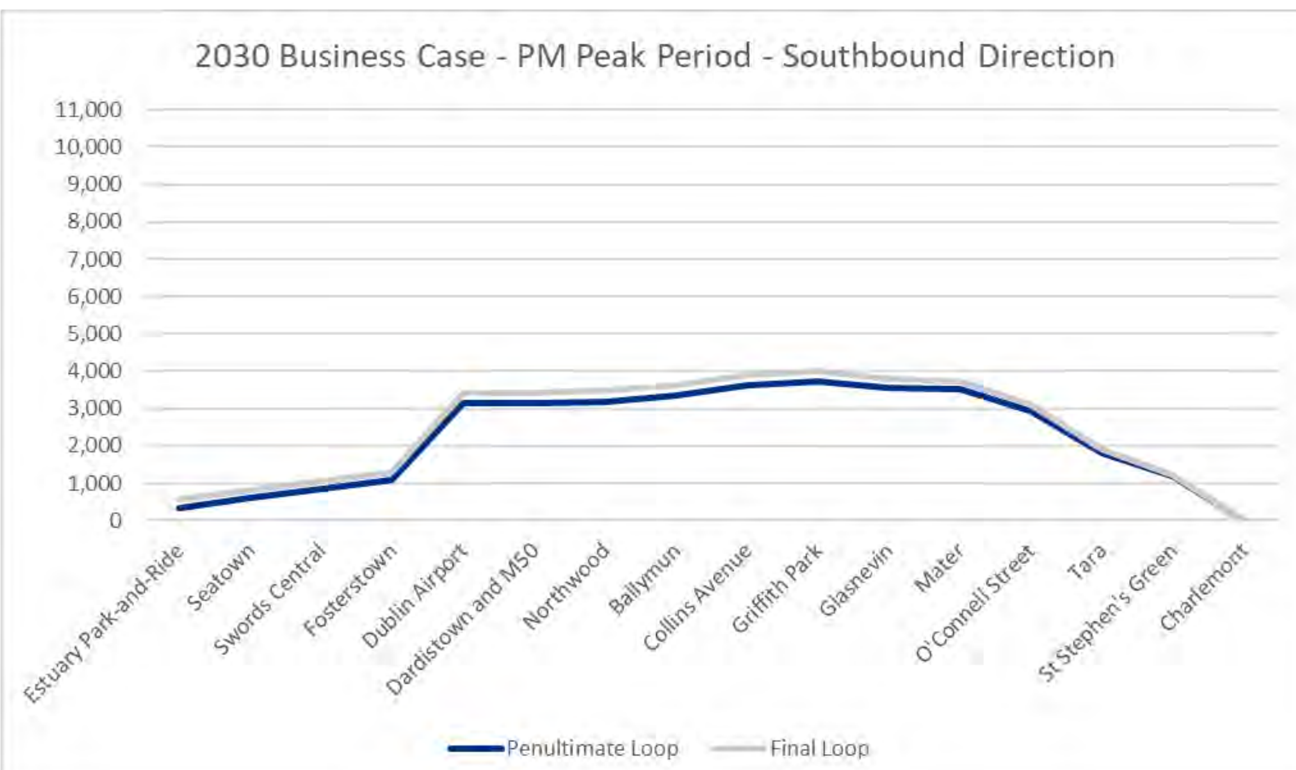


Figure 8-10: Line Flow Comparison, PM Peak 2030 Business Case Southbound Direction

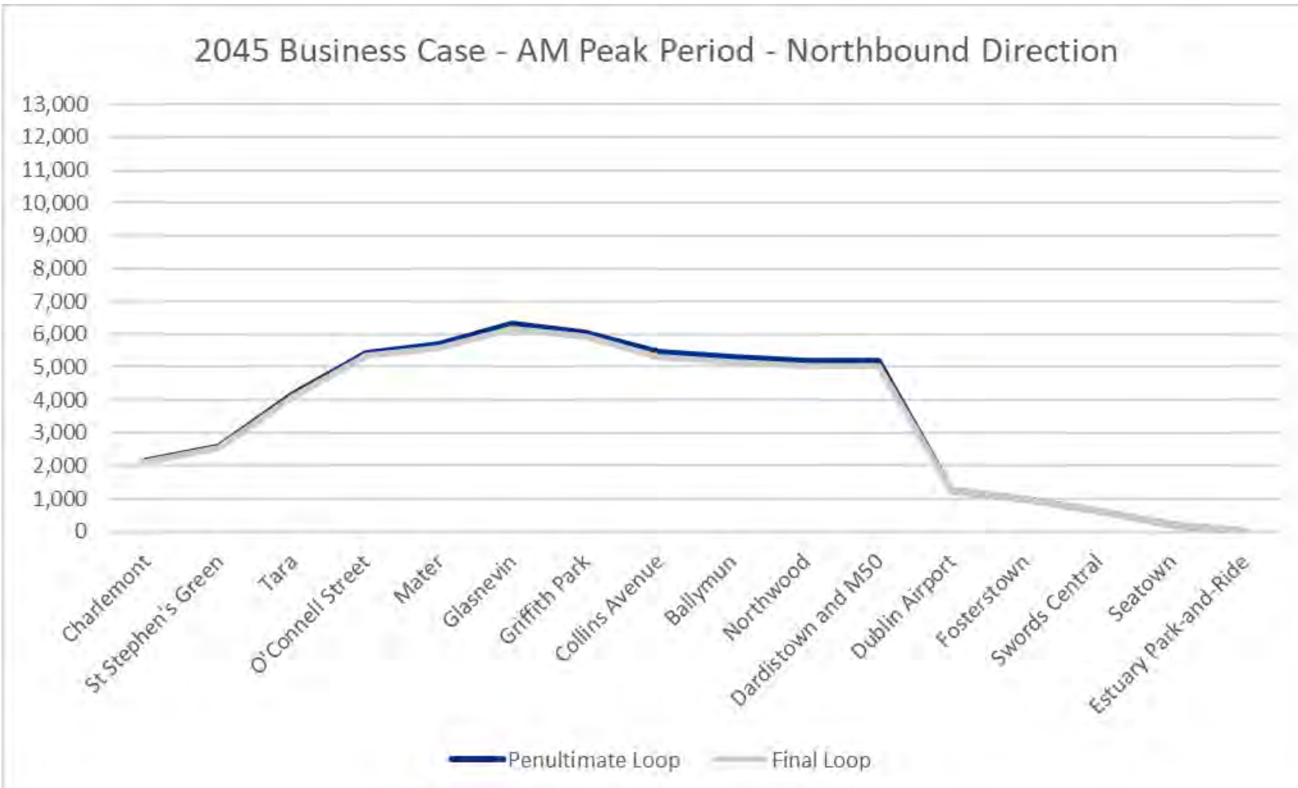


Figure 8-11: Line Flow Comparison, AM Peak 2045 Business Case Northbound Direction

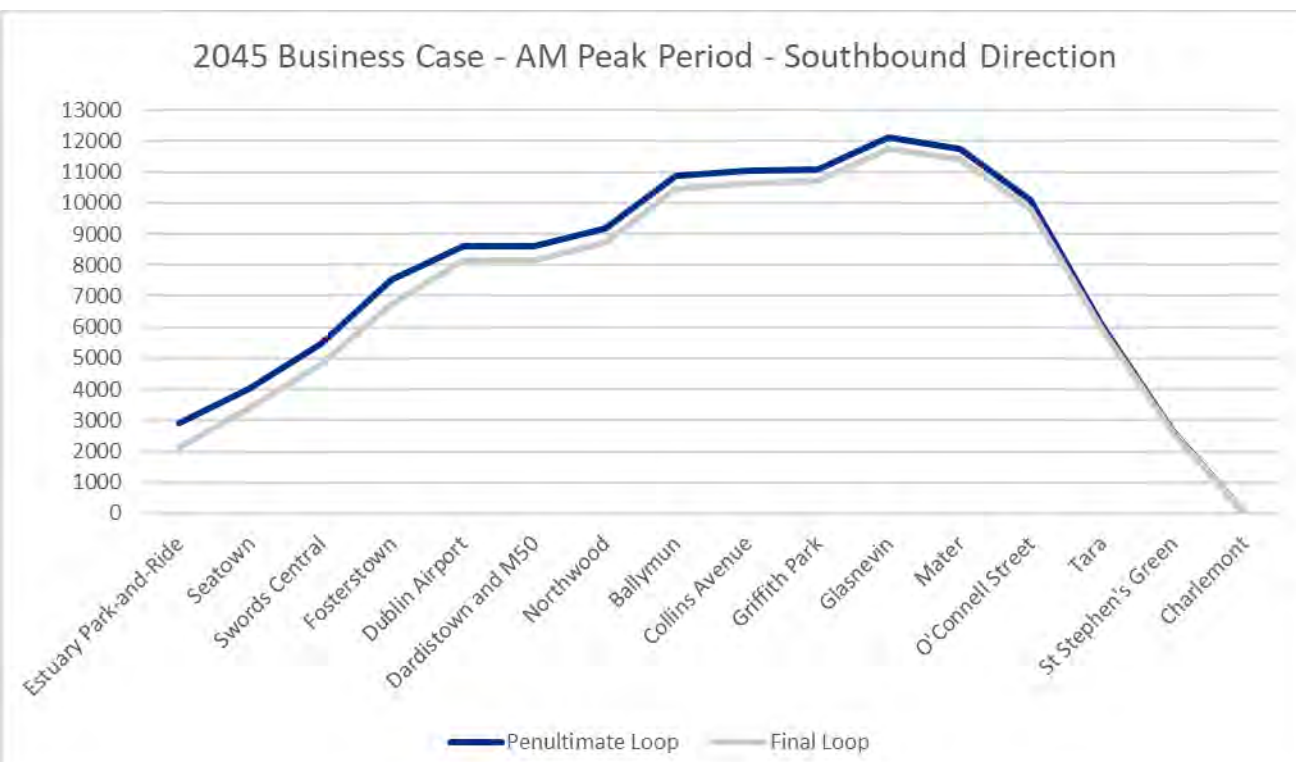


Figure 8-12: Line Flow Comparison, AM Peak 2045 Business Case Southbound Direction

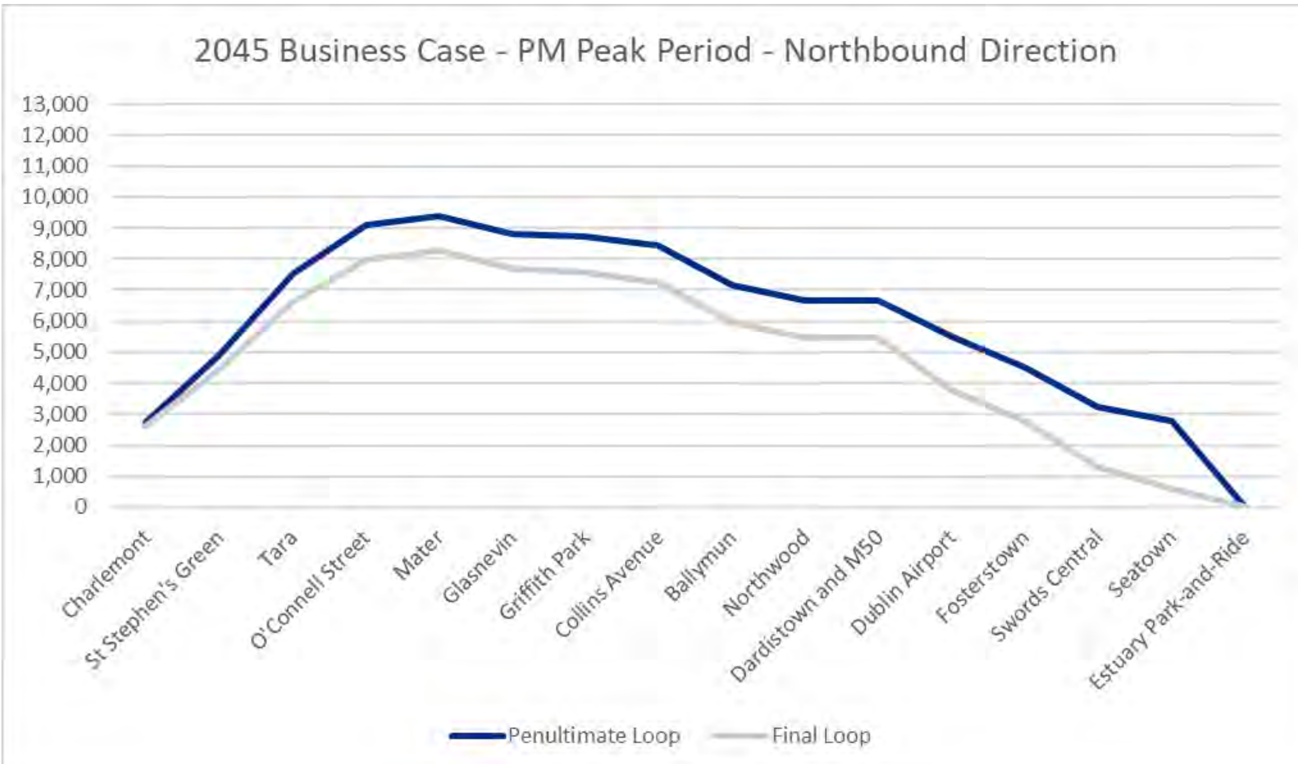


Figure 8-13: Line Flow Comparison, PM Peak 2045 Business Case Northbound Direction

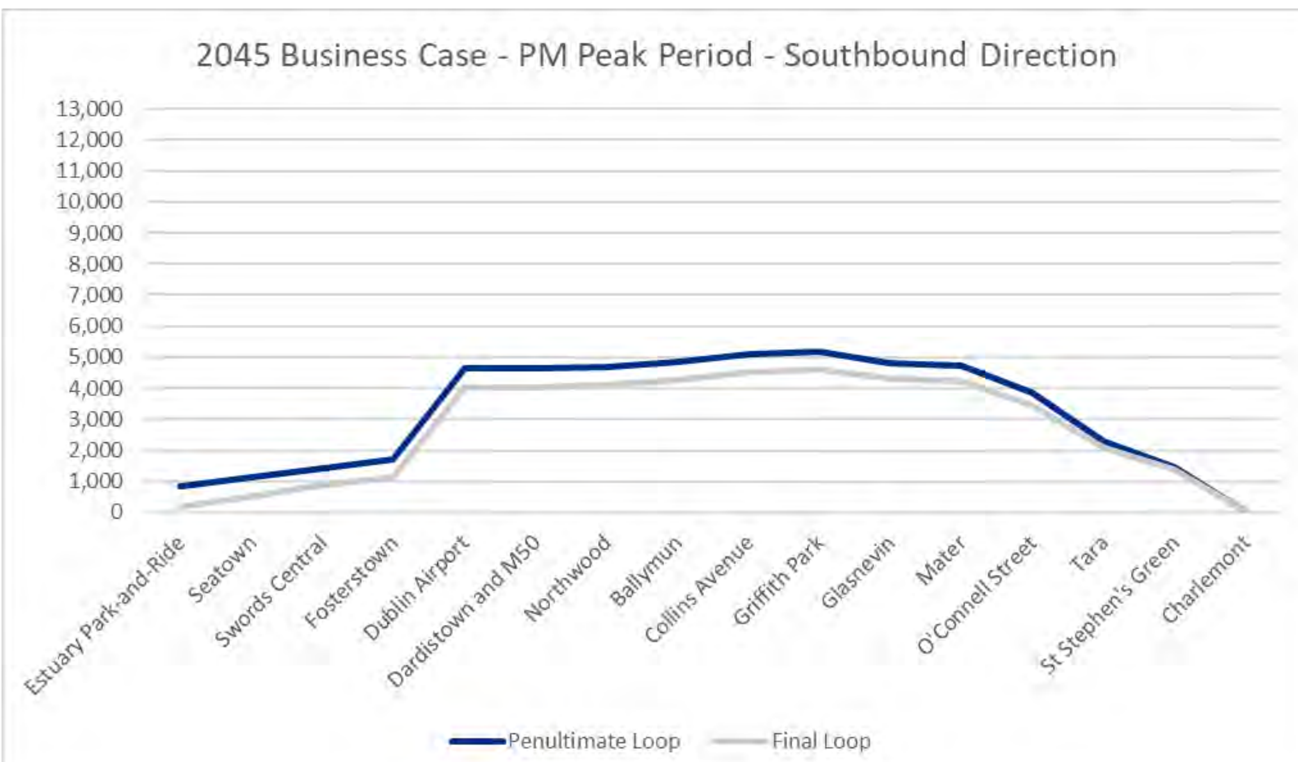


Figure 8-14: Line Flow Comparison, PM Peak 2045 Business Case Southbound Direction

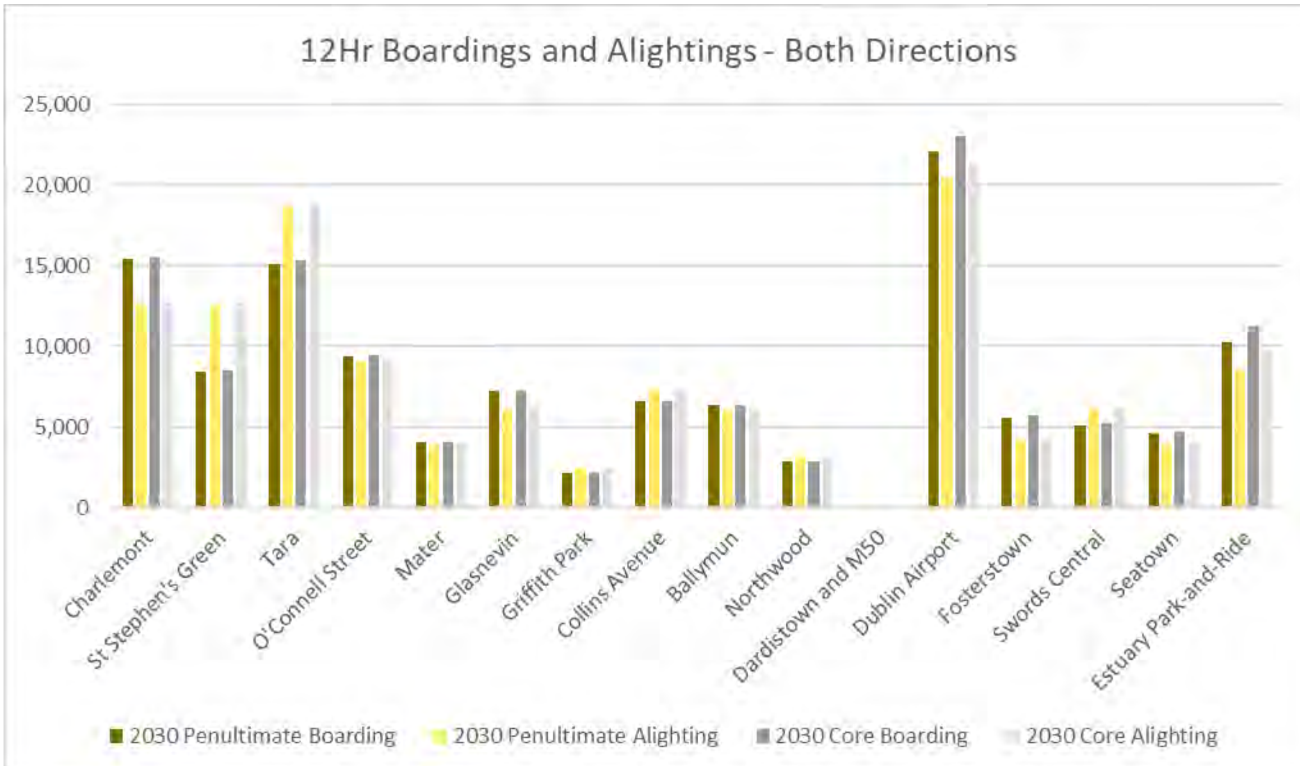


Figure 8-15: Boarding & Alighting Comparison, 12hr Period 2030 Business Case Both Directions

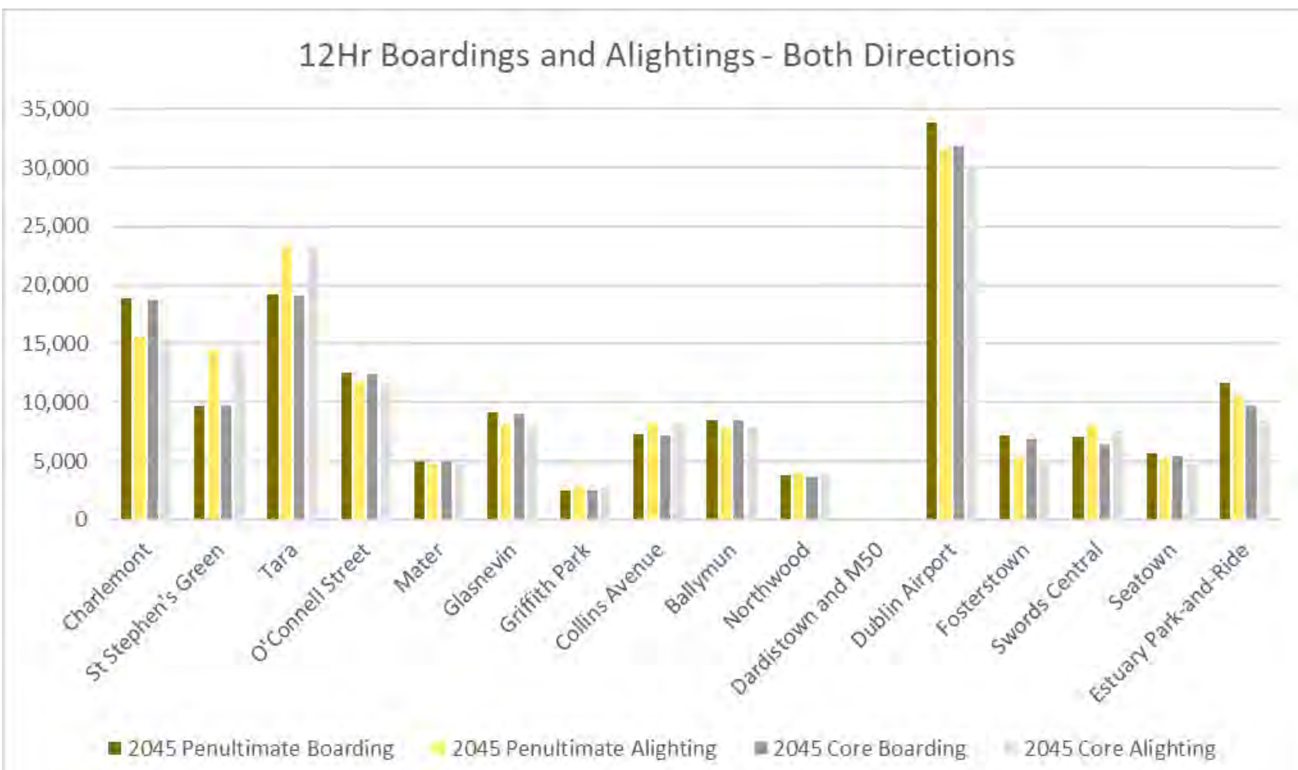


Figure 8-16: Boarding & Alighting Comparison, 12hr Period 2045 Business Case Both Directions

The results for 2030 show a similar pattern on the line flow for both final and penultimate loops, with the final loop presenting higher values across all time periods. The final loop maximum load is 5.024 in the northbound direction and 10.412 in the southbound direction. Differences with the penultimate loop in the AM peak for both northbound and southbound directions are minimal, 1.2% and 2.4% respectively. In the PM peak period, the differences are slightly higher, 7.5% in the northbound direction and 6.6% in the southbound direction. The maximum load for the final loop in the northbound direction is 7.616 and 3.999 in the southbound direction.

In 2045, the line flow is also similar however, the penultimate loop is the iteration with higher values across all time periods. Again, the AM period for both directions presents minimal differences in terms of maximum load, 6.307 in the northbound direction and 12.107 in the southbound direction, representing a percentage difference of 2.2% and 2.8% respectively. For the PM peak, the differences are higher, 13.3% in the northbound direction and 11.1% in the southbound direction. The maximum load for the penultimate loop in the northbound direction is 9.388 and 5.197 in the southbound direction.

In terms of boardings and alightings over a 12hr period, the difference between penultimate and final loop are minimal for both years from Charlemont to Northwood. In 2030 at Estuary, boardings and alightings are higher in the final loop, 9.5% and 12% respectively. For 2045, the final loop is higher, 20% for boardings and 23.9% for alightings.

Further analysis was undertaken to understand the differences in terms of user benefits in the penultimate and final loop runs for the 2030 and 2045 Business Case scenarios. The percentage difference in user benefits across the time periods for Public Transport in 2030 is small in both years. The penultimate loop is 1.09% higher in 2030 and 1.91% lower in 2045. The difference in user benefits for highway is higher, the penultimate loop is 10.7% higher in 2030 and 10.6% lower in 2045

Regarding overall impacts, the Net Present Value (NPV) difference for Public Transport is small. The penultimate loop is less than 1% lower than the final loop iteration. For highway, the penultimate loop is 10.8% lower than the final loop. Given that highway benefits accounts for approximately 30% of the total benefit, the aggregated impact is approximately 3%, standing for a small difference between both iterations.

9. Summary and Conclusion

The MetroLink modelling process has used the latest NTA ERM model to perform a series of 29 runs as the basis of appraisal of the Metrolink scheme. The Business Case (referred to as 'Core') runs used a Do Committed Schemes base for the 2030, 2045 and 2060 years.

Three scenario years (2030, 2045 and 2060) have been assessed and presented in detail in this report. For each year, the Core run has been modelled, as well as sensitivity tests including Slow Growth, Low Frequency, Alternative Demand, Enhanced Transport Networks and Enhanced Transport Network + Alternative Demand.

9.1 ERM Model Validation and MetroLink Convergence

The NTA ERM model development report notes that:

"The ERM was calibrated and validated against the recommended criteria set out in the UK TAG. The level of calibration and validation achieved across each of the model components is of a high standard when considering the model scale and type."

While the convergence of the modelling undertaken for Metrolink does not achieve the gap value recommended in the UK TAG, the convergence values are typical for a model of the size and complexity of MetroLink operating over a medium length forecast period in urban congested conditions.

To understand that potential significance of this, analysis was undertaken to understand the differences in terms of user benefits in the penultimate and final loop runs for the 2030 and 2045 Business Case scenarios. The results of this were:

- In both years, the percentage difference in user benefits across the time periods for Public Transport is small. The penultimate loop is 1.09% higher than the final loop in 2030 and 1.91% lower in 2045.
- The difference in user benefits for highway is higher, the penultimate loop is 10.7% higher in 2030 and 10.6% lower in 2045

Regarding overall impacts, the Net Present Value (NPV) difference for Public Transport is small. The penultimate loop is less than 1% lower than the final loop iteration. For highway, the penultimate loop is 10.8% lower than the final loop. Given that highway benefits accounts for approximately 30% of the total benefit, the aggregated impact is approximately 3%, standing for a small difference between both iterations.

In overall terms, this level of change in the benefits better the penultimate and final run is not significant and indicates that the model is appropriate tool for the appraisal process.

9.2 Summary of Business Case Core Run Results

The modelling exercise involved analysing various model outputs from each scenario to assess changes in travel behaviour. The key findings of the exercise were that with introduction of the MetroLink scheme:

- The strategic park and ride site facilitates significant volumes of people primarily along the M1 corridor (Balbriggan, Drogheda etc.) and to a lesser extent from towns from the north of Fingal (Skerries, Donabate) and from the N2 corridor to access the MetroLink, also reducing the length of their private car trips and removing trips from other parts of the strategic road network;
- There is a reduction in the public transport journey time from Swords, Dublin Airport and Ballymun to/from the City Centre;

- There is a reduction in private car travel along the length of the corridor of the MetroLink, in particular in areas such as Swords and Dublin Airport;
- Public transport usage is increased along other corridors such as the rail line to/from Cork, Maynooth and the Luas Green and Red Lines, as well as the DART along the southern side of the city; and
- There is transfer of people from bus to MetroLink from Swords, Dublin Airport and from the Ballymun areas.

Total passenger boardings over a 12-hour period in the Core runs were assessed. In the 2030 Core run, the total number of boarding passengers was 128,182. This increased by 22% from 2030 to 2045, up to 156,091 passengers. In 2060 this further increased to 209,815 boarding passengers, representing an 34% increase from 2045 to 2060.

9.3 Summary of Sensitivity Analysis

Sensitivity tests were undertaken to assess how sensitive the performance of the MetroLink is to slower growth, to operating a lower frequency service, to a change in travel behaviour (such as higher percentages of work from home), and finally how it performs where other proposed infrastructure and demand management measures are delivered over the lifetime of MetroLink.

The following sensitivity tests were undertaken for the MetroLink appraisal.

- Slow Growth;
- Low Frequency;
- Alternative Demand; and
- Enhanced Transport Networks (NDP and GDA).
- Enhanced Transport Network NDP + Alternative Demand

The different PV of benefits for assessed Sensitivity Analysis runs are summarised in Table 9-1.

Table 9-1: Comparison of Benefits – Core x Sensitivity Test Scenarios (in Billions)

Scenario	Core	NDP	Slow Growth	Alternative Demand	NDP + Alternative Demand
PV Benefits	**14.93**	**12.13**	**12.84**	**12.83**	**11.83**

10. References

2016-2019 CSO Aviation Stats' TAM05, www.data.gov.ie, Data Updated 2018

Luas Data, Transport Omnibus 2018 – Public Transport, Available at: www.cso.ie

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National Heavy Rail Census Report 2018 (National Transport Authority, 2019)

National Planning Framework 2040 (Department of Housing, Planning, Community and Local Government, 2018)

Regional Modelling System – Model Development Report (East Regional Model, Model Version 2), National Transport Authority, 2020.

Review of Future Capacity Needs at Ireland's State Airports– Final Report for the Department of Transport Tourism and Sport (Oxford Economics, 2018)

Transport Analysis Guidance (TAG) Unit 3.2 Public Transport Assignment, Department for Transport, 2020

Transport Infrastructure Ireland Project Appraisal Guidelines (Transport Infrastructure Ireland, 2016)

Transport Modelling Plan ML1-JAI-TRA-ROUT_XX-PL-Y-00001

Transport Strategy for the Greater Dublin Area 2016 – 2035 (National Transport Authority, 2016)

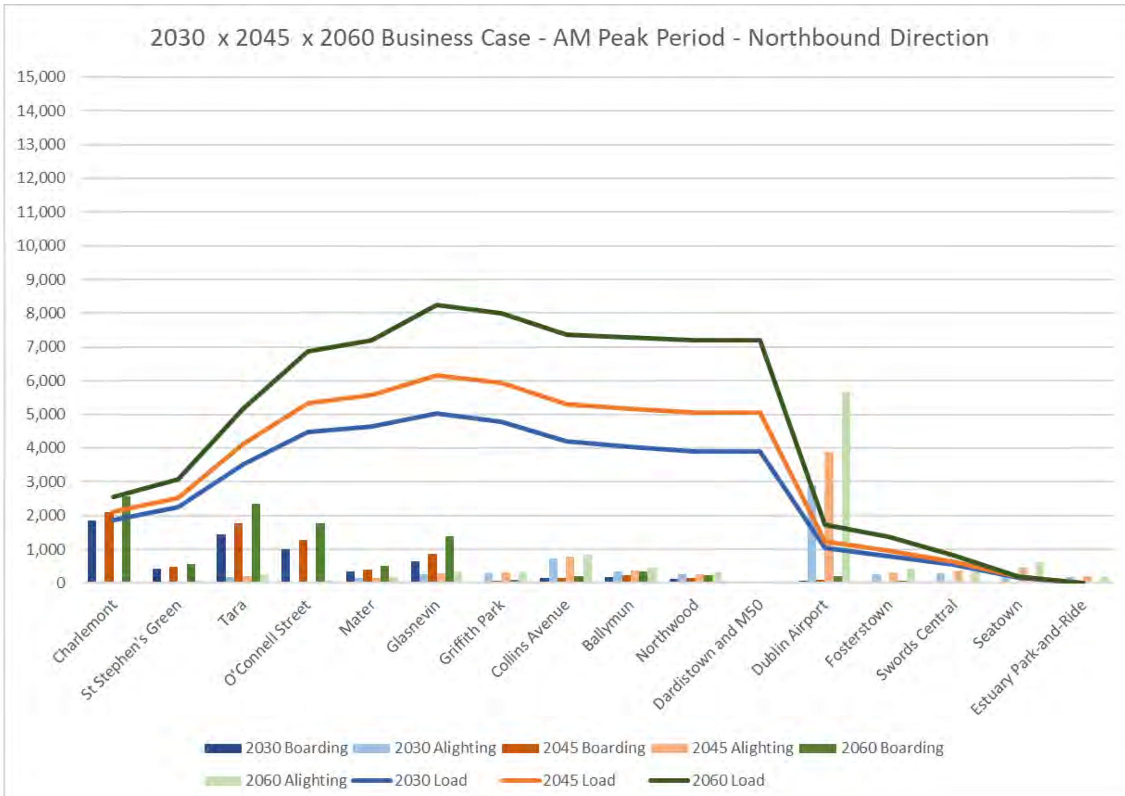
Appendix A. Modelling Results: Core Run Analysis

A.1 Boardings, Alightings and Loading Profile

2030 Business Case Core Run - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1866	0	1866	976	0	976	1083	0	1083	2276	0	2276
St Stephen's Green	416	43	2239	422	8	1390	645	4	1724	1833	5	4104
Tara	1444	170	3513	864	49	2205	1089	50	2763	2398	316	6186
O'Connell Street	996	42	4467	592	16	2782	720	19	3464	1265	47	7405
Mater	340	152	4655	191	59	2914	220	78	3606	398	186	7616
Glasnevin	638	269	5024	150	104	2960	137	172	3572	317	852	7082
Griffith Park	52	285	4791	30	66	2924	81	79	3574	129	235	6976
Collins Avenue	142	736	4197	77	184	2817	255	236	3594	465	751	6691
Ballymun	166	337	4027	74	217	2674	61	361	3294	84	1079	5695
Northwood	114	246	3895	43	95	2622	35	157	3173	71	465	5301
Dardistown and M50	0	0	3895	0	0	2622	0	0	3173	0	0	5301
Dublin Airport	58	2908	1046	101	1624	1099	162	1570	1764	522	1448	4374
Fosterstown	28	272	802	26	154	972	30	301	1493	61	842	3594
Swords Central	19	286	535	35	242	765	37	459	1072	133	1250	2477
Seatown	4	366	173	24	191	598	42	257	857	191	561	2107
Estuary Park-and-Ride	0	173	0	0	598	0	0	857	0	0	2107	0
2030 Business Case Core Run - Southbound Direction												
Estuary Park-and-Ride	2776	0	2776	870	0	870	497	0	497	573	0	573
Seatown	1105	145	3736	180	36	1013	156	36	617	289	48	814
Swords Central	1300	135	4901	245	38	1221	183	24	776	277	37	1054
Fosterstown	1673	58	6516	232	32	1421	160	20	916	262	28	1287
Dublin Airport	1652	787	7381	1950	96	3275	2241	80	3078	2264	138	3414
Dardistown and M50	0	0	7381	0	0	3275	0	0	3078	0	0	3414
Northwood	571	107	7845	120	48	3347	90	57	3110	163	104	3472
Ballymun	1427	110	9162	316	66	3597	232	84	3258	309	146	3635
Collins Avenue	903	714	9351	228	174	3650	238	111	3385	396	135	3896
Griffith Park	276	193	9434	65	54	3662	88	44	3429	159	56	3999
Glasnevin	1303	325	10412	149	141	3669	111	161	3380	269	468	3800
Mater	218	490	10141	70	212	3527	53	193	3239	157	216	3740
O'Connell Street	81	1487	8735	26	710	2843	27	701	2566	62	681	3121
Tara	128	3582	5281	36	1187	1692	34	1103	1498	117	1325	1913
St Stephen's Green	2	3051	2232	4	847	850	10	647	861	25	709	1229
Charlemont	0	2232	0	0	850	0	0	861	0	0	1229	0

2045 Business Case Core Run - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	2106	0	2106	1297	0	1297	1445	0	1445	2606	0	2606
St Stephen's Green	477	46	2537	511	10	1798	928	5	2369	1828	6	4428
Tara	1774	194	4117	1238	60	2976	1606	59	3915	2556	354	6630
O'Connell Street	1268	46	5338	899	19	3856	1106	21	5000	1429	51	8008
Mater	406	159	5586	265	76	4045	319	85	5234	471	199	8280
Glasnevin	869	287	6167	235	143	4137	207	199	5242	442	1026	7695
Griffith Park	62	305	5924	42	79	4100	104	87	5258	149	262	7582
Collins Avenue	162	775	5311	102	212	3990	289	263	5284	505	833	7255
Ballymun	229	378	5162	108	285	3813	103	466	4921	115	1411	5959
Northwood	154	270	5045	63	125	3751	50	200	4771	87	590	5456
Dardistown and M50	0	0	5045	0	0	3751	0	0	4771	0	0	5456
Dublin Airport	91	3893	1243	182	2586	1347	356	2346	2781	321	2015	3762
Fosterstown	43	316	970	29	194	1182	55	375	2461	20	1008	2775
Swords Central	28	359	639	40	333	889	99	592	1968	31	1513	1293
Seatown	4	445	199	25	252	662	98	329	1737	27	720	600
Estuary Park-and-Ride	0	199	0	0	662	0	0	1737	0	0	600	0
2045 Business Case Core Run - Southbound Direction												
Estuary Park-and-Ride	2138	0	2138	994	0	994	647	0	647	192	0	192
Seatown	1352	100	3390	236	31	1199	197	27	817	346	8	530
Swords Central	1551	113	4828	346	41	1504	246	28	1034	367	26	871
Fosterstown	1962	41	6749	305	38	1771	197	28	1203	302	26	1148
Dublin Airport	2220	823	8146	2872	130	4513	3304	98	4409	2972	80	4040
Dardistown and M50	0	0	8146	0	0	4513	0	0	4409	0	0	4040
Northwood	735	130	8751	169	72	4610	117	90	4436	190	137	4093
Ballymun	1861	140	10472	445	98	4957	301	126	4611	385	199	4279
Collins Avenue	968	791	10649	261	228	4990	260	157	4714	393	155	4517
Griffith Park	290	229	10709	77	73	4994	99	57	4756	169	67	4619
Glasnevin	1480	424	11765	189	230	4952	135	252	4638	298	622	4295
Mater	236	573	11428	80	315	4717	58	270	4426	161	239	4218
O'Connell Street	95	1706	9817	32	1005	3744	31	986	3471	69	830	3457
Tara	150	4060	5907	49	1626	2166	44	1568	1947	138	1515	2080
St Stephen's Green	3	3293	2617	5	1059	1112	9	831	1124	25	704	1401
Charlemont	0	2617	0	0	1112	0	0	1124	0	0	1401	0

2060 Business Case Core Run - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	2560	0	2560	1663	0	1663	1830	0	1830	3340	0	3340
St Stephen's Green	566	58	3069	604	13	2254	1151	6	2976	2356	7	5689
Tara	2361	261	5169	1671	82	3843	2148	82	5042	3496	434	8751
O'Connell Street	1770	70	6869	1243	29	5056	1504	36	6510	1958	69	10641
Mater	505	187	7187	348	101	5303	417	106	6821	593	227	11006
Glasnevin	1385	329	8243	333	182	5454	269	252	6838	613	1316	10303
Griffith Park	86	331	7998	56	95	5415	135	104	6869	183	293	10192
Collins Avenue	216	840	7375	127	246	5295	341	305	6905	567	930	9830
Ballymun	337	438	7274	150	358	5088	132	599	6438	164	1747	8246
Northwood	229	313	7190	91	157	5022	63	266	6235	127	720	7653
Dardistown and M50	0	0	7190	0	0	5022	0	0	6235	0	0	7653
Dublin Airport	217	5683	1724	298	3711	1610	512	3160	3587	728	2852	5528
Fosterstown	63	429	1358	31	247	1394	63	497	3152	41	1321	4249
Swords Central	36	573	822	37	450	981	139	773	2519	136	2035	2350
Seatown	3	623	201	24	327	678	91	417	2192	99	941	1508
Estuary Park-and-Ride	0	201	0	0	678	0	0	2192	0	0	1508	0
2060 Business Case Core Run - Southbound Direction												
Estuary Park-and-Ride	2503	0	2503	1438	0	1438	857	0	857	530	0	530
Seatown	1680	78	4105	300	49	1688	264	47	1074	460	34	956
Swords Central	2176	195	6086	454	67	2076	325	43	1356	543	53	1446
Fosterstown	2639	47	8678	374	48	2402	254	36	1574	386	46	1786
Dublin Airport	3291	1449	10520	4266	209	6459	4246	141	5679	4428	224	5990
Dardistown and M50	0	0	10520	0	0	6459	0	0	5679	0	0	5990
Northwood	924	185	11259	224	108	6575	153	119	5713	236	201	6026
Ballymun	2328	190	13398	576	140	7011	388	163	5937	482	287	6221
Collins Avenue	1089	912	13574	298	286	7024	292	169	6060	423	211	6433
Griffith Park	336	282	13628	91	91	7023	112	69	6103	184	88	6529
Glasnevin	1860	630	14859	238	364	6897	169	336	5936	349	997	5880
Mater	294	754	14398	102	444	6555	72	357	5651	186	309	5758
O'Connell Street	140	2188	12350	43	1430	5167	41	1290	4402	87	1212	4634
Tara	223	5238	7334	70	2368	2869	64	2049	2417	185	2167	2652
St Stephen's Green	5	4005	3333	7	1409	1467	14	1020	1412	43	894	1801
Charlemont	0	3333	0	0	1467	0	0	1412	0	0	1801	0


2030 x 2045 x 2060 Business Case - AM Peak Period - Northbound Direction
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Charlemont
St Stephen's Green
Tara
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Collins Avenue
Ballymun
Northwood
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Dublin Airport
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Swords Central
Seatown
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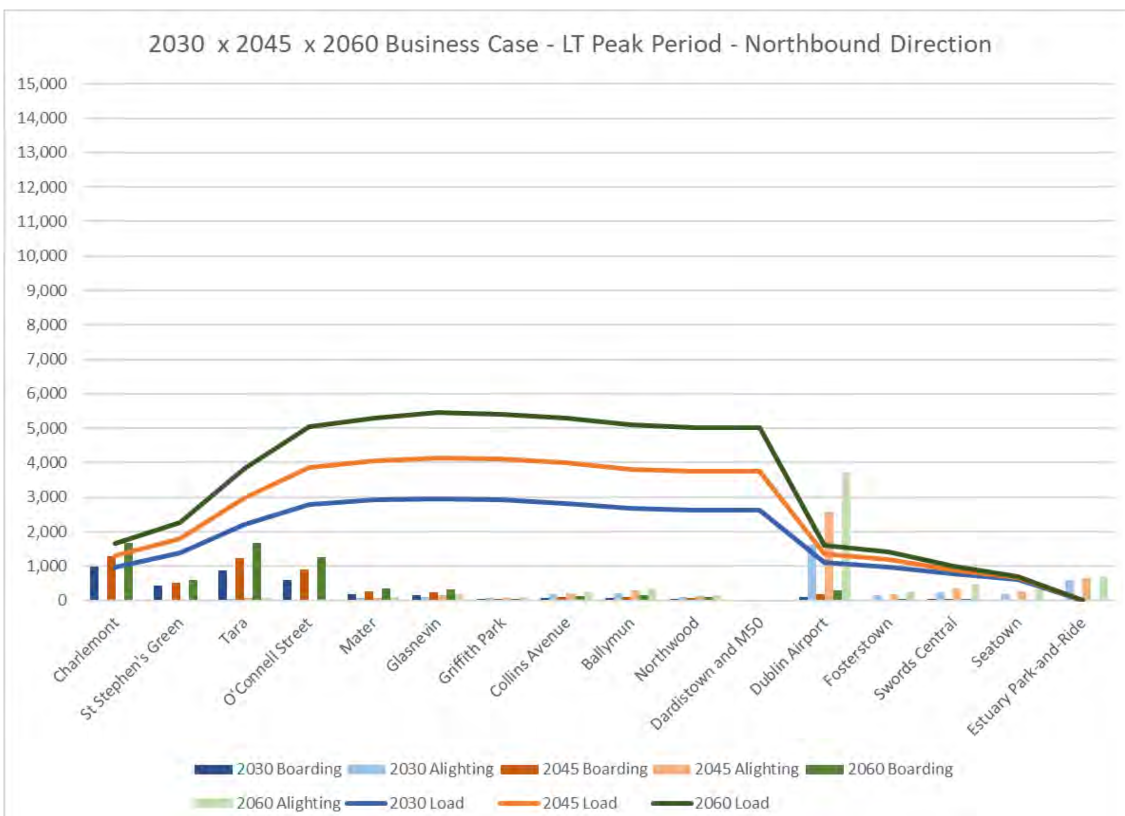
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Swords Central
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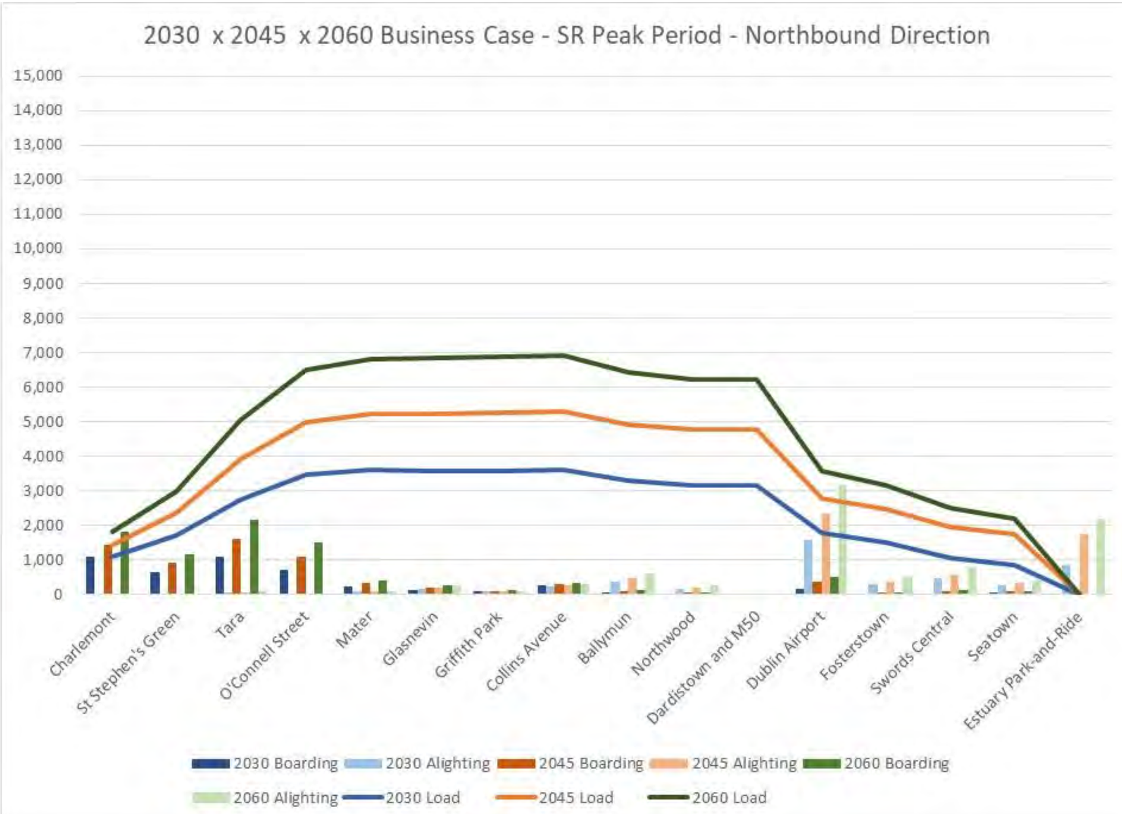
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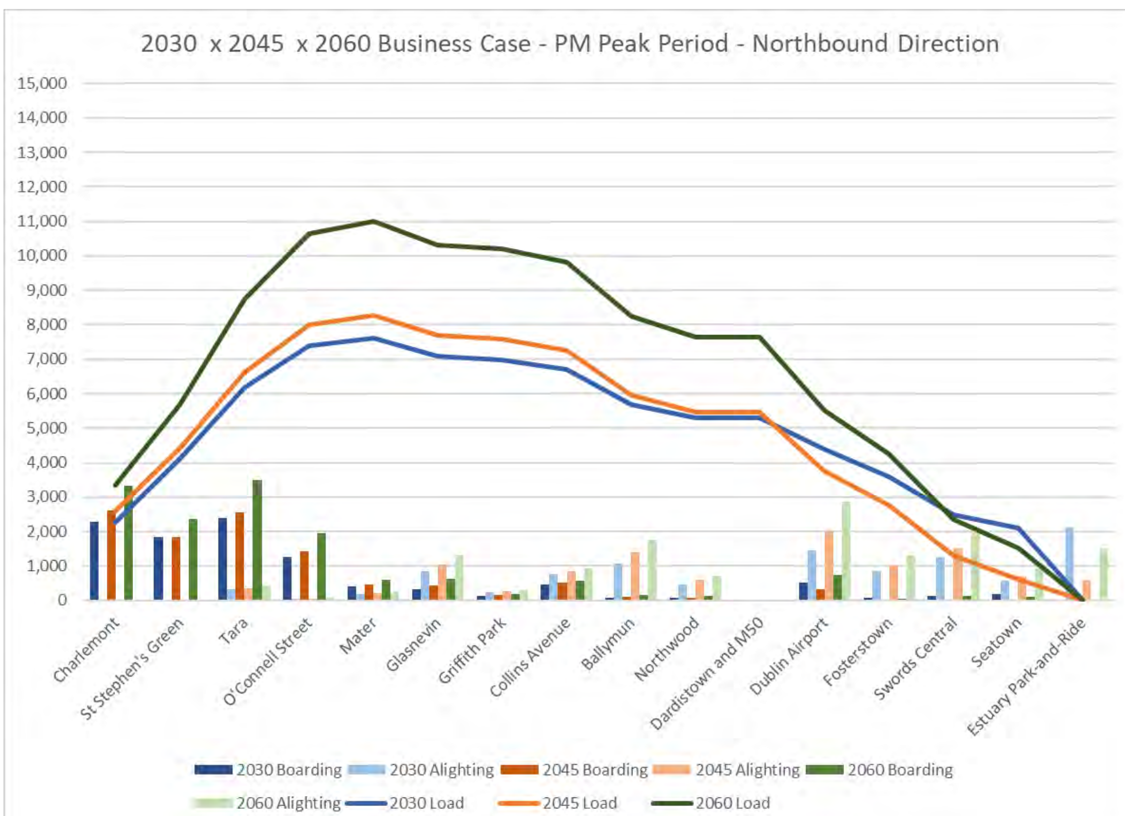
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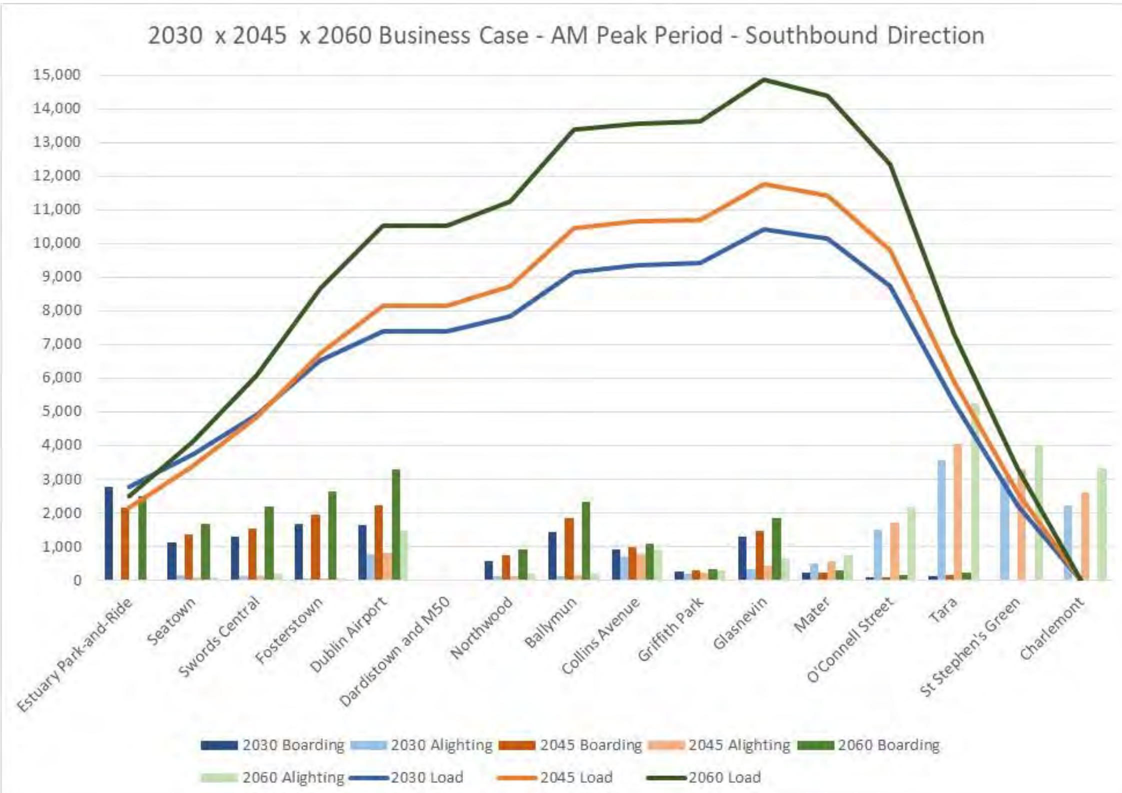
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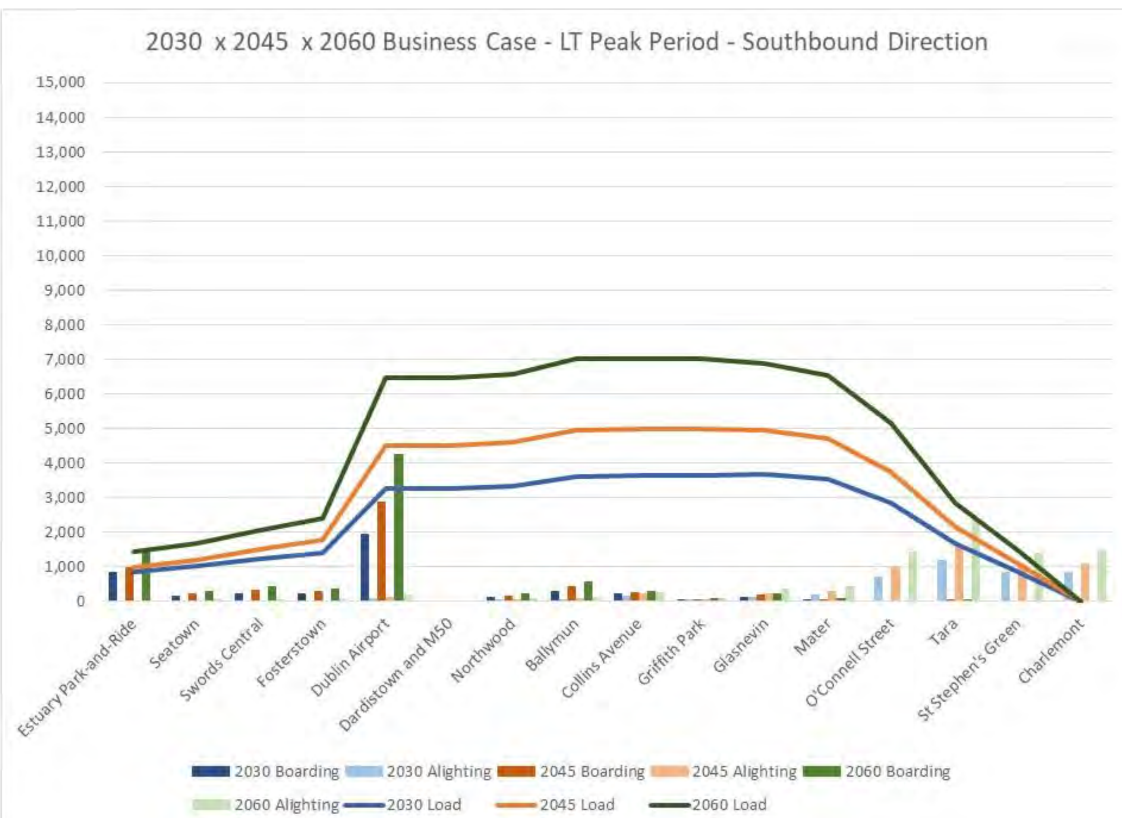
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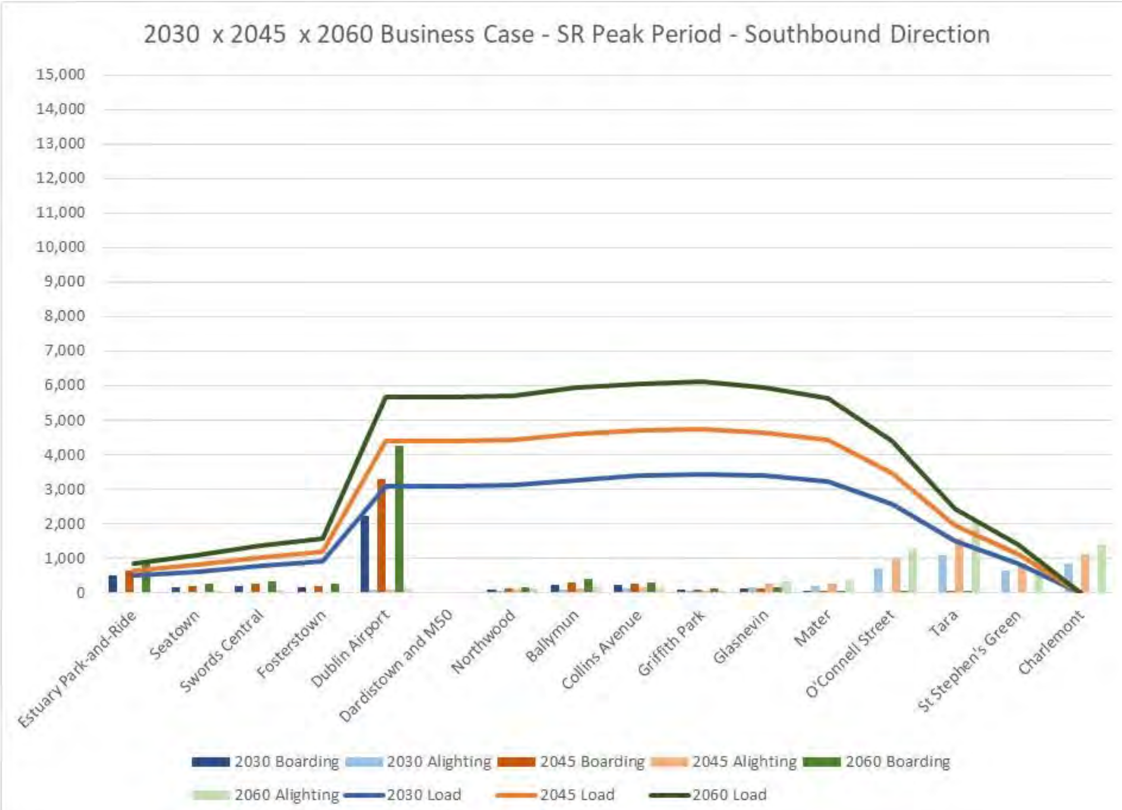
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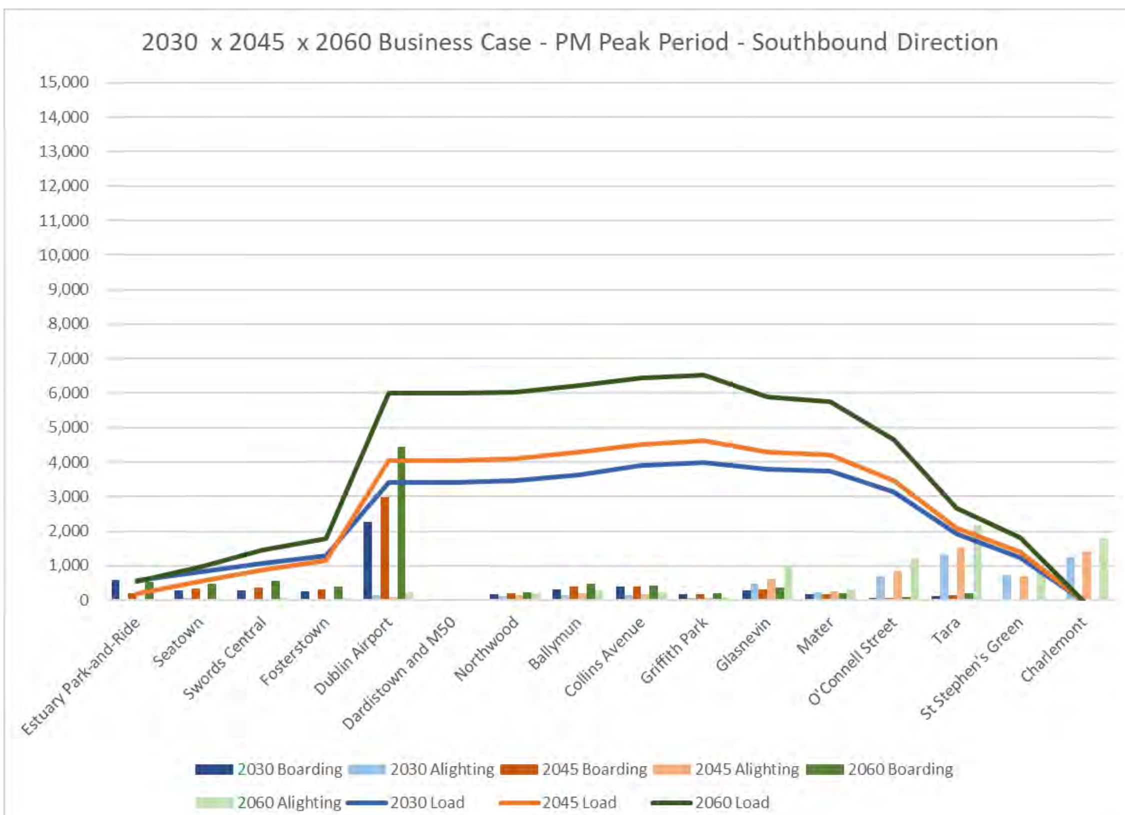
2030 x 2045 x 2060 Business Case - PM Peak Period - Southbound Direction
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A.2 Overall Network Statistics

A.2.1 Road Network Statistics

AM Peak Period						
Network Statistics	2030		2045		2060	
	Do Minimum	Do Scheme	Do Minimum	Do Scheme	Do Minimum	Do Scheme
Total Road Travel Time (pcu.hrs)	159,726	158,880	190,863	186,057	222,682	214,052
Total Road Distance Travelled (pcu.km)	7,291,245	7,304,301	8,291,512	8,096,762	9,177,830	8,879,845
Average Road Network Speed (kph)	46	46	43	44	41	42
LT Peak Period						
Network Statistics	2030		2045		2060	
	Do Minimum	Do Scheme	Do Minimum	Do Scheme	Do Minimu m	Do Scheme
Total Road Travel Time (pcu.hrs)	87,596	87,368	106,349	103,534	128,201	120,684
Total Road Distance Travelled (pcu.km)	4,696,350	4,708,339	5,520,903	5,395,657	6,245,501	6,012,055
Average Road Network Speed (kph)	54	54	52	52	49	50
SR Peak Period						
Network Statistics	2030		2045		2060	
	Do Minimum	Do Scheme	Do Minimum	Do Scheme	Do Minimu m	Do Scheme
Total Road Travel Time (pcu.hrs)	97,605	97,239	116,819	114,103	134,138	134,928
Total Road Distance Travelled (pcu.km)	5,202,898	5,213,349	5,976,679	5,882,246	6,680,679	6,534,840
Average Road Network Speed (kph)	53	54	51	52	50	48
PM Peak Period						
Network Statistics	2030		2045		2060	
	Do Minimum	Do Scheme	Do Minimum	Do Scheme	Do Minimu m	Do scheme
Total Road Travel Time (pcu.hrs)	147,706	147,901	173,126	168,007	198,474	188,643
Total Road Distance Travelled (pcu.km)	6,979,879	6,999,53 9	7,834,600	7,628,528	8,598,786	8,260,824
Average Road Network Speed (kph)	47	47	45	45	43	44

> Public Transport Statistics

Passenger Km and Vehicle Km by mode - 3h and 12h period											
2030 Business Case		Do Minimum					Do Something				
		AM	LT	SR	PM	12h	AM	LT	SR	PM	12h
Passenger Km	Bus	1,838,414	925,967	928,625	1,829,062	5,522,067	1,606,171	776,499	786,528	1,627,921	4,797,119
	Rail	1,522,848	508,318	528,897	1,795,866	4,355,929	1,500,272	503,055	523,259	1,786,709	4,313,295
	Luas	355,837	143,731	177,039	336,412	1,013,019	344,336	143,787	176,951	329,602	994,675
	Metro	0	0	0	0	0	388,346	231,967	231,160	345,863	1,197,336
	Total	3,717,099	1,578,016	1,634,561	3,961,340	10,891,016	3,839,124	1,655,309	1,717,898	4,090,094	11,302,425
2045 Business Case		Do Minimum					Do Something				
		AM	LT	SR	PM	12h	AM	LT	SR	PM	12h
Passenger Km	Bus	2,036,484	1,213,509	1,117,210	2,005,246	6,372,449	1,802,215	978,779	913,015	1,830,269	5,524,279
	Rail	1,868,167	654,616	662,884	2,205,257	5,390,924	1,934,494	645,065	668,172	2,272,131	5,519,862
	Luas	416,153	193,476	221,996	396,009	1,227,634	410,426	192,069	221,516	391,745	1,215,755
	Metro	0	0	0	0	0	440,156	313,777	335,388	357,112	1,446,433
	Total	4,320,804	2,061,601	2,002,090	4,606,512	12,991,007	4,587,291	2,129,691	2,138,091	4,851,257	13,706,329
2060 Business Case		Do Minimum					Do Something				
		AM	LT	SR	PM	12h	AM	LT	SR	PM	12h
Passenger Km	Bus	2,294,383	1,412,069	1,421,556	2,231,740	7,359,749	2,066,119	1,161,325	1,055,219	2,057,119	6,339,782
	Rail	2,327,160	801,180	857,961	2,690,532	6,676,833	2,504,802	801,164	853,932	2,832,831	6,992,729
	Luas	491,839	238,553	282,253	469,318	1,481,963	489,818	242,266	271,414	467,359	1,470,858
	Metro	0	0	0	0	0	570,870	425,743	433,322	502,228	1,932,163
	Total	5,113,382	2,451,802	2,561,770	5,391,591	15,518,545	5,631,609	2,630,499	2,613,888	5,859,537	16,735,532

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A.3 Mode Share

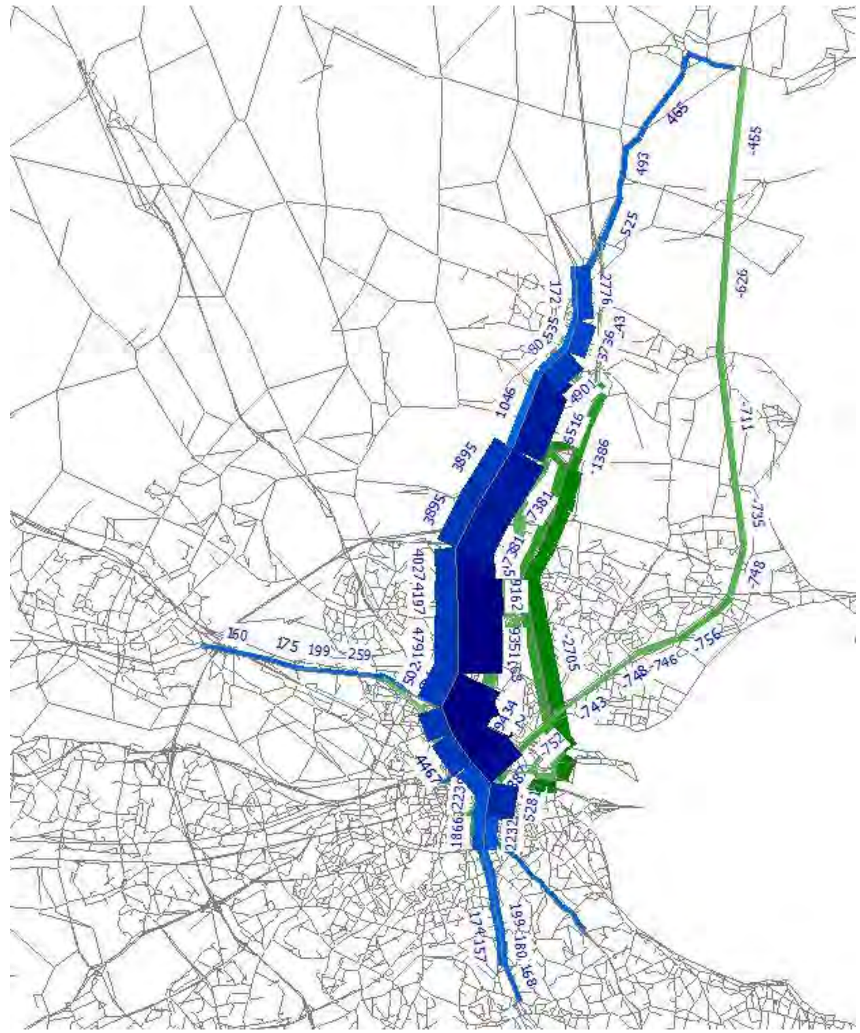
2030 Business Case Core Run								
DO MINIMUM	AM	% MODE SPLIT	LT	% MODE SPLIT	SR	% MODE SPLIT	PM	% MODE SPLIT
PT	124,279	15.79%	42,004	11.24%	48,580	9.82%	103,774	15.59%
Metro only	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Road	479,671	60.93%	239,802	64.15%	315,677	63.83%	432,753	65.02%
Cycle	19,735	2.51%	6,734	1.80%	8,509	1.72%	18,614	2.80%
Walk	163,620	20.78%	85,301	22.82%	121,774	24.62%	110,433	16.59%
DO SOMETHING	AM	% MODE SPLIT	LT	% MODE SPLIT	SR	% MODE SPLIT	PM	% MODE SPLIT
PT	117,949	14.92%	38,796	10.33%	44,847	9.04%	97,239	14.53%
Metro only	11,851	1.50%	5,913	1.57%	6,544	1.32%	11,772	1.76%
Road	479,198	60.62%	239,759	63.86%	315,535	63.58%	433,119	64.71%
Cycle	19,159	2.42%	6,595	1.76%	8,368	1.69%	18,042	2.70%
Walk	162,377	20.54%	84,359	22.47%	121,023	24.38%	109,190	16.31%

2045 Business Case Core Run								
DO MINIMUM	AM	% MODE SPLIT	LT	% MODE SPLIT	SR	% MODE SPLIT	PM	% MODE SPLIT
PT	141,887	16.17%	52,319	12.33%	57,371	10.30%	119,321	16.15%
Metro only	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Road	525,904	59.95%	266,207	62.73%	350,961	63.02%	472,867	63.99%
Cycle	23,579	2.69%	7,924	1.87%	10,502	1.89%	21,535	2.91%
Walk	185,939	21.19%	97,897	23.07%	138,077	24.79%	125,241	16.95%
DO SOMETHING	AM	% MODE SPLIT	LT	% MODE SPLIT	SR	% MODE SPLIT	PM	% MODE SPLIT
PT	135,050	15.35%	47,137	11.09%	52,067	9.31%	112,200	15.17%
Metro only	13,932	1.58%	7,952	1.87%	9,463	1.69%	12,254	1.66%
Road	522,885	59.42%	264,685	62.27%	349,461	62.51%	469,567	63.51%
Cycle	22,933	2.61%	7,757	1.82%	10,350	1.85%	20,834	2.82%
Walk	185,148	21.04%	97,528	22.94%	137,696	24.63%	124,536	16.84%

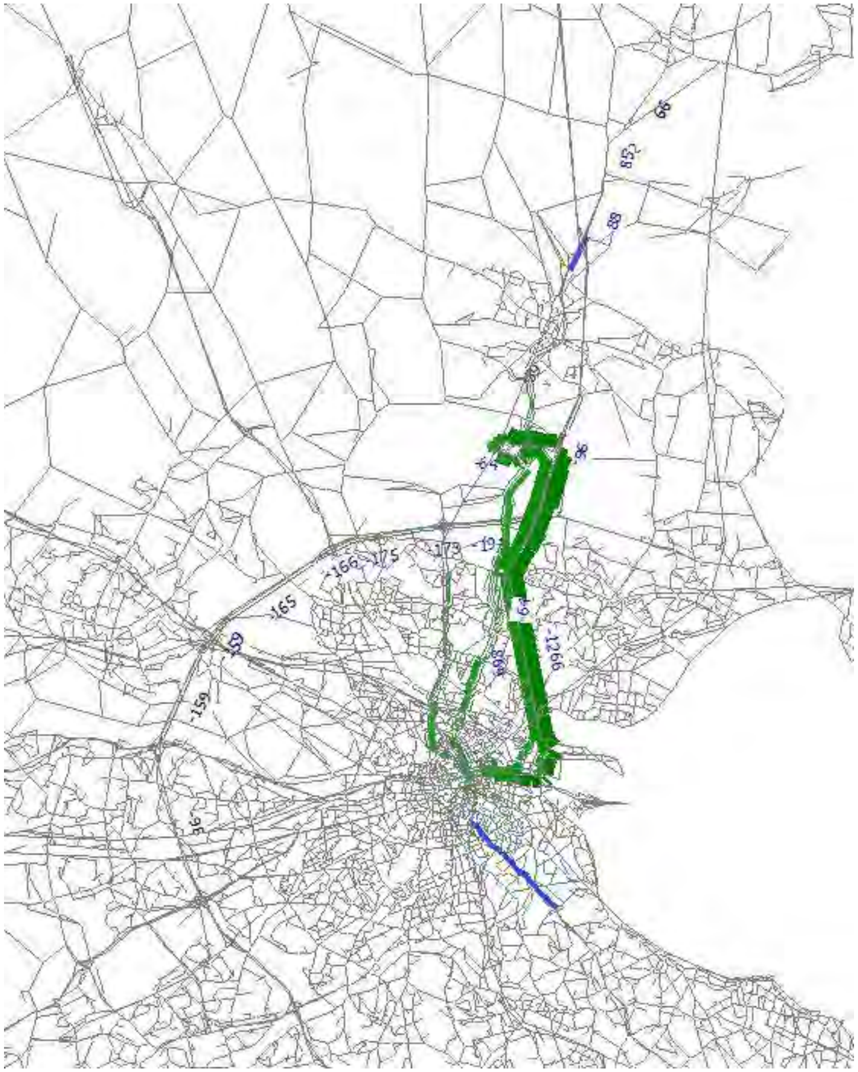
2060 Business Case Core Run								
DO MINIMUM	AM	% MODE SPLIT	LT	% MODE SPLIT	SR	% MODE SPLIT	PM	% MODE SPLIT
PT	164,740	16.95%	61,237	12.93%	69,524	11.25%	138,318	16.96%
Metro only	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Road	567,051	58.34%	292,012	61.67%	379,684	61.42%	509,731	62.50%
Cycle	28,516	2.93%	9,104	1.92%	12,803	2.07%	25,226	3.09%
Walk	211,711	21.78%	111,172	23.48%	156,186	25.26%	142,270	17.44%
DO SOMETHING	AM	% MODE SPLIT	LT	% MODE SPLIT	SR	% MODE SPLIT	PM	% MODE SPLIT
PT	158,622	16.25%	55,378	11.65%	60,823	9.76%	130,365	15.94%
Metro only	18,140	1.86%	10,932	2.30%	12,248	1.97%	17,338	2.12%
Road	560,626	57.43%	288,867	60.75%	380,972	61.16%	504,149	61.64%
Cycle	27,535	2.82%	8,930	1.88%	12,635	2.03%	24,210	2.96%
Walk	211,288	21.64%	111,391	23.43%	156,189	25.08%	141,893	17.35%

A.4 Link Flows

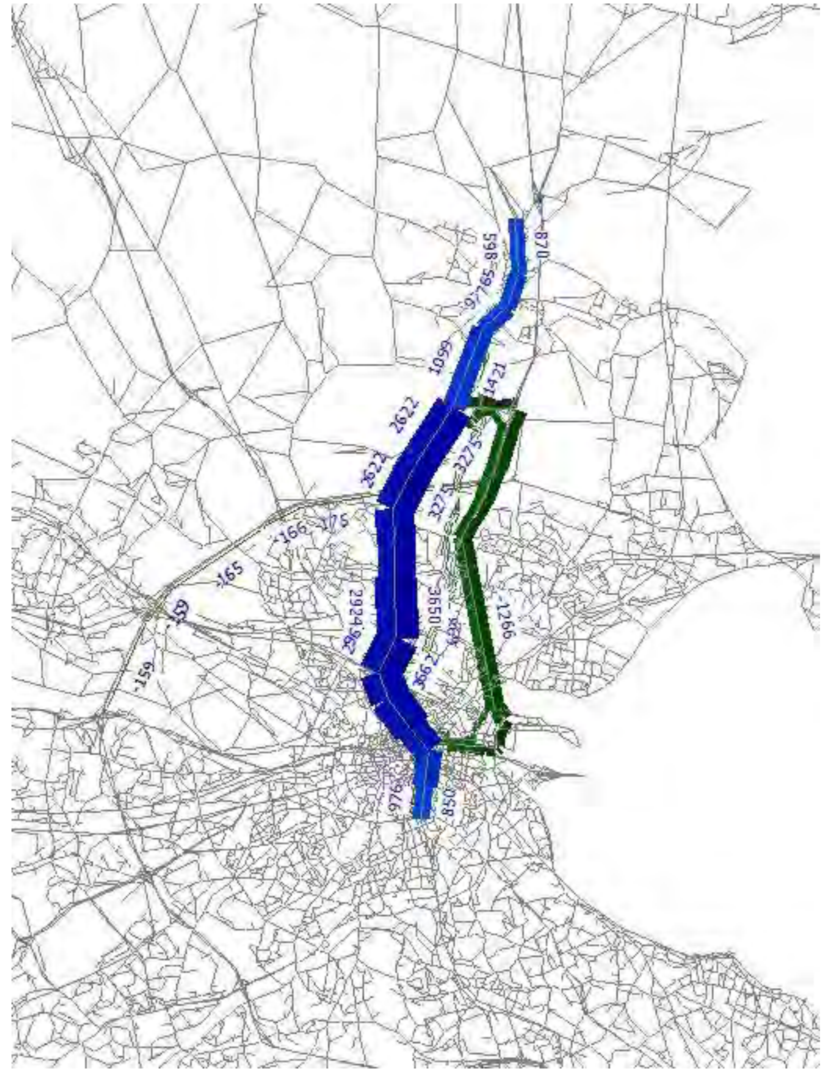
2030 Business Case Core Run – Bus Only – AM Peak Period



2030 Business Case Core Run – All Modes – AM Peak Period



2030 Business Case Core Run – Bus Only - LT Peak Period



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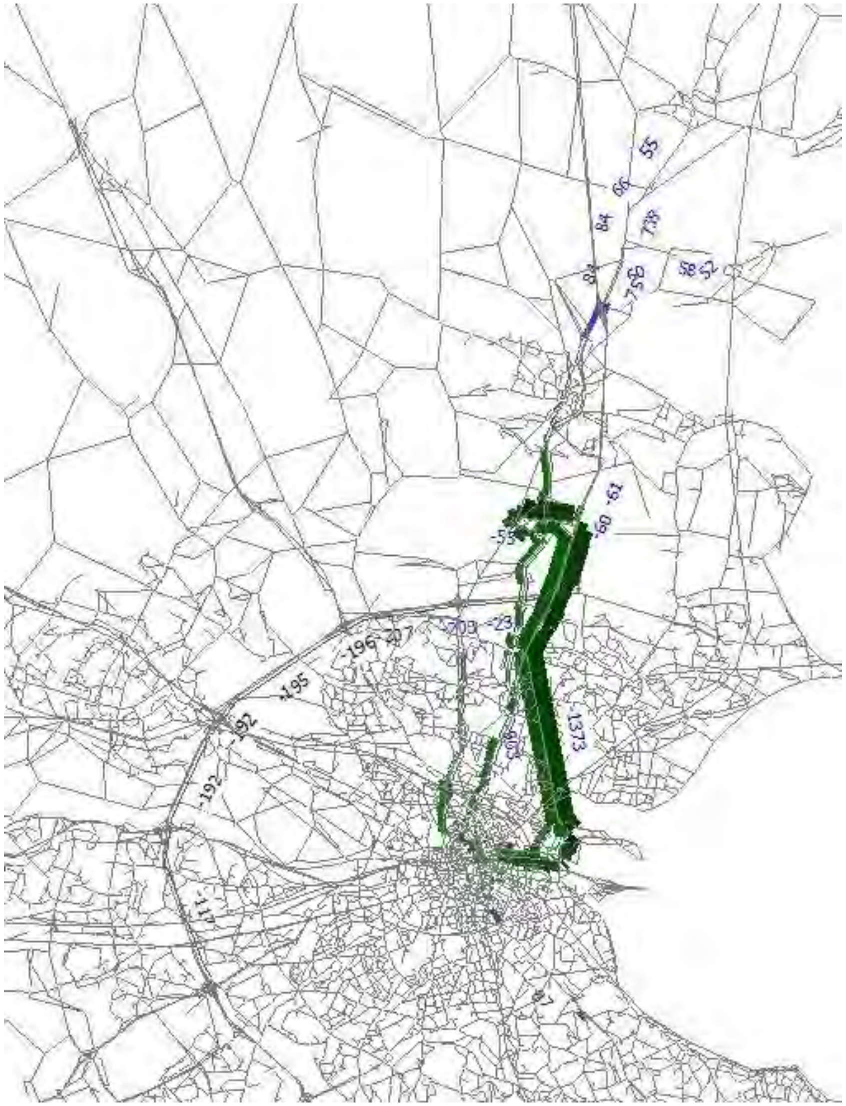
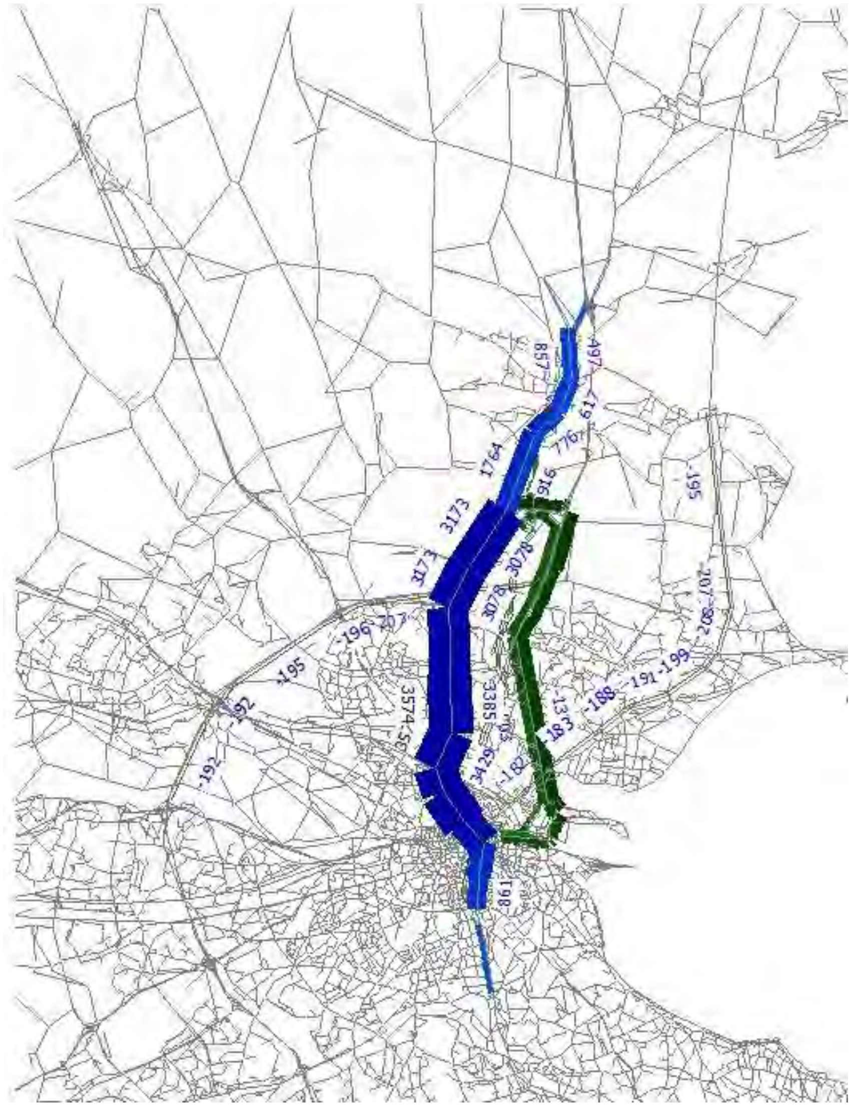
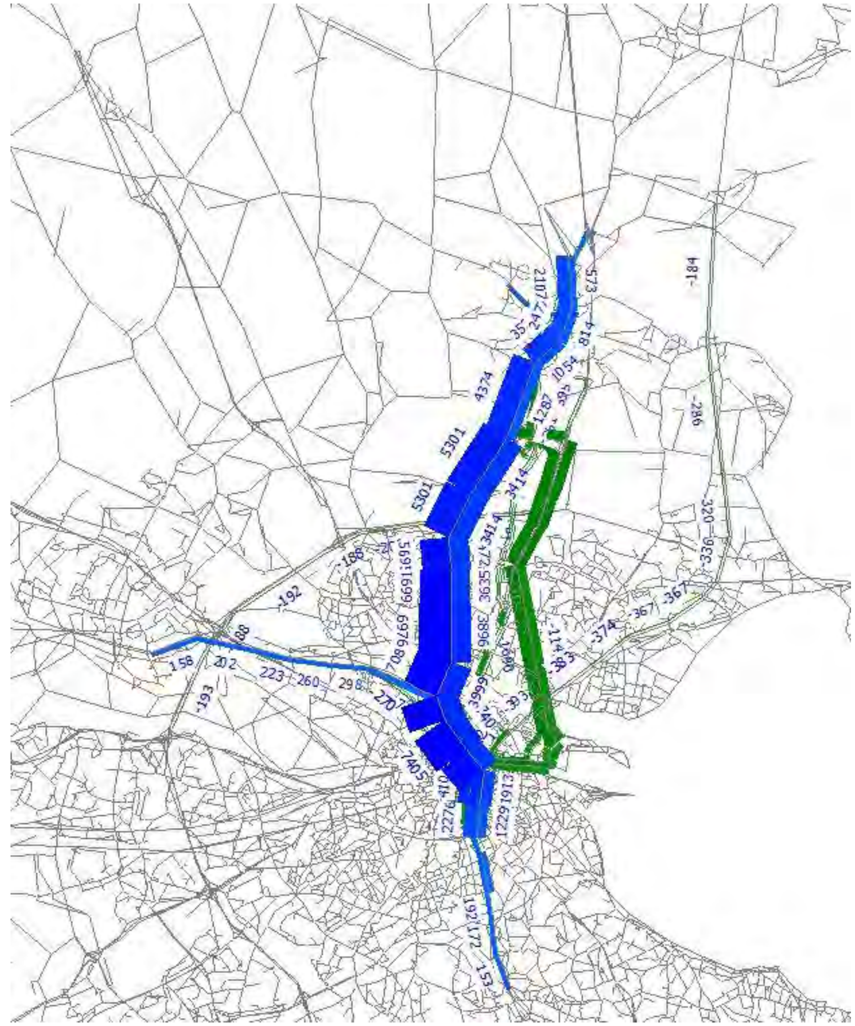


2030 Business Case Core Run – Bus Only – SR Peak Period

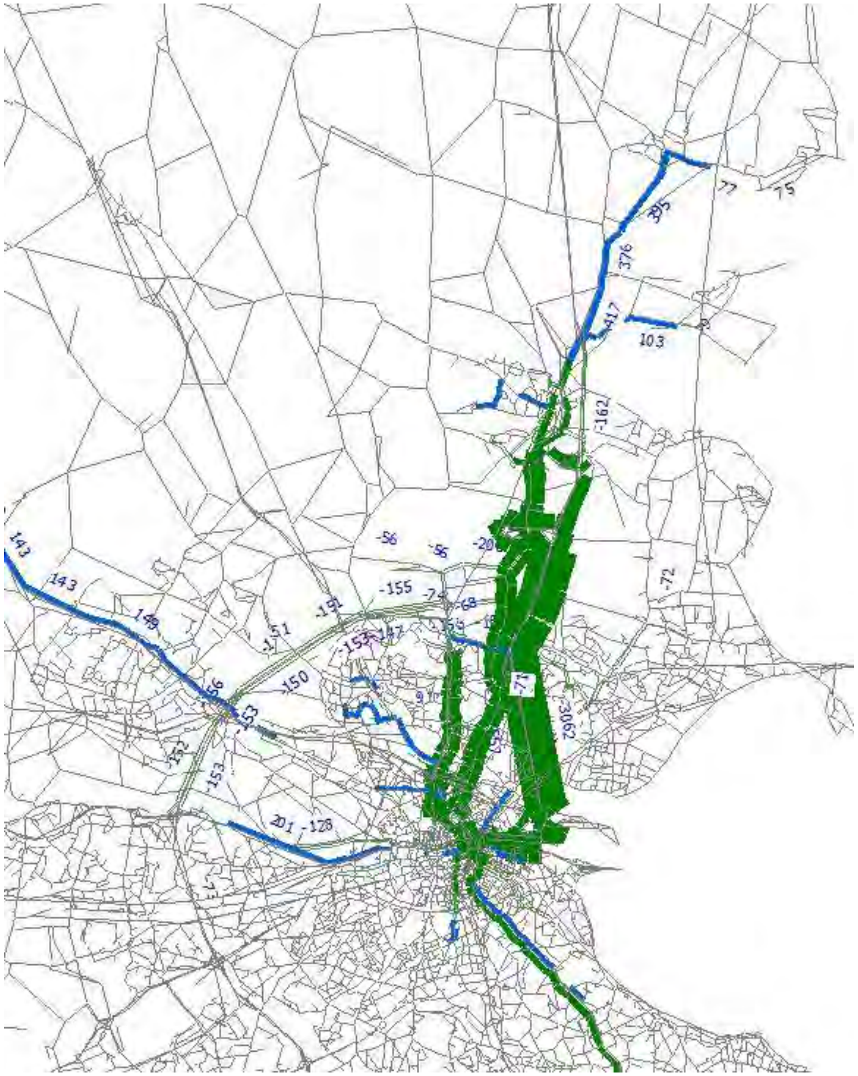


2030 Business Case Core Run – All Modes – SR Peak Period

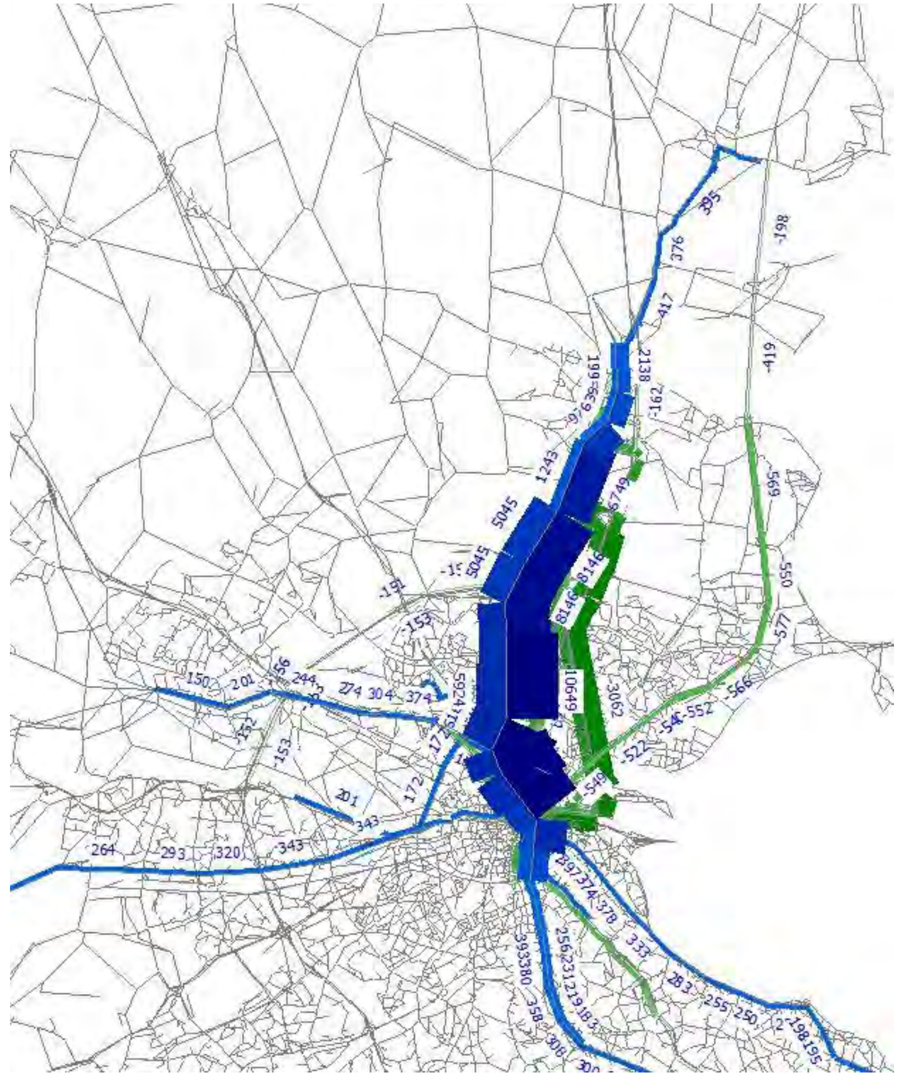
2030 Business Case Core Run – Bus Only – PM Peak Period



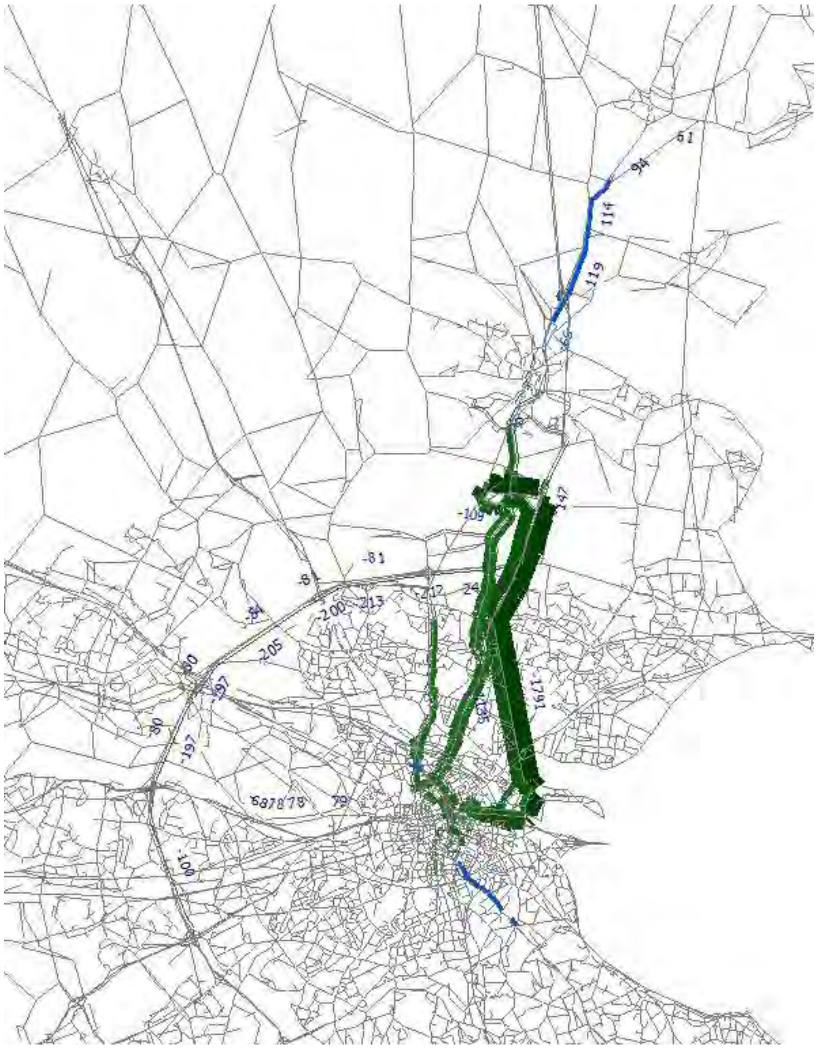
2030 Business Case Core Run - All Modes - PM Peak Period



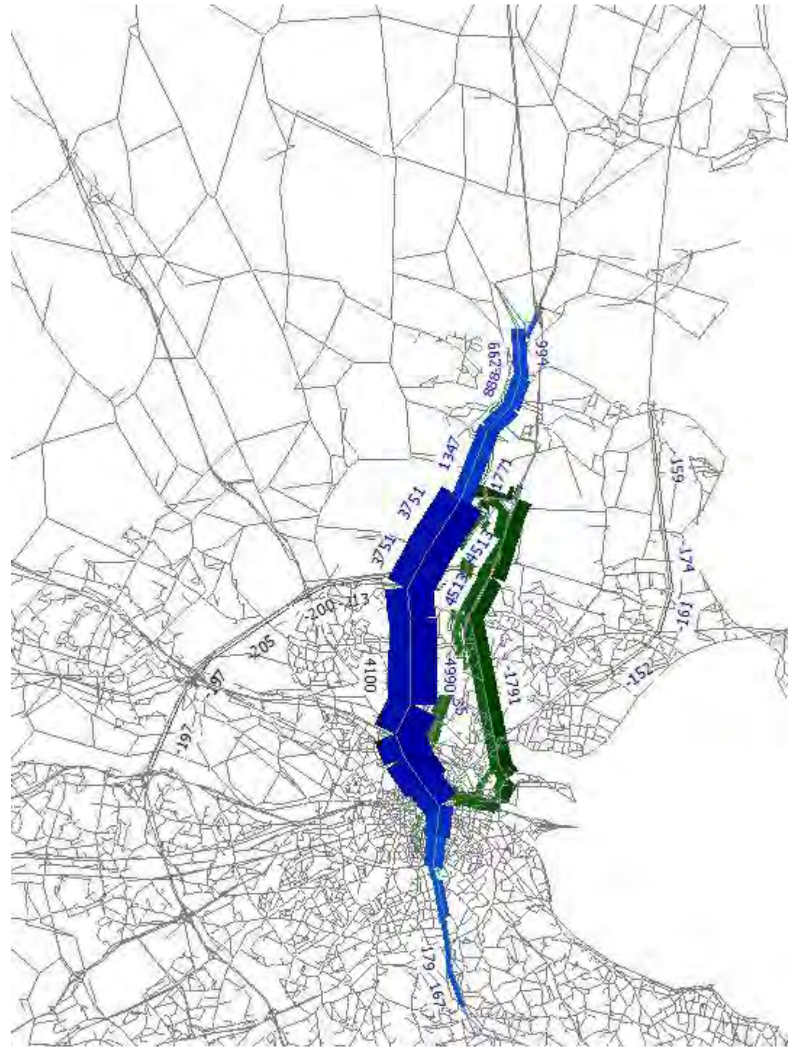
2045 Business Case Core Run – Bus Only – AM Peak Period



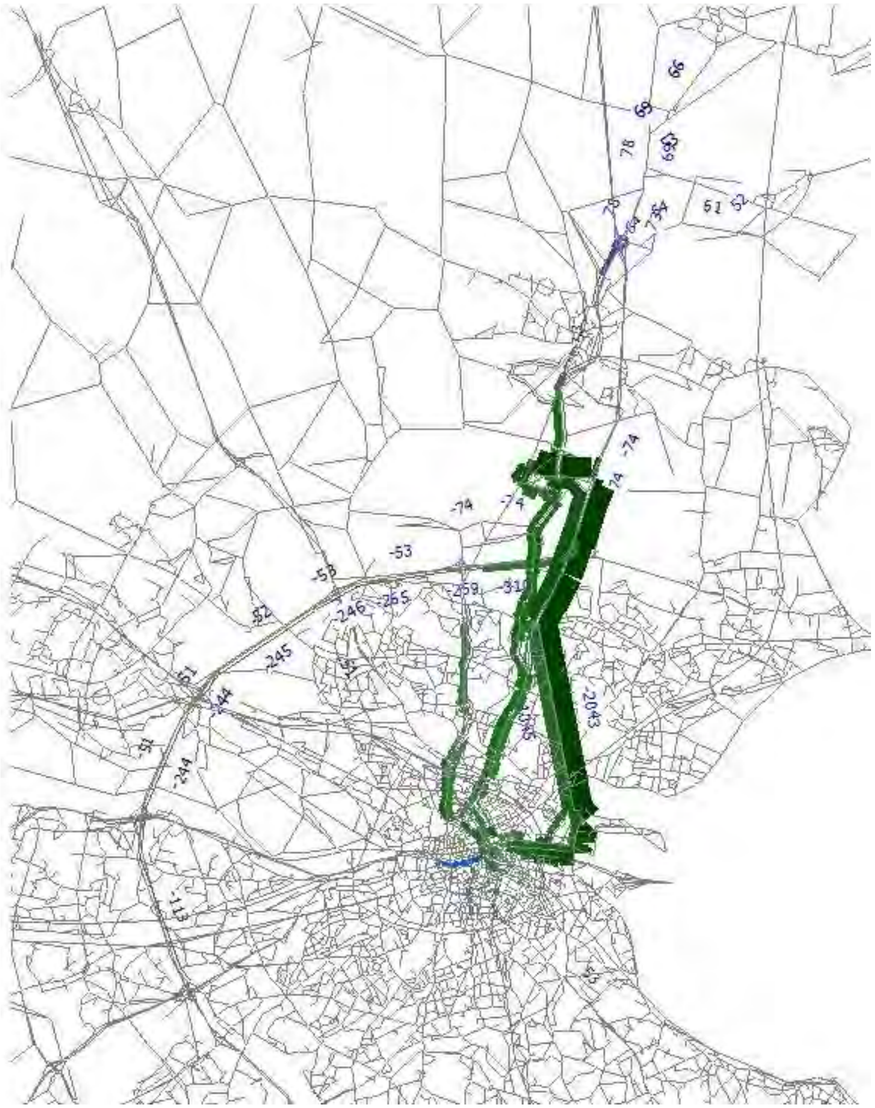
2045 Business Case Core Run – All Modes – AM Peak Period



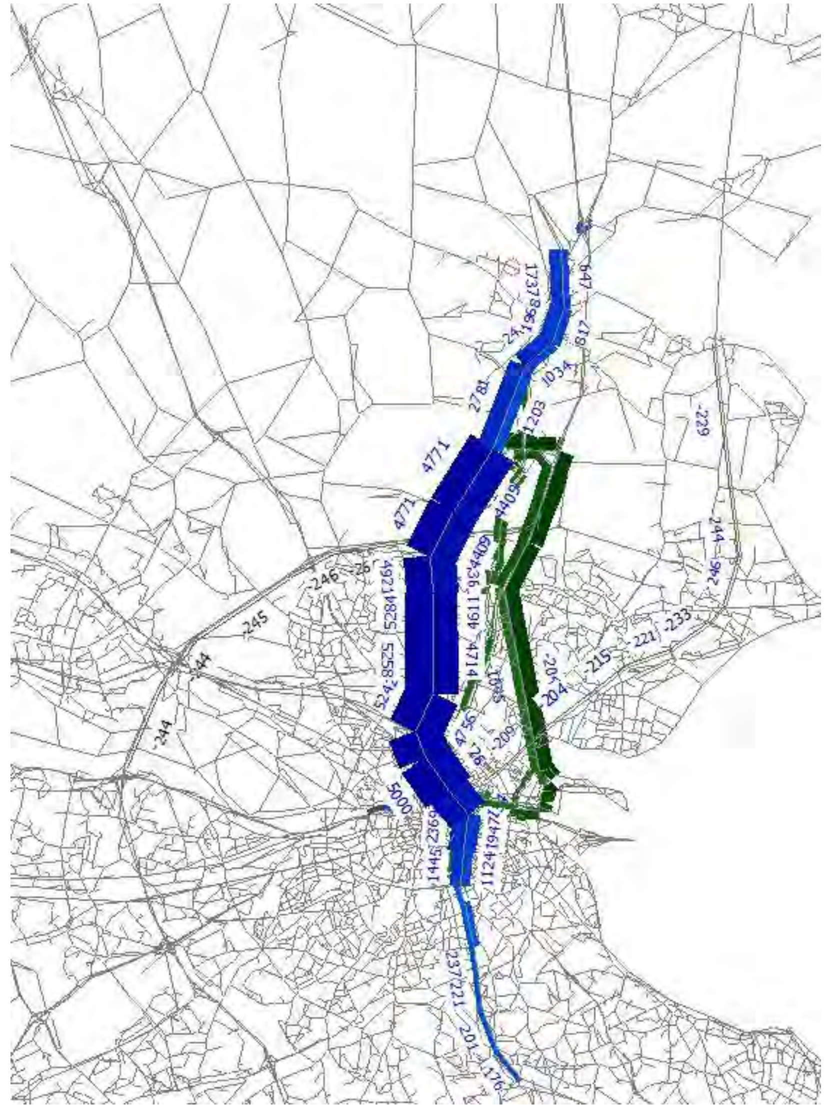
2045 Business Case Core Run – Bus Only – LT Peak Period



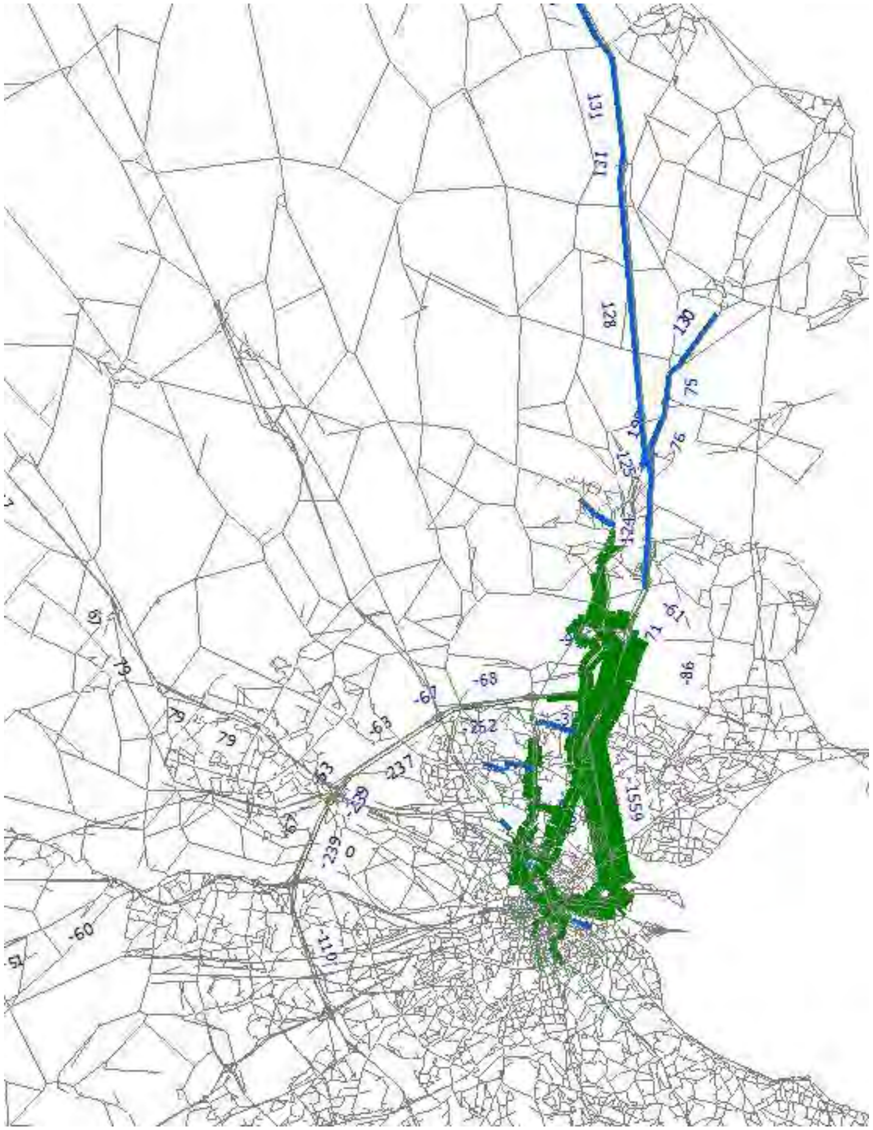
2045 Business Case Core Run – All Modes – LT Peak Period



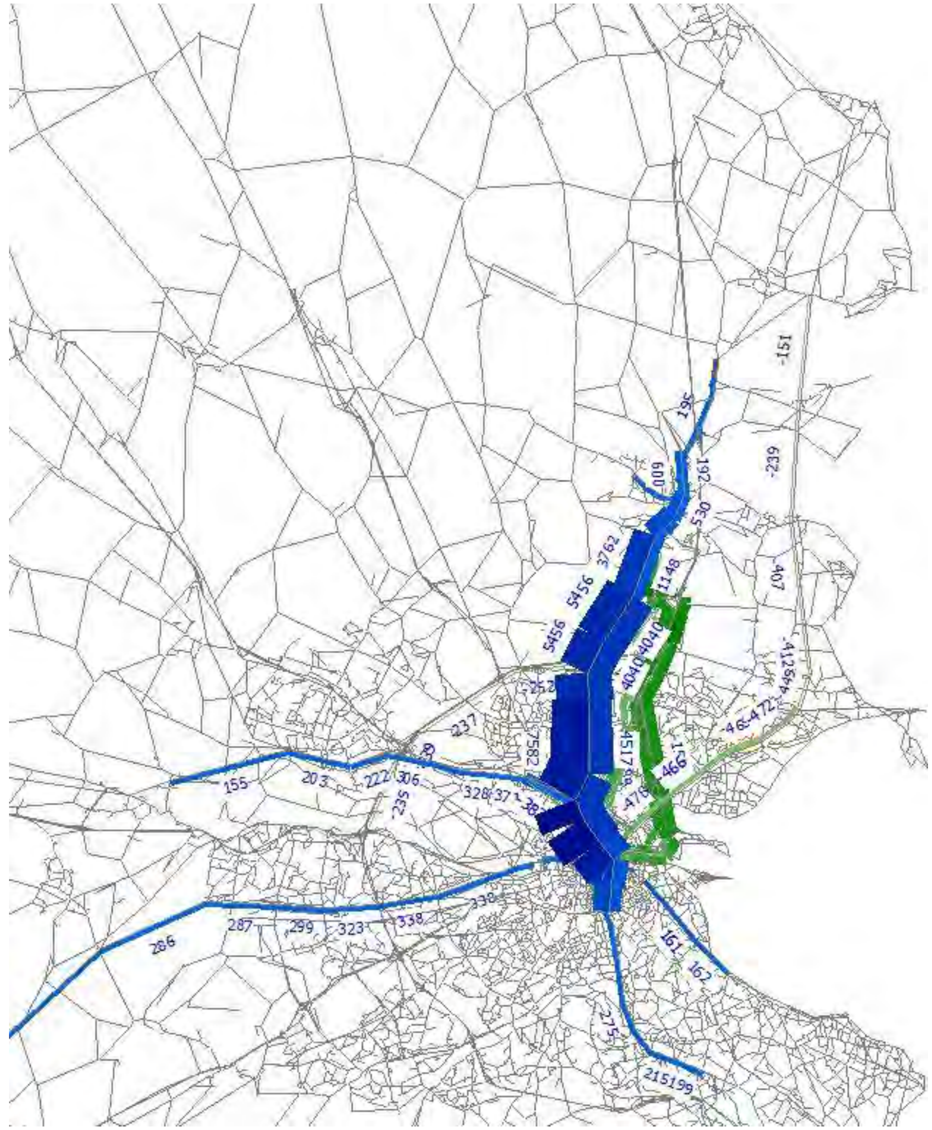
2045 Business Case Core Run – Bus Only – SR Peak Period



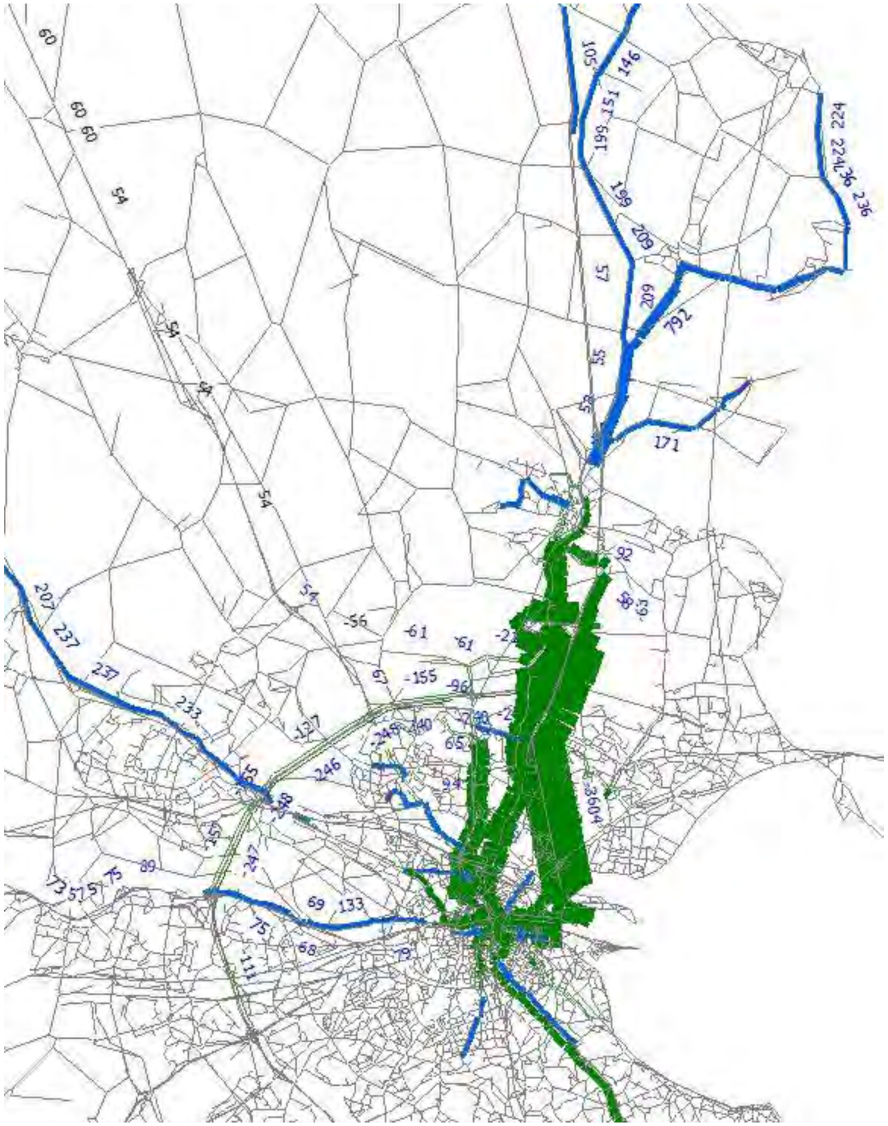
2045 Business Case Core Run – All Modes - SR Peak Period



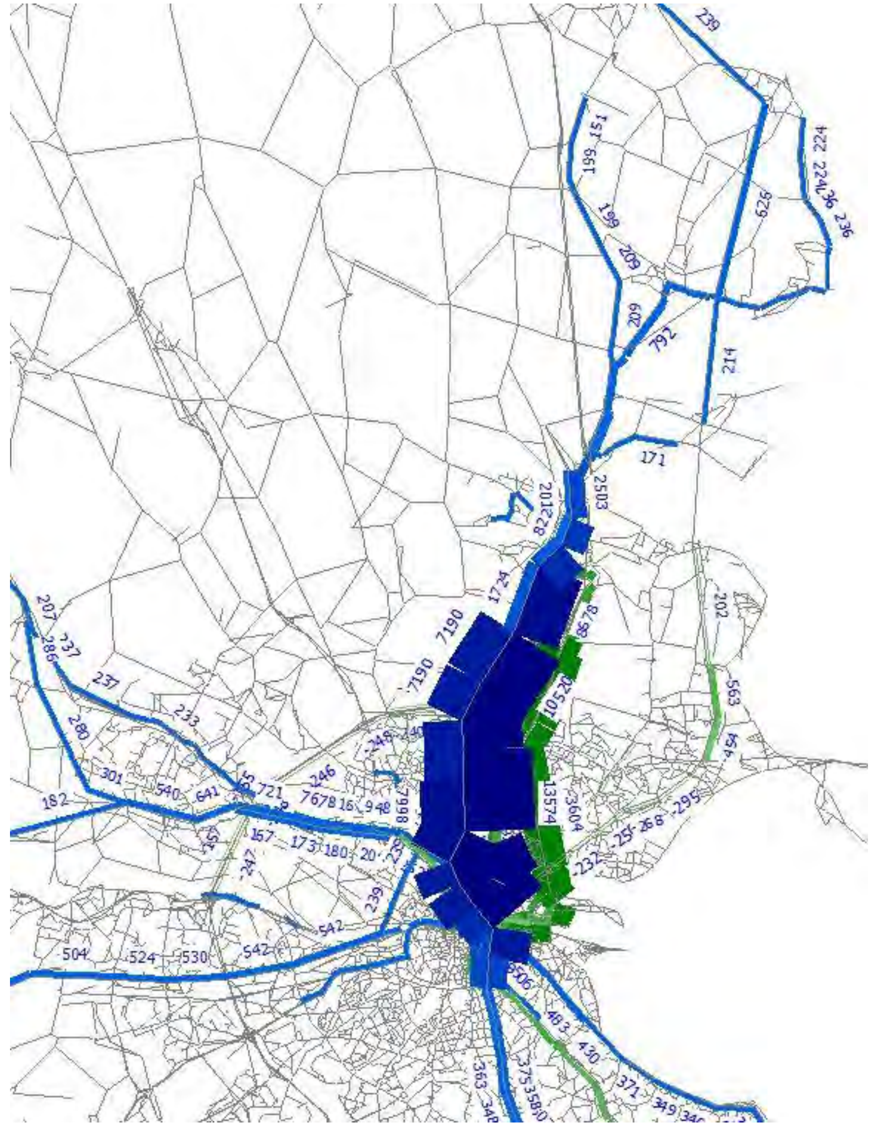
2045 Business Case Core Run – Bus Only – PM Peak Period



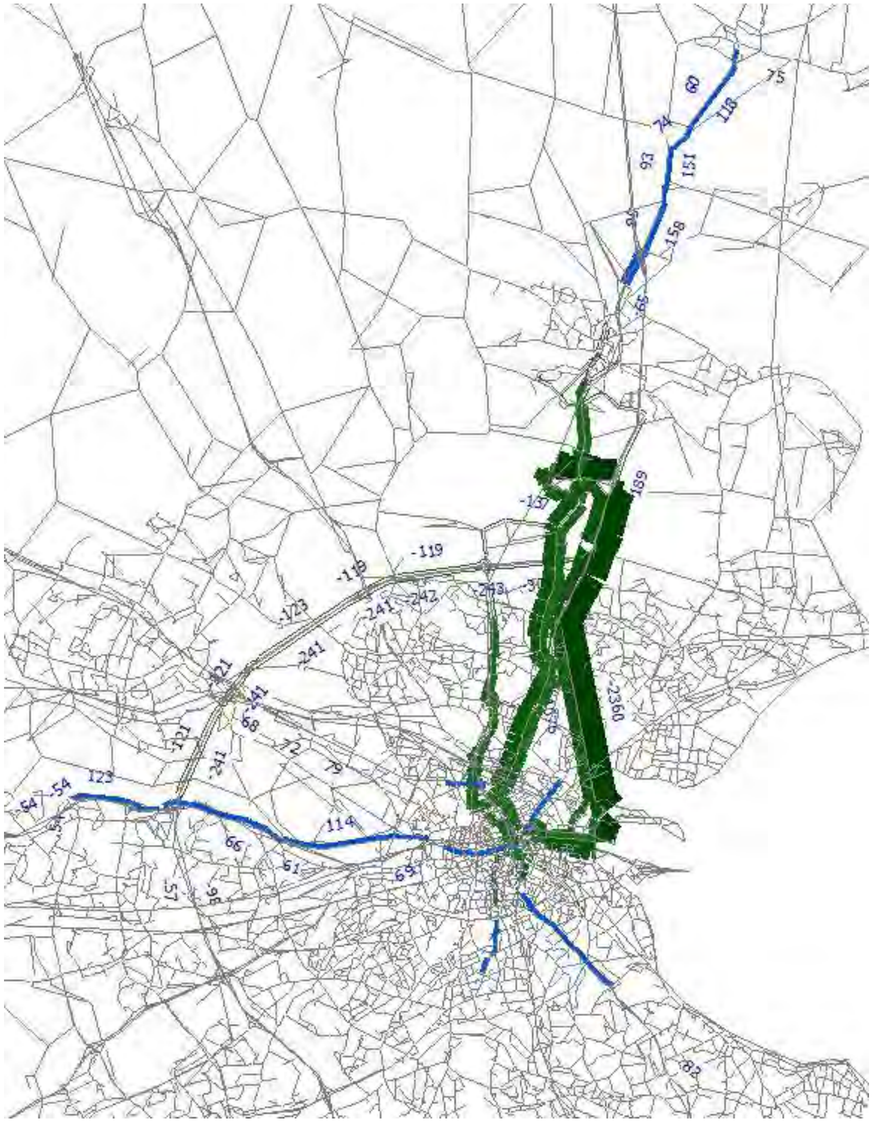
2045 Business Case Core Run – All Modes – PM Peak Period



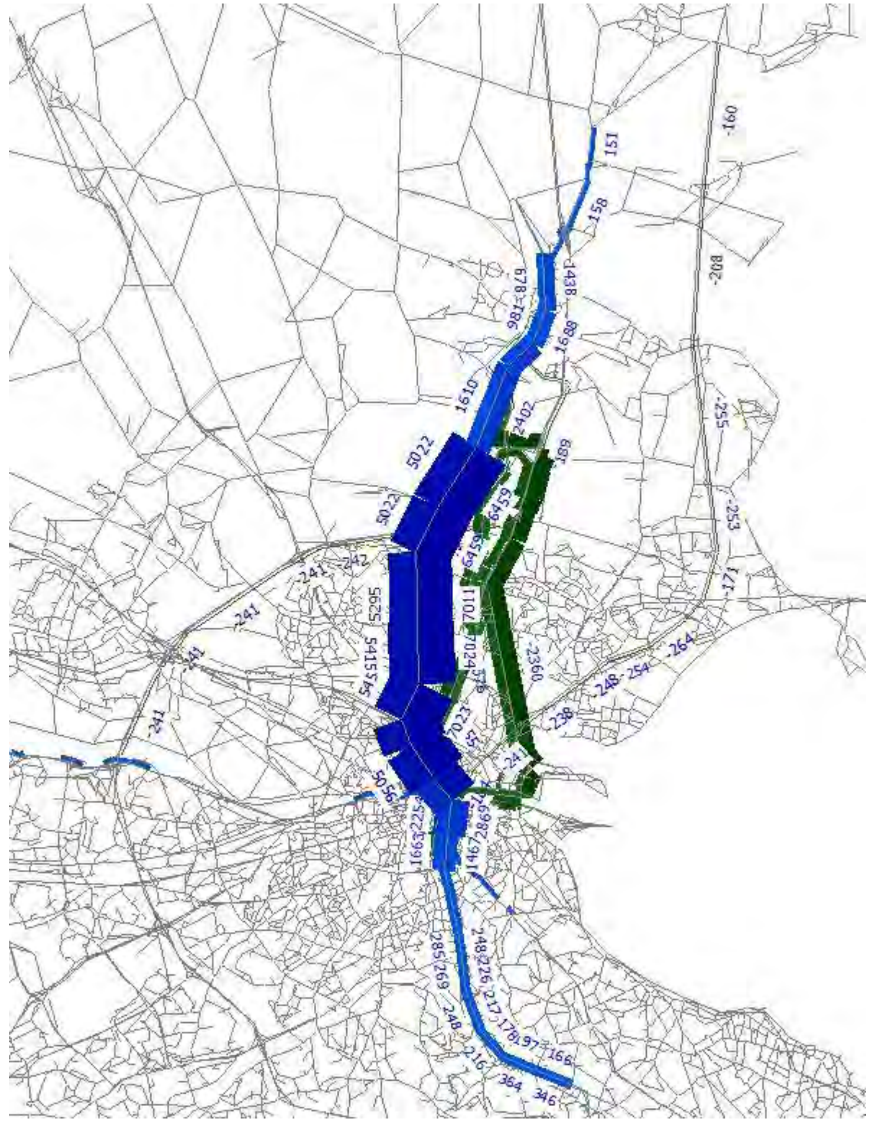
2060 Business Case Core Run – Bus Only – AM Peak Period



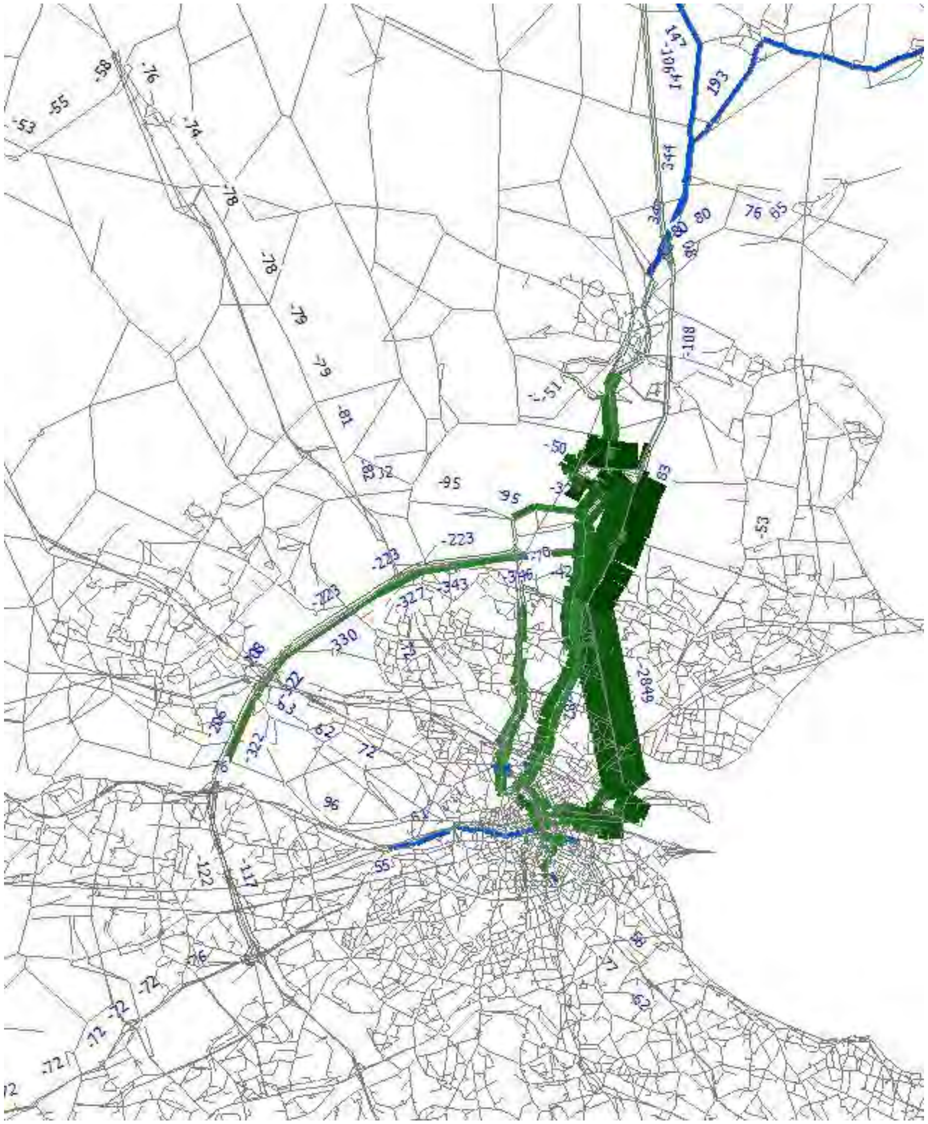
2060 Business Case Core Run – All Modes – AM Peak Period



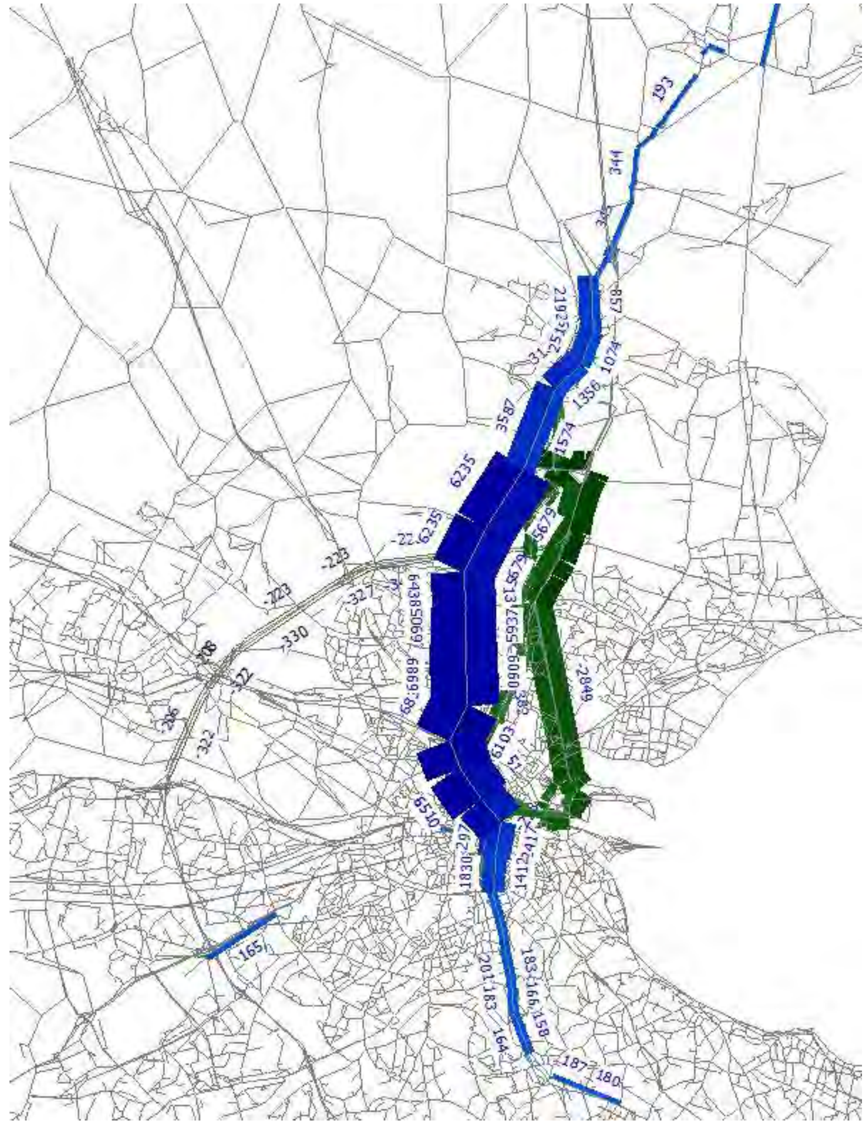
2060 Business Case Core Run – Bus Only – LT Peak Period



2060 Business Case Core Run – All Modes – LT Peak Period

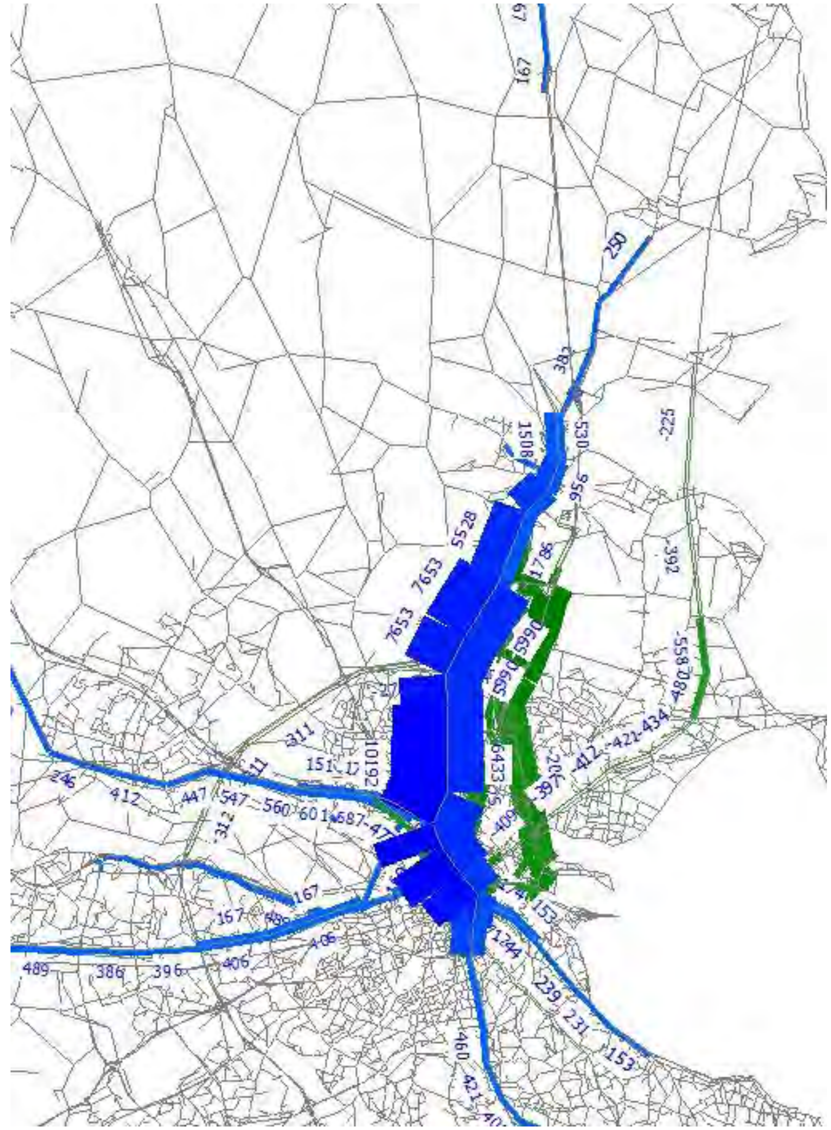


2060 Business Case Core Run – Bus Only – SR Peak Period



2060 Business Case Core Run – All Modes – SR Peak Period

2060 Business Case Core Run – Bus Only – PM Peak Period



2060 Business Case Core Run – All Modes – PM Peak Period

A.5 Journey Time Savings

Journey Time 2030 DS - 2030 DM Business Case AM Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	-0.2	-7.4	0.1	0.0	-11.7	-0.4	0.2	0.0	0.0	-0.8	-1.1	0.0	0.0	0.0	-26.1	0.9	-13.7
St Stephen's Green	0.1	0.0	0.1	-3.0	-10.9	0.0	-0.3	-14.1	-2.9	0.0	0.0	0.0	-2.2	-3.5	0.0	0.0	0.0	-33.0	-0.8	-13.1
College Street (Trinity)	0.0	0.0	0.0	0.1	-8.2	0.0	0.0	-10.7	-0.2	0.1	0.0	0.0	-0.1	-0.8	0.0	0.0	0.0	-27.0	5.4	-6.8
Glasnevin	-2.7	-9.0	-1.2	0.0	-0.1	-6.1	-9.0	2.2	-0.1	-16.6	0.5	0.5	-11.7	-0.8	-5.7	-6.5	-0.1	-29.2	-8.8	-24.0
DCU	-4.4	-9.7	-4.3	0.0	0.0	-10.0	0.0	0.0	0.0	-16.3	-3.5	-3.5	-13.2	-0.8	-22.8	-11.1	-0.1	-13.1	-12.4	-9.6
Rathgar Road	0.1	0.0	0.2	-5.7	-15.0	0.0	0.0	-18.6	-1.5	0.0	0.1	0.4	-6.3	-5.9	-0.8	-0.8	0.3	-34.8	-1.7	-20.8
Coolock	-0.1	-0.1	-0.2	-7.3	0.2	-0.3	0.0	0.0	-0.1	-1.2	0.1	-0.1	0.0	-0.8	0.0	0.0	-0.1	-0.8	0.1	0.1
Ballymun	-9.3	-14.7	-8.7	2.3	0.0	-15.6	-0.1	0.0	0.0	-20.6	-0.2	-0.2	-20.0	-0.8	-12.5	-15.7	-0.1	-10.9	-10.2	-7.9
Finglas	-0.2	-5.9	-0.4	0.9	-0.1	-0.8	-0.2	-0.1	0.0	-10.9	2.9	2.9	0.0	-0.7	1.4	0.3	0.4	-10.4	-10.8	-0.7
Sandyford	0.0	0.0	0.0	-8.6	-15.3	0.0	-1.2	-18.8	-2.7	0.0	0.0	0.0	-3.5	-6.7	-0.3	-0.3	0.2	-35.4	-2.4	-21.8
Tallaght	0.0	0.0	0.0	1.3	-6.6	0.0	0.0	-10.5	-1.1	0.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-23.3	5.3	-15.3
Red Cow	0.0	0.0	0.0	1.2	-6.5	0.0	0.0	-10.5	0.4	0.2	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-22.4	7.0	9.1
Blanchardstown	1.7	0.1	0.7	-12.1	-4.4	-1.2	0.0	-9.8	0.0	-1.6	0.0	0.1	0.0	-6.0	0.0	0.0	-0.1	-22.7	-1.9	-20.9
Ashbourne	-0.8	-0.8	-0.8	-0.8	-0.3	-0.8	-0.6	1.7	-0.8	-2.1	-0.1	-0.1	-9.0	0.0	-7.2	-9.0	5.1	-11.1	-13.0	4.1
Donabate	0.0	0.0	0.0	1.1	-14.1	0.9	0.0	-13.7	-16.7	-1.7	0.0	0.0	0.0	-17.8	0.0	0.0	0.0	1.0	0.4	-8.4
Balbriggan	-7.8	0.0	0.0	-15.5	-5.6	0.9	-7.8	-6.2	-6.3	-1.7	-7.8	-7.8	-7.8	0.2	0.0	0.0	-0.1	4.3	-9.6	2.2
Drogheda	0.0	0.0	0.0	-3.1	2.7	1.3	2.7	5.8	-11.3	-1.9	0.0	0.0	0.0	0.3	0.0	0.2	0.0	-8.9	0.0	1.6
Swords Pavilion	-16.3	-17.4	-7.3	-40.9	-17.1	-13.7	0.6	-17.0	-18.3	-19.6	-7.2	-7.1	-24.2	-31.8	0.4	6.5	-7.8	0.0	0.1	-8.5
Swords East	2.6	3.7	5.4	-14.4	-15.3	3.0	-1.4	-15.3	-16.6	-3.7	5.1	4.6	-7.2	-31.1	0.5	6.5	-5.5	-0.9	0.0	-5.0
Airport	-13.3	-11.5	-7.3	-25.3	-6.9	-20.7	0.1	-5.7	-7.0	-25.1	8.9	11.9	-19.7	-13.0	-2.0	5.9	-0.6	3.2	3.5	0.0

Journey Time 2030 DS - 2030 DM Business Case LT Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.6	-5.4	0.0	0.0	-9.5	0.3	0.0	0.0	0.0	0.0	-0.5	3.7	-0.5	-14.6	-24.3	2.7	-11.6
St Stephen's Green	0.0	0.0	0.0	-1.0	-7.9	0.0	0.0	-12.2	-0.1	0.0	0.0	0.0	0.0	-2.2	-0.8	-3.9	-19.1	-30.9	1.1	-12.4
College Street (Trinity)	0.0	0.0	0.0	1.3	-4.6	0.0	0.0	-9.5	0.1	0.0	0.0	0.0	0.0	-0.2	5.3	-0.2	-13.0	-18.0	2.2	-3.2
Glasnevin	-0.6	-6.8	1.1	0.0	-0.1	-0.4	-5.0	2.4	0.0	-13.1	0.8	0.8	-11.7	-0.2	-2.3	-22.8	-11.3	-27.6	-27.0	-18.7
DCU	-0.8	-5.4	-0.8	0.0	0.0	-6.4	0.0	0.0	0.0	-12.0	8.1	8.1	-17.6	0.0	-17.5	-12.4	4.9	-12.6	-11.9	-8.4
Rathgar Road	0.0	0.0	0.0	1.1	-13.0	0.0	0.0	-16.4	0.0	0.0	0.1	0.1	0.0	0.4	9.1	1.8	-9.2	-33.2	7.4	-17.9
Coolock	0.0	0.0	0.0	-1.8	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	-0.3	0.0	0.0	0.0	25.7	-0.1	-14.7
Ballymun	-6.4	-11.6	-5.6	2.4	0.0	-12.2	0.0	0.0	0.0	-17.9	2.4	2.4	-8.1	0.0	-20.6	-16.3	-5.4	-10.3	-9.2	-6.8
Finglas	0.0	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.6	-0.6	-1.4	0.0	-0.1	-15.2	-17.9	-4.0	-9.2	-8.4	-5.4
Sandyford	0.0	0.0	0.0	-7.5	-13.3	0.0	-0.2	-16.9	-0.8	0.0	0.0	0.0	0.0	-5.7	0.6	-6.6	-17.7	-33.8	-5.0	-19.3
Tallaght	0.0	0.0	0.0	1.7	-4.6	0.0	0.0	-8.2	0.6	0.6	0.0	0.0	0.0	1.7	6.8	0.6	0.0	-23.7	6.8	-9.5
Red Cow	0.0	0.0	0.0	3.0	-4.4	0.0	0.0	-8.2	0.5	-3.5	0.0	0.0	0.0	1.9	6.8	0.6	0.0	-23.7	-20.3	17.4
Blanchardstown	-1.7	0.0	0.0	-11.7	-4.2	-0.8	0.0	-19.4	0.0	0.0	0.0	0.0	0.0	0.0	5.4	-0.1	1.9	-20.8	-20.1	-14.6
Ashbourne	1.0	1.0	1.0	1.0	2.0	1.3	2.3	3.5	1.0	0.3	1.7	1.7	0.0	0.0	-2.5	-0.4	0.0	4.7	7.8	12.9
Donabate	0.6	-1.7	0.9	-14.2	-9.7	7.5	0.0	-10.8	-10.9	-4.0	0.0	0.0	0.5	-1.5	0.0	0.0	0.0	0.4	0.4	-3.0
Balbriggan	0.0	-0.8	0.0	-13.1	-16.2	2.6	0.0	-22.9	-14.0	-6.6	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.5	0.5	0.4
Drogheda	0.0	0.0	0.0	-9.9	19.7	0.4	0.0	-9.5	-10.4	-0.9	0.0	0.0	0.0	0.0	0.0	0.2	0.0	-16.8	-12.8	-0.2
Swords Pavilion	-13.7	-10.4	-4.6	-35.6	-13.4	-8.1	9.4	-13.9	-10.3	-37.7	-5.0	-4.9	-25.4	0.6	0.8	1.0	1.2	0.0	-1.4	-2.4
Swords East	3.4	-9.0	-3.4	-38.4	-16.4	-5.2	0.0	-18.4	-16.3	-21.1	-4.1	-2.9	-2.6	4.2	0.8	1.0	1.2	0.0	0.0	1.2
Airport	-13.0	-16.9	-11.4	-24.3	-6.4	-19.4	7.4	-5.0	-2.2	-26.4	12.5	19.3	-20.9	-0.1	-6.1	1.0	0.2	1.5	2.3	0.0

Journey Time 2030 DS - 2030 DM Business Case SR Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.2	-5.9	0.0	0.0	-10.7	-0.1	0.0	0.0	0.0	0.0	-0.2	4.8	0.1	-13.8	-30.0	1.2	-13.9
St Stephen's Green	0.0	0.0	0.0	-1.8	-9.1	0.0	0.2	-13.0	-1.3	0.0	0.0	0.0	0.0	-2.6	0.3	-0.3	-18.3	-31.8	0.0	-10.5
College Street (Trinity)	0.0	0.0	0.0	0.8	-6.2	0.0	0.0	-9.7	0.0	0.0	0.0	0.0	0.0	0.1	6.4	0.1	-12.1	-16.2	4.5	-10.8
Glasnevin	-1.1	-7.7	0.6	0.0	-0.1	-3.8	-5.1	2.3	0.0	-15.4	0.5	0.5	0.0	0.1	-1.0	-11.9	-14.0	-35.2	-27.9	-19.7
DCU	-2.0	-6.2	-2.3	0.0	0.0	-8.5	0.0	0.0	0.0	-12.8	7.1	7.1	0.1	0.1	-25.0	-14.7	16.8	-19.5	-18.4	-8.3
Rathgar Road	0.0	0.0	0.0	-1.3	-14.4	0.0	0.0	-18.6	0.0	0.0	-0.1	0.0	-0.1	-1.8	8.3	2.3	-10.2	-41.5	4.0	-22.5
Coolock	0.0	0.0	0.0	-1.8	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1	0.0	0.6	0.6	0.1	0.2	26.4	-0.1	-15.9
Ballymun	-7.8	-12.9	-7.1	2.5	0.0	-14.5	0.0	0.0	0.0	-18.8	1.2	1.2	0.1	0.1	-43.7	-18.6	-7.5	-15.9	-15.3	-7.3
Finglas	0.0	-1.9	0.1	0.0	0.0	-0.2	0.0	0.0	0.0	-7.3	-1.4	-1.9	0.0	0.1	-12.4	-16.8	-4.0	-12.3	-11.8	-3.8
Sandyford	0.0	0.0	0.0	-8.2	-14.2	0.0	-0.6	-18.3	-2.7	0.0	0.0	0.0	-0.1	-6.3	1.6	-3.2	-17.0	-42.0	-3.3	-21.4
Tallaght	0.0	0.0	0.0	1.7	-5.4	0.0	0.1	-8.3	0.7	1.1	0.0	0.0	-0.1	2.3	5.0	0.1	0.2	-31.5	6.9	-11.3
Red Cow	0.0	0.0	0.0	3.3	-5.3	0.0	0.0	-6.7	0.8	0.0	0.0	0.0	-0.1	2.4	4.9	0.1	0.2	-9.4	5.3	14.6
Blanchardstown	0.0	0.0	0.0	-21.9	1.7	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	36.4	0.1	-20.6	1.5	-0.7	11.3
Ashbourne	0.1	0.1	0.1	0.1	0.9	0.1	1.1	2.8	0.0	-0.6	0.8	0.8	-0.1	0.0	-1.3	0.2	0.2	5.6	8.3	-3.4
Donabate	0.8	-1.3	1.0	-8.3	-13.2	7.0	0.0	-13.0	-10.6	-3.7	0.0	0.0	0.0	-12.7	0.0	0.0	0.0	0.4	0.4	-1.3
Balbriggan	0.0	-1.4	0.0	-11.8	-18.3	3.6	0.0	-25.4	-15.4	-6.5	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.2	0.4	0.3
Drogheda	0.0	0.0	0.0	-10.5	21.5	0.5	0.0	-11.5	-15.6	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-19.5	-15.2	0.0
Swords Pavilion	-12.8	-10.7	-4.9	-39.8	-15.8	-8.9	1.8	-15.7	-13.2	-29.0	-8.9	-5.2	-28.1	1.2	0.9	1.3	-8.4	0.0	0.0	-2.7
Swords East	2.7	-1.8	2.4	-13.6	-19.2	4.2	0.0	-16.6	-14.8	-7.3	7.9	7.9	-1.3	4.8	0.9	1.3	1.6	0.0	0.0	0.9
Airport	-15.4	-15.4	-6.5	-25.9	-7.3	-21.9	7.0	-4.6	-2.1	-28.9	3.8	16.9	-6.8	-2.0	-7.6	-0.6	-1.3	-0.2	0.9	0.0

Journey Time 2030 DS - 2030 DM Business Case PM Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	-0.2	-9.2	0.1	-0.3	-13.4	-1.1	0.1	0.0	0.0	-0.9	0.9	0.0	9.4	0.0	-19.5	-2.3	-13.8
St Stephen's Green	0.2	0.0	0.1	-2.1	-12.3	0.0	-0.2	-16.9	-6.0	0.0	0.0	0.0	-0.1	-0.4	0.0	0.0	0.0	-10.9	-2.0	-18.3
College Street (Trinity)	0.0	0.0	0.0	0.2	-9.2	0.1	-0.1	-13.8	-0.1	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	-12.9	4.8	-7.0
Glasnevin	-1.2	-7.4	-0.3	0.0	-0.2	-7.8	-23.4	1.5	-0.1	-14.8	0.2	0.2	-11.2	0.9	-6.4	0.6	-11.0	-35.0	-19.7	-21.3
DCU	-3.2	-7.1	-3.9	0.0	0.0	-9.3	0.0	0.0	-0.1	-13.7	5.8	5.8	-12.9	1.1	-11.1	-10.8	0.1	-18.0	-9.8	-9.3
Rathgar Road	0.2	0.0	0.1	-4.6	-17.5	0.0	-0.6	-20.9	-4.2	0.0	0.2	0.2	-7.4	1.6	-0.7	-0.4	-3.1	-21.2	3.0	-20.8
Coolock	0.0	0.0	0.0	-10.2	-0.3	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.8	0.0	9.4	0.0	0.2	0.2	-0.5
Ballymun	-8.5	-13.7	-7.9	2.5	0.0	-15.1	0.0	0.0	-0.1	-19.4	0.1	0.1	-11.4	1.1	-16.5	-14.9	-4.9	-14.2	-1.4	-7.4
Finglas	-0.8	-6.8	-0.5	0.0	-0.6	-6.7	-0.5	-0.6	0.0	-13.0	2.6	2.6	0.0	1.0	3.8	-8.4	18.0	-13.7	-11.7	-6.9
Sandyford	0.0	0.0	-0.2	-8.6	-17.2	-0.1	-2.5	-20.6	-6.4	0.0	0.0	0.0	-2.3	-3.6	-0.7	-0.7	-2.5	-17.4	-8.2	-21.5
Tallaght	0.0	0.0	0.0	3.5	-8.0	0.1	-0.1	-12.0	-0.2	0.3	0.0	0.0	0.0	2.9	0.0	9.4	0.0	-8.4	1.1	-10.8
Red Cow	0.0	0.0	0.0	3.2	-8.0	0.0	-0.4	-11.9	0.0	0.7	0.0	0.0	0.0	3.1	0.0	9.4	0.0	-8.4	1.4	7.4
Blanchardstown	1.6	0.0	0.7	-12.0	-3.6	-0.7	-0.1	-8.2	0.0	-1.8	-0.1	-0.1	0.0	0.0	0.0	9.4	0.0	-27.7	-6.6	-17.6
Ashbourne	0.1	0.1	0.0	0.1	0.3	0.0	0.8	2.9	0.1	-0.7	0.6	0.7	-7.0	0.0	-0.7	-0.6	0.2	9.2	12.4	-0.4
Donabate	0.0	0.0	0.0	-6.4	-8.1	1.0	-0.1	10.1	-4.3	-1.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.4	0.4	-24.5
Balbriggan	-0.7	0.1	0.0	-9.4	-14.2	0.3	-0.4	-21.1	-19.1	-8.1	1.9	1.7	0.1	0.4	0.0	0.0	0.0	0.3	6.4	0.4
Drogheda	-5.8	0.0	0.0	-13.6	21.7	-3.6	-9.2	-11.7	-21.9	-12.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-17.1	2.8	0.0
Swords Pavilion	-21.9	-21.5	-12.5	-39.8	-16.0	-21.7	1.4	-14.9	-12.1	-42.8	-12.4	14.1	-32.8	-2.1	1.1	3.7	-14.0	0.0	0.1	-2.9
Swords East	1.2	-1.9	3.2	-11.3	-0.6	-1.8	0.2	-0.3	2.6	-10.5	3.5	3.6	-1.8	-3.7	0.0	1.2	0.0	-0.1	0.0	0.7
Airport	-15.5	-14.0	-5.6	-21.4	-7.0	-23.2	2.0	-5.8	-3.0	-27.4	20.2	9.7	-21.5	10.9	-0.5	3.7	1.5	0.6	1.8	0.0

Journey Time 2045 DS - 2045 DM Business Case AM Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.0	-7.5	0.2	0.2	-12.1	0.3	0.2	0.0	0.0	-0.8	-1.1	0.0	0.0	0.0	-26.0	0.8	-23.0
St Stephen's Green	0.0	0.0	0.1	-2.9	-11.3	0.1	0.2	-14.5	-2.0	0.0	0.0	0.0	-2.2	-3.4	0.0	0.0	0.0	-32.7	-0.9	-14.3
College Street (Trinity)	0.0	0.0	0.0	0.2	-8.3	0.2	0.2	-12.7	0.4	0.1	0.0	0.0	-0.2	-0.9	0.0	0.0	0.0	-27.3	5.3	-8.7
Glasnevin	-3.8	-9.3	-2.1	0.0	-0.1	-6.4	-8.5	2.1	0.2	-16.8	0.4	0.4	-11.7	-0.9	-5.5	-8.7	0.1	-28.7	-14.1	-24.5
DCU	-4.8	-9.9	-4.7	0.1	0.0	-9.9	0.0	0.0	0.3	-16.5	-3.2	-3.2	-12.5	-1.3	-23.0	-15.4	-0.8	-13.5	-12.8	-9.7
Rathgar Road	0.1	0.1	0.2	-4.6	-15.6	0.0	0.3	-18.9	-0.4	0.0	0.2	0.5	-6.6	-5.8	-0.8	-2.9	0.0	-34.3	-1.8	-22.4
Coolock	0.3	0.3	0.2	-7.0	0.2	0.3	0.0	-0.1	0.2	-0.8	0.5	0.3	0.3	-1.0	0.3	0.3	-3.9	0.0	0.3	0.3
Ballymun	-9.3	-14.7	-8.6	2.4	0.0	-15.6	-0.5	0.0	0.3	-20.5	-0.2	-0.2	-21.5	-1.2	-12.4	-18.0	-0.8	-11.1	-10.4	-8.1
Finglas	0.2	-6.2	0.1	-1.0	0.0	-0.7	-0.6	0.0	0.0	-11.7	2.3	2.3	0.0	-1.1	-0.9	-15.5	7.9	-10.3	-11.2	-7.3
Sandyford	0.0	0.0	0.0	-8.2	-15.8	-0.1	-1.2	-18.7	-1.7	0.0	0.0	0.0	-4.1	-6.4	-0.4	-0.3	-0.1	-35.0	-2.3	-23.7
Tallaght	0.0	0.0	0.0	1.7	-6.3	-0.1	0.2	-10.4	1.9	0.1	0.0	0.0	0.2	1.2	0.0	0.0	0.0	-23.6	5.4	-18.5
Red Cow	0.0	0.0	0.0	1.6	-6.2	-0.1	0.2	-10.4	1.4	0.2	0.0	0.0	0.2	1.2	0.0	0.0	0.0	-22.5	7.1	1.8
Blanchardstown	1.6	0.0	0.7	-12.1	-3.5	-1.0	0.1	-8.4	0.0	-1.6	0.2	0.2	0.0	-2.1	0.0	0.0	0.0	-22.3	-2.0	-21.3
Ashbourne	-0.5	-0.5	-0.5	-0.5	-0.2	-0.5	0.0	1.7	-0.7	-2.0	0.3	0.3	-9.3	0.0	-6.9	-14.3	1.2	-18.4	-16.7	3.7
Donabate	5.5	0.0	0.0	7.3	-13.9	1.0	5.6	-14.1	-8.2	-1.8	5.5	5.5	5.5	-17.2	0.0	0.0	0.0	1.0	0.2	-9.1
Balbriggan	0.0	7.8	7.8	-7.7	6.8	8.8	0.2	-16.2	3.6	6.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	3.4	-0.3	2.0
Drogheda	0.0	0.0	0.0	-5.2	0.8	1.0	0.8	4.8	-12.9	-1.7	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	4.1	-0.3	1.1
Swords Pavilion	-15.4	-17.9	-7.7	-40.6	-17.4	-14.1	2.1	-17.3	-18.3	-20.0	-7.6	-7.5	-24.3	-33.3	0.7	0.3	-8.4	0.0	0.0	-9.3
Swords East	2.4	3.5	4.4	-14.6	-15.9	2.7	-0.4	-15.9	-16.9	-4.0	4.2	3.6	-7.4	-25.0	0.8	0.3	0.2	-0.3	0.0	-5.9
Airport	-13.7	-11.8	-7.8	-24.8	-6.9	-21.0	-0.3	-5.7	-6.7	-25.6	-3.6	13.0	-20.4	-14.0	-2.3	0.3	-0.2	3.1	3.5	0.0

Journey Time 2045 DS - 2045 DM Business Case LT Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.8	-5.2	0.0	0.1	-9.5	0.7	0.0	0.0	0.0	0.0	-0.1	3.8	-0.3	-14.2	-25.1	2.2	-15.6
St Stephen's Green	0.0	0.0	0.0	-0.9	-7.9	0.0	0.2	-12.2	0.2	0.0	0.0	0.0	0.0	-1.9	-0.7	-2.7	-18.7	-31.8	1.6	-16.0
College Street (Trinity)	0.0	0.0	0.0	1.4	-4.9	0.0	0.1	-9.4	0.5	0.0	0.0	0.0	0.0	0.2	5.4	-0.1	-12.5	-25.7	8.2	-7.3
Glasnevin	-0.6	-6.8	0.9	0.0	0.0	-1.1	-4.5	2.4	0.1	-13.1	0.8	0.8	-11.7	0.1	-2.2	-17.0	-20.2	-28.5	-27.9	-23.0
DCU	-0.7	-5.3	-0.7	0.0	0.0	-7.8	0.0	0.0	0.0	-12.0	8.1	8.1	-20.4	-0.2	-19.2	-16.0	18.0	-14.3	-13.5	-9.7
Rathgar Road	0.0	0.0	0.0	1.0	-13.0	0.0	0.2	-16.4	0.4	0.0	0.1	0.1	0.0	0.8	9.1	2.0	-8.9	-34.4	6.8	-21.9
Coolock	0.3	0.2	0.2	-1.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.1	0.3	-0.9	0.2	0.3	0.3	24.9	0.0	0.9
Ballymun	-6.3	-11.5	-5.5	2.4	0.0	-13.8	0.1	0.0	0.0	-17.8	2.4	2.4	-12.1	-0.2	-20.9	-18.8	-8.6	-12.2	-11.2	-8.1
Finglas	1.2	-1.1	0.3	0.2	0.0	0.3	0.0	0.0	0.0	-3.6	-0.3	-1.6	0.0	-0.1	-14.7	-19.9	-7.0	-10.9	-10.1	-6.6
Sandyford	0.0	0.0	-0.2	-7.4	-13.4	0.0	0.0	-16.9	-0.7	0.0	0.0	0.0	-0.2	-5.4	0.7	-6.1	-17.3	-34.6	-3.7	-23.9
Tallaght	0.0	0.0	0.0	1.9	-4.5	0.0	0.2	-8.4	0.9	0.5	0.0	0.0	0.0	2.1	6.4	0.4	0.0	-24.5	6.4	-14.0
Red Cow	0.0	0.0	0.0	3.1	-4.5	-0.1	0.2	-8.4	0.8	-3.1	0.0	0.0	0.0	2.3	6.4	0.4	0.0	-24.6	7.7	5.8
Blanchardstown	-1.6	0.3	0.3	-11.7	-2.2	-1.0	0.2	-19.2	0.0	-1.7	0.2	0.2	0.0	0.0	5.5	0.0	0.5	-21.6	-21.0	-19.2
Ashbourne	0.3	0.3	0.3	0.2	1.1	0.6	1.7	2.3	0.0	-0.5	1.0	1.0	-0.3	0.0	-6.7	0.4	-0.1	-1.7	1.0	7.9
Donabate	0.5	-1.6	0.7	-14.2	-11.8	7.3	0.1	-11.9	-10.7	-3.9	0.0	0.0	0.4	-6.8	0.0	0.0	0.0	0.4	0.4	-3.7
Balbriggan	0.0	-0.5	0.0	-12.7	-19.1	2.3	0.2	-25.8	-13.2	-6.0	0.0	0.0	0.0	0.3	0.0	0.0	0.5	0.5	0.5	0.5
Drogheda	0.0	0.0	0.0	-3.0	21.0	0.0	0.2	-13.5	-4.3	0.3	0.0	0.0	0.0	-0.2	0.0	0.7	0.0	-14.9	-9.4	-1.7
Swords Pavilion	-15.7	-10.9	-5.1	-35.1	-14.4	-13.6	9.4	-14.8	-11.6	-40.9	-5.5	-5.5	-25.4	-2.7	0.7	1.0	1.5	0.0	0.0	-2.9
Swords East	3.4	-9.2	-3.6	-39.5	-19.0	-4.8	0.0	-19.1	-16.7	-24.4	-4.1	-4.0	-4.9	0.9	0.7	1.0	1.5	0.0	0.0	0.6
Airport	-13.9	-17.8	-14.6	-25.0	-6.5	-20.4	6.8	-5.0	-1.8	-26.7	-5.8	17.6	-23.7	-2.6	-6.8	-0.9	-1.7	0.5	1.6	0.0

Journey Time 2045 DS - 2045 DM Business Case SR Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.3	-6.4	-1.0	0.1	-10.9	0.4	0.0	0.0	0.0	0.3	0.9	6.6	0.2	0.3	-31.9	0.8	-10.4
St Stephen's Green	0.0	0.0	0.0	-1.7	-9.3	0.0	0.8	-13.3	-2.0	0.0	0.0	0.0	0.3	-1.5	2.1	0.2	-15.1	-36.9	-0.4	-12.1
College Street (Trinity)	0.0	0.0	0.0	0.9	-6.5	0.0	0.1	-11.0	0.5	0.0	0.0	0.0	0.3	1.2	8.3	0.2	0.3	-23.5	6.4	-11.5
Glasnevin	-1.1	-7.8	0.5	0.0	-0.1	-4.5	-4.6	2.1	0.3	-15.3	0.5	0.5	-13.8	1.1	0.9	-5.8	4.7	-35.2	-38.9	-23.2
DCU	-1.9	-6.2	-2.3	0.0	0.0	-8.4	0.0	0.0	0.0	-12.8	7.0	7.0	0.4	1.0	-23.3	-13.7	18.2	-20.4	-19.5	-9.3
Rathgar Road	0.0	0.0	0.0	-1.3	-14.7	0.0	0.2	-18.8	0.4	0.0	0.1	0.0	0.3	-0.7	10.0	2.3	0.1	-42.2	3.5	-21.0
Coolock	0.3	0.3	0.3	-10.2	0.2	0.2	0.0	0.1	0.0	0.3	0.1	0.1	0.3	0.2	1.0	0.5	0.6	25.9	-0.1	0.8
Ballymun	-7.7	-13.0	-7.1	2.4	0.0	-14.4	0.0	0.0	0.0	-18.8	1.1	1.1	0.4	1.1	-42.8	-17.6	-6.2	-16.9	-16.4	-8.4
Finglas	0.1	-1.9	0.2	0.1	0.4	-1.1	0.3	0.3	0.0	-7.5	-1.3	-1.9	0.4	0.9	-10.7	-14.6	-1.9	-12.6	-12.1	-4.1
Sandyford	0.0	0.0	-0.1	-8.1	-14.5	0.0	-0.5	-18.5	-2.4	0.0	0.0	0.0	0.2	-5.2	3.5	0.1	-13.7	-42.0	-3.6	-20.9
Tallaght	0.0	0.0	0.0	1.8	-5.2	0.0	0.3	-9.4	1.0	-0.5	0.0	0.0	0.2	3.3	2.8	0.2	0.3	-32.3	6.6	-14.0
Red Cow	0.0	0.0	0.0	3.3	-5.1	-0.5	0.2	-9.1	1.1	-6.3	0.0	0.0	0.2	3.5	3.0	0.2	0.3	-32.2	6.6	9.9
Blanchardstown	0.2	0.2	0.2	-22.4	1.7	0.2	0.2	1.7	0.0	0.2	0.2	0.2	0.0	0.3	39.5	0.2	0.3	2.8	-0.1	10.8
Ashbourne	0.2	0.2	0.2	0.1	1.3	0.2	1.3	3.6	0.0	-0.5	0.9	0.9	-0.3	0.0	3.0	1.3	0.9	1.7	4.2	11.9
Donabate	0.7	-1.2	0.9	-8.3	-13.5	6.7	0.0	-13.3	-10.0	-3.7	0.0	0.0	0.5	-1.4	0.0	0.0	0.0	0.4	0.4	-1.6
Balbriggan	0.0	-1.1	0.0	-11.4	-18.5	3.6	0.2	-25.6	-13.8	-6.1	0.0	0.0	0.0	0.9	0.0	0.0	2.5	0.3	0.5	0.2
Drogheda	0.0	0.0	0.0	-9.9	21.2	0.0	0.2	-12.3	-14.5	-0.4	0.0	0.0	0.0	-0.1	0.0	0.5	0.0	-19.5	-15.2	-0.9
Swords Pavilion	-13.3	-11.3	-5.5	-37.6	-16.1	-12.4	1.8	-15.9	-13.3	-34.6	-11.0	-5.8	-47.2	3.1	2.5	3.4	-6.5	0.0	0.1	-2.8
Swords East	2.6	-1.0	3.1	-16.1	-19.5	3.7	0.1	-16.7	-14.9	-7.4	7.7	7.7	-1.5	6.7	2.5	3.4	4.4	0.0	0.0	0.8
Airport	-15.0	-16.4	-6.8	-25.7	-7.3	-22.5	6.0	-4.6	-2.0	-28.7	-6.9	15.3	-23.2	0.6	-5.0	3.4	1.1	-0.2	0.8	0.0

Journey Time 2045 DS - 2045 DM Business Case PM Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.0	-9.0	0.0	-0.2	-13.3	-0.5	0.2	0.0	0.0	-0.9	0.5	0.0	0.0	0.0	-18.7	-4.5	-18.3
St Stephen's Green	0.1	0.0	0.1	-1.9	-12.2	0.0	0.1	-16.9	-5.3	0.0	0.0	0.0	-0.1	-1.1	0.0	0.0	0.0	-14.8	-6.4	-22.9
College Street (Trinity)	0.0	0.0	0.0	0.4	-9.2	0.1	0.1	-13.7	0.4	0.1	0.0	0.0	0.2	1.2	0.0	0.0	0.0	-12.1	0.5	-8.2
Glasnevin	-1.4	-7.2	-0.1	0.0	-0.1	-7.5	-24.4	1.5	0.2	-15.0	0.3	0.3	-11.2	0.6	-6.5	-4.8	-9.1	-36.6	-20.7	-24.6
DCU	-3.2	-7.2	-4.0	0.1	0.0	-9.5	-0.1	0.0	0.5	-13.9	5.8	5.8	-13.0	-0.1	-10.8	-17.2	-1.5	-20.4	-12.6	-10.7
Rathgar Road	0.2	0.0	0.2	-4.4	-17.3	0.0	-0.7	-20.9	-3.4	0.0	-6.2	-6.7	-7.6	0.6	0.3	0.3	-0.8	-26.0	-1.4	-25.7
Coolock	0.3	0.4	0.4	-10.1	-0.3	0.5	0.0	0.0	0.5	0.3	0.4	0.3	0.3	0.2	0.3	0.3	0.3	-0.1	0.0	-1.6
Ballymun	-8.6	-13.8	-8.5	2.6	0.0	-15.2	-0.4	0.0	0.5	-19.5	0.1	0.1	-11.2	-0.1	-16.5	-21.1	-8.3	-16.2	-3.7	-8.9
Finglas	-0.5	-6.5	-0.2	0.2	-0.1	-6.7	-0.3	-0.1	0.0	-13.1	2.9	2.8	0.0	0.3	3.9	-7.8	17.1	-15.9	-13.7	-8.6
Sandyford	-0.1	0.0	-0.2	-8.3	-17.0	-0.1	-2.2	-20.5	-5.5	0.0	-0.1	-0.1	-2.5	-5.5	-0.7	-0.7	-1.4	-21.8	-12.2	-25.9
Tallaght	0.0	0.0	0.0	7.2	-8.0	-3.0	0.2	-12.2	0.1	0.8	0.0	0.0	7.9	2.8	0.0	0.0	0.0	-11.9	-0.2	-15.3
Red Cow	0.0	0.0	0.0	3.4	-8.1	-0.2	-0.1	-12.1	0.3	1.2	0.0	0.0	-1.3	2.8	0.0	0.0	0.0	-11.9	1.2	10.8
Blanchardstown	1.6	0.0	0.7	-12.0	-3.5	-0.7	-0.1	-7.7	0.0	-1.9	0.1	0.1	0.0	1.1	0.0	0.0	0.0	-30.1	-7.3	-20.7
Ashbourne	0.3	0.3	0.3	0.2	1.0	0.2	1.2	3.3	0.0	-0.6	0.9	0.9	-6.8	0.0	-0.5	0.2	-0.2	4.1	7.2	14.1
Donabate	0.0	0.0	0.0	-6.3	-8.1	0.6	0.1	9.1	-3.2	-2.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.2	0.2	-24.9
Balbriggan	-0.4	0.1	0.0	-9.0	-12.0	0.2	-0.2	-23.7	-17.4	-7.7	1.7	1.5	0.3	0.5	0.0	0.0	0.0	0.0	6.8	0.0
Drogheda	-5.1	0.0	0.0	-13.1	21.2	-3.6	-0.1	-13.5	-20.0	-11.5	0.0	0.0	0.0	-0.3	0.0	-0.1	0.0	-17.5	2.0	-0.5
Swords Pavilion	-23.7	-23.8	-14.8	-38.5	-16.3	-29.0	2.0	-15.4	-11.8	-47.9	-14.7	9.3	-31.1	-6.5	0.7	-0.5	-13.7	0.0	0.5	-3.2
Swords East	1.1	-2.4	2.6	-12.0	-1.1	-2.7	0.4	-0.6	3.1	-11.2	2.9	3.0	-2.3	-4.7	0.1	-0.5	0.1	-0.1	0.0	0.4
Airport	-15.8	-16.2	-6.1	-24.6	-7.1	-24.4	-0.7	-5.8	-2.1	-28.8	3.9	7.6	-21.2	6.9	-2.9	-0.5	-0.5	-0.3	1.9	0.0

Journey Time 2060 DS - 2060 DM Business Case AM Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.0	-7.9	0.0	0.4	-12.7	0.4	0.2	0.0	0.0	-0.9	-0.7	0.0	0.0	0.0	-27.5	-0.6	-22.8
St Stephen's Green	0.0	0.0	0.0	-2.8	-11.8	0.0	0.5	-14.9	-2.0	0.0	0.0	0.0	-2.3	-2.9	0.0	0.0	0.0	-33.4	-1.1	-16.3
College Street (Trinity)	0.0	0.0	0.0	0.3	-8.6	0.1	0.4	-13.0	0.5	0.1	0.0	0.0	-0.2	-0.4	0.0	0.0	0.0	-28.7	5.2	-10.8
Glasnevin	-4.1	-9.5	-3.2	0.0	0.0	-9.5	-7.9	2.0	0.3	-17.8	0.4	0.6	-11.7	-0.5	-4.9	-6.9	-7.3	-30.1	-10.7	-24.4
DCU	-5.4	-10.3	-5.3	0.1	0.0	-11.1	0.0	0.0	-0.1	-17.2	-3.2	-3.2	-12.6	-2.6	-23.0	-18.0	-2.1	-15.8	-15.6	-10.1
Rathgar Road	0.1	0.1	0.1	-4.6	-16.1	0.0	0.6	-19.4	-0.6	0.0	0.0	0.6	-6.9	-5.3	0.3	0.2	0.8	-34.3	-2.0	-24.2
Coolock	0.5	0.5	0.4	-6.8	-0.1	0.6	0.0	-0.7	-0.7	-1.0	0.7	0.6	0.5	-14.3	0.5	0.5	0.5	-0.3	0.4	-2.1
Ballymun	-9.6	-15.0	-8.9	2.6	0.0	-16.6	0.0	0.0	0.0	-20.8	-0.6	-0.6	-22.4	-2.3	-12.3	-22.2	-2.1	-12.5	-12.0	-8.2
Finglas	0.9	-4.1	1.1	2.1	0.0	-3.0	-0.1	0.0	0.0	-9.7	4.8	4.2	0.0	-0.8	0.5	-8.0	-10.5	-12.9	-13.6	-1.0
Sandyford	0.0	0.0	0.0	-7.7	-15.7	-0.1	-0.2	-18.4	-0.7	0.0	0.0	0.0	-4.6	-5.7	-0.3	-0.3	-0.1	-35.1	-2.3	-25.2
Tallaght	0.0	0.0	0.0	2.0	-5.9	0.0	0.4	-10.8	1.4	0.1	0.0	0.0	0.0	1.9	0.0	0.0	0.0	-24.4	6.1	-19.7
Red Cow	0.0	0.0	0.0	1.9	-5.8	0.0	0.4	-9.2	1.3	0.3	0.0	0.0	0.0	2.0	0.0	0.0	0.0	-23.1	7.3	-19.1
Blanchardstown	1.6	0.0	-0.4	-12.1	-2.6	-1.0	0.3	-8.2	0.0	-1.7	0.4	0.4	0.0	0.1	0.0	0.0	0.0	-23.7	-2.2	-21.3
Ashbourne	-2.7	-2.7	-2.7	-2.9	-2.5	-3.3	-1.8	-0.6	-3.2	-4.8	-1.8	-1.8	-18.0	0.0	-9.7	-16.4	23.6	-22.5	-18.5	3.1
Donabate	0.0	0.0	0.0	7.3	-6.8	1.1	0.3	-16.9	-7.8	-2.1	0.0	0.0	0.0	-17.3	0.0	0.0	0.0	-0.4	-1.1	-9.8
Balbriggan	0.0	0.0	0.0	-7.5	-6.1	1.1	0.3	-21.3	-4.1	-2.0	0.0	0.0	0.0	-0.9	0.0	0.0	-0.1	-7.9	-1.4	1.0
Drogheda	0.0	0.0	0.0	-5.8	2.0	1.1	2.0	4.6	-8.4	-1.8	-0.1	-0.1	0.0	-0.7	0.0	2.5	0.0	5.0	-1.4	1.8
Swords Pavilion	-19.3	-20.5	-11.6	-38.8	-15.4	-18.5	1.2	-15.7	-17.0	-23.7	-11.4	-11.4	-27.9	-33.5	0.6	0.8	-9.0	0.0	-0.1	-11.3
Swords East	1.5	2.6	7.8	-15.4	-14.2	1.6	-1.7	-14.3	-15.7	-4.9	5.9	5.6	-8.3	-24.6	0.7	0.9	0.6	-0.7	0.0	-6.4
Airport	-16.9	-9.7	-8.8	-29.0	-6.9	-27.7	0.2	-5.6	-7.0	-29.5	-5.4	17.5	-23.9	-18.0	-9.2	-1.1	-2.2	-0.4	1.0	0.0

Journey Time 2060 DS - 2060 DM Business Case LT Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connel Street	0.0	0.0	0.0	0.8	-5.4	0.8	0.4	-9.7	0.7	0.1	0.0	0.0	-0.1	-2.6	4.1	0.0	-12.2	-25.2	1.5	-22.1
St Stephen's Green	0.0	0.0	0.0	-1.0	-8.1	0.6	0.4	-12.5	0.0	0.0	0.0	0.0	-0.1	-4.4	-0.4	-1.1	-16.7	-32.0	0.9	-26.4
College Street (Trinity)	0.0	0.0	0.0	1.5	-4.8	0.8	0.4	-9.4	0.6	0.0	0.0	0.0	-0.1	-2.2	5.7	0.0	0.0	-25.9	7.5	-17.1
Glasnevin	-0.8	-7.0	0.9	0.0	0.0	-0.4	-4.7	2.4	0.0	-13.7	0.8	0.8	-11.7	-2.4	-1.9	-11.6	2.0	-28.5	-28.1	-25.7
DCU	-1.1	-6.0	-0.1	0.2	0.0	-7.5	-0.1	0.0	0.0	-12.3	-3.9	1.0	-16.8	-1.1	-20.5	-18.1	18.7	-14.9	-14.4	-10.3
Rathgar Road	-0.1	0.1	0.1	0.9	-13.4	0.0	0.4	-16.5	0.5	0.0	0.0	0.0	-0.1	-1.7	9.2	2.1	-0.2	-34.5	6.0	-31.5
Coolock	0.3	0.3	0.3	-10.1	0.0	1.0	0.0	0.0	0.1	0.2	0.1	0.2	0.4	-3.6	0.4	0.4	0.4	22.9	-0.1	-1.5
Ballymun	-6.4	-11.6	-5.6	2.7	0.1	-13.6	-2.1	0.0	0.1	-17.8	-3.0	2.4	-13.8	-1.0	-20.3	-21.2	-8.1	-12.7	-11.8	-8.9
Finglas	0.4	-1.5	0.4	0.2	-0.1	0.9	-2.4	-0.1	0.0	-8.7	-1.7	-1.7	0.1	-2.2	-14.4	-20.9	-8.8	-13.6	-12.9	-9.7
Sandyford	-0.1	0.0	-0.6	-7.4	-13.7	0.0	0.2	-17.0	-1.1	0.0	0.0	-0.1	-0.7	-7.9	0.9	-5.5	-15.4	-34.7	-4.4	-32.1
Tallaght	0.0	0.0	0.0	2.1	-3.2	-1.0	0.4	-6.9	1.0	-2.3	0.0	0.0	-0.1	-0.2	6.0	0.0	0.0	-24.6	5.7	-22.4
Red Cow	0.0	0.0	0.0	3.3	-3.2	-1.7	0.8	-7.0	1.0	-1.6	0.0	0.0	-0.1	0.1	5.9	0.0	0.0	-24.6	6.9	-11.0
Blanchardstown	-0.4	0.4	0.5	-11.7	-1.5	-0.9	0.4	-19.2	0.0	-2.9	0.5	0.5	0.0	0.1	5.8	0.0	1.0	-21.7	-18.3	-19.3
Ashbourne	1.4	1.4	1.4	1.2	2.2	2.4	3.1	3.6	1.0	0.5	2.1	2.1	-0.4	0.0	-6.2	0.5	-0.2	-14.6	-7.6	0.9
Donabate	0.5	-1.4	0.7	-14.0	-11.8	7.9	0.4	-12.0	-9.3	-3.9	0.0	0.0	0.4	-19.1	0.0	0.0	0.0	0.4	0.4	-5.8
Balbriggan	0.0	0.0	0.0	-11.5	-13.6	2.4	0.4	-4.4	-10.5	-4.9	0.0	0.0	0.0	0.5	0.0	0.0	0.6	0.5	0.7	-7.1
Drogheda	0.0	0.0	0.0	-8.0	25.7	0.6	0.4	6.7	2.0	0.3	0.0	0.0	0.0	-0.2	0.0	1.0	0.0	-13.2	-7.5	-6.9
Swords Pavilion	-16.7	-12.1	-6.4	-34.5	-15.1	-13.6	10.3	-15.5	-10.1	-40.8	-6.7	-6.7	-25.3	-2.9	0.7	0.9	1.5	0.0	0.0	-4.0
Swords East	2.4	-10.1	-4.6	-37.1	-17.8	-4.7	0.1	-18.0	-14.3	-22.6	-5.1	-5.0	-4.5	0.7	0.7	0.9	1.5	0.0	0.0	-0.4
Airport	-14.6	-19.1	-18.0	-26.8	-6.5	-20.0	6.7	-4.9	0.4	-27.8	-9.3	17.1	-24.8	-2.1	-6.2	1.0	-0.3	0.6	1.6	0.0

Journey Time 2060 DS - 2060 DM Business Case SR Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.4	-6.3	-1.3	0.5	-11.0	0.9	0.1	0.0	0.0	0.3	1.4	7.4	0.1	0.2	-32.2	0.3	-10.4
St Stephen's Green	-0.1	0.0	-0.1	-1.8	-9.4	-0.5	0.6	-13.5	-1.4	0.0	0.0	0.0	0.3	-1.1	3.0	0.1	-14.1	-36.4	-0.9	-12.1
College Street (Trinity)	0.0	0.0	0.0	0.9	-6.4	-0.5	0.5	-11.0	1.0	0.1	0.0	0.0	0.3	1.7	9.1	0.1	0.2	-22.2	5.9	-12.3
Glasnevin	-1.2	-7.9	0.5	0.0	0.2	-5.2	-3.8	2.4	0.8	-15.3	0.5	0.5	-15.6	1.8	1.7	-3.7	-13.3	-35.6	-38.8	-22.7
DCU	-2.2	-6.7	-1.7	0.2	0.0	-8.6	0.1	0.0	1.6	-12.9	0.4	0.4	-20.2	-11.4	-23.3	-12.5	16.6	-21.4	-19.6	-9.1
Rathgar Road	-0.1	0.1	0.1	-1.4	-15.0	0.0	0.6	-19.0	0.9	0.0	-0.3	-0.1	0.6	0.2	10.8	3.4	-2.4	-42.6	2.9	-19.9
Coolock	0.5	0.5	0.5	-10.9	0.1	-0.1	0.0	0.2	1.9	0.5	0.3	0.3	0.5	-0.5	0.2	0.6	0.6	25.4	0.4	5.3
Ballymun	-7.7	-12.9	-7.1	2.8	0.1	-14.5	-8.7	0.0	1.7	-18.8	1.2	1.2	1.7	-1.8	-42.4	-16.9	-6.1	-17.2	-16.4	-8.2
Finglas	0.3	-1.8	0.4	0.2	-0.8	-1.6	-1.2	-0.8	0.0	-8.0	-1.0	-1.7	0.1	1.0	-10.7	-14.7	-2.9	-14.0	-13.2	-5.0
Sandyford	-0.1	0.0	-0.5	-8.2	-14.8	0.0	-1.0	-18.6	-2.4	0.0	-0.1	-0.1	-0.1	-4.8	4.3	0.7	-12.7	-42.5	-4.2	-20.4
Tallaght	0.0	0.0	0.0	2.0	-5.4	-0.3	0.6	-9.6	1.6	5.7	0.0	0.0	0.3	4.2	6.1	0.1	0.1	-32.5	6.1	-14.3
Red Cow	0.0	0.0	0.0	3.6	-5.3	0.0	0.5	-9.4	1.7	-0.8	0.0	0.0	0.3	4.6	6.4	0.1	0.1	-32.4	6.2	4.3
Blanchardstown	0.2	0.5	0.5	-22.7	0.8	0.4	0.5	0.9	0.1	0.5	0.5	0.5	0.0	0.5	40.9	0.1	-0.8	2.9	-0.8	12.1
Ashbourne	-0.2	-0.2	-0.2	-0.4	-0.5	-1.1	1.1	0.9	-0.6	-1.1	0.3	0.2	0.0	0.0	-2.7	2.1	1.3	3.5	6.2	13.6
Donabate	0.7	-1.0	0.9	-8.1	-14.7	6.3	0.1	-12.8	-5.3	-3.6	0.0	0.0	0.5	-17.5	0.0	0.0	0.0	0.5	0.5	-3.1
Balbriggan	0.0	-0.7	0.0	-10.6	-18.0	3.5	0.5	-23.9	-8.5	-5.5	0.0	0.0	0.0	2.4	0.0	0.0	6.6	0.5	0.8	5.4
Drogheda	0.0	0.0	0.0	-9.3	37.1	-0.6	0.5	-4.2	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.8	0.0	-9.9	1.6	9.3
Swords Pavilion	-15.3	-12.2	-6.4	-37.1	-16.2	-15.7	2.3	-15.9	-8.9	-39.1	-13.0	-12.6	-49.3	1.3	3.0	3.8	-6.6	0.0	0.2	-2.7
Swords East	2.2	-0.9	3.2	-17.0	-18.3	2.8	0.3	-16.3	-11.1	-7.8	7.4	7.4	-1.8	4.9	3.2	3.8	-2.5	0.0	0.0	1.0
Airport	-16.0	-17.3	-7.5	-28.3	-7.5	-23.1	5.4	-4.7	2.3	-29.7	-10.7	16.3	-25.9	-1.2	-4.1	3.9	0.9	-0.2	0.8	0.0

Journey Time 2060 DS - 2060 DM Business Case PM Peak Period	O'Connell Street	St Stephen's Green	College Street (Trinity)	Glasnevin	DCU	Rathgar Road	Coolock	Ballymun	Finglas	Sandyford	Tallaght	Red Cow	Blanchardstown	Ashbourne	Donabate	Balbriggan	Drogheda	Swords Pavilion	Swords East	Airport
O'Connell Street	0.0	0.0	0.0	0.1	-8.6	-0.1	0.2	-12.9	-0.4	0.2	0.0	0.0	-0.9	1.5	0.0	0.0	0.0	-21.3	-5.4	-14.9
St Stephen's Green	0.0	0.0	0.1	-1.9	-11.7	0.1	0.5	-16.6	-5.2	0.0	0.0	0.0	-0.1	-1.0	0.0	0.0	0.0	-17.7	-9.0	-24.0
College Street (Trinity)	0.0	0.0	0.0	0.5	-8.7	0.4	0.5	-13.4	0.5	0.1	0.0	0.0	-0.1	1.0	0.0	0.0	0.0	-19.3	-2.0	-8.3
Glasnevin	-1.4	-7.3	-0.2	0.0	0.2	-7.7	-15.4	1.8	0.2	-15.3	0.1	0.5	-11.2	1.0	-4.2	-6.5	-6.5	-36.4	-28.0	-28.5
DCU	-3.6	-7.9	-3.5	0.2	0.0	-9.4	-0.4	0.0	-0.8	-14.6	-7.3	5.6	-10.8	-14.5	-11.0	-16.5	-6.9	-20.5	-16.6	-10.7
Rathgar Road	0.2	0.1	0.2	-4.4	-16.8	0.0	0.8	-20.4	-3.1	0.0	0.3	0.4	-7.8	1.7	-0.3	-0.3	-0.2	-28.1	-4.0	-27.1
Coolock	0.5	0.7	0.5	-10.2	-0.5	1.0	0.0	-0.6	-1.3	0.6	0.6	0.5	0.6	1.2	0.5	0.5	0.6	0.0	0.1	-1.3
Ballymun	-8.5	-13.8	-8.6	2.9	0.1	-15.1	-2.5	0.0	-0.7	-19.5	-7.0	-0.1	-10.5	-1.5	-16.8	-20.5	-7.8	-16.3	-15.5	-9.0
Finglas	-0.4	-6.5	-0.1	0.2	-0.1	-6.7	-0.5	-0.2	0.0	-13.3	3.0	3.0	0.0	0.6	11.1	-6.7	-14.6	-16.5	-15.7	-9.2
Sandyford	-0.1	0.0	-0.1	-8.2	-16.6	-0.1	-1.6	-20.0	-5.5	0.0	-0.1	-0.1	-2.9	-5.4	-0.6	-0.6	-0.6	-24.1	-14.1	-28.4
Tallaght	0.0	0.0	0.0	7.5	-7.8	-3.8	0.5	-12.1	0.4	0.8	0.0	0.0	-0.4	3.3	0.0	0.0	0.0	-13.8	-1.1	-16.8
Red Cow	0.0	0.0	0.0	3.7	-7.8	-0.2	0.2	-12.1	0.4	0.8	0.0	0.0	-0.5	3.3	0.0	0.0	0.0	-13.8	0.2	8.0
Blanchardstown	1.7	0.0	0.7	-12.0	-3.3	-0.7	1.9	-7.5	0.0	-2.2	-0.2	-0.2	0.0	0.6	0.0	0.0	0.0	-30.0	-7.7	-24.2
Ashbourne	0.4	0.4	0.4	0.2	1.3	0.4	1.9	3.7	0.1	-0.7	0.9	0.9	-6.9	0.0	-0.1	0.3	0.0	2.2	5.5	12.0
Donabate	0.0	0.0	0.0	-6.0	-8.0	0.8	0.5	-2.9	-2.7	-2.2	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.3	0.3	-25.1
Balbriggan	-0.2	0.1	0.0	-8.4	-12.7	0.8	0.3	-24.2	-15.5	-7.0	1.2	0.8	0.3	1.4	0.0	0.0	0.0	-0.2	6.7	0.0
Drogheda	0.0	0.0	0.0	-12.2	20.4	-1.4	0.1	-14.6	-17.7	-4.6	0.0	0.0	0.0	-0.4	0.0	0.1	0.0	-17.6	0.5	-1.3
Swords Pavilion	-34.7	-28.4	-19.1	-39.1	-18.5	-43.2	3.2	-16.2	-13.5	-48.6	-19.0	5.8	-31.8	-10.3	1.2	1.7	-12.5	0.0	0.9	-3.5
Swords East	0.3	-2.8	2.2	-12.4	-2.8	-3.1	0.1	-1.2	1.6	-11.6	2.6	2.6	-2.7	-4.1	0.1	-2.0	0.1	-0.1	0.0	0.1
Airport	-17.3	-18.8	-7.8	-27.6	-7.8	-26.3	1.1	-5.9	-3.2	-31.9	-5.1	10.0	-22.9	3.3	-1.9	1.7	0.2	-0.2	1.0	0.0

Transfers to/from MetroLink Stations

2030 Business Case Core Run - LT Peak Period								
Station	Transfers to MetroLink				Transfers from MetroLink			
	First Boarders	From Bus	From Rail/DART	From Luas	Final Destination	To Bus	To Rail/DART	To Luas
Estuary Park-and-Ride	682	187	-	-	474	123	-	-
Seatown	191	12	-	-	224	3	-	-
Swords Central	247	33	-	-	206	73	-	-
Fosterstown	204	55	-	-	177	9	-	-
Dublin Airport	1,978	73	-	-	1,683	36	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	158	5	-	-	127	16	-	-
Ballymun	365	25	-	-	257	26	-	-
Collins Avenue	260	44	-	-	268	91	-	-
Griffiths Park	95	0	-	-	119	1	-	-
Glasnevin	115	132	53	-	120	74	51	-
Mater	174	87	-	-	181	90	-	-
O Connell Street	287	86	-	245	348	14	-	364
Tara	417	323	159	1	632	425	178	0
SSG	420	6	-	-	592	263	-	-
Charlemont	320	295	-	361	389	136	-	324

2030 Business Case Core Run - SR Peak Period								
Station	Transfers to MetroLink				Transfers from MetroLink			
	First Boarders	From Bus	From Rail/DART	From Luas	Final Destination	To Bus	To Rail/DART	To Luas
Estuary Park-and-Ride	357	140	-	-	571	286	-	-
Seatown	193	5	-	-	286	7	-	-
Swords Central	193	28	-	-	331	153	-	-
Fosterstown	157	33	-	-	295	26	-	-
Dublin Airport	2,370	33	-	-	1,577	73	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	120	5	-	-	202	13	-	-
Ballymun	271	21	-	-	397	48	-	-
Collins Avenue	460	34	-	-	243	104	-	-
Griffiths Park	169	0	-	-	122	1	-	-
Glasnevin	102	104	43	-	134	120	79	-

Mater	186	87	-	-	185	86	-	-
O Connell Street	364	69	-	314	293	8	-	418
Tara	636	278	208	1	451	448	253	0
SSG	597	59	-	-	434	217	-	-
Charlemont	369	288	-	426	326	154	-	381

2030 Business Case Core Run - PM Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	461	112	-	-	1,756	351	-	-
Seatown	475	5	-	-	596	13	-	-
Swords Central	383	27	-	-	779	507	-	-
Fosterstown	266	57	-	-	668	203	-	-
Dublin Airport	2,722	64	-	-	1,438	148	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	217	16	-	-	505	64	-	-
Ballymun	366	27	-	-	998	228	-	-
Collins Avenue	800	61	-	-	604	281	-	-
Griffiths Park	287	0	-	-	288	3	-	-
Glasnevin	151	250	187	-	272	426	622	-
Mater	402	153	-	-	300	103	-	-
O Connell Street	880	93	-	355	317	14	-	396
Tara	1,565	592	357	2	417	762	462	0
SSG	1,772	86	-	-	383	331	-	-
Charlemont	1,025	442	-	809	514	240	-	475

2045 Business Case Core Run - AM Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	1,088	1,050	-	-	88	111	-	-
Seatown	1,198	158	-	-	540	4	-	-
Swords Central	1,328	251	-	-	403	69	-	-
Fosterstown	1,523	482	-	-	327	30	-	-
Dublin Airport	2,206	105	-	-	4,671	46	-	-
Dardistown and M50	-	-	-	-	-	-	-	-

Northwood	876	13	-	-	321	80	-	-
Ballymun	1,822	268	-	-	455	63	-	-
Collins Avenue	990	140	-	-	1,293	274	-	-
Griffiths Park	351	0	-	-	532	2	-	-
Glasnevin	342	912	1,094	-	265	186	260	-
Mater	379	263	-	-	566	166	-	-
O Connell Street	411	186	-	766	1,160	26	-	566
Tara	469	678	777	0	2,429	1,200	625	1
SSG	405	75	-	-	2,456	883	-	-
Charlemont	545	601	-	960	1,343	354	-	920

2045 Business Case Core Run - LT Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	747	247	-	-	497	165	-	-
Seatown	242	18	-	-	277	5	-	-
Swords Central	341	45	-	-	279	95	-	-
Fosterstown	257	77	-	-	221	12	-	-
Dublin Airport	2,966	88	-	-	2,670	46	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	226	6	-	-	176	21	-	-
Ballymun	521	32	-	-	350	32	-	-
Collins Avenue	304	59	-	-	320	120	-	-
Griffiths Park	119	0	-	-	151	1	-	-
Glasnevin	152	178	93	-	174	101	98	-
Mater	228	118	-	-	248	143	-	-
O Connell Street	379	140	-	412	470	20	-	534
Tara	559	499	227	2	826	613	247	0
SSG	507	9	-	-	727	343	-	-
Charlemont	405	397	-	495	500	170	-	442

2045 Business Case Core Run - SR Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	501	146	-	-	1,424	313	-	-

Seatown	289	7	-	-	347	10	-	-
Swords Central	312	33	-	-	422	199	-	-
Fosterstown	212	40	-	-	375	28	-	-
Dublin Airport	3,623	36	-	-	2,361	83	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	160	7	-	-	273	17	-	-
Ballymun	360	44	-	-	536	56	-	-
Collins Avenue	527	22	-	-	280	140	-	-
Griffiths Park	203	0	-	-	143	1	-	-
Glasnevin	137	131	73	-	160	155	137	-
Mater	260	117	-	-	230	126	-	-
O Connell Street	539	108	-	490	388	11	-	608
Tara	967	410	271	2	636	629	362	0
SSG	865	72	-	-	570	266	-	-
Charlemont	509	365	-	571	426	188	-	511

2045 Business Case Core Run - PM Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	69	123	-	-	185	415	-	-
Seatown	367	5	-	-	705	23	-	-
Swords Central	367	30	-	-	948	591	-	-
Fosterstown	257	65	-	-	818	215	-	-
Dublin Airport	3,234	59	-	-	1,926	169	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	264	13	-	-	652	75	-	-
Ballymun	471	29	-	-	1,355	254	-	-
Collins Avenue	835	63	-	-	676	312	-	-
Griffiths Park	318	0	-	-	325	4	-	-
Glasnevin	172	288	279	-	300	497	851	-
Mater	458	174	-	-	337	101	-	-
O Connell Street	914	119	-	465	338	16	-	527
Tara	1,599	669	424	2	427	872	570	1

SSG	1,757	95	-	-	364	345	-	-
Charlemont	1,171	508	-	928	562	267	-	572

2060 Business Case Core Run - AM Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	1,142	1,361	-	-	62	139	-	-
Seatown	1,449	234	-	-	696	5	-	-
Swords Central	1,825	387	-	-	674	95	-	-
Fosterstown	2,017	685	-	-	428	47	-	-
Dublin Airport	3,400	107	-	-	7,077	54	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	1,138	16	-	-	399	99	-	-
Ballymun	2,363	302	-	-	562	65	-	-
Collins Avenue	1,129	176	-	-	1,438	314	-	-
Griffiths Park	422	1	-	-	612	2	-	-
Glasnevin	412	1,109	1,724	-	320	227	412	-
Mater	493	305	-	-	725	216	-	-
O Connell Street	582	244	-	1,084	1,488	19	-	751
Tara	606	902	1,075	0	3,092	1,612	793	2
SSG	489	82	-	-	2,973	1,091	-	-
Charlemont	673	702	-	1,186	1,729	435	-	1,170

2060 Business Case Core Run - LT Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	1,158	280	-	-	471	207	-	-
Seatown	300	24	-	-	369	7	-	-
Swords Central	438	54	-	-	393	124	-	-
Fosterstown	311	94	-	-	280	14	-	-
Dublin Airport	4,465	100	-	-	3,871	49	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	307	8	-	-	237	29	-	-
Ballymun	688	39	-	-	457	40	-	-
Collins Avenue	354	72	-	-	370	162	-	-

Griffiths Park	146	1	-	-	185	1	-	-
Glasnevin	190	231	150	-	228	147	171	-
Mater	289	161	-	-	334	212	-	-
O Connell Street	475	202	-	608	645	26	-	788
Tara	718	709	311	3	1,178	917	354	1
SSG	594	17	-	-	971	451	-	-
Charlemont	499	513	-	651	648	217	-	602

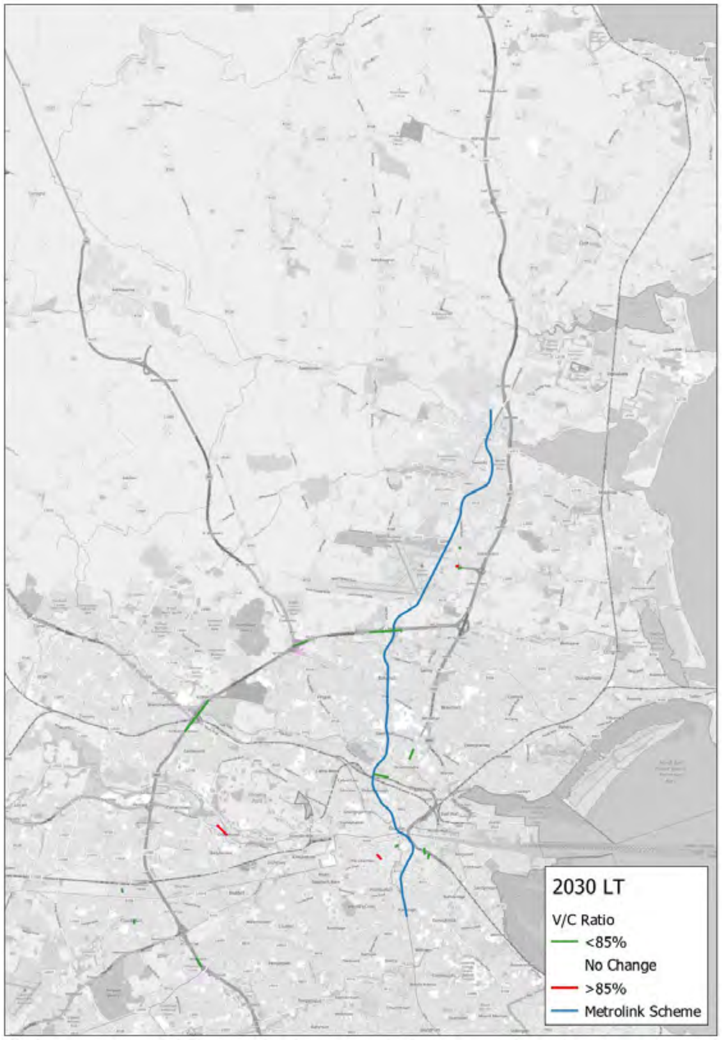
2060 Business Case Core Run - SR Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	687	170	-	-	1,711	481	-	-
Seatown	346	8	-	-	450	15	-	-
Swords Central	424	40	-	-	546	269	-	-
Fosterstown	265	52	-	-	498	35	-	-
Dublin Airport	4,727	31	-	-	3,168	133	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	209	7	-	-	362	23	-	-
Ballymun	467	53	-	-	698	65	-	-
Collins Avenue	603	29	-	-	331	142	-	-
Griffiths Park	246	1	-	-	172	1	-	-
Glasnevin	177	162	99	-	195	191	202	-
Mater	354	135	-	-	286	177	-	-
O Connell Street	704	157	-	684	513	20	-	794
Tara	1,313	552	343	4	836	830	464	1
SSG	1,075	91	-	-	709	317	-	-
Charlemont	649	454	-	727	534	230	-	648

2060 Business Case Core Run - PM Peak Period								
Station	**Transfers to MetroLink**				**Transfers from MetroLink**			
	First Boarders	**From Bus**	**From Rail/DART**	**From Luas**	**Final Destination**	**To Bus**	**To Rail/DART**	**To Luas**
Estuary Park-and-Ride	391	138	-	-	974	533	-	-
Seatown	553	6	-	-	955	19	-	-
Swords Central	640	39	-	-	1,328	761	-	-
Fosterstown	349	78	-	-	1,113	254	-	-

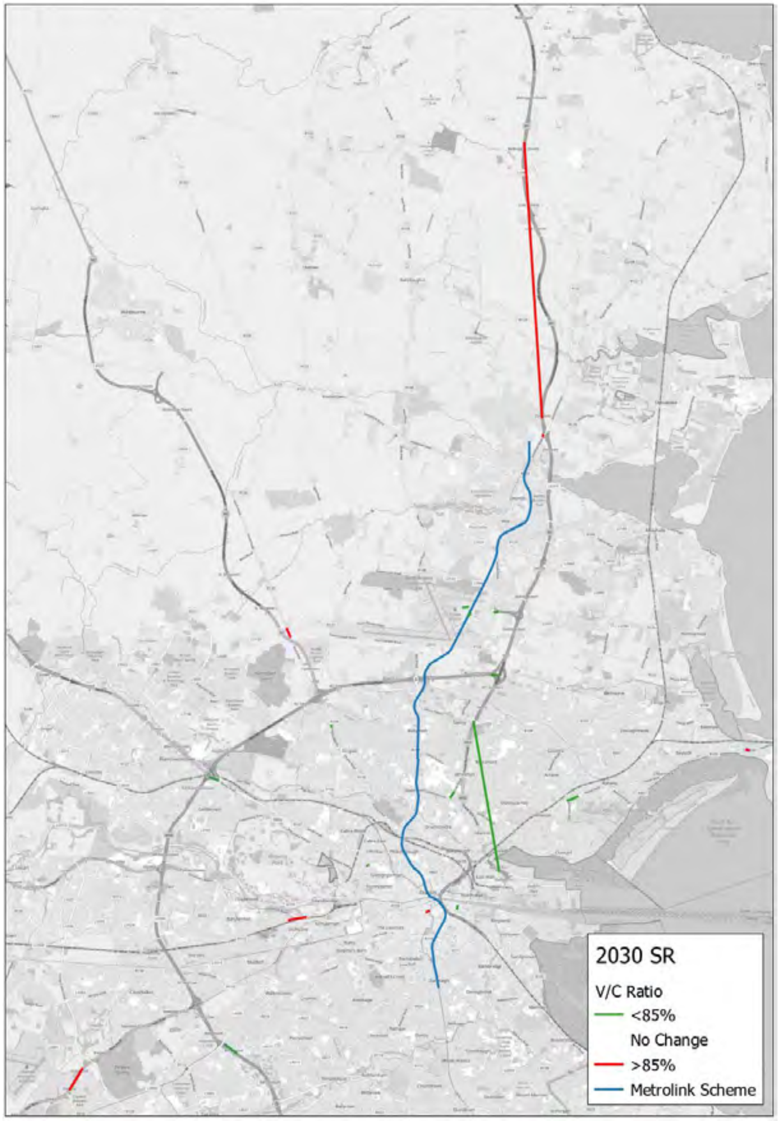
Dublin Airport	5,085	71	-	-	2,877	199	-	-
Dardistown and M50	-	-	-	-	-	-	-	-
Northwood	346	17	-	-	828	92	-	-
Ballymun	611	35	-	-	1,740	294	-	-
Collins Avenue	914	76	-	-	773	367	-	-
Griffiths Park	366	0	-	-	377	5	-	-
Glasnevin	204	355	404	-	357	632	1,324	-
Mater	572	207	-	-	419	117	-	-
O Connell Street	1,245	161	-	639	476	21	-	784
Tara	2,252	894	532	3	628	1,148	824	1
SSG	2,286	114	-	-	514	387	-	-
Charlemont	1,523	636	-	1,180	715	331	-	756

A.6 Volume Capacity Ratio

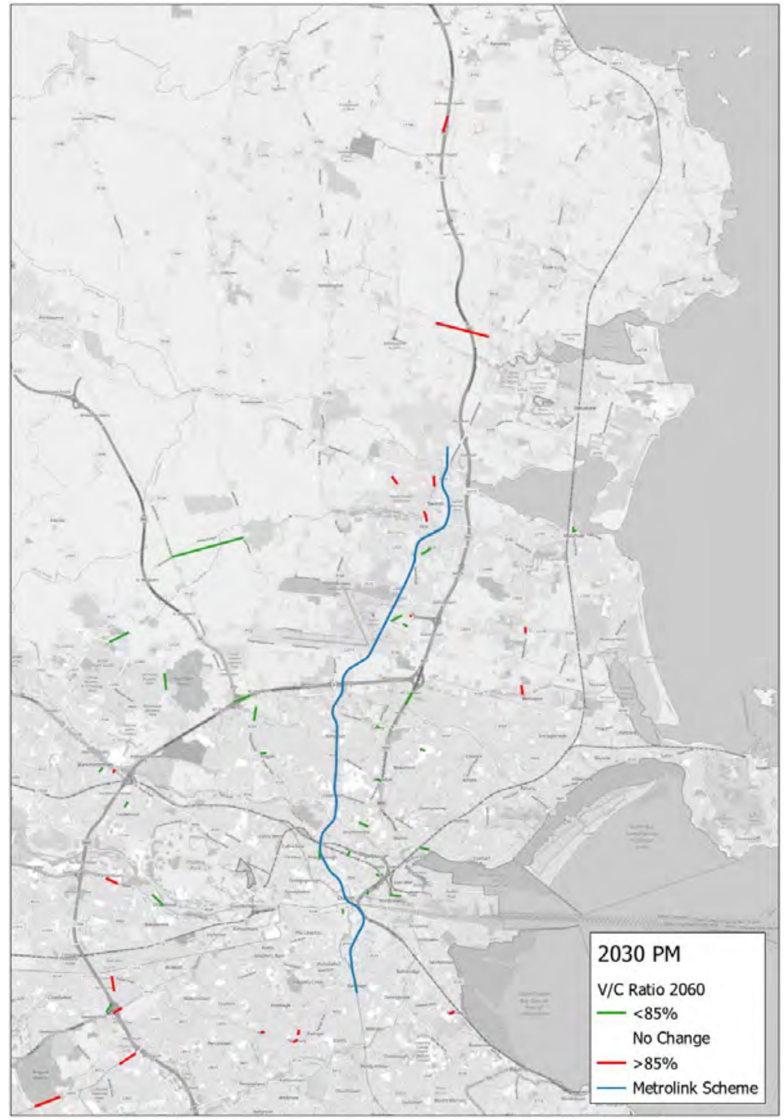
2030 Business Case Core Run – AM Peak Period



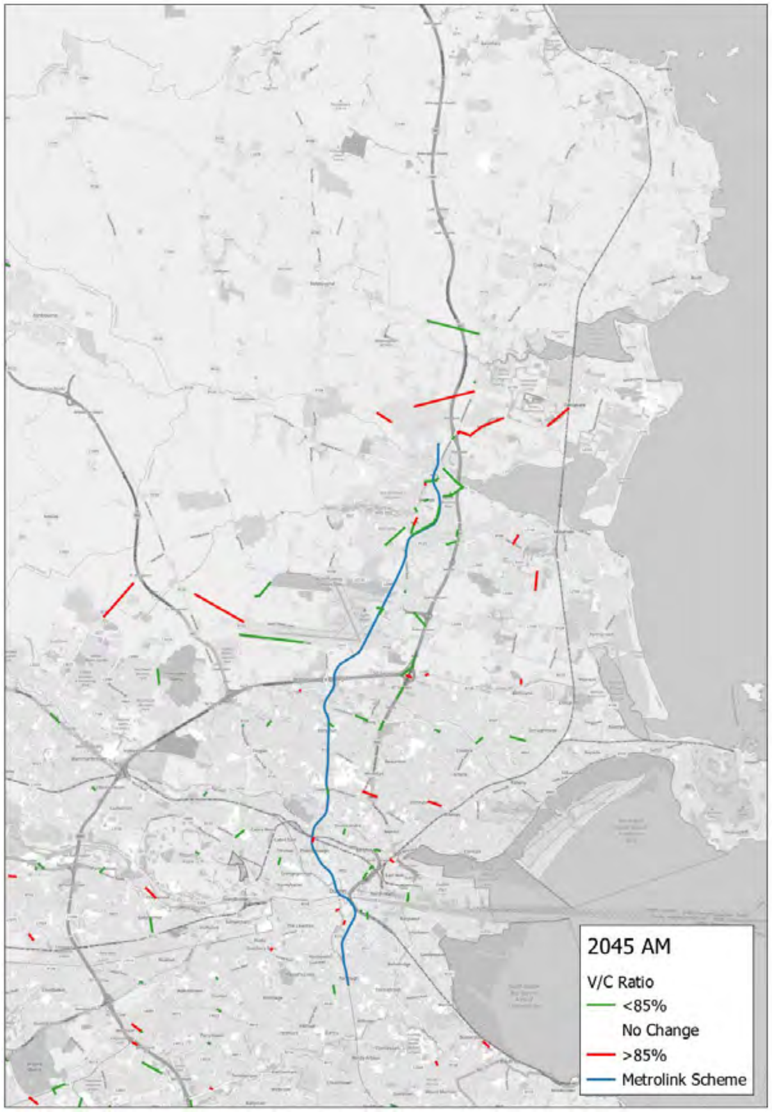
2030 Business Case Core Run – LT Peak Period



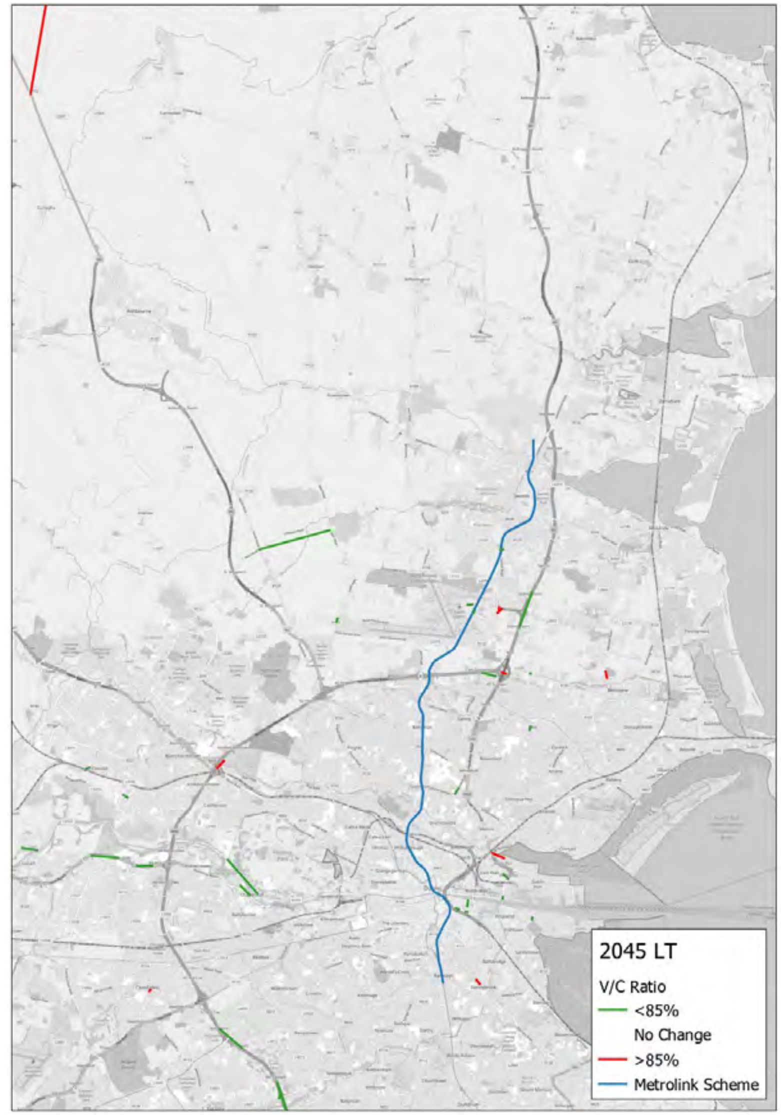
2030 Business Case Core Run – SR Peak Period



2030 Business Case Core Run – PM Peak Period

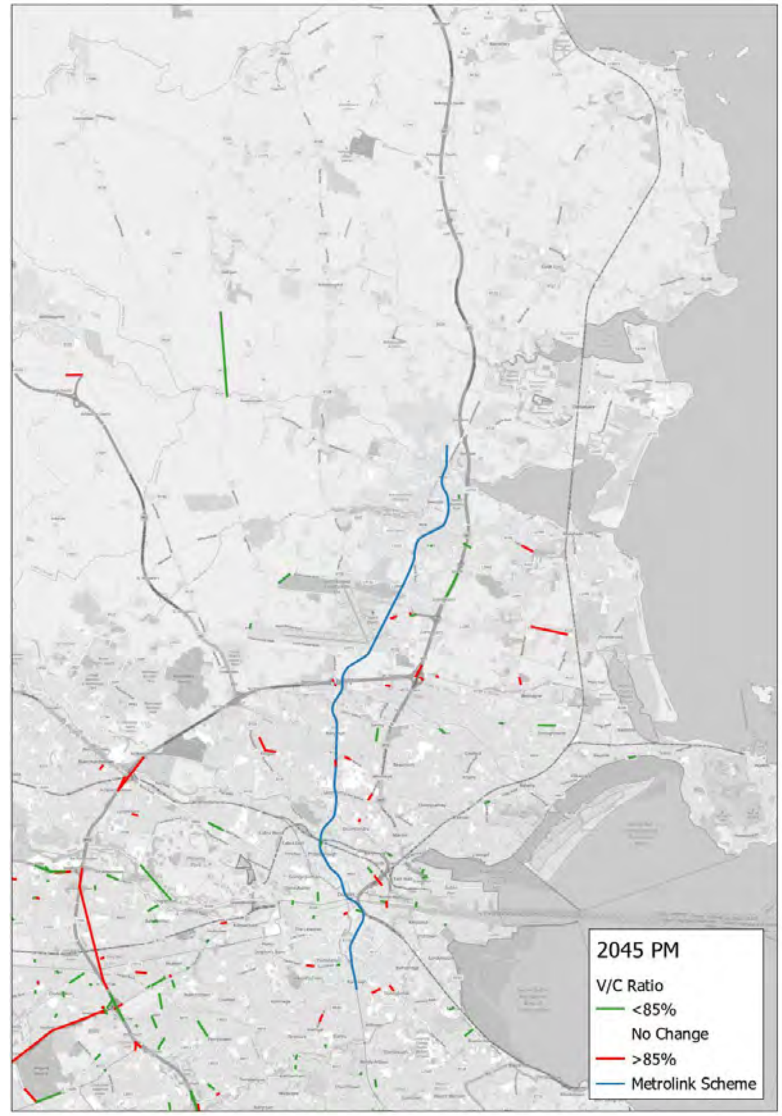


2045 Business Case Core Run – AM Peak Period



2045 Business Case Core Run – LT Peak Period

2045 Business Case Core Run – SR Peak Period

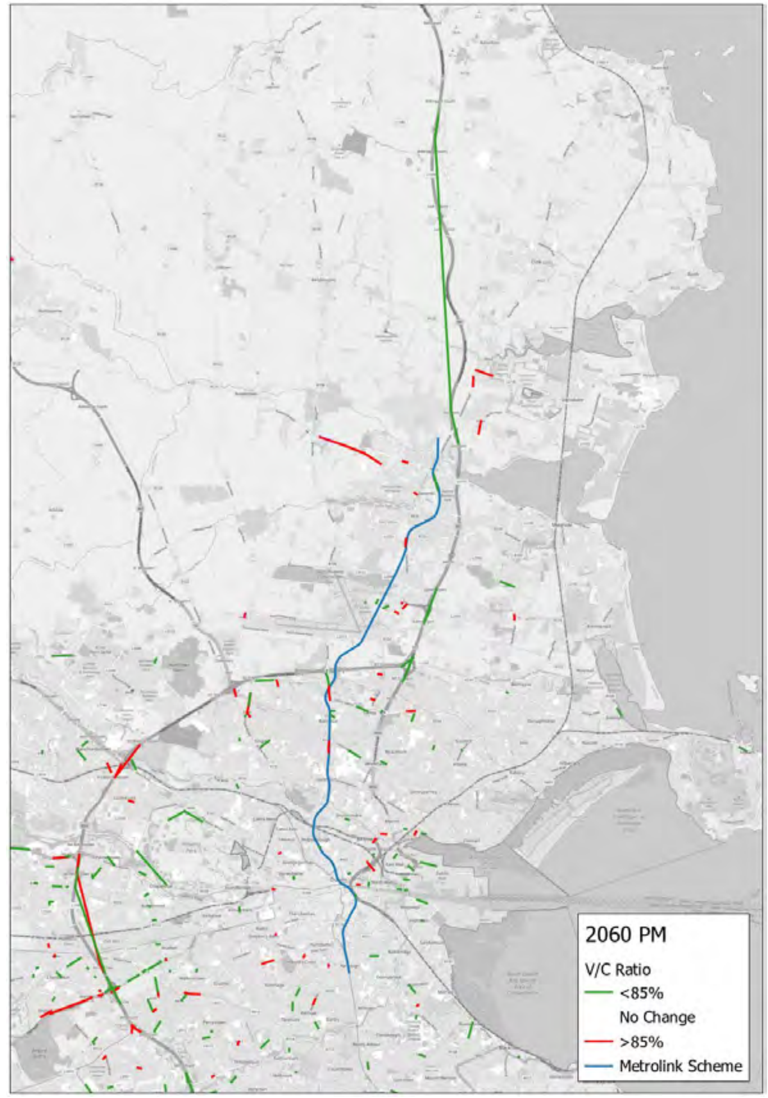


2045 Business Case Core Run – PM Peak Period

2060 Business Case Core Run – AM Peak Period

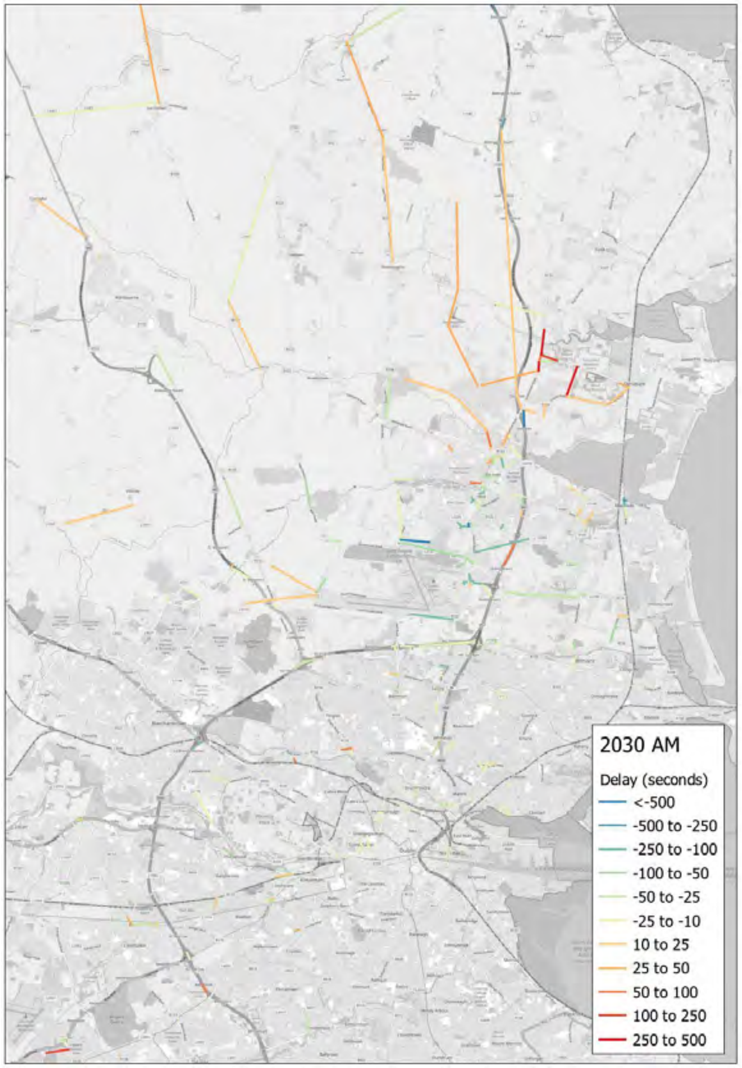
2060 Business Case Core Run – LT Peak Period

2060 Business Case Core Run – SR Peak Period

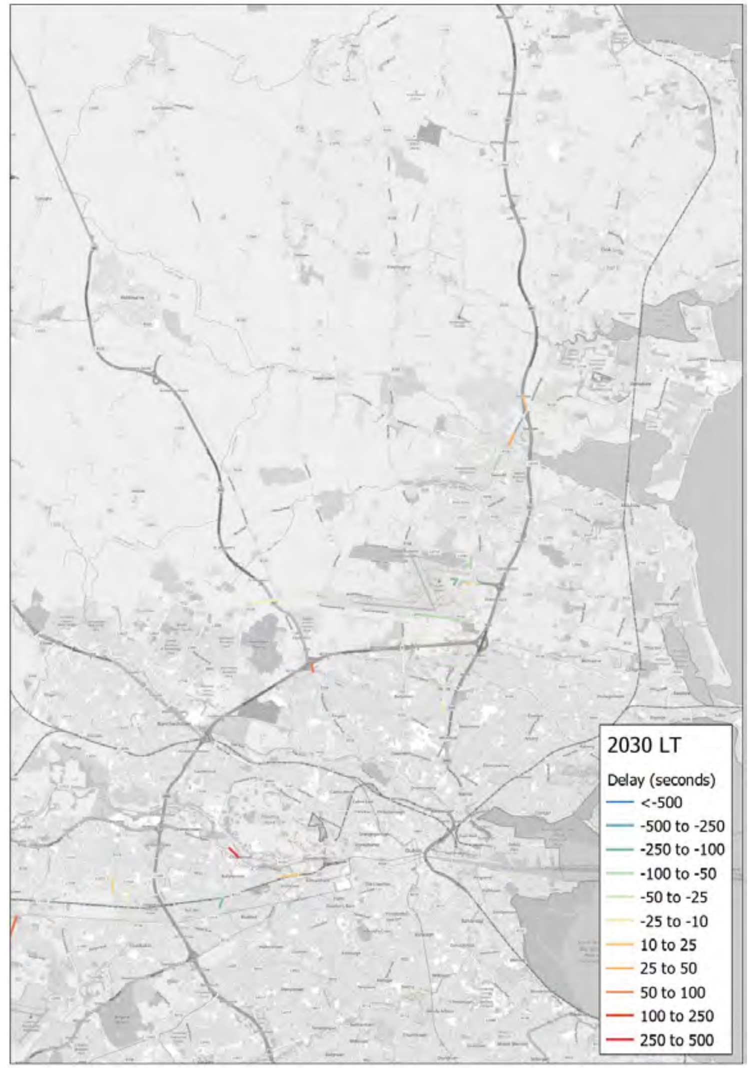


2060 Business Case Core Run – PM Peak Period

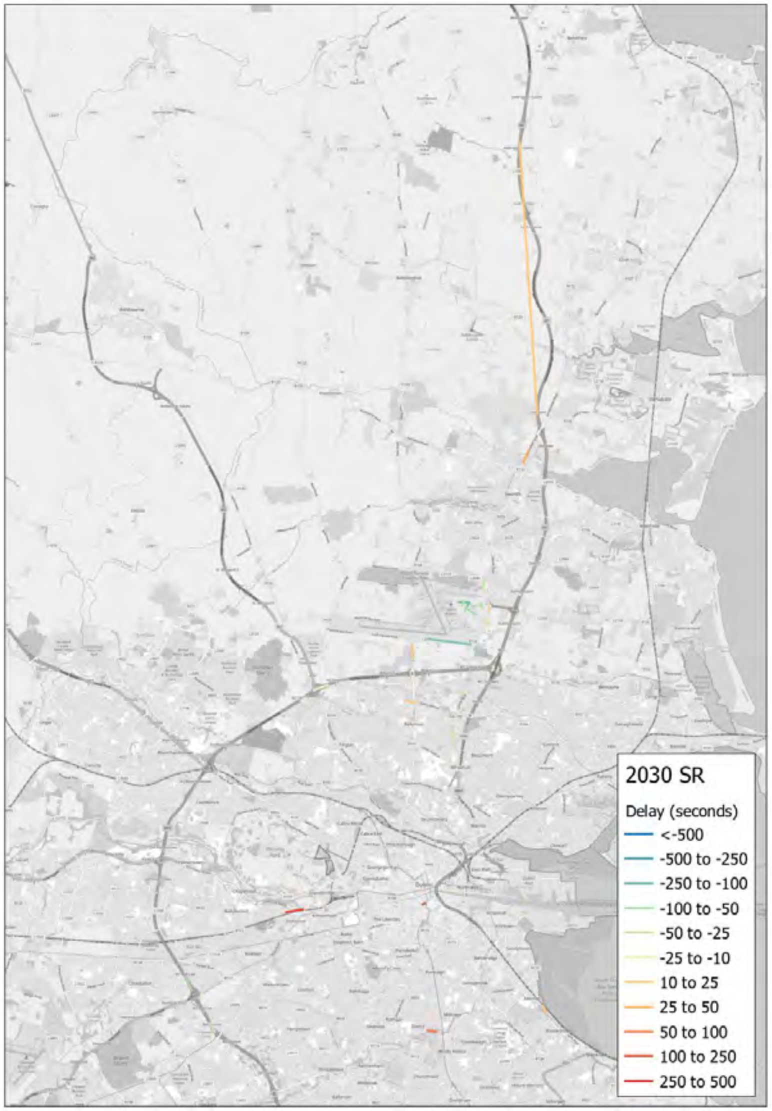
A.7 Delays



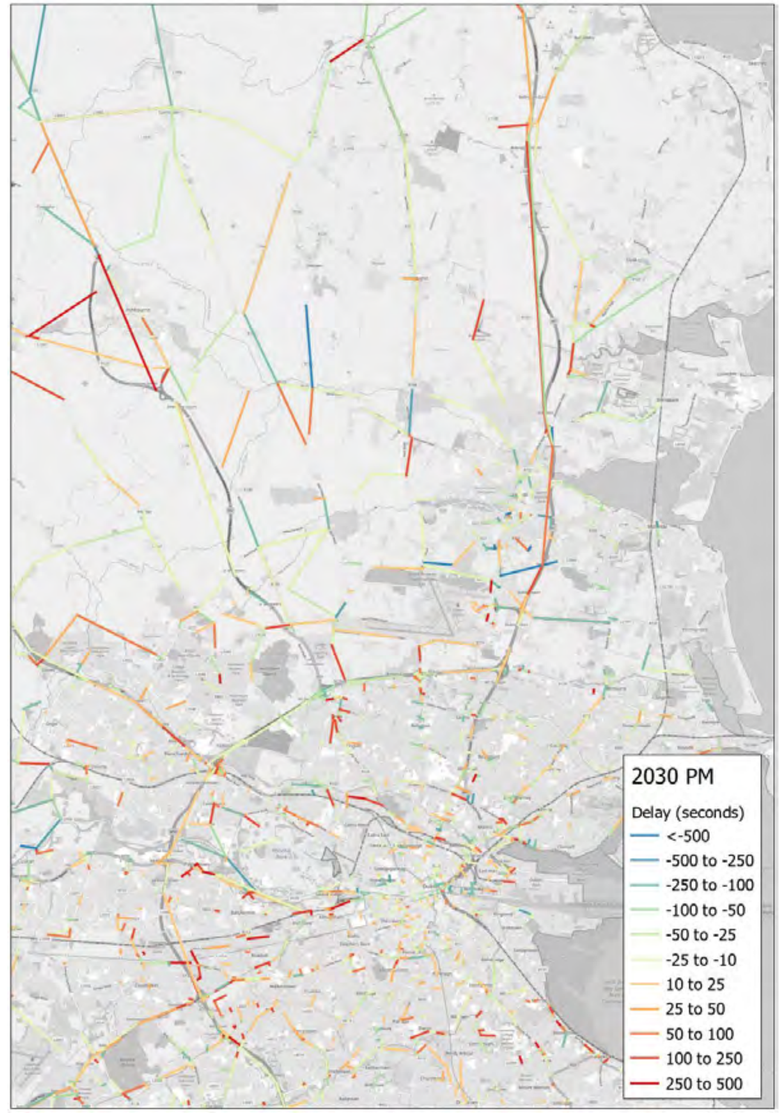
2030 Business Case Core Run – AM Peak Period



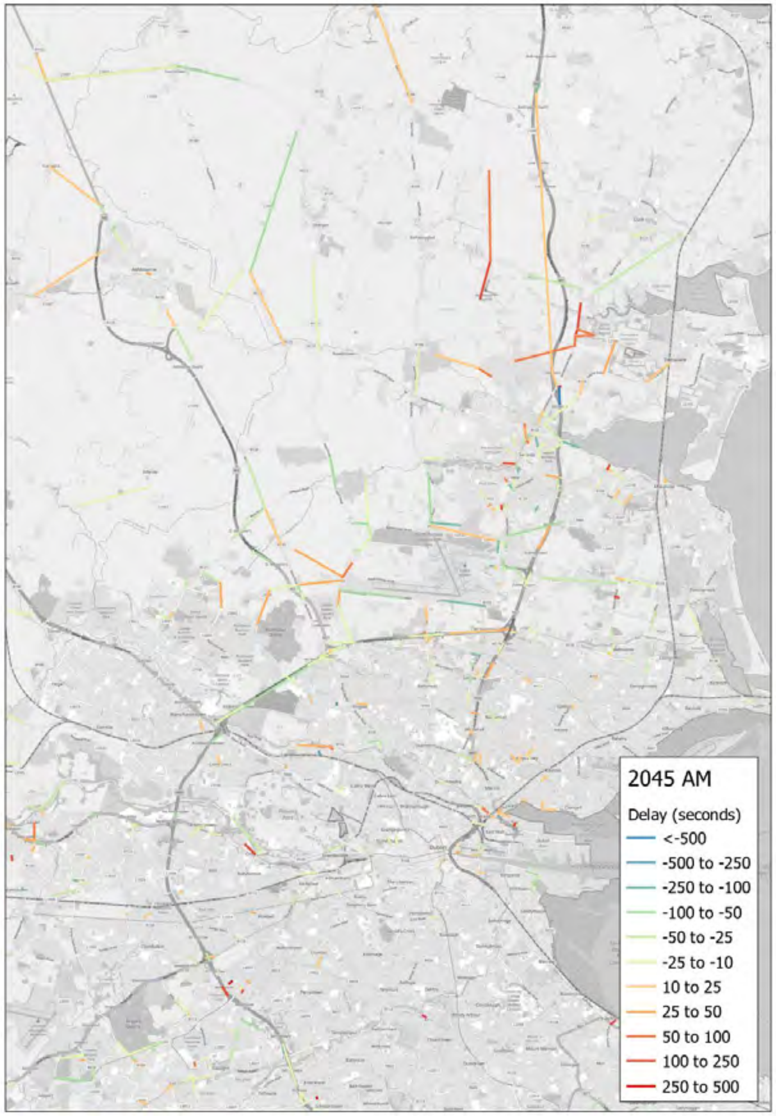
2030 Business Case Core Run – LT Peak Period



2030 Business Case Core Run – SR Peak Period

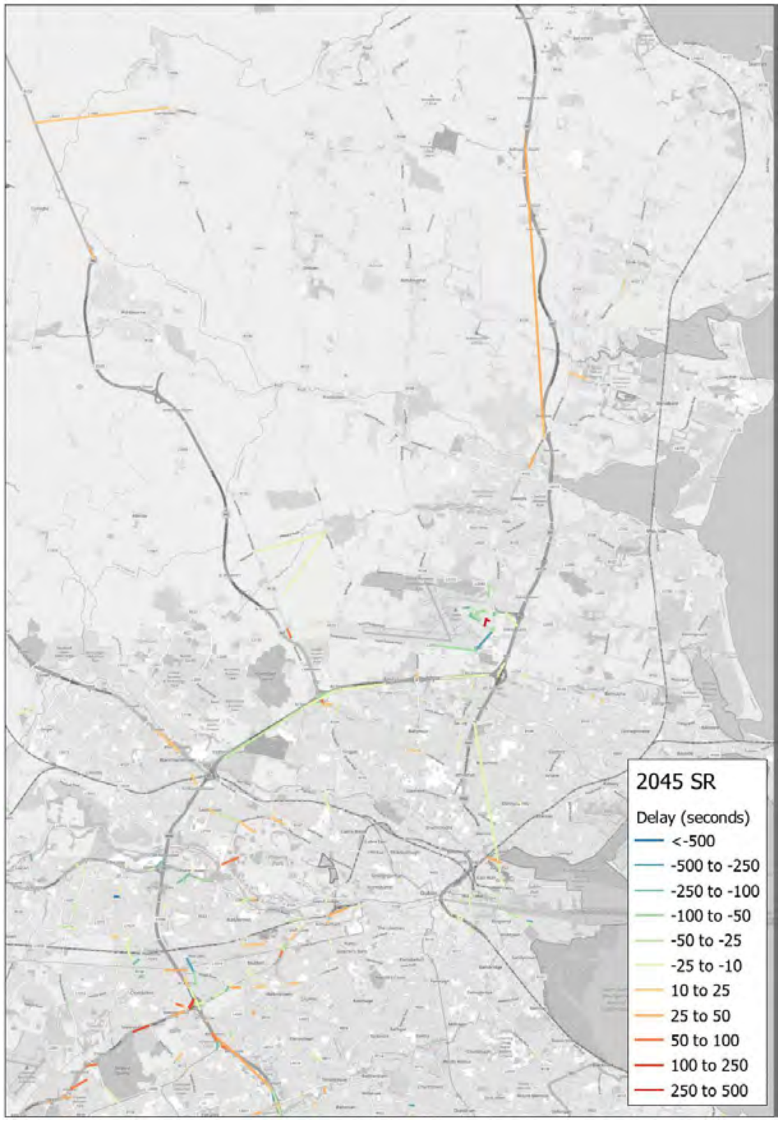


2030 Business Case Core Run – PM Peak Period



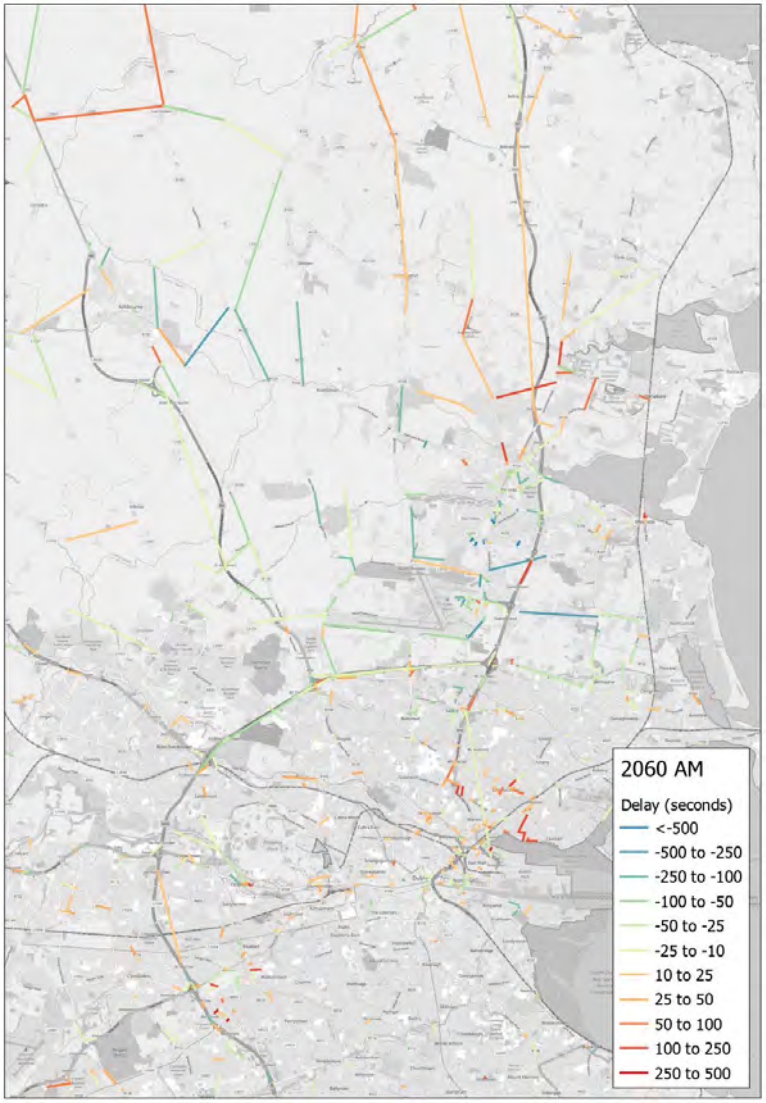
2045 Business Case Core Run – AM Peak Period

2045 Business Case Core Run – LT Peak Period

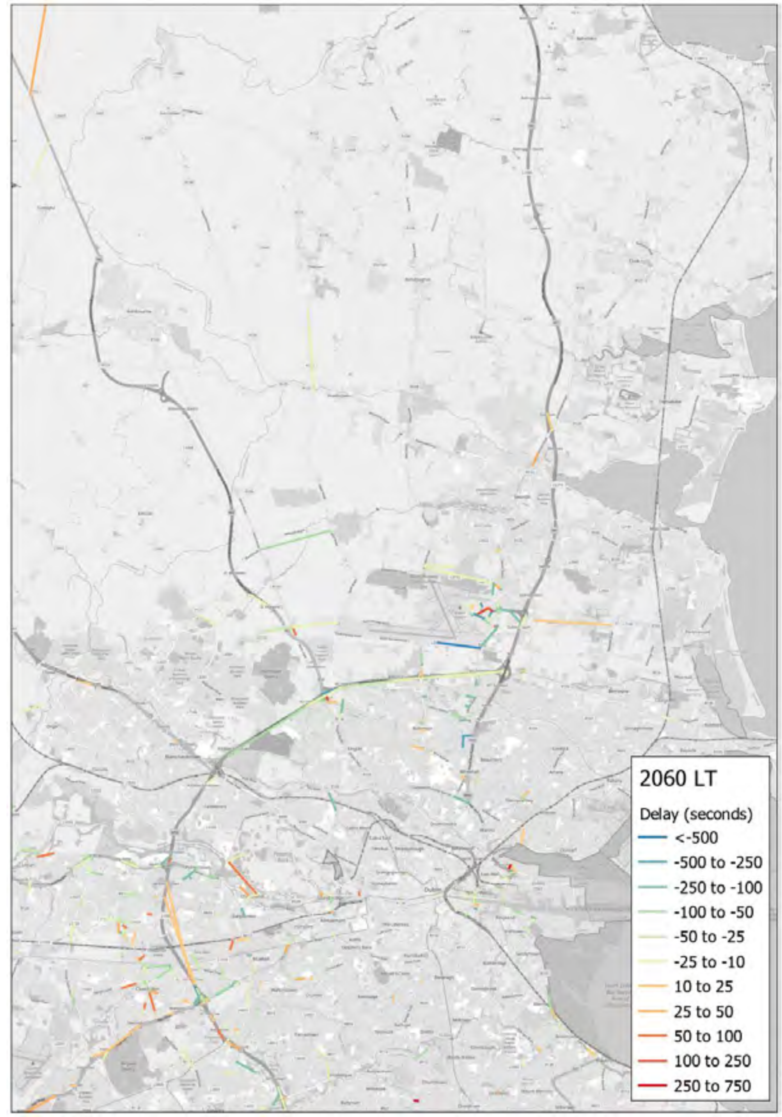


2045 Business Case Core Run – SR Peak Period

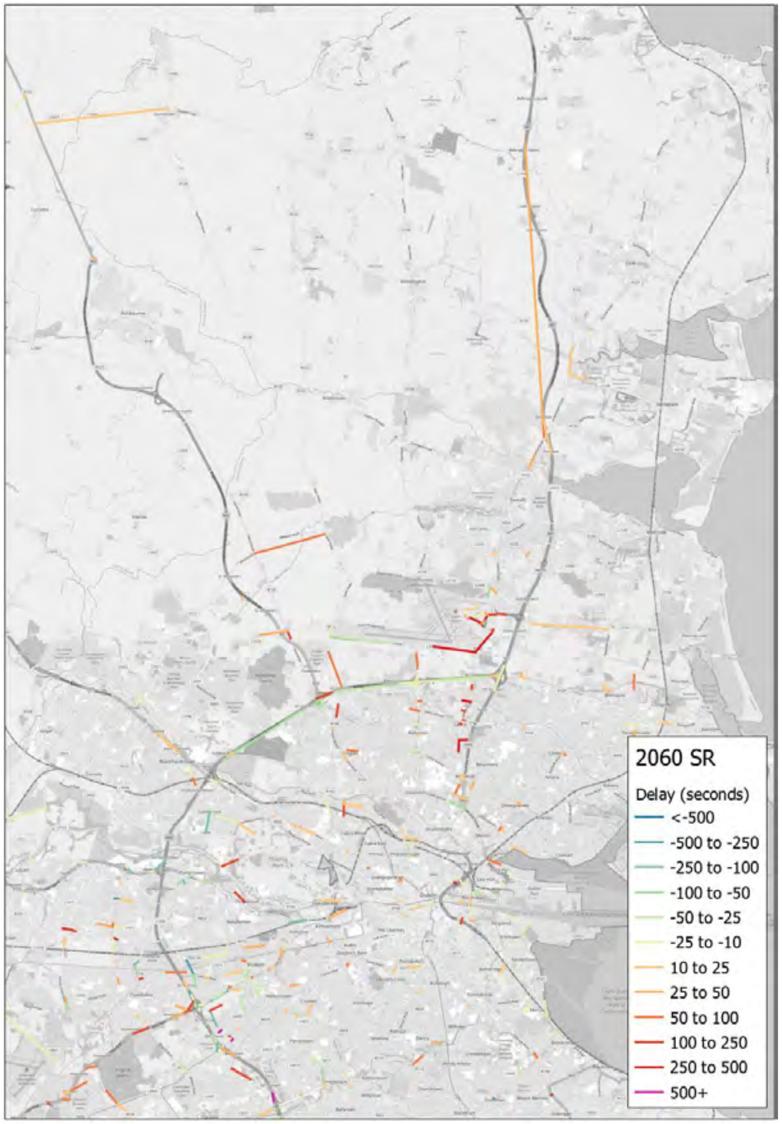
2045 Business Case Core Run – PM Peak Period



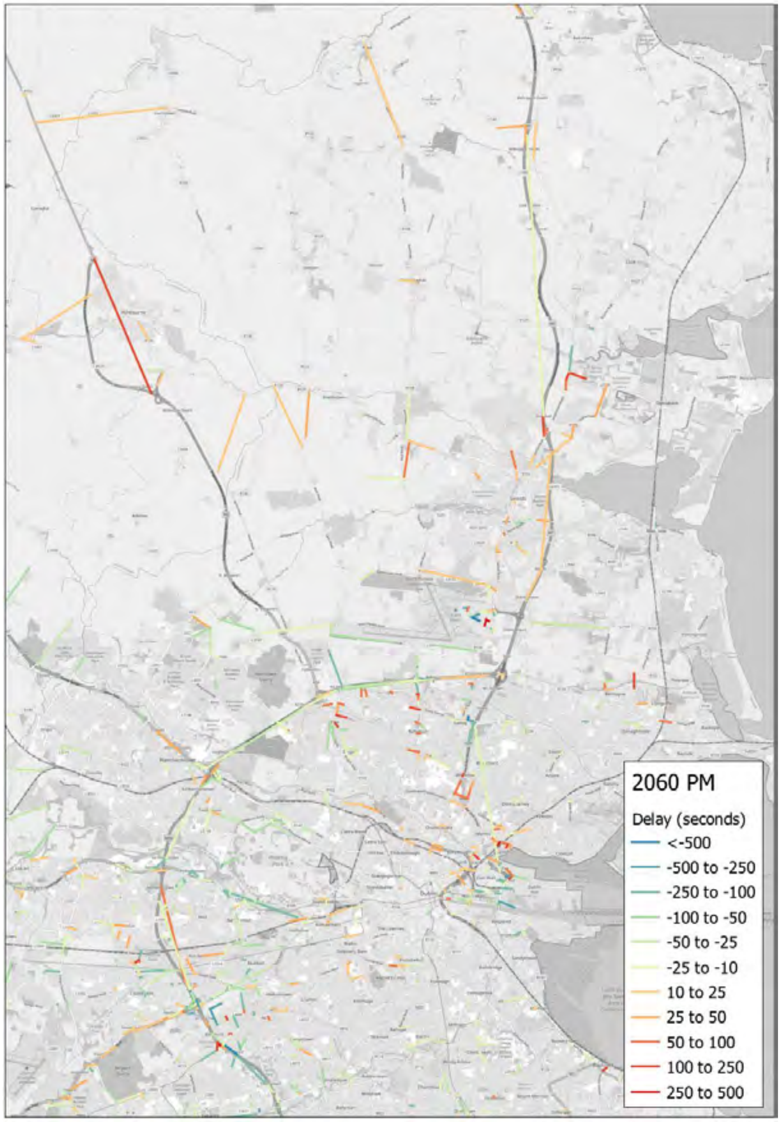
2060 Business Case Core Run – AM Peak Period



2060 Business Case Core Run – LT Peak Period



2060 Business Case Core Run – SR Peak Period



2060 Business Case Core Run – PM Peak Period

Appendix B. Modelling Results: Sensitivity Analysis

B.1 Slow Growth - Boardings, Alightings and Loading Profile

2030 Slow Growth - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1831	0	1831	940	0	940	1053	0	1053	2201	0	2201
St Stephen's Green	408	43	2196	414	8	1346	653	4	1702	1760	5	3955
Tara	1393	165	3423	829	48	2128	1080	49	2733	2284	313	5926
O'Connell Street	961	42	4342	560	15	2673	702	18	3416	1200	46	7079
Mater	327	151	4518	182	57	2798	211	77	3550	378	186	7271
Glasnevin	610	268	4860	142	103	2837	131	169	3512	302	835	6738
Griffith Park	50	281	4629	29	65	2801	77	78	3511	124	233	6629
Collins Avenue	136	731	4035	74	181	2694	248	232	3526	445	743	6331
Ballymun	155	330	3860	70	209	2555	58	347	3238	79	1032	5378
Northwood	107	244	3723	41	92	2504	34	152	3120	67	449	4996
Dardistown and M50	0	0	3723	0	0	2504	0	0	3120	0	0	4996
Dublin Airport	49	2753	1019	91	1517	1078	155	1476	1798	458	1366	4089
Fosterstown	25	262	781	26	149	956	32	287	1544	58	799	3348
Swords Central	18	273	526	34	232	758	41	441	1144	111	1198	2261
Seatown	3	353	177	23	183	598	48	247	945	177	535	1902
Estuary Park-and-Ride	0	177	0	0	598	0	0	945	0	0	1902	0
2030 Slow Growt - Southbound Direction												
Estuary Park-and-Ride	2689	0	2689	882	0	882	534	0	534	532	0	532
Seatown	1061	137	3614	174	36	1020	150	38	646	280	45	767
Swords Central	1247	116	4745	234	38	1216	174	25	795	262	34	995
Fosterstown	1585	56	6273	226	32	1411	155	21	929	255	27	1224
Dublin Airport	1569	713	7129	1828	88	3150	2105	75	2959	2136	123	3236
Dardistown and M50	0	0	7129	0	0	3150	0	0	2959	0	0	3236
Northwood	547	103	7573	115	45	3221	86	53	2992	159	99	3296
Ballymun	1363	104	8832	302	62	3461	223	79	3136	300	136	3460
Collins Avenue	889	689	9032	224	166	3518	235	106	3265	393	129	3724
Griffith Park	274	187	9119	65	51	3531	87	42	3309	157	54	3827
Glasnevin	1286	310	10096	147	133	3546	110	150	3270	268	440	3656
Mater	216	470	9842	69	201	3414	52	185	3137	157	210	3603
O'Connell Street	80	1432	8490	25	679	2760	27	670	2494	61	648	3016
Tara	124	3482	5132	35	1150	1645	33	1065	1462	114	1273	1858
St Stephen's Green	2	2970	2164	4	829	820	10	640	832	25	687	1195
Charlemont	0	2164	0	0	820	0	0	832	0	0	1195	0

2045 Slow Growth - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	2015	0	2015	1182	0	1182	1332	0	1332	2451	0	2451
St Stephen's Green	452	44	2423	476	9	1649	881	4	2209	1746	5	4192
Tara	1649	185	3886	1100	56	2693	1491	56	3644	2388	340	6240
O'Connell Street	1170	44	5012	785	18	3460	996	20	4620	1320	49	7510
Mater	386	155	5244	241	74	3627	291	81	4829	439	192	7758
Glasnevin	779	279	5744	203	139	3691	186	187	4828	394	969	7183
Griffith Park	57	301	5500	37	72	3656	97	84	4842	143	256	7071
Collins Avenue	152	769	4882	90	204	3542	302	253	4891	499	806	6764
Ballymun	203	364	4722	94	264	3372	75	432	4534	103	1306	5560
Northwood	137	261	4598	55	116	3311	45	187	4393	79	549	5090
Dardistown and M50	0	0	4598	0	0	3311	0	0	4393	0	0	5090
Dublin Airport	65	3516	1148	129	2198	1242	278	2059	2611	281	1788	3583
Fosterstown	41	294	895	28	177	1093	53	341	2324	22	931	2674
Swords Central	26	330	590	39	294	837	93	536	1881	38	1401	1312
Seatown	4	413	180	25	226	636	95	300	1675	43	661	693
Estuary Park-and-Ride	0	180	0	0	636	0	0	1675	0	0	693	0
2045 Slow Growth - Southbound Direction												
Estuary Park-and-Ride	2234	0	2234	969	0	969	651	0	651	220	0	220
Seatown	1247	104	3377	218	32	1155	182	29	804	327	12	535
Swords Central	1465	111	4731	315	41	1430	224	29	1000	338	26	847
Fosterstown	1847	43	6535	284	37	1676	181	27	1154	285	23	1109
Dublin Airport	1797	751	7580	2231	111	3797	2571	86	3639	2413	77	3445
Dardistown and M50	0	0	7580	0	0	3797	0	0	3639	0	0	3445
Northwood	681	118	8143	153	58	3892	108	73	3674	182	119	3508
Ballymun	1719	128	9734	405	82	4215	278	106	3846	359	175	3692
Collins Avenue	943	782	9895	250	205	4260	256	130	3971	391	139	3944
Griffith Park	285	217	9963	72	64	4268	96	50	4017	166	60	4049
Glasnevin	1430	366	11028	179	186	4261	129	197	3949	288	529	3809
Mater	240	528	10740	77	273	4066	57	226	3780	159	217	3751
O'Connell Street	94	1553	9280	29	846	3249	29	828	2981	66	718	3099
Tara	143	3843	5581	44	1395	1898	40	1314	1707	131	1311	1918
St Stephen's Green	3	3144	2440	5	936	967	8	738	978	25	657	1287
Charlemont	0	2440	0	0	967	0	0	978	0	0	1287	0

2060 Slow Growth - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	2337	0	2337	1449	0	1449	1654	0	1654	2978	0	2978
St Stephen's Green	524	56	2805	490	12	1927	1011	6	2660	2063	7	5034
Tara	2009	240	4575	1345	74	3198	1815	74	4400	2987	405	7616
O'Connell Street	1457	66	5966	1016	27	4187	1269	28	5642	1661	66	9212
Mater	458	179	6245	298	91	4394	372	99	5915	532	226	9518
Glasnevin	1016	311	6950	273	165	4502	252	226	5941	518	1195	8841
Griffith Park	72	322	6700	48	88	4462	121	97	5965	166	284	8723
Collins Avenue	183	824	6060	110	232	4340	332	292	6005	525	905	8343
Ballymun	267	411	5915	127	324	4142	98	540	5563	134	1610	6868
Northwood	180	295	5800	75	142	4075	59	237	5386	101	671	6298
Dardistown and M50	0	0	5800	0	0	4075	0	0	5386	0	0	6298
Dublin Airport	124	4528	1396	239	3019	1294	487	2771	3102	395	2393	4300
Fosterstown	51	356	1091	23	224	1093	52	443	2711	23	1180	3143
Swords Central	33	415	709	34	392	735	119	698	2132	36	1714	1466
Seatown	5	490	224	18	294	460	105	381	1856	28	840	653
Estuary Park-and-Ride	0	224	0	0	460	0	0	1856	0	0	653	0
2060 Slow Growth - Southbound Direction												
Estuary Park-and-Ride	2518	0	2518	503	0	503	706	0	706	209	0	209
Seatown	1536	120	3934	266	15	754	223	28	901	380	9	580
Swords Central	1778	155	5557	395	26	1124	285	31	1155	424	29	975
Fosterstown	2275	49	7782	342	26	1440	224	31	1349	343	33	1285
Dublin Airport	2620	1030	9372	3487	139	4788	3993	116	5225	3498	101	4682
Dardistown and M50	0	0	9372	0	0	4788	0	0	5225	0	0	4682
Northwood	850	149	10073	197	87	4898	136	111	5249	212	161	4733
Ballymun	2133	161	12044	513	118	5293	345	150	5444	434	233	4934
Collins Avenue	1060	834	12271	284	252	5324	279	188	5535	413	176	5171
Griffith Park	325	259	12336	85	82	5327	107	65	5577	179	76	5273
Glasnevin	1731	508	13560	216	287	5256	155	313	5420	330	735	4868
Mater	305	658	13206	95	361	4990	67	327	5160	180	264	4784
O'Connell Street	132	1943	11394	39	1102	3926	38	1166	4032	84	972	3895
Tara	195	4796	6793	63	1721	2268	55	1871	2216	169	1746	2318
St Stephen's Green	4	3774	3023	7	1029	1246	13	939	1291	43	773	1588
Charlemont	0	3023	0	0	1246	0	0	1291	0	0	1588	0

B.2 Low Frequency - Boardings, Alightings and Loading Profile

2030 Low Frequency - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1519	0	1519	841	0	841	961	0	961	1793	0	1793
St Stephen's Green	368	19	1868	358	3	1195	618	2	1577	1434	2	3226
Tara	1233	67	3035	707	23	1879	984	23	2538	1877	158	4945
O'Connell Street	859	16	3879	509	6	2381	659	7	3191	1038	18	5965
Mater	277	85	4070	162	34	2509	194	43	3341	342	104	6204
Glasnevin	547	190	4427	125	71	2563	119	115	3346	268	550	5922
Griffith Park	40	229	4238	23	49	2538	67	60	3354	107	191	5838
Collins Avenue	123	596	3765	67	144	2460	237	188	3402	425	637	5626
Ballymun	145	290	3620	66	179	2347	54	306	3149	74	959	4741
Northwood	102	212	3510	39	78	2308	33	130	3052	62	404	4399
Dardistown and M50	0	0	3510	0	0	2308	0	0	3052	0	0	4399
Dublin Airport	47	2670	887	90	1492	905	166	1453	1765	353	1324	3428
Fosterstown	19	228	678	21	127	799	37	254	1548	42	711	2760
Swords Central	13	241	450	28	210	617	52	399	1200	93	1058	1795
Seatown	2	314	139	16	167	466	57	226	1031	139	488	1446
Estuary Park-and-Ride	0	139	0	0	466	0	0	1031	0	0	1446	0
2030 Low Frequency - Southbound Direction												
Estuary Park-and-Ride	2231	0	2231	731	0	731	532	0	532	415	0	415
Seatown	998	121	3108	157	28	860	134	36	631	252	37	630
Swords Central	1097	106	4099	213	34	1039	159	25	764	240	26	844
Fosterstown	1454	36	5516	197	28	1208	135	20	879	223	20	1047
Dublin Airport	1527	641	6403	1867	83	2992	2128	71	2937	2000	103	2944
Dardistown and M50	0	0	6403	0	0	2992	0	0	2937	0	0	2944
Northwood	494	95	6802	99	44	3046	75	53	2958	132	92	2984
Ballymun	1265	94	7972	266	58	3255	197	75	3080	262	127	3118
Collins Avenue	763	660	8076	186	157	3284	195	102	3172	300	113	3305
Griffith Park	211	162	8125	50	45	3289	69	37	3204	128	46	3387
Glasnevin	874	276	8723	100	124	3264	78	143	3140	182	379	3190
Mater	117	419	8421	38	184	3118	29	171	2998	85	174	3100
O'Connell Street	33	1254	7200	11	631	2498	12	650	2361	27	578	2549
Tara	58	2891	4368	17	1018	1497	15	1000	1376	53	1045	1557
St Stephen's Green	1	2506	1863	2	751	747	5	613	768	8	590	975
Charlemont	0	1863	0	0	747	0	0	768	0	0	975	0

2045 Low Frequency - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1894	0	1894	1202	0	1202	1327	0	1327	2321	0	2321
St Stephen's Green	450	30	2314	474	6	1670	818	3	2142	1650	3	3968
Tara	1633	122	3825	1142	42	2770	1433	39	3535	2323	250	6041
O'Connell Street	1187	29	4984	847	13	3604	1015	14	4536	1322	33	7330
Mater	377	119	5242	247	58	3793	291	64	4763	436	148	7617
Glasnevin	808	241	5809	217	118	3891	188	164	4788	408	832	7194
Griffith Park	54	273	5590	38	68	3861	94	76	4806	135	232	7097
Collins Avenue	153	693	5050	96	185	3772	277	234	4850	485	761	6821
Ballymun	216	349	4917	102	256	3617	98	428	4520	107	1324	5604
Northwood	148	248	4816	61	112	3566	47	182	4386	82	548	5139
Dardistown and M50	0	0	4816	0	0	3566	0	0	4386	0	0	5139
Dublin Airport	82	3759	1139	167	2497	1235	338	2259	2464	303	1935	3507
Fosterstown	37	290	887	27	171	1091	49	349	2164	18	928	2597
Swords Central	24	329	581	37	308	821	87	556	1695	35	1382	1249
Seatown	3	408	177	23	234	609	83	310	1468	38	672	615
Estuary Park-and-Ride	0	177	0	0	609	0	0	1468	0	0	615	0
2045 Low Frequency - Southbound Direction												
Estuary Park-and-Ride	1927	0	1927	934	0	934	524	0	524	198	0	198
Seatown	1267	94	3100	221	28	1127	183	24	683	319	10	507
Swords Central	1415	102	4413	322	40	1409	229	24	887	340	23	824
Fosterstown	1833	33	6213	279	35	1653	180	24	1043	279	22	1080
Dublin Airport	2149	780	7582	2766	125	4293	3240	95	4188	2853	81	3851
Dardistown and M50	0	0	7582	0	0	4293	0	0	4188	0	0	3851
Northwood	681	124	8140	152	69	4377	106	87	4207	172	132	3892
Ballymun	1744	128	9755	407	90	4693	276	118	4365	351	187	4056
Collins Avenue	890	760	9885	235	215	4713	233	152	4446	352	145	4263
Griffith Park	255	204	9936	67	66	4715	87	52	4481	151	60	4354
Glasnevin	1211	387	10760	155	208	4662	112	240	4353	245	576	4022
Mater	178	527	10411	60	294	4429	44	255	4142	121	221	3922
O'Connell Street	63	1569	8905	21	940	3510	21	936	3226	45	782	3185
Tara	102	3651	5356	34	1519	2024	30	1449	1807	92	1375	1902
St Stephen's Green	2	2979	2378	3	994	1034	4	765	1046	15	662	1254
Charlemont	0	2378	0	0	1034	0	0	1046	0	0	1254	0

2060 Low Frequency - Northbound Direction												
Station	AM			LT			SR			PM		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	2264	0	2264	1539	0	1539	1684	0	1684	2907	0	2907
St Stephen's Green	537	38	2762	527	9	2057	1016	4	2695	1985	5	4888
Tara	2128	169	4721	1503	56	3504	1888	54	4530	2994	310	7572
O'Connell Street	1565	36	6250	1178	17	4664	1356	19	5867	1717	42	9247
Mater	450	140	6560	325	78	4912	375	77	6165	538	170	9615
Glasnevin	1143	274	7429	322	154	5080	256	209	6211	571	1095	9091
Griffith Park	73	295	7208	51	82	5050	118	91	6239	161	260	8993
Collins Avenue	202	747	6663	121	216	4955	310	279	6270	522	850	8664
Ballymun	300	402	6561	144	324	4774	120	552	5838	148	1647	7165
Northwood	210	285	6486	88	142	4721	59	238	5659	111	673	6603
Dardistown and M50	0	0	6486	0	0	4721	0	0	5659	0	0	6603
Dublin Airport	178	5205	1459	291	3641	1370	519	3044	3134	421	2760	4264
Fosterstown	55	368	1146	22	220	1173	51	453	2732	19	1188	3094
Swords Central	34	458	721	33	429	776	140	716	2156	33	1717	1410
Seatown	4	514	211	16	315	478	105	395	1866	18	875	553
Estuary Park-and-Ride	0	211	0	0	478	0	0	1866	0	0	553	0
2060 Low Frequency - Southbound Direction												
Estuary Park-and-Ride	2330	0	2330	614	0	614	567	0	567	182	0	182
Seatown	1550	119	3761	282	17	879	229	23	773	397	6	573
Swords Central	1914	174	5501	424	27	1275	296	27	1042	464	30	1007
Fosterstown	2268	42	7727	354	25	1605	231	29	1245	347	34	1320
Dublin Airport	3087	1160	9655	4195	182	5618	4321	116	5450	4003	124	5199
Dardistown and M50	0	0	9655	0	0	5618	0	0	5450	0	0	5199
Northwood	862	163	10354	203	106	5716	138	117	5471	210	183	5226
Ballymun	2193	168	12379	533	131	6118	355	158	5668	435	260	5401
Collins Avenue	1003	833	12549	270	269	6119	259	188	5740	375	186	5590
Griffith Park	297	241	12605	80	85	6114	98	65	5773	162	78	5674
Glasnevin	1539	564	13581	199	347	5966	144	331	5586	283	846	5111
Mater	221	669	13132	77	406	5637	55	319	5322	138	271	4979
O'Connell Street	93	1991	11235	29	1269	4397	28	1230	4121	57	1084	3951
Tara	147	4767	6614	49	1956	2491	43	1924	2240	123	1781	2294
St Stephen's Green	2	3631	2986	4	1157	1337	7	928	1318	21	762	1553
Charlemont	0	2986	0	0	1337	0	0	1318	0	0	1553	0

B.3 Alternative Demand - Boardings, Alightings and Loading Profile

2030 Alternative Demand - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1716	0	1716	900	0	900	1006	0	1006	1961	0	1961
St Stephen's Green	387	36	2068	393	6	1287	631	4	1633	1400	5	3356
Tara	1320	143	3245	782	41	2028	1044	43	2634	1908	280	4984
O'Connell Street	912	37	4120	548	14	2562	691	17	3308	1043	39	5988
Mater	310	133	4296	172	51	2683	200	69	3440	341	160	6169
Glasnevin	545	259	4582	138	90	2731	126	146	3419	283	683	5769
Griffith Park	44	269	4356	28	61	2698	70	70	3419	110	197	5682
Collins Avenue	121	711	3766	72	172	2599	182	209	3392	343	629	5396
Ballymun	145	318	3594	72	207	2464	72	325	3138	73	922	4548
Northwood	98	233	3459	41	89	2416	34	139	3033	58	388	4218
Dardistown and M50	0	0	3459	0	0	2416	0	0	3033	0	0	4218
Dublin Airport	45	2529	975	88	1478	1026	138	1442	1729	311	1331	3198
Fosterstown	23	245	752	25	141	910	38	235	1531	42	633	2606
Swords Central	16	260	508	32	222	720	48	364	1216	89	990	1706
Seatown	3	342	170	20	179	561	62	218	1061	162	430	1438
Estuary Park-and-Ride	0	170	0	0	561	0	0	1061	0	0	1438	0
2030 Alternative Demand - Southbound Direction												
Estuary Park-and-Ride	2161	0	2161	858	0	858	626	0	626	437	0	437
Seatown	871	133	2899	159	34	983	148	44	730	275	44	668
Swords Central	987	96	3790	211	38	1155	172	28	874	258	30	896
Fosterstown	1281	46	5025	200	30	1326	151	23	1002	242	23	1116
Dublin Airport	1490	504	6010	1777	82	3021	2007	72	2937	1898	101	2913
Dardistown and M50	0	0	6010	0	0	3021	0	0	2937	0	0	2913
Northwood	478	89	6399	107	45	3084	86	52	2971	151	88	2976
Ballymun	1216	94	7522	293	63	3314	226	78	3119	295	127	3144
Collins Avenue	742	520	7744	201	152	3363	222	98	3243	370	114	3399
Griffith Park	229	167	7806	57	50	3370	84	40	3287	149	48	3501
Glasnevin	1054	287	8573	123	126	3368	105	141	3251	253	373	3381
Mater	190	413	8351	62	184	3245	50	178	3123	143	193	3332
O'Connell Street	69	1227	7192	23	661	2606	25	660	2488	57	600	2789
Tara	105	2957	4340	28	1064	1570	31	1066	1453	99	1165	1723
St Stephen's Green	2	2413	1930	4	793	781	9	648	814	21	643	1102
Charlemont	0	1930	0	0	781	0	0	814	0	0	1102	0

2045 Alternative Demand - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1975	0	1975	1163	0	1163	1267	0	1267	2374	0	2374
St Stephen's Green	448	37	2386	405	7	1561	676	4	1939	1677	5	4047
Tara	1690	164	3912	1024	52	2533	1245	54	3130	2440	308	6179
O'Connell Street	1176	40	5047	781	16	3298	902	19	4013	1366	42	7503
Mater	384	139	5292	235	61	3472	271	76	4209	427	166	7764
Glasnevin	776	272	5797	209	113	3567	181	169	4221	403	789	7378
Griffith Park	55	288	5564	37	69	3535	91	78	4234	131	217	7291
Collins Avenue	148	738	4973	93	193	3435	212	233	4213	408	683	7016
Ballymun	211	357	4827	103	264	3274	98	419	3891	104	1188	5933
Northwood	140	256	4710	59	114	3219	46	179	3757	80	486	5527
Dardistown and M50	0	0	4710	0	0	3219	0	0	3757	0	0	5527
Dublin Airport	93	3629	1174	163	2333	1049	256	2149	1864	608	1875	4260
Fosterstown	33	294	913	17	180	886	29	317	1577	52	823	3490
Swords Central	22	335	600	24	302	608	48	488	1136	179	1225	2444
Seatown	3	413	191	10	242	377	55	280	911	227	566	2105
Estuary Park-and-Ride	0	191	0	0	377	0	0	911	0	0	2105	0
2045 Alternative Demand - Southbound Direction												
Estuary Park-and-Ride	2782	0	2782	381	0	381	657	0	657	648	0	648
Seatown	1029	199	3612	204	7	578	187	52	792	330	61	917
Swords Central	1294	192	4713	292	22	848	233	36	989	341	43	1214
Fosterstown	1704	55	6363	253	14	1086	186	25	1150	285	32	1467
Dublin Airport	2132	951	7544	2651	118	3619	3023	116	4057	2795	179	4084
Dardistown and M50	0	0	7544	0	0	3619	0	0	4057	0	0	4084
Northwood	609	122	8030	147	66	3699	111	82	4086	179	129	4133
Ballymun	1565	128	9467	400	94	4006	292	118	4260	368	188	4314
Collins Avenue	784	621	9630	226	194	4038	240	141	4359	380	146	4548
Griffith Park	238	200	9668	65	63	4040	91	52	4398	158	61	4645
Glasnevin	1180	398	10450	152	201	3991	122	226	4294	277	577	4346
Mater	199	513	10136	69	258	3802	53	250	4098	146	237	4254
O'Connell Street	77	1539	8674	27	822	3007	28	919	3208	62	814	3502
Tara	125	3617	5182	43	1252	1798	39	1424	1823	117	1532	2087
St Stephen's Green	2	2843	2341	4	809	993	7	783	1047	22	773	1336
Charlemont	0	2341	0	0	993	0	0	1047	0	0	1336	0

2045 Alternative Demand - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1975	0	1975	1163	0	1163	1267	0	1267	2374	0	2374
St Stephen's Green	448	37	2386	405	7	1561	676	4	1939	1677	5	4047
Tara	1690	164	3912	1024	52	2533	1245	54	3130	2440	308	6179
O'Connell Street	1176	40	5047	781	16	3298	902	19	4013	1366	42	7503
Mater	384	139	5292	235	61	3472	271	76	4209	427	166	7764
Glasnevin	776	272	5797	209	113	3567	181	169	4221	403	789	7378
Griffith Park	55	288	5564	37	69	3535	91	78	4234	131	217	7291
Collins Avenue	148	738	4973	93	193	3435	212	233	4213	408	683	7016
Ballymun	211	357	4827	103	264	3274	98	419	3891	104	1188	5933
Northwood	140	256	4710	59	114	3219	46	179	3757	80	486	5527
Dardistown and M50	0	0	4710	0	0	3219	0	0	3757	0	0	5527
Dublin Airport	93	3629	1174	163	2333	1049	256	2149	1864	608	1875	4260
Fosterstown	33	294	913	17	180	886	29	317	1577	52	823	3490
Swords Central	22	335	600	24	302	608	48	488	1136	179	1225	2444
Seatown	3	413	191	10	242	377	55	280	911	227	566	2105
Estuary Park-and-Ride	0	191	0	0	377	0	0	911	0	0	2105	0
2045 Alternative Demand - Southbound Direction												
Estuary Park-and-Ride	2782	0	2782	381	0	381	657	0	657	648	0	648
Seatown	1029	199	3612	204	7	578	187	52	792	330	61	917
Swords Central	1294	192	4713	292	22	848	233	36	989	341	43	1214
Fosterstown	1704	55	6363	253	14	1086	186	25	1150	285	32	1467
Dublin Airport	2132	951	7544	2651	118	3619	3023	116	4057	2795	179	4084
Dardistown and M50	0	0	7544	0	0	3619	0	0	4057	0	0	4084
Northwood	609	122	8030	147	66	3699	111	82	4086	179	129	4133
Ballymun	1565	128	9467	400	94	4006	292	118	4260	368	188	4314
Collins Avenue	784	621	9630	226	194	4038	240	141	4359	380	146	4548
Griffith Park	238	200	9668	65	63	4040	91	52	4398	158	61	4645
Glasnevin	1180	398	10450	152	201	3991	122	226	4294	277	577	4346
Mater	199	513	10136	69	258	3802	53	250	4098	146	237	4254
O'Connell Street	77	1539	8674	27	822	3007	28	919	3208	62	814	3502
Tara	125	3617	5182	43	1252	1798	39	1424	1823	117	1532	2087
St Stephen's Green	2	2843	2341	4	809	993	7	783	1047	22	773	1336
Charlemont	0	2341	0	0	993	0	0	1047	0	0	1336	0

B.4 Enhanced Transport Network: National Development Plan - Boardings, Alightings and Loading Profile

2030 National Development Plan - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1882	0	1882	852	0	852	1017	0	1017	2279	0	2279
St Stephen's Green	675	12	2545	658	4	1506	1015	2	2029	2168	1	4446
Tara	1056	236	3365	751	80	2177	1009	88	2950	1749	391	5804
O'Connell Street	829	52	4142	473	18	2632	633	20	3563	1150	56	6898
Mater	250	130	4262	178	44	2766	207	57	3713	370	157	7110
Glasnevin	1074	259	5077	296	96	2966	283	203	3794	476	778	6809
Griffith Park	57	228	4906	31	60	2938	76	70	3800	120	224	6705
Collins Avenue	221	600	4527	118	196	2860	253	250	3803	418	821	6302
Ballymun	205	454	4279	89	248	2701	66	428	3441	101	1310	5093
Northwood	99	219	4159	33	81	2653	29	115	3355	63	303	4853
Dardistown and M50	0	0	4159	0	0	2653	0	0	3355	0	0	4853
Dublin Airport	70	3131	1099	94	1735	1012	171	1638	1889	384	1521	3715
Fosterstown	26	368	757	19	253	779	33	508	1413	47	1305	2457
Swords Central	18	300	475	25	230	574	47	343	1117	82	884	1655
Seatown	2	375	102	14	177	411	47	221	944	116	576	1195
Estuary Park-and-Ride	0	102	0	0	411	0	0	944	0	0	1195	0
2030 National Development Plan - Southbound Direction												
Estuary Park-and-Ride	1566	0	1566	636	0	636	512	0	512	413	0	413
Seatown	908	118	2355	152	25	763	150	30	632	291	29	676
Swords Central	1071	102	3324	227	28	962	186	22	796	286	21	941
Fosterstown	2074	45	5354	309	25	1246	229	18	1008	352	26	1267
Dublin Airport	1842	585	6612	2169	68	3347	2465	58	3415	2474	109	3632
Dardistown and M50	0	0	6612	0	0	3347	0	0	3415	0	0	3632
Northwood	499	76	7034	98	37	3408	80	43	3452	165	65	3732
Ballymun	1742	123	8653	358	86	3680	267	107	3613	401	170	3963
Collins Avenue	1165	624	9195	242	227	3696	256	171	3698	532	173	4321
Griffith Park	241	217	9220	49	64	3681	66	45	3718	120	64	4376
Glasnevin	724	641	9302	118	364	3435	100	443	3375	194	920	3650
Mater	184	448	9039	54	188	3302	43	173	3245	131	273	3508
O'Connell Street	104	1229	7914	19	554	2766	19	554	2710	69	514	3063
Tara	152	2891	5175	33	1087	1712	39	1101	1648	90	1191	1962
St Stephen's Green	1	2591	2586	2	711	1003	5	603	1050	13	590	1385
Charlemont	0	2586	0	0	1003	0	0	1050	0	0	1385	0

2045 National Development Plan - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	2175	0	2175	1104	0	1104	1281	0	1281	2745	0	2745
St Stephen's Green	776	13	2938	789	4	1889	1160	3	2438	2570	1	5314
Tara	1386	275	4049	1048	99	2838	1241	107	3572	2257	433	7138
O'Connell Street	1064	58	5055	683	20	3500	814	22	4365	1457	61	8534
Mater	309	136	5228	244	50	3695	276	59	4581	440	166	8807
Glasnevin	1615	273	6570	498	118	4075	447	243	4786	656	959	8505
Griffith Park	72	243	6399	41	67	4049	95	75	4806	139	233	8411
Collins Avenue	275	651	6023	160	216	3993	315	268	4852	489	862	8038
Ballymun	305	507	5821	138	311	3820	101	531	4421	139	1621	6555
Northwood	154	241	5733	50	100	3770	40	145	4316	85	389	6251
Dardistown and M50	0	0	5733	0	0	3770	0	0	4316	0	0	6251
Dublin Airport	154	4497	1390	169	2789	1150	322	2464	2174	765	2114	4902
Fosterstown	39	443	985	18	311	857	28	630	1573	65	1539	3428
Swords Central	24	418	591	25	305	577	59	451	1181	184	1104	2507
Seatown	3	481	113	12	231	359	47	284	944	184	726	1965
Estuary Park-and-Ride	0	113	0	0	359	0	0	944	0	0	1965	0
2045 National Development Plan - Southbound Direction												
Estuary Park-and-Ride	2068	0	2068	578	0	578	519	0	519	667	0	667
Seatown	1166	169	3065	199	25	752	197	35	682	363	46	984
Swords Central	1353	207	4211	313	30	1035	250	26	905	394	38	1340
Fosterstown	2437	57	6590	382	23	1394	279	18	1166	413	38	1714
Dublin Airport	2591	1041	8141	3057	135	4315	3503	101	4568	3622	208	5127
Dardistown and M50	0	0	8141	0	0	4315	0	0	4568	0	0	5127
Northwood	636	100	8676	131	54	4392	99	66	4601	193	102	5219
Ballymun	2155	165	10666	474	124	4743	345	159	4786	487	250	5456
Collins Avenue	1219	745	11139	265	288	4720	279	209	4856	555	222	5788
Griffith Park	249	250	11139	55	76	4699	72	57	4871	127	80	5835
Glasnevin	933	845	11227	154	538	4315	115	676	4310	216	1362	4689
Mater	189	550	10866	59	252	4122	46	226	4129	135	330	4493
O'Connell Street	121	1489	9499	22	703	3441	21	716	3435	74	679	3889
Tara	186	3570	6115	45	1424	2062	47	1450	2032	104	1613	2379
St Stephen's Green	1	3008	3108	2	790	1275	5	717	1320	13	731	1661
Charlemont	0	3108	0	0	1275	0	0	1320	0	0	1661	0

B.5 Enhanced Transport Network: Greater Dublin Area Transport Strategy - Boardings, Alightings and Loading Profile

2045 Greater Dublin Area Transport Strategy - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1908	0	1908	1098	0	1098	1257	0	1257	2416	0	2416
St Stephen's Green	686	12	2582	768	4	1863	1148	2	2403	2193	1	4608
Tara	1591	206	3968	1357	89	3131	1740	98	4044	2394	415	6588
O'Connell Street	1083	42	5008	658	15	3774	832	17	4859	1361	47	7901
Mater	325	105	5228	238	42	3970	278	46	5090	494	124	8271
Glasnevin	668	131	5765	240	60	4150	220	88	5223	327	319	8279
Griffith Park	55	228	5591	35	57	4129	83	61	5244	138	204	8213
Collins Avenue	229	544	5276	146	169	4106	320	196	5368	462	699	7977
Ballymun	258	373	5162	133	281	3958	99	464	5003	140	1537	6579
Northwood	124	211	5074	50	97	3911	41	138	4907	83	378	6284
Dardistown and M50	0	0	5074	0	0	3911	0	0	4907	0	0	6284
Dublin Airport	115	3909	1279	190	2709	1392	352	2446	2812	286	2112	4458
Fosterstown	49	401	928	27	313	1106	49	662	2200	16	1819	2655
Swords Central	24	389	563	40	328	818	87	494	1793	13	1347	1321
Seatown	4	424	143	21	229	610	77	286	1584	4	744	581
Estuary Park-and-Ride	0	143	0	0	610	0	0	1584	0	0	581	0
2045 Greater Dublin Area Transport Strategy - Southbound Direction												
Estuary Park-and-Ride	2366	0	2366	933	0	933	527	0	527	134	0	134
Seatown	1326	84	3608	194	29	1098	185	20	693	323	2	455
Swords Central	1650	95	5163	332	38	1392	259	24	928	375	16	814
Fosterstown	2620	33	7749	392	35	1749	268	22	1174	384	25	1173
Dublin Airport	2427	663	9513	3010	112	4647	3549	78	4645	3020	77	4116
Dardistown and M50	0	0	9513	0	0	4647	0	0	4645	0	0	4116
Northwood	560	102	9971	127	56	4718	94	66	4673	171	83	4205
Ballymun	2094	177	11889	427	129	5017	304	161	4816	393	215	4383
Collins Avenue	1003	739	12153	194	281	4930	207	217	4807	365	174	4574
Griffith Park	224	251	12126	47	54	4923	69	43	4833	116	58	4632
Glasnevin	329	504	11951	59	278	4704	49	341	4541	85	679	4038
Mater	153	616	11488	50	248	4506	39	204	4376	105	234	3910
O'Connell Street	94	1639	9943	18	754	3770	16	746	3646	47	701	3255
Tara	208	4195	5956	44	1741	2072	43	1694	1996	84	1441	1899
St Stephen's Green	1	3004	2953	2	809	1266	4	675	1325	11	436	1474
Charlemont	0	2953	0	0	1266	0	0	1325	0	0	1474	0

2060 Greater Dublin Area Transport Strategy - Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	2332	0	2332	1497	0	1497	1658	0	1658	2897	0	2897
St Stephen's Green	774	16	3090	939	6	2430	1423	3	3078	2448	1	5343
Tara	2300	270	5120	2044	120	4354	2445	133	5390	3089	506	7926
O'Connell Street	1336	53	6403	981	21	5314	1168	22	6536	1629	59	9495
Mater	389	123	6668	353	57	5611	394	56	6874	563	148	9910
Glasnevin	949	148	7469	450	77	5984	358	106	7127	434	417	9927
Griffith Park	73	242	7300	55	68	5971	107	70	7163	158	223	9863
Collins Avenue	322	583	7038	243	195	6019	389	225	7326	494	766	9591
Ballymun	366	426	6978	245	359	5905	160	597	6889	181	1854	7918
Northwood	185	241	6922	91	125	5871	67	182	6774	112	472	7558
Dardistown and M50	0	0	6922	0	0	5871	0	0	6774	0	0	7558
Dublin Airport	187	5496	1613	322	4693	1501	506	3893	3387	476	2880	5154
Fosterstown	77	498	1192	22	417	1106	56	837	2606	23	2094	3083
Swords Central	32	531	693	27	463	670	110	626	2090	20	1579	1523
Seatown	4	534	163	13	301	381	87	371	1806	5	911	618
Estuary Park-and-Ride	0	163	0	0	381	0	0	1806	0	0	618	0
2060 Greater Dublin Area Transport Strategy - Southbound Direction												
Estuary Park-and-Ride	2684	0	2684	501	0	501	661	0	661	145	0	145
Seatown	1584	100	4167	290	11	780	243	27	877	400	2	544
Swords Central	1881	141	5907	521	18	1282	351	32	1195	513	23	1034
Fosterstown	2996	41	8862	551	21	1812	338	31	1502	463	38	1459
Dublin Airport	3270	991	11141	4524	306	6030	4837	144	6195	4492	119	5832
Dardistown and M50	0	0	11141	0	0	6030	0	0	6195	0	0	5832
Northwood	713	130	11724	176	81	6125	123	91	6227	211	126	5917
Ballymun	2516	224	14016	568	188	6505	381	219	6389	469	321	6064
Collins Avenue	1067	759	14323	227	367	6365	226	247	6368	379	234	6209
Griffith Park	242	274	14291	56	68	6353	76	51	6393	125	73	6261
Glasnevin	423	645	14070	77	423	6007	60	510	5943	100	1014	5347
Mater	181	729	13521	64	343	5727	48	265	5726	122	307	5163
O'Connell Street	120	1952	11689	26	967	4786	22	984	4763	61	958	4265
Tara	227	5160	6756	63	2384	2464	59	2302	2521	115	1994	2387
St Stephen's Green	2	3297	3461	3	867	1600	5	848	1677	15	544	1858
Charlemont	0	3461	0	0	1600	0	0	1677	0	0	1858	0

B.6 Enhanced Transport Network: National Development Plan + Alternative Demand - Boardings, Alightings and Loading Profile

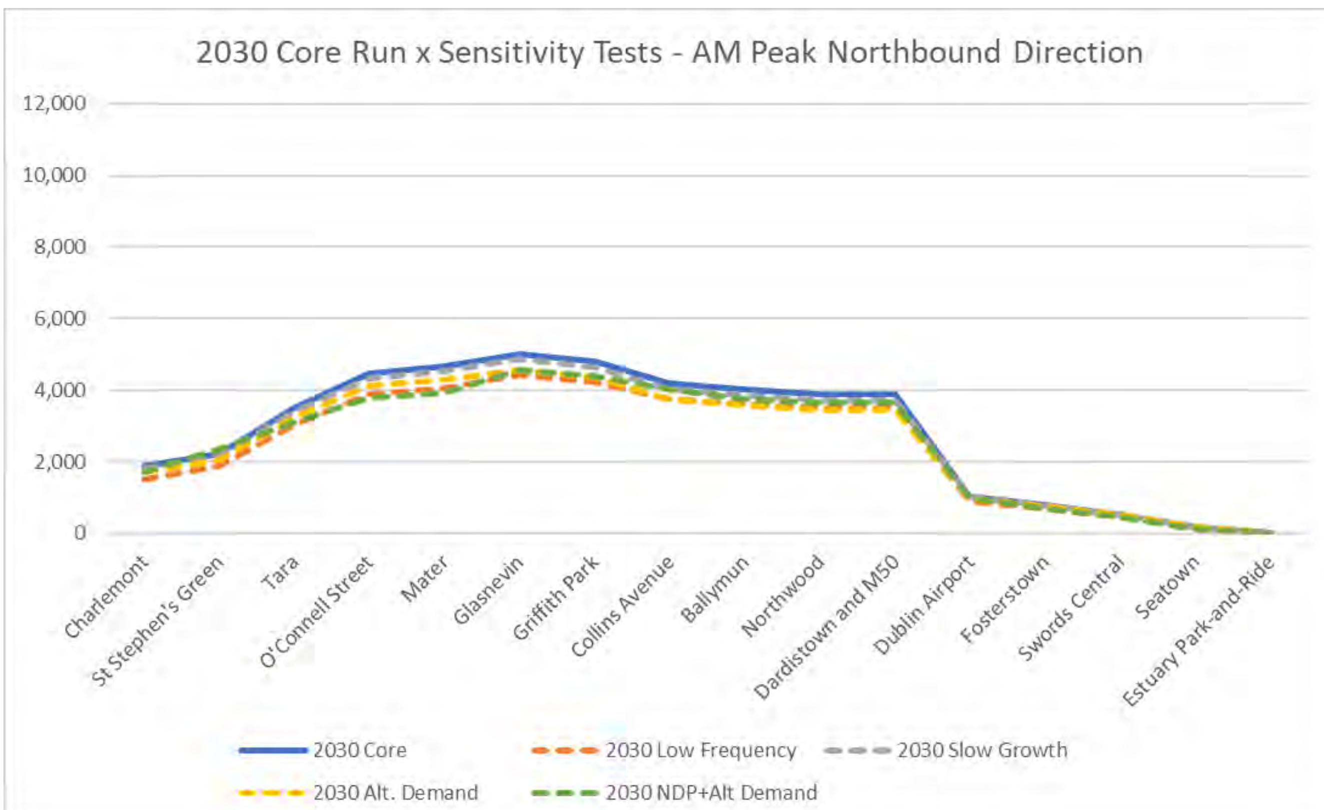
2030 National Development Plan + Alternative Demand Northbound Direction												
Station	AM			LT			SR			PM		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1713	0	1713	807	0	807	926	0	926	2039	0	2039
St Stephen's Green	641	9	2345	629	4	1433	879	2	1803	1811	1	3849
Tara	942	197	3090	714	76	2071	891	80	2613	1499	353	4995
O'Connell Street	755	44	3802	449	17	2503	572	18	3166	996	49	5943
Mater	224	113	3913	169	42	2629	190	52	3304	327	136	6134
Glasnevin	891	249	4555	269	91	2808	261	176	3388	425	633	5925
Griffith Park	48	216	4387	30	57	2781	69	63	3394	107	188	5844
Collins Avenue	189	563	4013	111	188	2705	206	228	3372	319	709	5453
Ballymun	176	426	3763	86	241	2550	66	389	3049	88	1141	4400
Northwood	82	200	3646	31	77	2504	26	105	2970	52	263	4190
Dardistown and M50	0	0	3646	0	0	2504	0	0	2970	0	0	4190
Dublin Airport	61	2690	1017	76	1591	989	124	1518	1577	283	1386	3087
Fosterstown	21	337	701	19	237	771	29	426	1180	41	1055	2072
Swords Central	15	270	445	25	215	581	37	282	936	78	687	1464
Seatown	2	344	104	13	167	428	42	193	785	127	450	1141
Estuary Park-and-Ride	0	104	0	0	428	0	0	785	0	0	1141	0
2030 National Development Plan + Alternative Demand Southbound Direction												
Estuary Park-and-Ride	1297	0	1297	718	0	718	481	0	481	396	0	396
Seatown	707	112	1893	140	27	830	142	32	590	268	32	632
Swords Central	810	82	2621	206	30	1005	175	21	745	260	20	871
Fosterstown	1687	38	4271	286	24	1267	218	16	947	322	23	1171
Dublin Airport	1701	400	5571	1953	62	3158	2243	54	3136	2054	96	3128
Dardistown and M50	0	0	5571	0	0	3158	0	0	3136	0	0	3128
Northwood	424	63	5932	93	34	3218	73	39	3170	150	56	3222
Ballymun	1516	108	7339	348	79	3487	264	98	3336	380	147	3456
Collins Avenue	990	460	7869	230	197	3520	242	156	3422	495	150	3801
Griffith Park	199	198	7871	46	60	3506	63	42	3443	113	54	3860
Glasnevin	570	592	7848	109	324	3291	94	394	3143	180	735	3305
Mater	154	389	7614	52	174	3169	41	164	3020	120	242	3183
O'Connell Street	85	1044	6655	18	534	2653	17	514	2523	62	461	2784
Tara	128	2404	4379	31	1055	1629	37	1017	1543	76	1061	1799
St Stephen's Green	1	2097	2283	2	687	944	4	560	987	10	553	1255
Charlemont	0	2283	0	0	944	0	0	987	0	0	1255	0

2045 National Development Plan + Alternative Demand Northbound Direction												
Station	**AM**			**LT**			**SR**			**PM**		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	1977	0	1977	1059	0	1059	1200	0	1200	2388	0	2388
St Stephen's Green	740	10	2708	778	4	1833	1078	3	2276	2004	1	4392
Tara	1232	229	3710	1023	91	2765	1178	95	3358	1742	390	5743
O'Connell Street	971	49	4633	663	19	3409	781	20	4119	1201	53	6892
Mater	282	119	4796	232	46	3595	262	54	4327	385	142	7134
Glasnevin	1299	252	5843	473	106	3963	434	204	4557	588	749	6974
Griffith Park	59	228	5674	41	63	3940	85	68	4575	124	197	6902
Collins Avenue	228	613	5289	163	205	3898	259	244	4589	392	734	6559
Ballymun	256	479	5066	137	299	3736	95	484	4200	123	1412	5270
Northwood	128	228	4965	51	96	3690	39	134	4104	70	335	5005
Dardistown and M50	0	0	4965	0	0	3690	0	0	4104	0	0	5005
Dublin Airport	127	3851	1241	202	2662	1231	270	2408	1967	384	1956	3433
Fosterstown	32	394	879	21	301	951	32	533	1466	32	1262	2203
Swords Central	20	361	539	30	315	666	51	389	1128	80	858	1425
Seatown	3	429	112	14	224	455	51	251	927	108	579	953
Estuary Park-and-Ride	0	112	0	0	455	0	0	927	0	0	953	0
2045 National Development Plan + Alternative Demand Southbound Direction												
Estuary Park-and-Ride	1314	0	1314	740	0	740	476	0	476	328	0	328
Seatown	947	117	2145	181	27	894	183	29	630	329	25	631
Swords Central	1058	102	3101	281	34	1141	238	22	846	348	21	958
Fosterstown	1920	33	4987	339	27	1453	263	17	1092	374	26	1306
Dublin Airport	2371	594	6764	3242	111	4584	3414	91	4415	3024	117	4214
Dardistown and M50	0	0	6764	0	0	4584	0	0	4415	0	0	4214
Northwood	545	84	7225	123	60	4647	95	65	4445	177	85	4305
Ballymun	1883	147	8962	450	136	4961	336	157	4624	462	217	4551
Collins Avenue	1018	563	9417	246	301	4906	261	206	4679	527	188	4890
Griffith Park	206	224	9399	50	75	4881	68	55	4692	119	68	4941
Glasnevin	701	770	9329	128	572	4437	108	644	4156	202	1090	4053
Mater	162	478	9014	55	249	4243	43	216	3983	123	298	3877
O'Connell Street	98	1239	7873	20	732	3531	19	691	3311	67	585	3359
Tara	152	2932	5093	38	1506	2064	43	1405	1949	88	1346	2100
St Stephen's Green	1	2388	2706	2	817	1249	4	684	1270	10	624	1486
Charlemont	0	2706	0	0	1249	0	0	1270	0	0	1486	0

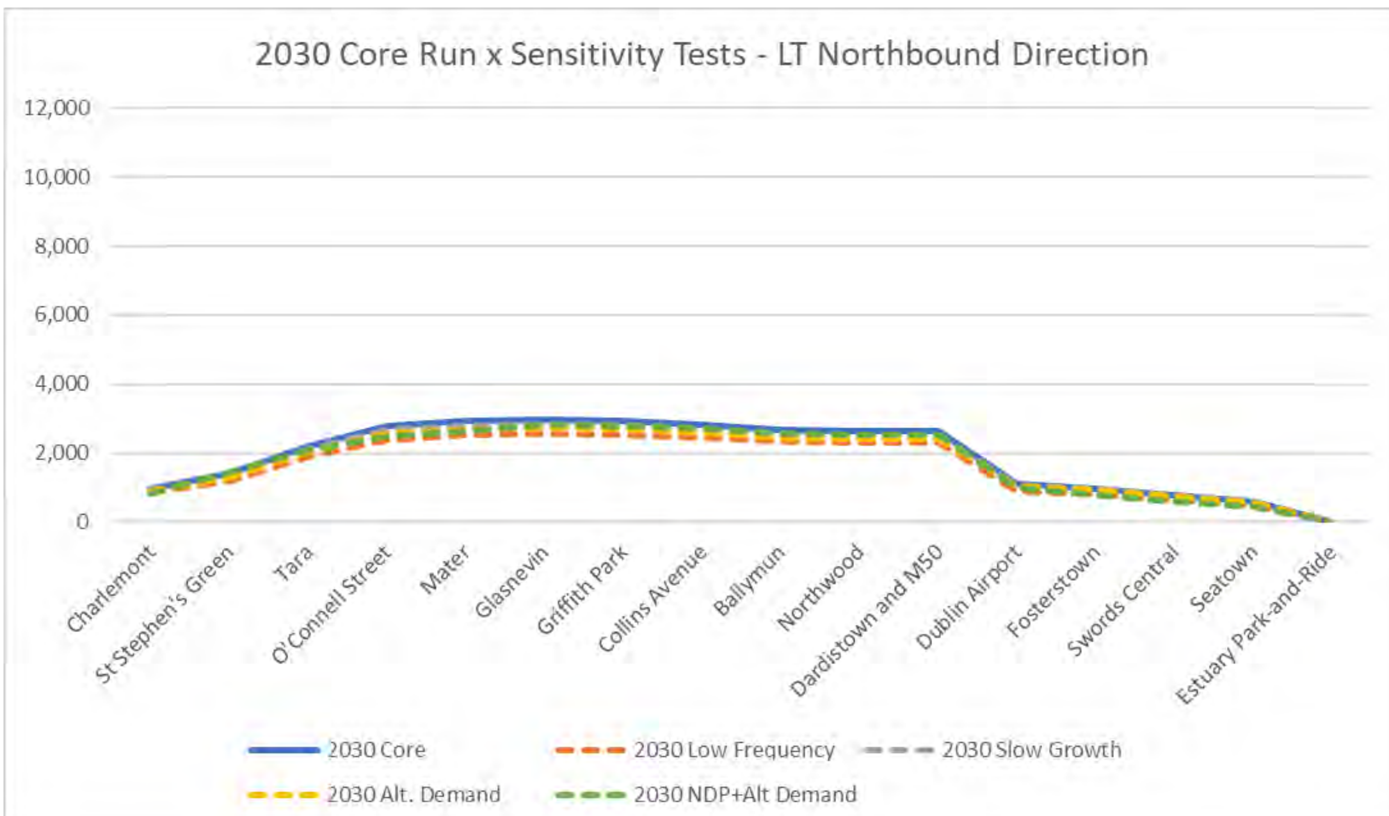
2060 National Development Plan + Alternative Demand Northbound Direction												
Station	AM			LT			SR			PM		
Station	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load	Boarding	Alighting	Load
Charlemont	2254	0	2254	1348	0	1348	1480	0	1480	2812	0	2812
St Stephen's Green	849	11	3092	965	4	2309	1252	3	2729	2442	1	5253
Tara	1544	267	4369	1398	106	3600	1448	112	4065	2275	426	7102
O'Connell Street	1179	54	5494	925	21	4504	998	22	5041	1542	57	8587
Mater	332	125	5701	311	51	4764	341	58	5324	453	151	8890
Glasnevin	1763	264	7200	815	124	5456	666	240	5750	779	883	8786
Griffith Park	74	236	7038	56	70	5443	106	74	5783	139	209	8716
Collins Avenue	295	628	6704	259	221	5480	333	263	5853	436	772	8379
Ballymun	343	523	6524	229	349	5360	144	573	5424	161	1656	6884
Northwood	178	249	6454	89	112	5336	63	162	5325	90	404	6570
Dardistown and M50	0	0	6454	0	0	5336	0	0	5325	0	0	6570
Dublin Airport	194	5177	1470	292	4276	1353	433	3519	2239	782	2600	4752
Fosterstown	41	465	1047	22	352	1023	30	646	1623	51	1442	3362
Swords Central	25	448	624	29	396	656	55	503	1175	181	1049	2494
Seatown	3	502	125	14	273	396	51	313	914	202	702	1994
Estuary Park-and-Ride	0	125	0	0	396	0	0	914	0	0	1994	0
2060 National Development Plan + Alternative Demand Southbound Direction												
Estuary Park-and-Ride	2096	0	2096	663	0	663	513	0	513	659	0	659
Seatown	1105	181	3020	243	31	875	226	37	702	381	50	989
Swords Central	1259	194	4085	402	36	1241	301	27	975	431	36	1384
Fosterstown	2329	47	6367	420	27	1633	314	18	1271	432	37	1778
Dublin Airport	3100	1005	8461	4278	296	5615	4682	155	5798	4116	234	5660
Dardistown and M50	0	0	8461	0	0	5615	0	0	5798	0	0	5660
Northwood	662	105	9018	154	79	5689	117	90	5826	202	117	5744
Ballymun	2210	185	11044	536	176	6049	395	212	6009	534	289	5990
Collins Avenue	1107	627	11523	261	361	5950	277	262	6024	534	235	6289
Griffith Park	220	255	11488	54	86	5918	71	67	6028	123	82	6329
Glasnevin	859	971	11376	154	770	5303	122	919	5231	223	1483	5069
Mater	171	583	10965	59	312	5050	46	275	5002	127	353	4844
O'Connell Street	112	1535	9541	23	871	4202	22	875	4149	73	746	4171
Tara	173	3676	6039	46	1817	2431	50	1811	2388	99	1747	2524
St Stephen's Green	1	2846	3194	2	918	1516	5	822	1572	11	784	1751
Charlemont	0	3194	0	0	1516	0	0	1572	0	0	1751	0

B.7 Business Case Core Runs x Sensitivity Analysis – Loading Profile

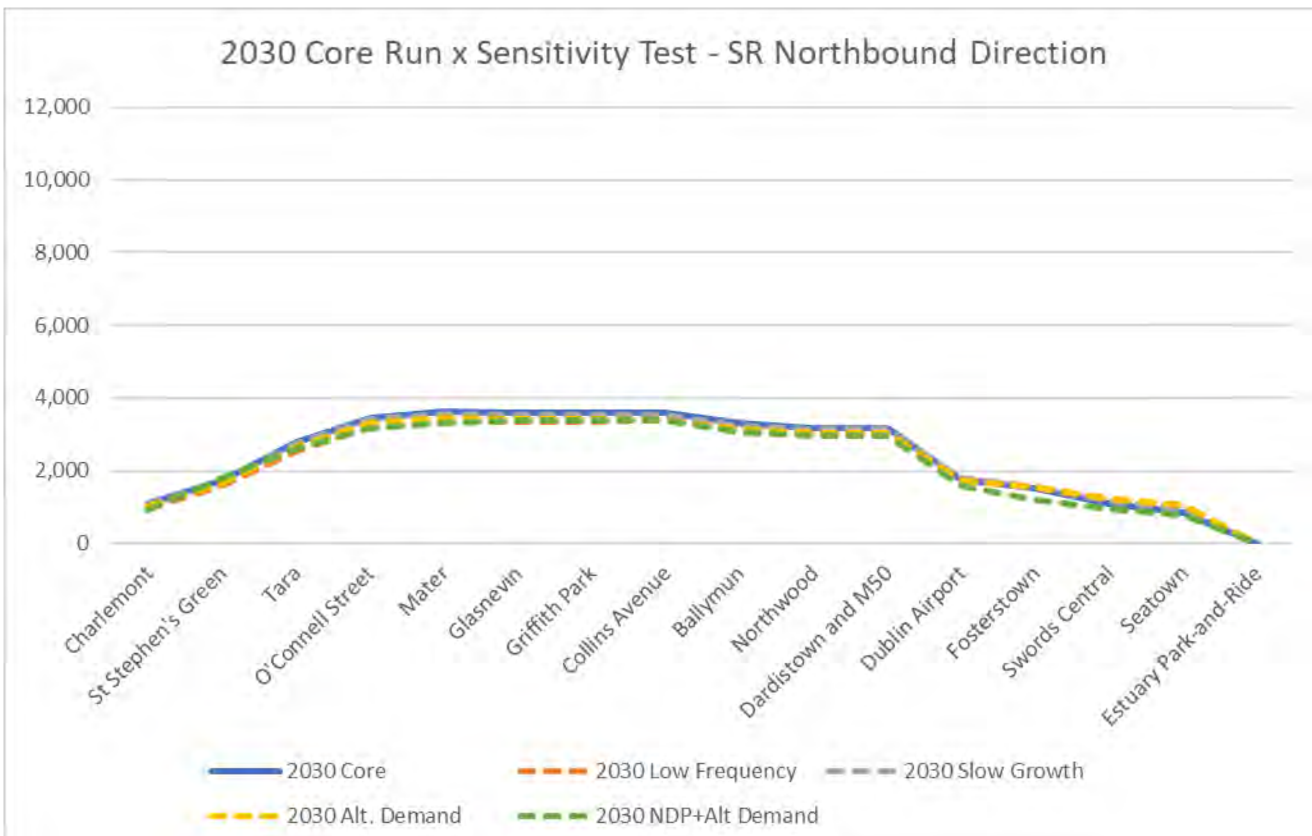
AM Peak Period					
Boarding -Northbound Direction	2030 Business Case	2030 Low Frequency	2030 Slow Growth	2030 Alternative Demand	2030 NDP + Alternative Demand
Charlemont	1,866	1,519	1,831	1,716	1,713
St Stephen's Green	2,239	1,868	2,196	2,068	2,345
Tara	3,513	3,035	3,423	3,245	3,090
O'Connell Street	4,467	3,879	4,342	4,120	3,802
Mater	4,655	4,070	4,518	4,296	3,913
Glasnevin	5,024	4,427	4,860	4,582	4,555
Griffith Park	4,791	4,238	4,629	4,356	4,387
Collins Avenue	4,197	3,765	4,035	3,766	4,013
Ballymun	4,027	3,620	3,860	3,594	3,763
Northwood	3,895	3,510	3,723	3,459	3,646
Dardistown and M50	3,895	3,510	3,723	3,459	3,646
Dublin Airport	1,046	887	1,019	975	1,017
Fosterstown	802	678	781	752	701
Swords Central	535	450	526	508	445
Seatown	173	139	177	170	104
Estuary Park-and-Ride	0	0	0	0	0



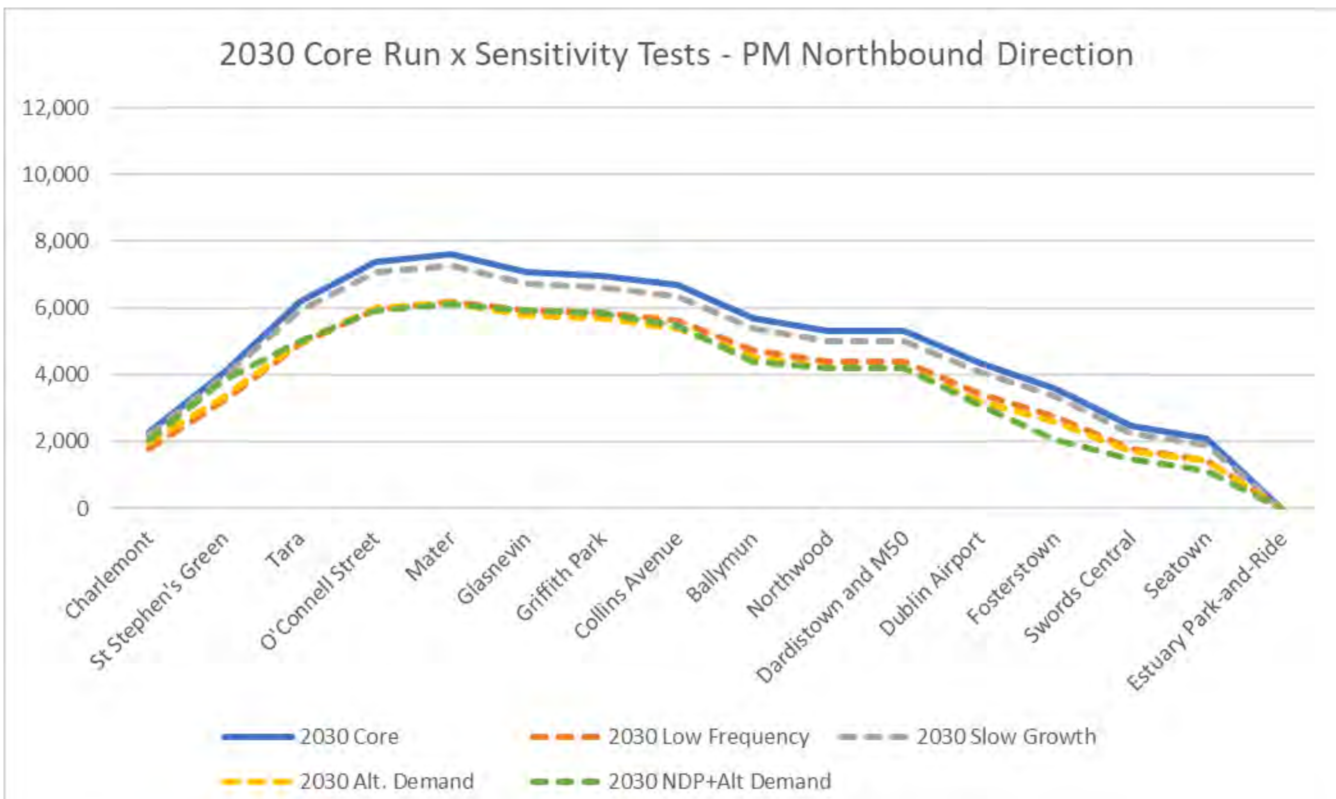
LT Peak Period					
Boarding- Northbound Direction	**2030 Business Case**	**2030 Low Frequency**	**2030 Slow Growth**	**2030 Alternative Demand**	**2030 NDP + Alternative Demand**
Estuary Park-and-Ride	976	841	940	900	807
Seatown	1,390	1,195	1,346	1,287	1,433
Swords Central	2,205	1,879	2,128	2,028	2,071
Fosterstown	2,782	2,381	2,673	2,562	2,503
Dublin Airport	2,914	2,509	2,798	2,683	2,629
Dardistown and M50	2,960	2,563	2,837	2,731	2,808
Northwood	2,924	2,538	2,801	2,698	2,781
Ballymun	2,817	2,460	2,694	2,599	2,705
Collins Avenue	2,674	2,347	2,555	2,464	2,550
Griffith Park	2,622	2,308	2,504	2,416	2,504
Glasnevin	2,622	2,308	2,504	2,416	2,504
Mater	1,099	905	1,078	1,026	989
O'Connell Street	972	799	956	910	771
Tara	765	617	758	720	581
St Stephen's Green	598	466	598	561	428
Charlemont	0	0	0	0	0



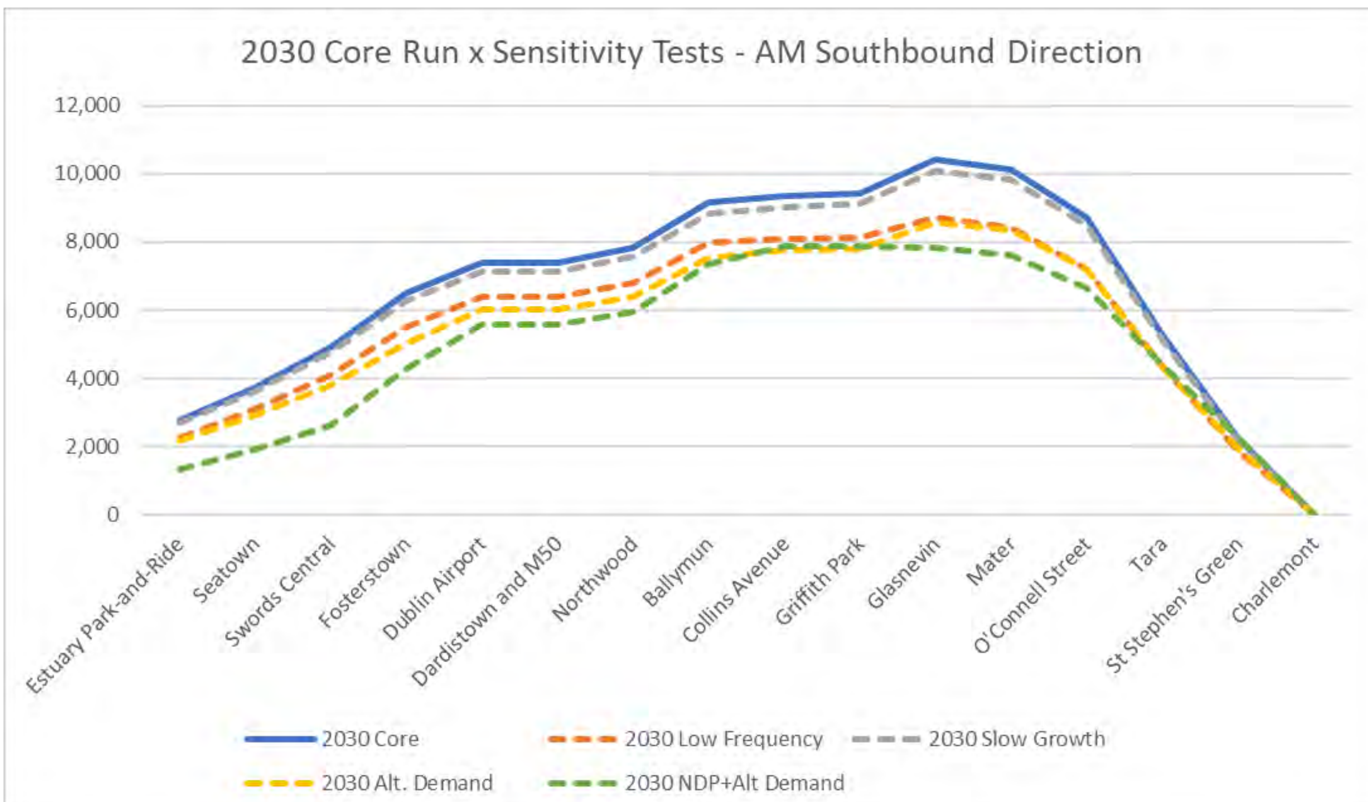
SR Peak Period					
Boarding -Northbound Direction	2030 Business Case	2030 Low Frequency	2030 Slow Growth	2030 Alternative Demand	2030 NDP + Alternative Demand
Charlemont	1,083	961	1,053	1,006	926
St Stephen's Green	1,724	1,577	1,702	1,633	1,803
Tara	2,763	2,538	2,733	2,634	2,613
O'Connell Street	3,464	3,191	3,416	3,308	3,166
Mater	3,606	3,341	3,550	3,440	3,304
Glasnevin	3,572	3,346	3,512	3,419	3,388
Griffith Park	3,574	3,354	3,511	3,419	3,394
Collins Avenue	3,594	3,402	3,526	3,392	3,372
Ballymun	3,294	3,149	3,238	3,138	3,049
Northwood	3,173	3,052	3,120	3,033	2,970
Dardistown and M50	3,173	3,052	3,120	3,033	2,970
Dublin Airport	1,764	1,765	1,798	1,729	1,577
Fosterstown	1,493	1,548	1,544	1,531	1,180
Swords Central	1,072	1,200	1,144	1,216	936
Seatown	857	1,031	945	1,061	785
Estuary Park-and-Ride	0	0	0	0	0



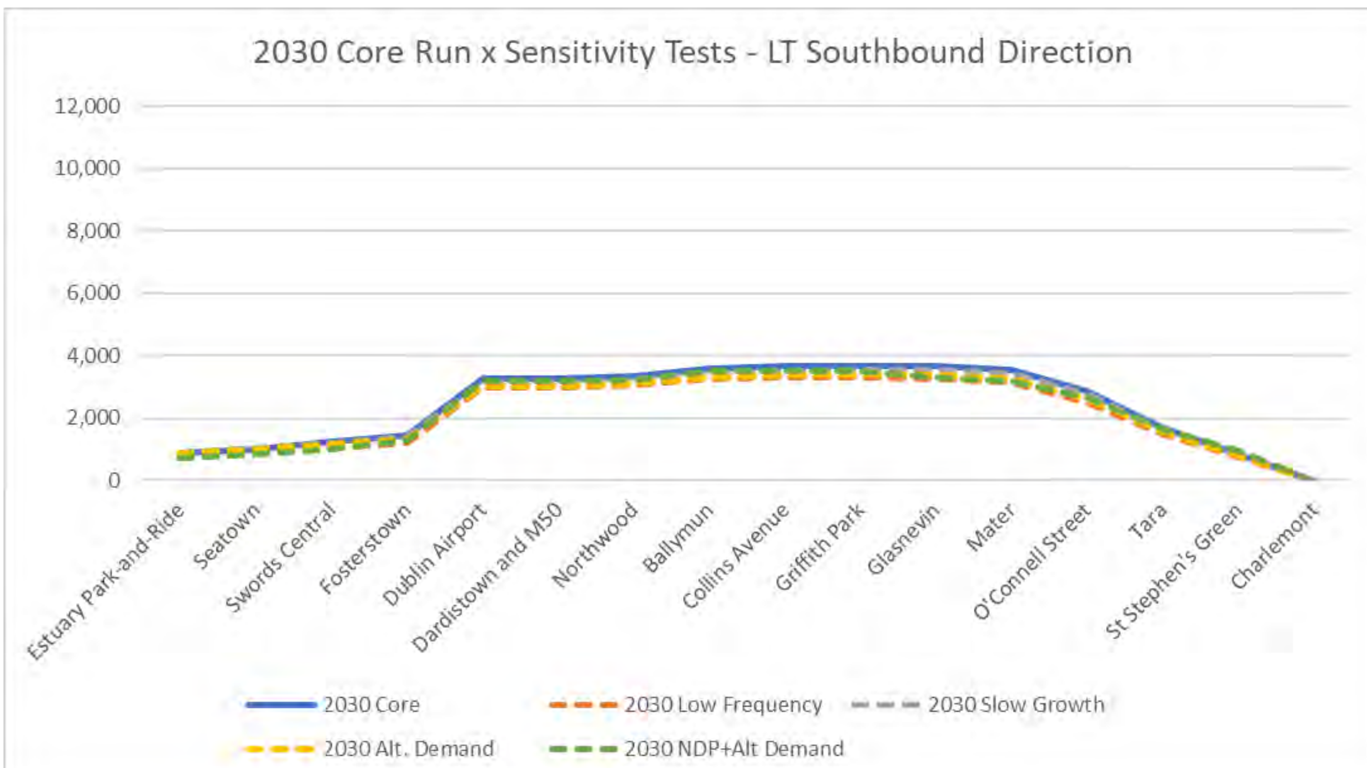
PM Peak Period					
Boarding -Northbound Direction	**2030 Business Case**	**2030 Low Frequency**	**2030 Slow Growth**	**2030 Alternative Demand**	**2030 NDP+ Alternative Demand**
Charlemont	2,276	1,793	2,201	1,961	2,039
St Stephen's Green	4,104	3,226	3,955	3,356	3,849
Tara	6,186	4,945	5,926	4,984	4,995
O'Connell Street	7,405	5,965	7,079	5,988	5,943
Mater	7,616	6,204	7,271	6,169	6,134
Glasnevin	7,082	5,922	6,738	5,769	5,925
Griffith Park	6,976	5,838	6,629	5,682	5,844
Collins Avenue	6,691	5,626	6,331	5,396	5,453
Ballymun	5,695	4,741	5,378	4,548	4,400
Northwood	5,301	4,399	4,996	4,218	4,190
Dardistown and M50	5,301	4,399	4,996	4,218	4,190
Dublin Airport	4,374	3,428	4,089	3,198	3,087
Fosterstown	3,594	2,760	3,348	2,606	2,072
Swords Central	2,477	1,795	2,261	1,706	1,464
Seatown	2,107	1,446	1,902	1,438	1,141
Estuary Park-and-Ride	0	0	0	0	0



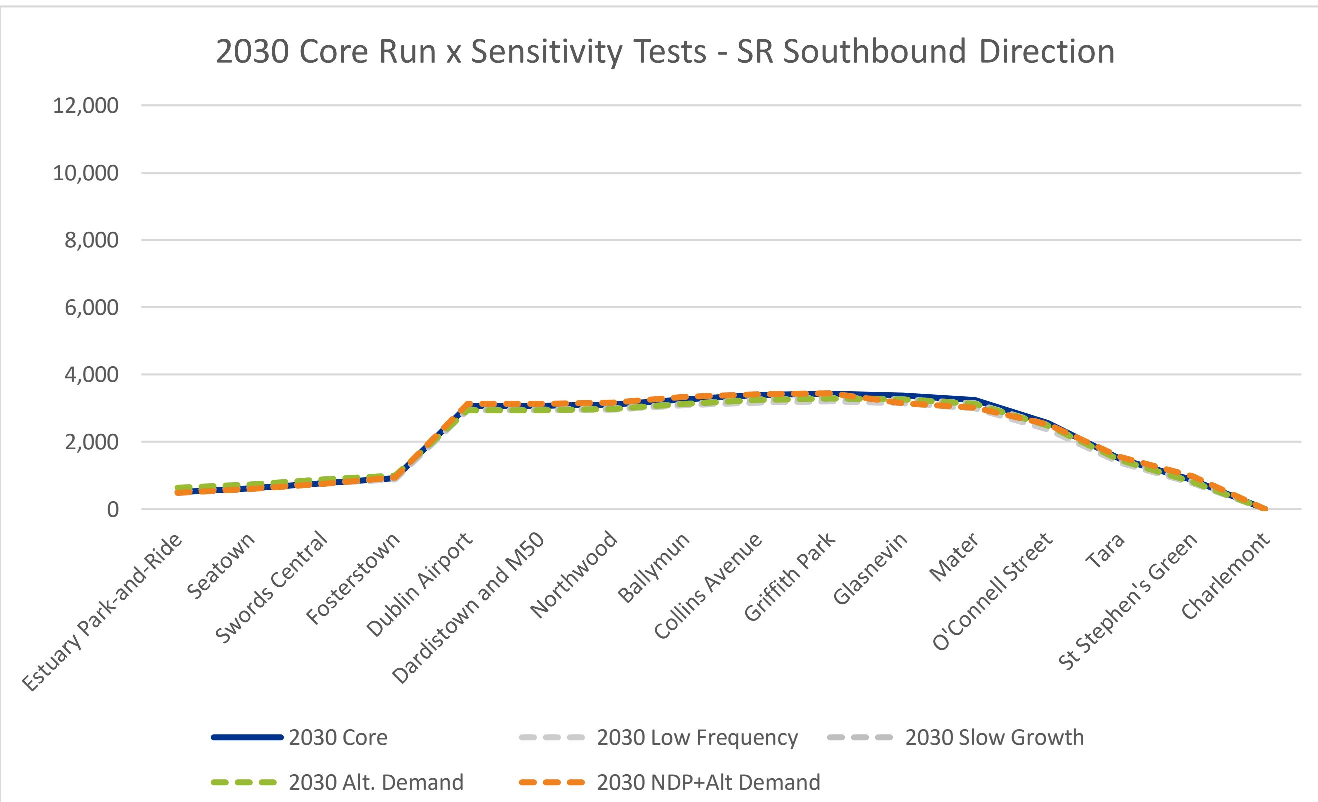
AM Peak Period					
Boarding -Southbound Direction	**2030 Business Case**	**2030 Low Frequency**	**2030 Slow Growth**	**2030 Alternative Demand**	**2030 NDP+ Alternative Demand**
Estuary Park-and-Ride	2,776	2,231	2,689	2,161	1,297
Seatown	3,736	3,108	3,614	2,899	1,893
Swords Central	4,901	4,099	4,745	3,790	2,621
Fosterstown	6,516	5,516	6,273	5,025	4,271
Dublin Airport	7,381	6,403	7,129	6,010	5,571
Dardistown and M50	7,381	6,403	7,129	6,010	5,571
Northwood	7,845	6,802	7,573	6,399	5,932
Ballymun	9,162	7,972	8,832	7,522	7,339
Collins Avenue	9,351	8,076	9,032	7,744	7,869
Griffith Park	9,434	8,125	9,119	7,806	7,871
Glasnevin	10,412	8,723	10,096	8,573	7,848
Mater	10,141	8,421	9,842	8,351	7,614
O'Connell Street	8,735	7,200	8,490	7,192	6,655
Tara	5,281	4,368	5,132	4,340	4,379
St Stephen's Green	2,232	1,863	2,164	1,930	2,283
Charlemont	0	0	0	0	0



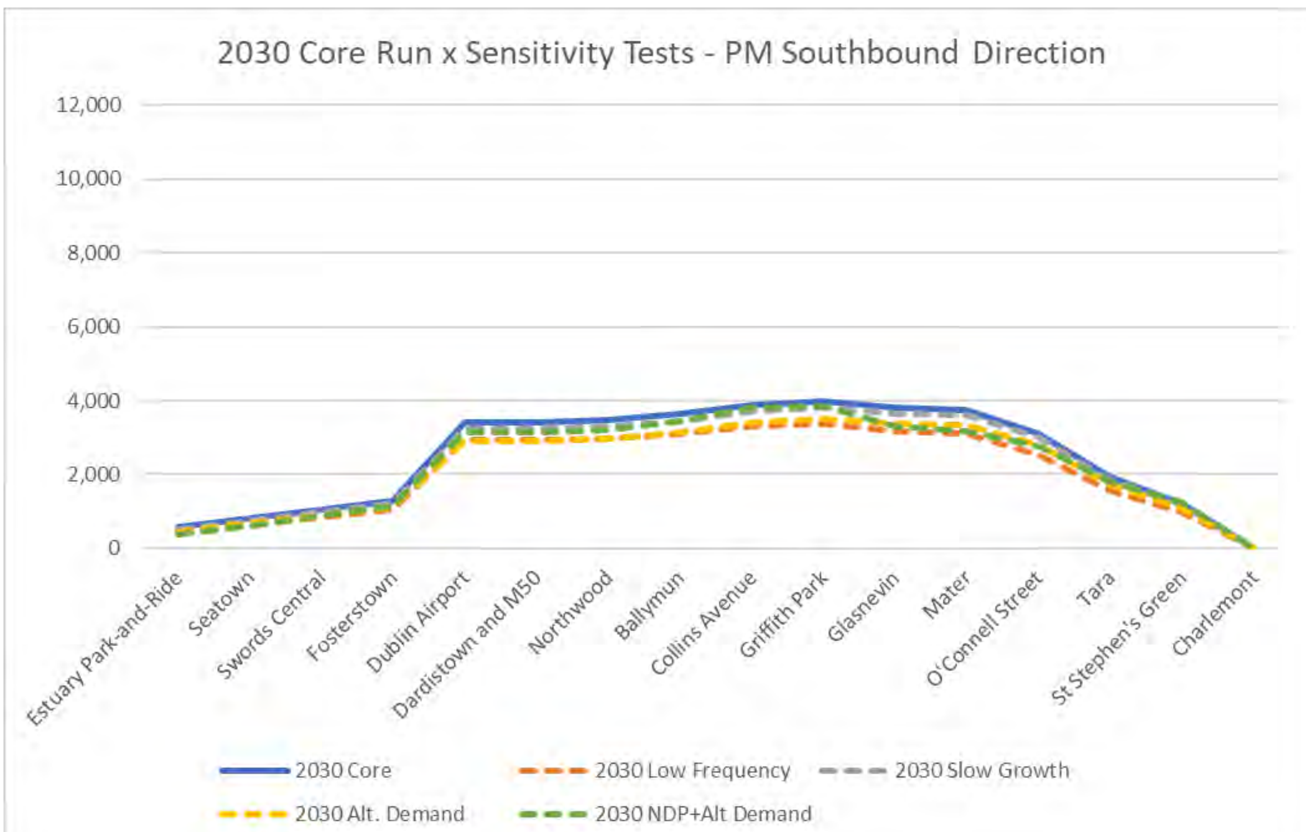
LT Peak Period					
Boarding -Southbound Direction	**2030 Business Case**	**2030 Low Frequency**	**2030 Slow Growth**	**2030 Alternative Demand**	**2030 NDP+ Alternative Demand**
Estuary Park-and-Ride	870	731	882	858	718
Seatown	1,013	860	1,020	983	830
Swords Central	1,221	1,039	1,216	1,155	1,005
Fosterstown	1,421	1,208	1,411	1,326	1,267
Dublin Airport	3,275	2,992	3,150	3,021	3,158
Dardistown and M50	3,275	2,992	3,150	3,021	3,158
Northwood	3,347	3,046	3,221	3,084	3,218
Ballymun	3,597	3,255	3,461	3,314	3,487
Collins Avenue	3,650	3,284	3,518	3,363	3,520
Griffith Park	3,662	3,289	3,531	3,370	3,506
Glasnevin	3,669	3,264	3,546	3,368	3,291
Mater	3,527	3,118	3,414	3,245	3,169
O'Connell Street	2,843	2,498	2,760	2,606	2,653
Tara	1,692	1,497	1,645	1,570	1,629
St Stephen's Green	850	747	820	781	944
Charlemont	0	0	0	0	0



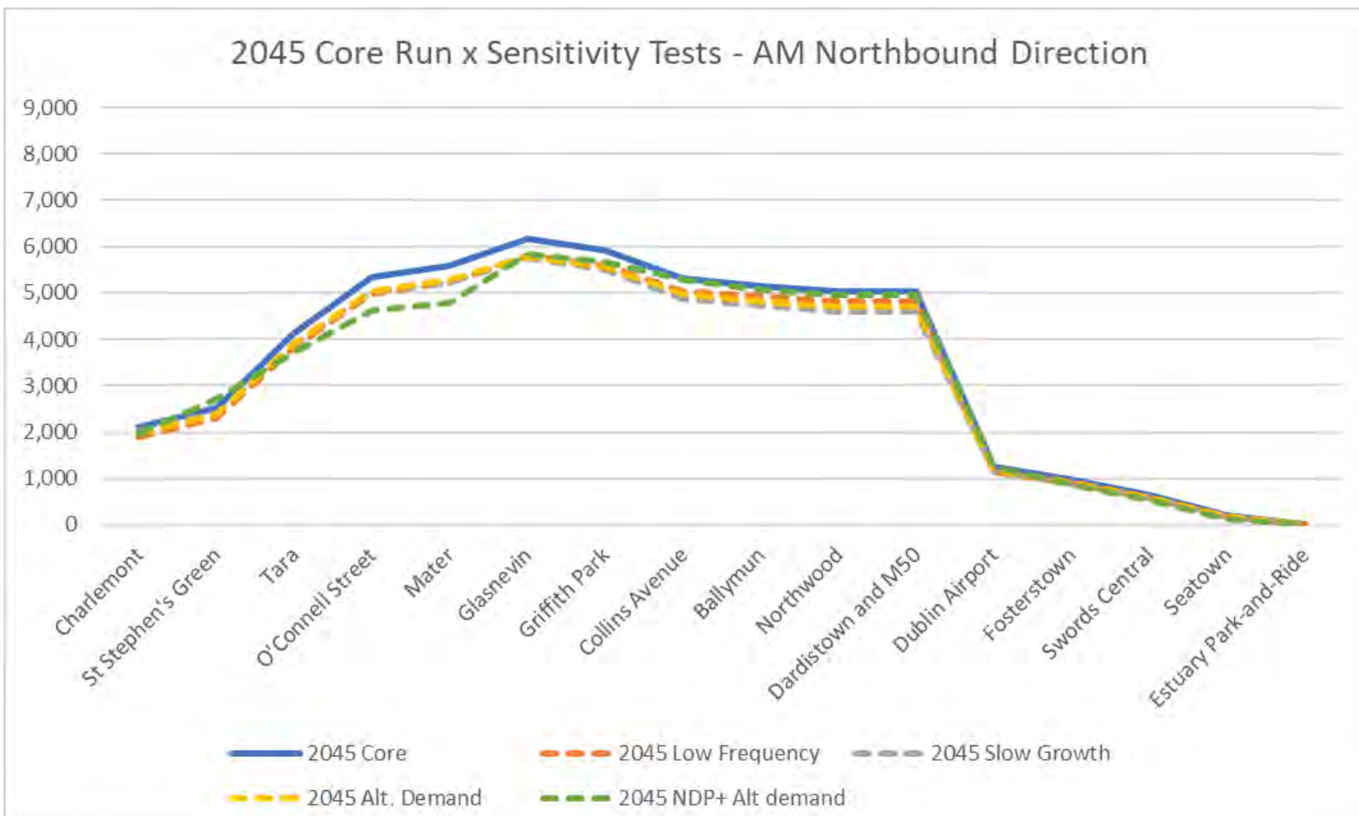
SR Peak Period					
Boarding -Southbound Direction	**2030 Business Case**	**2030 Low Frequency**	**2030 Slow Growth**	**2030 Alternative Demand**	**2030 NDP + Alternative Demand**
Estuary Park-and-Ride	497	532	534	626	481
Seatown	617	631	646	730	590
Swords Central	776	764	795	874	745
Fosterstown	916	879	929	1,002	947
Dublin Airport	3,078	2,937	2,959	2,937	3,136
Dardistown and M50	3,078	2,937	2,959	2,937	3,136
Northwood	3,110	2,958	2,992	2,971	3,170
Ballymun	3,258	3,080	3,136	3,119	3,336
Collins Avenue	3,385	3,172	3,265	3,243	3,422
Griffith Park	3,429	3,204	3,309	3,287	3,443
Glasnevin	3,380	3,140	3,270	3,251	3,143
Mater	3,239	2,998	3,137	3,123	3,020
O'Connell Street	2,566	2,361	2,494	2,488	2,523
Tara	1,498	1,376	1,462	1,453	1,543
St Stephen's Green	861	768	832	814	987
Charlemont	0	0	0	0	0



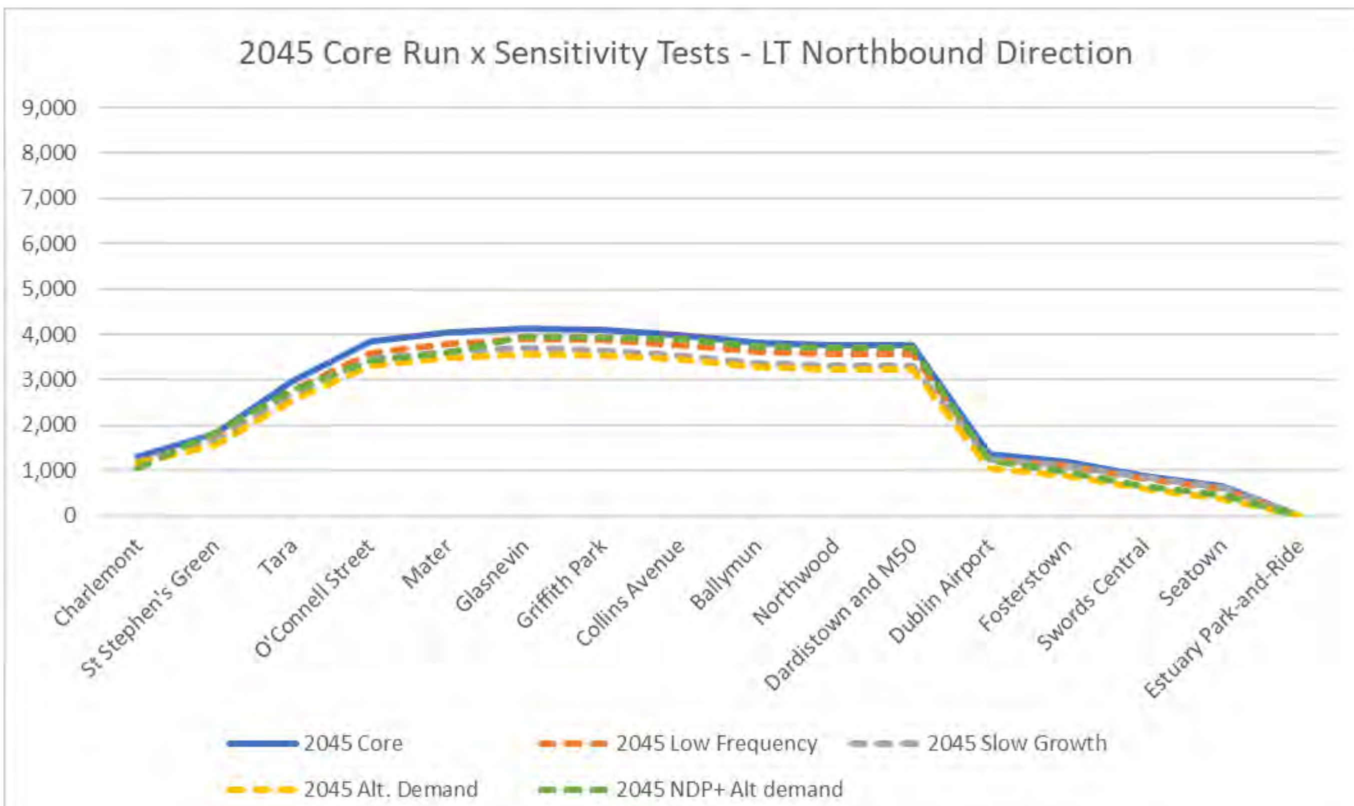
PM Peak Period					
Boarding -Southbound Direction	**2030 Business Case**	**2030 Low Frequency**	**2030 Slow Growth**	**2030 Alternative Demand**	**2030 NDP+ Alternative Demand**
Estuary Park-and-Ride	573	415	532	437	396
Seatown	814	630	767	668	632
Swords Central	1,054	844	995	896	871
Fosterstown	1,287	1,047	1,224	1,116	1,171
Dublin Airport	3,414	2,944	3,236	2,913	3,128
Dardistown and M50	3,414	2,944	3,236	2,913	3,128
Northwood	3,472	2,984	3,296	2,976	3,222
Ballymun	3,635	3,118	3,460	3,144	3,456
Collins Avenue	3,896	3,305	3,724	3,399	3,801
Griffith Park	3,999	3,387	3,827	3,501	3,860
Glasnevin	3,800	3,190	3,656	3,381	3,305
Mater	3,740	3,100	3,603	3,332	3,183
O'Connell Street	3,121	2,549	3,016	2,789	2,784
Tara	1,913	1,557	1,858	1,723	1,799
St Stephen's Green	1,229	975	1,195	1,102	1,255
Charlemont	0	0	0	0	0



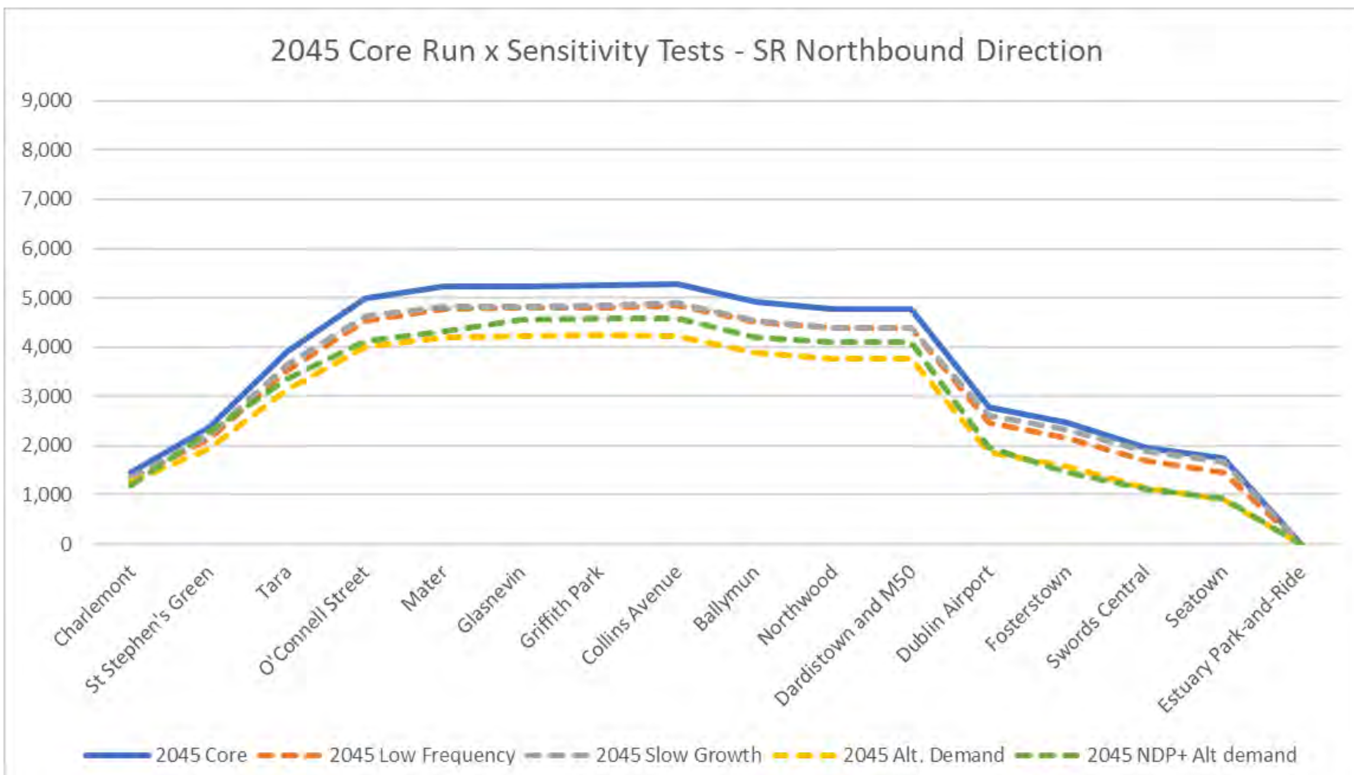
AM Peak Period					
Boarding -Northbound Direction	2045 Business Case	2045 Low Frequency	2045 Slow Growth	2045 Alternative Demand	2045 NDP + Alternative Demand
Charlemont	2,106	1,894	2,015	1,975	1,977
St Stephen's Green	2,537	2,314	2,423	2,386	2,708
Tara	4,117	3,825	3,886	3,912	3,710
O'Connell Street	5,338	4,984	5,012	5,047	4,633
Mater	5,586	5,242	5,244	5,292	4,796
Glasnevin	6,167	5,809	5,744	5,797	5,843
Griffith Park	5,924	5,590	5,500	5,564	5,674
Collins Avenue	5,311	5,050	4,882	4,973	5,289
Ballymun	5,162	4,917	4,722	4,827	5,066
Northwood	5,045	4,816	4,598	4,710	4,965
Dardistown and M50	5,045	4,816	4,598	4,710	4,965
Dublin Airport	1,243	1,139	1,148	1,174	1,241
Fosterstown	970	887	895	913	879
Swords Central	639	581	590	600	539
Seatown	199	177	180	191	112
Estuary Park-and-Ride	0	0	0	0	0



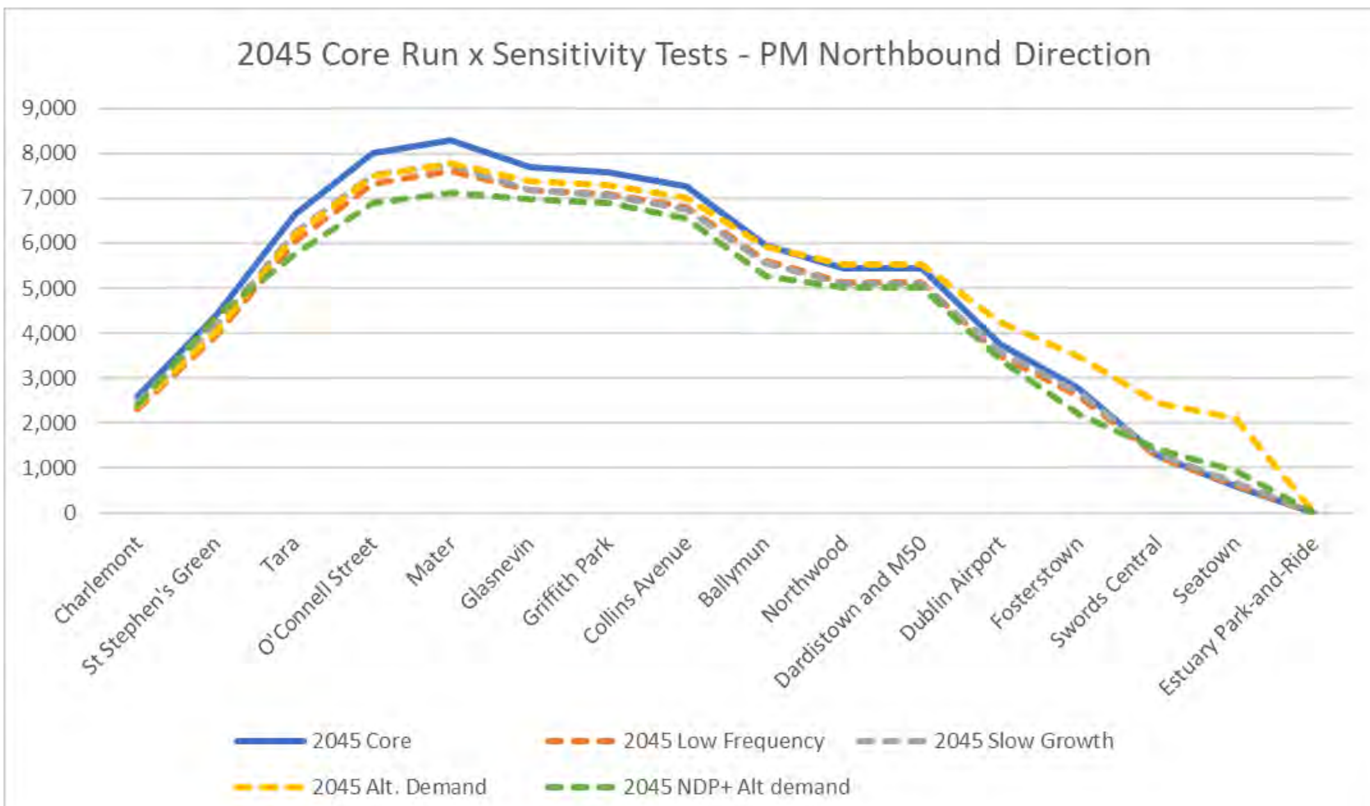
LT Peak Period					
Boarding- Northbound Direction	**2045 Business Case**	**2045 Low Frequency**	**2045 Slow Growth**	**2045 Alternative Demand**	**2045 NDP + Alternative Demand**
Estuary Park-and-Ride	1,297	1,202	1,182	1,163	1,059
Seatown	1,798	1,670	1,649	1,561	1,833
Swords Central	2,976	2,770	2,693	2,533	2,765
Fosterstown	3,856	3,604	3,460	3,298	3,409
Dublin Airport	4,045	3,793	3,627	3,472	3,595
Dardistown and M50	4,137	3,891	3,691	3,567	3,963
Northwood	4,100	3,861	3,656	3,535	3,940
Ballymun	3,990	3,772	3,542	3,435	3,898
Collins Avenue	3,813	3,617	3,372	3,274	3,736
Griffith Park	3,751	3,566	3,311	3,219	3,690
Glasnevin	3,751	3,566	3,311	3,219	3,690
Mater	1,347	1,235	1,242	1,049	1,231
O'Connell Street	1,182	1,091	1,093	886	951
Tara	889	821	837	608	666
St Stephen's Green	662	609	636	377	455
Charlemont	0	0	0	0	0



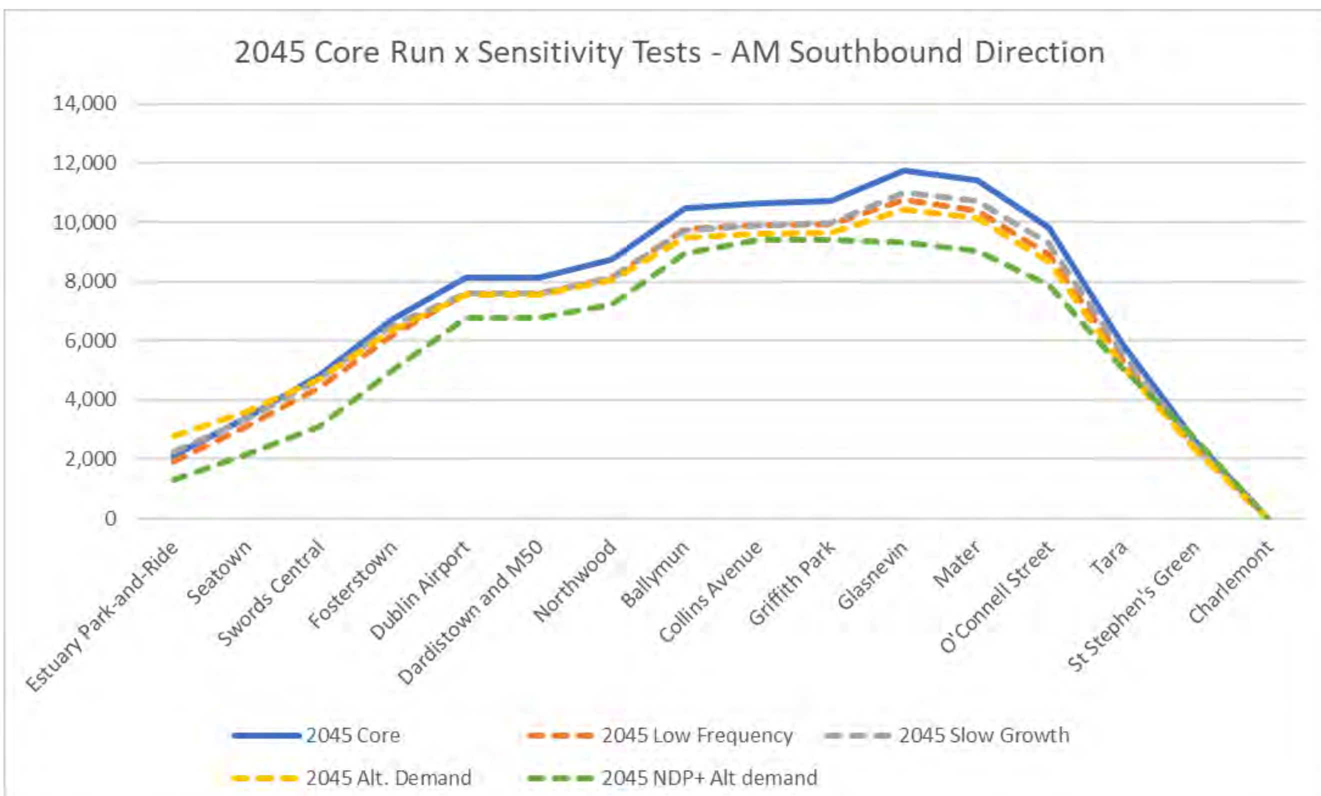
SR Peak Period					
Boarding -Northbound Direction	**2045 Business Case**	**2045 Low Frequency**	**2045 Slow Growth**	**2045 Alternative Demand**	**2045 NDP + Alternative Demand**
Charlemont	1,445	1,327	1,332	1,267	1,200
St Stephen's Green	2,369	2,142	2,209	1,939	2,276
Tara	3,915	3,535	3,644	3,130	3,358
O'Connell Street	5,000	4,536	4,620	4,013	4,119
Mater	5,234	4,763	4,829	4,209	4,327
Glasnevin	5,242	4,788	4,828	4,221	4,557
Griffith Park	5,258	4,806	4,842	4,234	4,575
Collins Avenue	5,284	4,850	4,891	4,213	4,589
Ballymun	4,921	4,520	4,534	3,891	4,200
Northwood	4,771	4,386	4,393	3,757	4,104
Dardistown and M50	4,771	4,386	4,393	3,757	4,104
Dublin Airport	2,781	2,464	2,611	1,864	1,967
Fosterstown	2,461	2,164	2,324	1,577	1,466
Swords Central	1,968	1,695	1,881	1,136	1,128
Seatown	1,737	1,468	1,675	911	927
Estuary Park-and-Ride	0	0	0	0	0



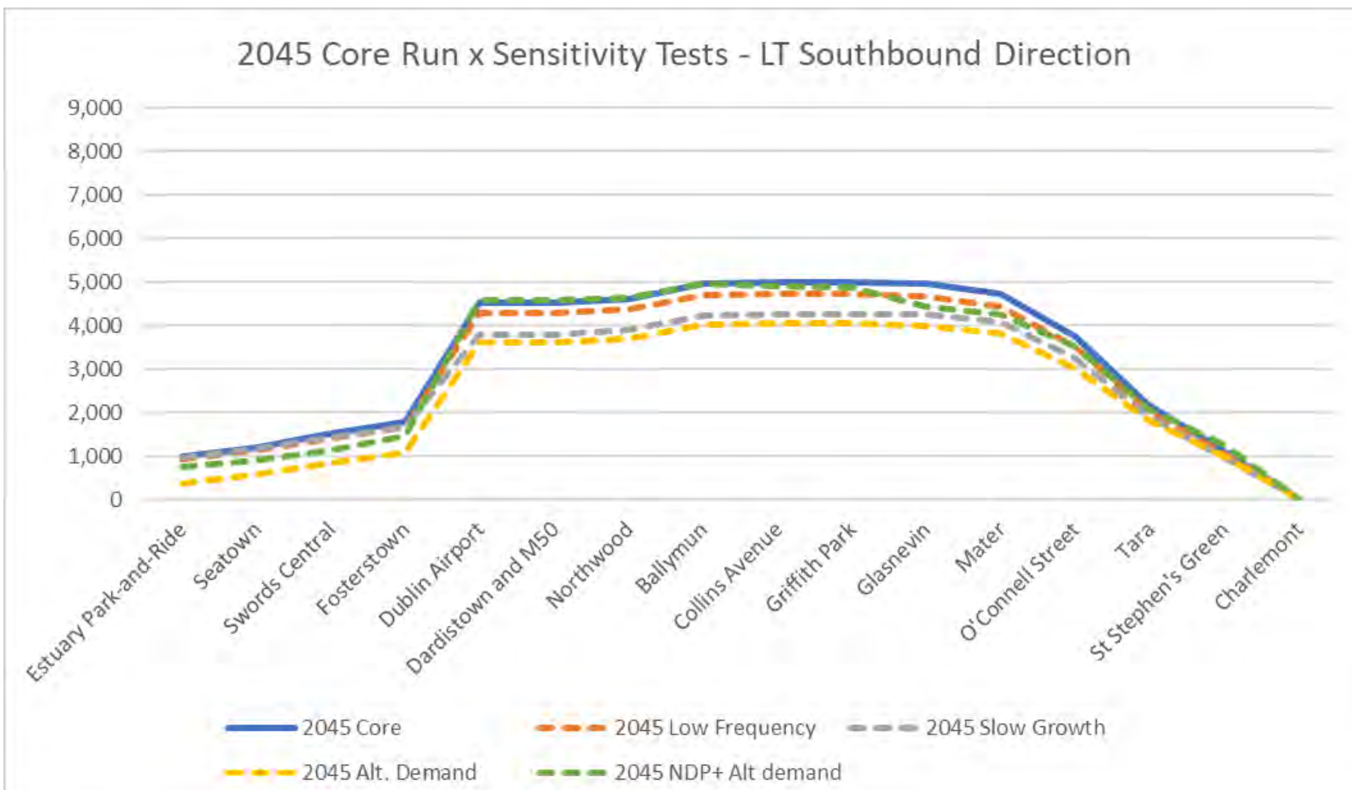
PM Peak Period					
Boarding -Northbound Direction	**2045 Business Case**	**2045 Low Frequency**	**2045 Slow Growth**	**2045 Alternative Demand**	**2045 NDP+ Alternative Demand**
Charlemont	2,606	2,321	2,451	2,374	2,388
St Stephen's Green	4,428	3,968	4,192	4,047	4,392
Tara	6,630	6,041	6,240	6,179	5,743
O'Connell Street	8,008	7,330	7,510	7,503	6,892
Mater	8,280	7,617	7,758	7,764	7,134
Glasnevin	7,695	7,194	7,183	7,378	6,974
Griffith Park	7,582	7,097	7,071	7,291	6,902
Collins Avenue	7,255	6,821	6,764	7,016	6,559
Ballymun	5,959	5,604	5,560	5,933	5,270
Northwood	5,456	5,139	5,090	5,527	5,005
Dardistown and M50	5,456	5,139	5,090	5,527	5,005
Dublin Airport	3,762	3,507	3,583	4,260	3,433
Fosterstown	2,775	2,597	2,674	3,490	2,203
Swords Central	1,293	1,249	1,312	2,444	1,425
Seatown	600	615	693	2,105	953
Estuary Park-and-Ride	0	0	0	0	0



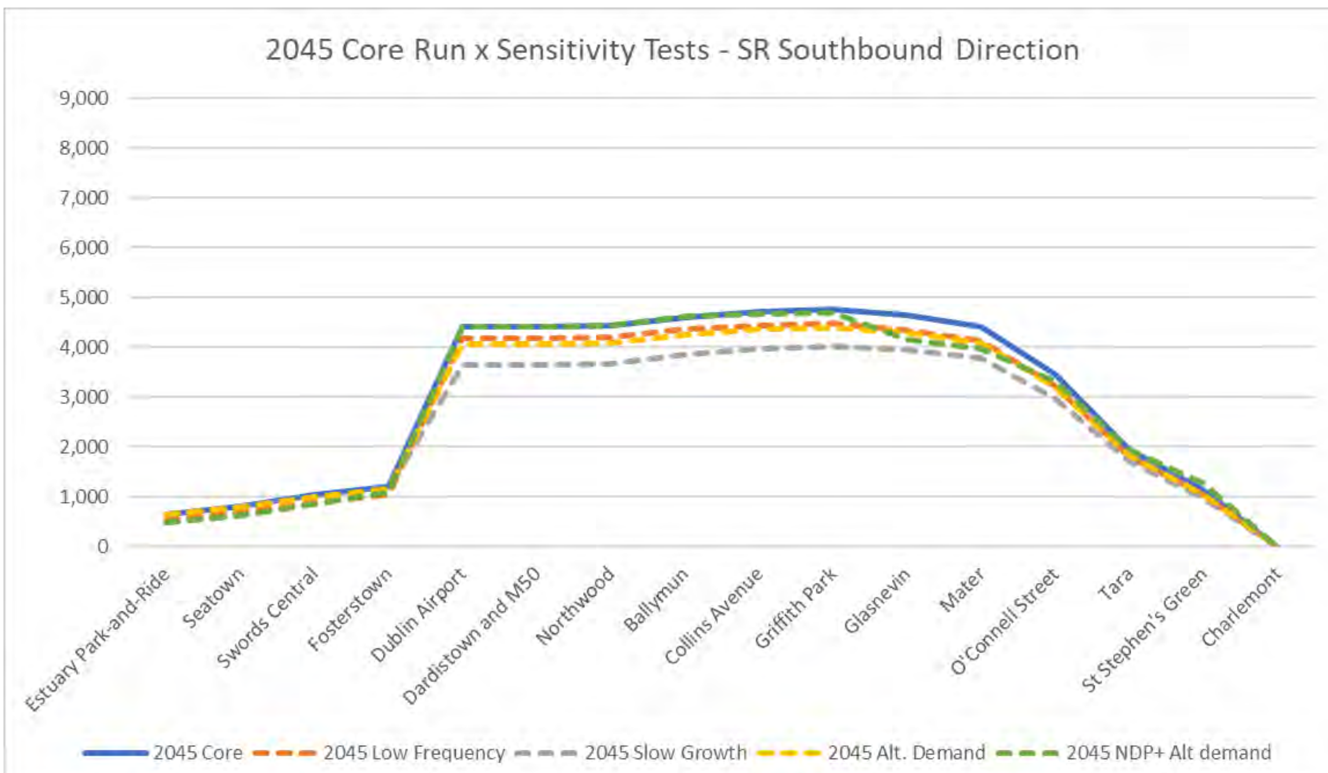
AM Peak Period					
Boarding -Southbound Direction	2045 Business Case	2045 Low Frequency	2045 Slow Growth	2045 Alternative Demand	2045 NDP + Alternative Demand
Estuary Park-and-Ride	2,138	1,927	2,234	2,782	1,314
Seatown	3,390	3,100	3,377	3,612	2,145
Swords Central	4,828	4,413	4,731	4,713	3,101
Fosterstown	6,749	6,213	6,535	6,363	4,987
Dublin Airport	8,146	7,582	7,580	7,544	6,764
Dardistown and M50	8,146	7,582	7,580	7,544	6,764
Northwood	8,751	8,140	8,143	8,030	7,225
Ballymun	10,472	9,755	9,734	9,467	8,962
Collins Avenue	10,649	9,885	9,895	9,630	9,417
Griffith Park	10,709	9,936	9,963	9,668	9,399
Glasnevin	11,765	10,760	11,028	10,450	9,329
Mater	11,428	10,411	10,740	10,136	9,014
O'Connell Street	9,817	8,905	9,280	8,674	7,873
Tara	5,907	5,356	5,581	5,182	5,093
St Stephen's Green	2,617	2,378	2,440	2,341	2,706
Charlemont	0	0	0	0	0



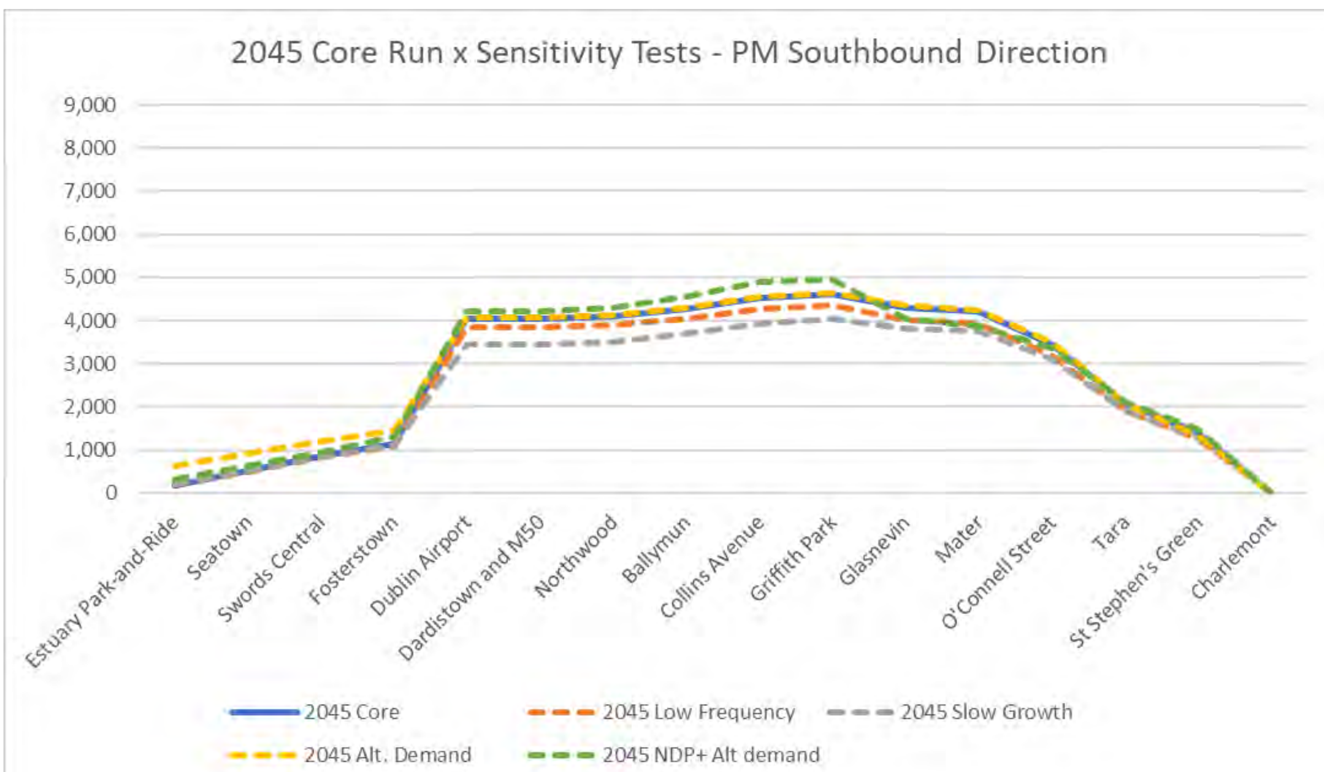
LT Peak Period					
Boarding -Southbound Direction	**2045 Business Case**	**2045 Low Frequency**	**2045 Slow Growth**	**2045 Alternative Demand**	**2045 NDP + Alternative Demand**
Estuary Park-and-Ride	994	934	969	381	740
Seatown	1,199	1,127	1,155	578	894
Swords Central	1,504	1,409	1,430	848	1,141
Fosterstown	1,771	1,653	1,676	1,086	1,453
Dublin Airport	4,513	4,293	3,797	3,619	4,584
Dardistown and M50	4,513	4,293	3,797	3,619	4,584
Northwood	4,610	4,377	3,892	3,699	4,647
Ballymun	4,957	4,693	4,215	4,006	4,961
Collins Avenue	4,990	4,713	4,260	4,038	4,906
Griffith Park	4,994	4,715	4,268	4,040	4,881
Glasnevin	4,952	4,662	4,261	3,991	4,437
Mater	4,717	4,429	4,066	3,802	4,243
O'Connell Street	3,744	3,510	3,249	3,007	3,531
Tara	2,166	2,024	1,898	1,798	2,064
St Stephen's Green	1,112	1,034	967	993	1,249
Charlemont	0	0	0	0	0



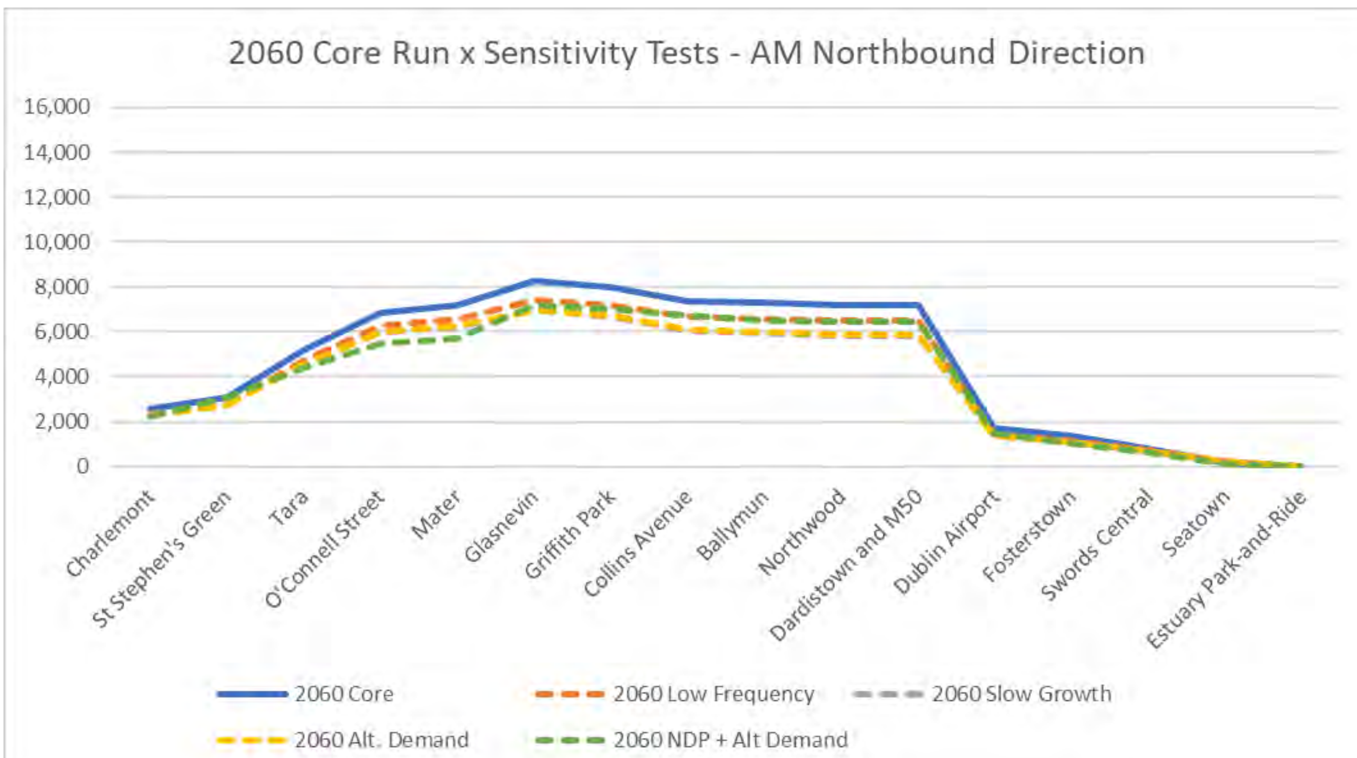
SR Peak Period					
Boarding -Southbound Direction	**2045 Business Case**	**2045 Low Frequency**	**2045 Slow Growth**	**2045 Alternative Demand**	**2045 NDP + Alternative Demand**
Estuary Park-and-Ride	647	524	651	657	476
Seatown	817	683	804	792	630
Swords Central	1,034	887	1,000	989	846
Fosterstown	1,203	1,043	1,154	1,150	1,092
Dublin Airport	4,409	4,188	3,639	4,057	4,415
Dardistown and M50	4,409	4,188	3,639	4,057	4,415
Northwood	4,436	4,207	3,674	4,086	4,445
Ballymun	4,611	4,365	3,846	4,260	4,624
Collins Avenue	4,714	4,446	3,971	4,359	4,679
Griffith Park	4,756	4,481	4,017	4,398	4,692
Glasnevin	4,638	4,353	3,949	4,294	4,156
Mater	4,426	4,142	3,780	4,098	3,983
O'Connell Street	3,471	3,226	2,981	3,208	3,311
Tara	1,947	1,807	1,707	1,823	1,949
St Stephen's Green	1,124	1,046	978	1,047	1,270
Charlemont	0	0	0	0	0



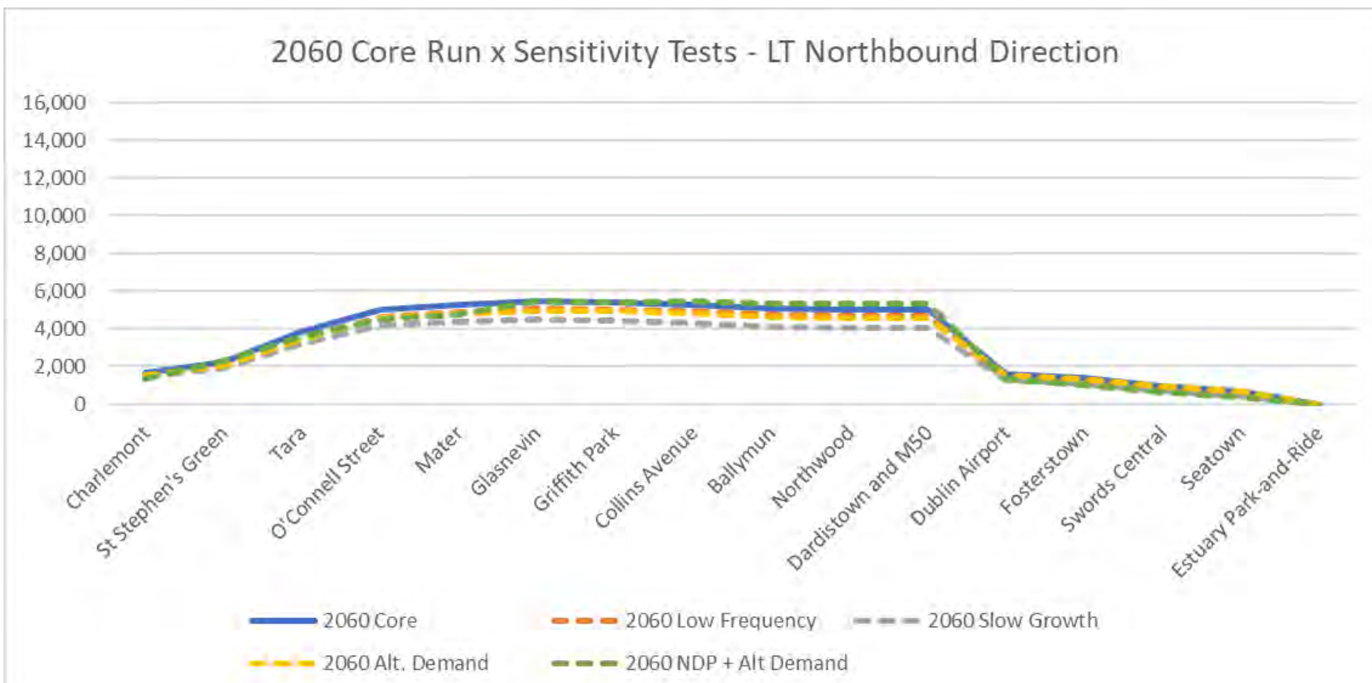
PM Peak Period					
Boarding -Southbound Direction	**2045 Business Case**	**2045 Low Frequency**	**2045 Slow Growth**	**2045 Alternative Demand**	**2045 NDP + Alternative Demand**
Estuary Park-and-Ride	192	198	220	648	328
Seatown	530	507	535	917	631
Swords Central	871	824	847	1,214	958
Fosterstown	1,148	1,080	1,109	1,467	1,306
Dublin Airport	4,040	3,851	3,445	4,084	4,214
Dardistown and M50	4,040	3,851	3,445	4,084	4,214
Northwood	4,093	3,892	3,508	4,133	4,305
Ballymun	4,279	4,056	3,692	4,314	4,551
Collins Avenue	4,517	4,263	3,944	4,548	4,890
Griffith Park	4,619	4,354	4,049	4,645	4,941
Glasnevin	4,295	4,022	3,809	4,346	4,053
Mater	4,218	3,922	3,751	4,254	3,877
O'Connell Street	3,457	3,185	3,099	3,502	3,359
Tara	2,080	1,902	1,918	2,087	2,100
St Stephen's Green	1,401	1,254	1,287	1,336	1,486
Charlemont	0	0	0	0	0



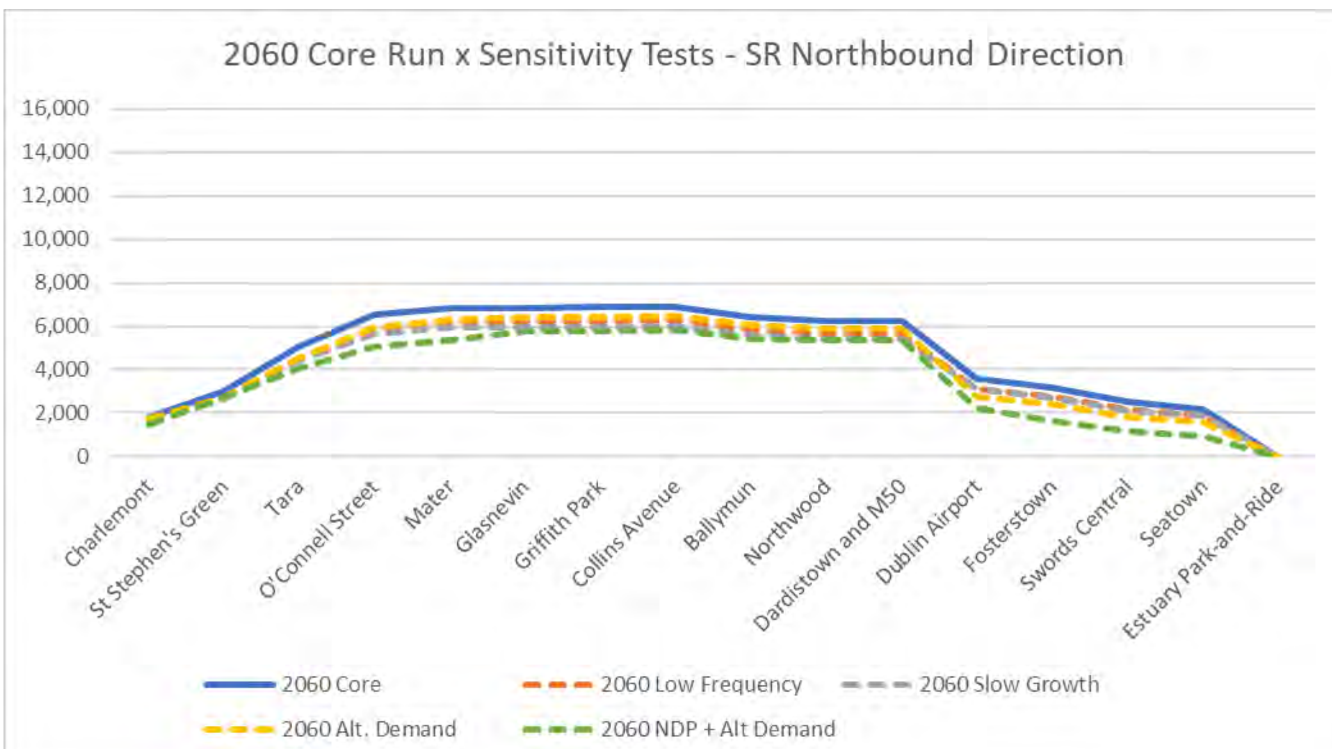
AM Peak Period					
Boarding -Northbound Direction	**2060 Business Case**	**2060 Low Frequency**	**2060 Slow Growth**	**2060 Alternative Demand**	**2060 NDP + Alternative Demand**
Charlemont	2,560	2,264	2,337	2,284	2,254
St Stephen's Green	3,069	2,762	2,805	2,757	3,092
Tara	5,169	4,721	4,575	4,573	4,369
O'Connell Street	6,869	6,250	5,966	5,969	5,494
Mater	7,187	6,560	6,245	6,264	5,701
Glasnevin	8,243	7,429	6,950	6,958	7,200
Griffith Park	7,998	7,208	6,700	6,719	7,038
Collins Avenue	7,375	6,663	6,060	6,108	6,704
Ballymun	7,274	6,561	5,915	5,974	6,524
Northwood	7,190	6,486	5,800	5,869	6,454
Dardistown and M50	7,190	6,486	5,800	5,869	6,454
Dublin Airport	1,724	1,459	1,396	1,383	1,470
Fosterstown	1,358	1,146	1,091	1,085	1,047
Swords Central	822	721	709	707	624
Seatown	201	211	224	219	125
Estuary Park-and-Ride	0	0	0	0	0



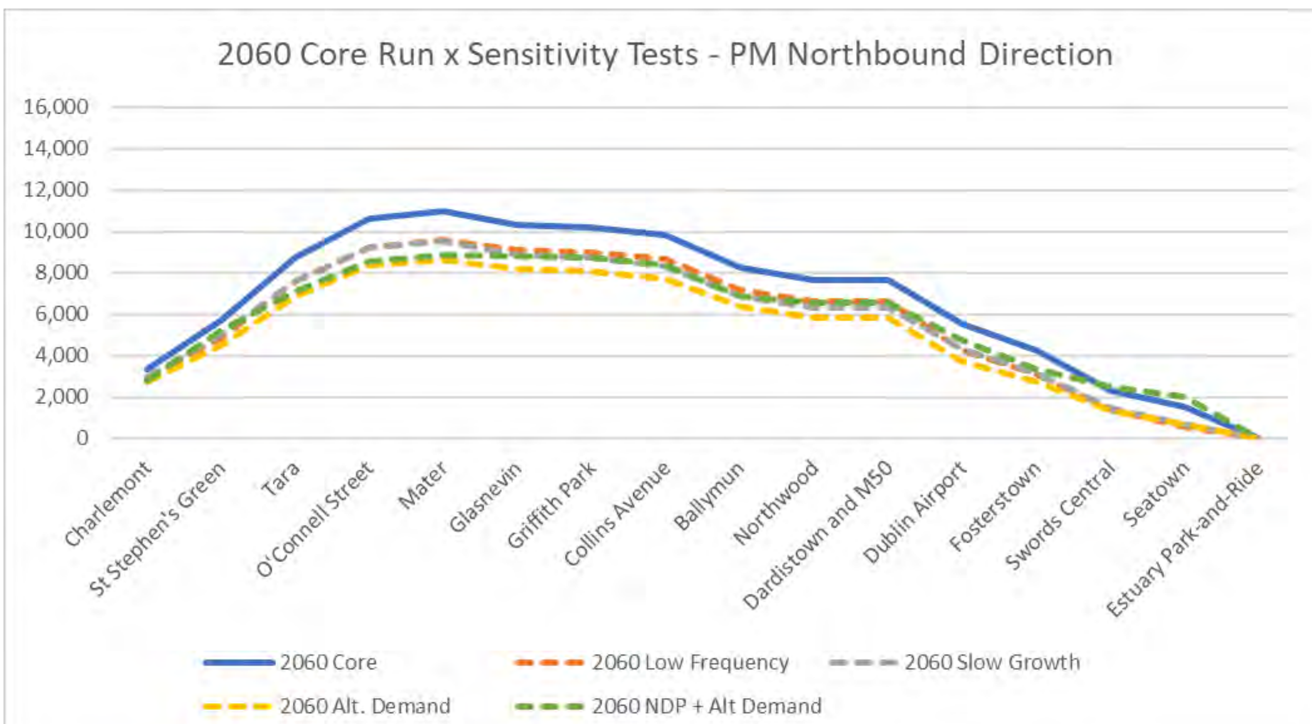
LT Peak Period					
Boarding-Northbound Direction	2060 Business Case	2060 Low Frequency	2060 Slow Growth	2060 Alternative Demand	2060 NDP + Alternative Demand
Estuary Park-and-Ride	1,663	1,539	1,449	1,517	1,348
Seatown	2,254	2,057	1,927	2,076	2,309
Swords Central	3,843	3,504	3,198	3,508	3,600
Fosterstown	5,056	4,664	4,187	4,600	4,504
Dublin Airport	5,303	4,912	4,394	4,828	4,764
Dardistown and M50	5,454	5,080	4,502	4,967	5,456
Northwood	5,415	5,050	4,462	4,934	5,443
Ballymun	5,295	4,955	4,340	4,824	5,480
Collins Avenue	5,088	4,774	4,142	4,633	5,360
Griffith Park	5,022	4,721	4,075	4,573	5,336
Glasnevin	5,022	4,721	4,075	4,573	5,336
Mater	1,610	1,370	1,294	1,538	1,353
O'Connell Street	1,394	1,173	1,093	1,348	1,023
Tara	981	776	735	990	656
St Stephen's Green	678	478	460	719	396
Charlemont	0	0	0	0	0



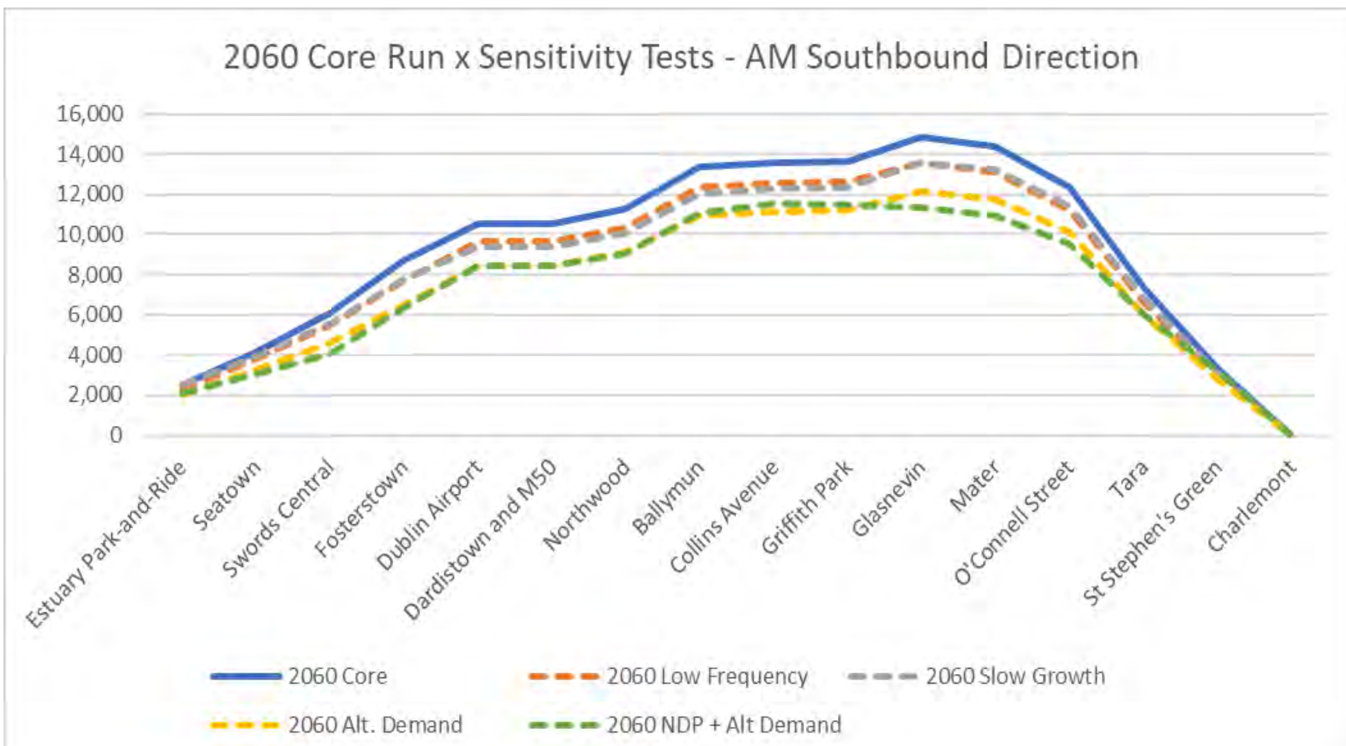
SR Peak Period					
Boarding -Northbound Direction	**2060 Business Case**	**2060 Low Frequency**	**2060 Slow Growth**	**2060 Alternative Demand**	**2060 NDP + Alternative Demand**
Charlemont	1,830	1,684	1,654	1,746	1,480
St Stephen's Green	2,976	2,695	2,660	2,707	2,729
Tara	5,042	4,530	4,400	4,553	4,065
O'Connell Street	6,510	5,867	5,642	5,945	5,041
Mater	6,821	6,165	5,915	6,281	5,324
Glasnevin	6,838	6,211	5,941	6,403	5,750
Griffith Park	6,869	6,239	5,965	6,437	5,783
Collins Avenue	6,905	6,270	6,005	6,459	5,853
Ballymun	6,438	5,838	5,563	6,052	5,424
Northwood	6,235	5,659	5,386	5,904	5,325
Dardistown and M50	6,235	5,659	5,386	5,904	5,325
Dublin Airport	3,587	3,134	3,102	2,755	2,239
Fosterstown	3,152	2,732	2,711	2,389	1,623
Swords Central	2,519	2,156	2,132	1,838	1,175
Seatown	2,192	1,866	1,856	1,578	914
Estuary Park-and-Ride	0	0	0	0	0



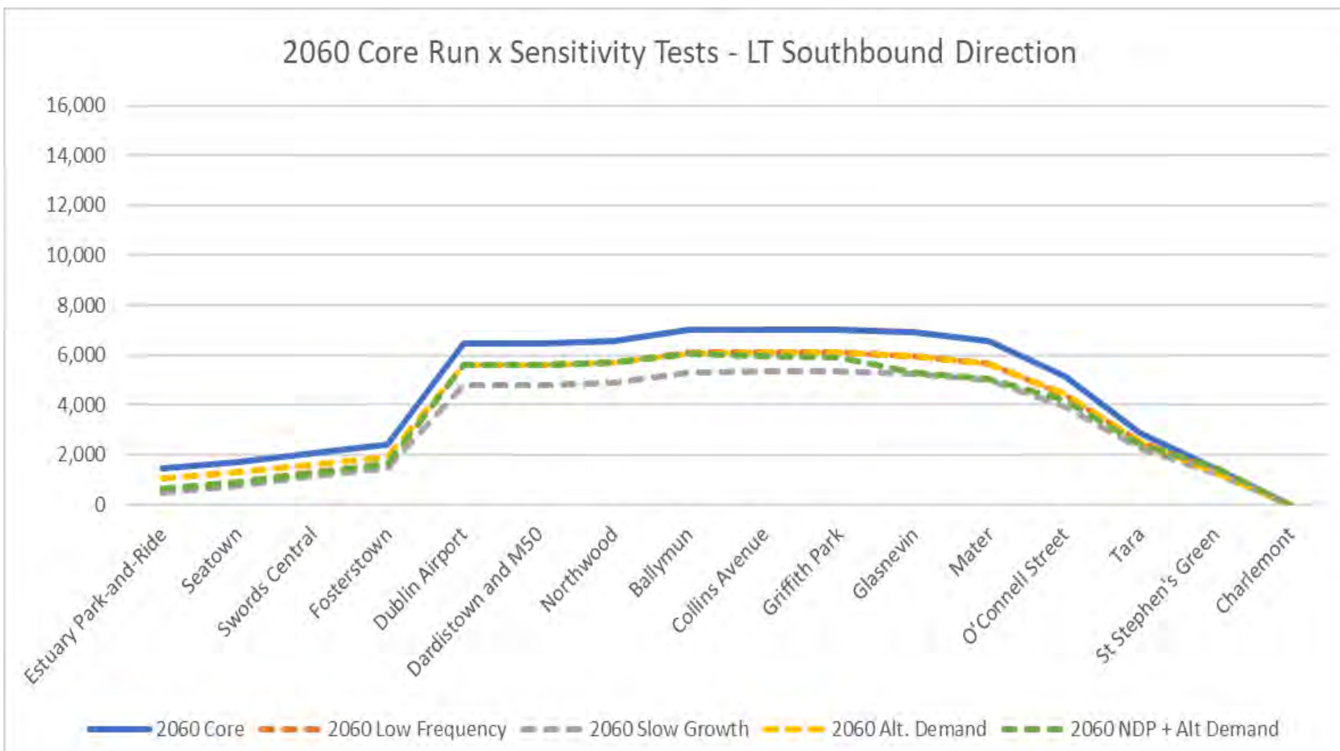
PM Peak Period					
Boarding -Northbound Direction	**2060 Business Case**	**2060 Low Frequency**	**2060 Slow Growth**	**2060 Alternative Demand**	**2060 NDP + Alternative Demand**
Charlemont	3,340	2,907	2,978	2,743	2,812
St Stephen's Green	5,689	4,888	5,034	4,496	5,253
Tara	8,751	7,572	7,616	6,844	7,102
O'Connell Street	10,641	9,247	9,212	8,350	8,587
Mater	11,006	9,615	9,518	8,647	8,890
Glasnevin	10,303	9,091	8,841	8,174	8,786
Griffith Park	10,192	8,993	8,723	8,081	8,716
Collins Avenue	9,830	8,664	8,343	7,731	8,379
Ballymun	8,246	7,165	6,868	6,377	6,884
Northwood	7,653	6,603	6,298	5,863	6,570
Dardistown and M50	7,653	6,603	6,298	5,863	6,570
Dublin Airport	5,528	4,264	4,300	3,719	4,752
Fosterstown	4,249	3,094	3,143	2,768	3,362
Swords Central	2,350	1,410	1,466	1,357	2,494
Seatown	1,508	553	653	699	1,994
Estuary Park-and-Ride	0	0	0	0	0



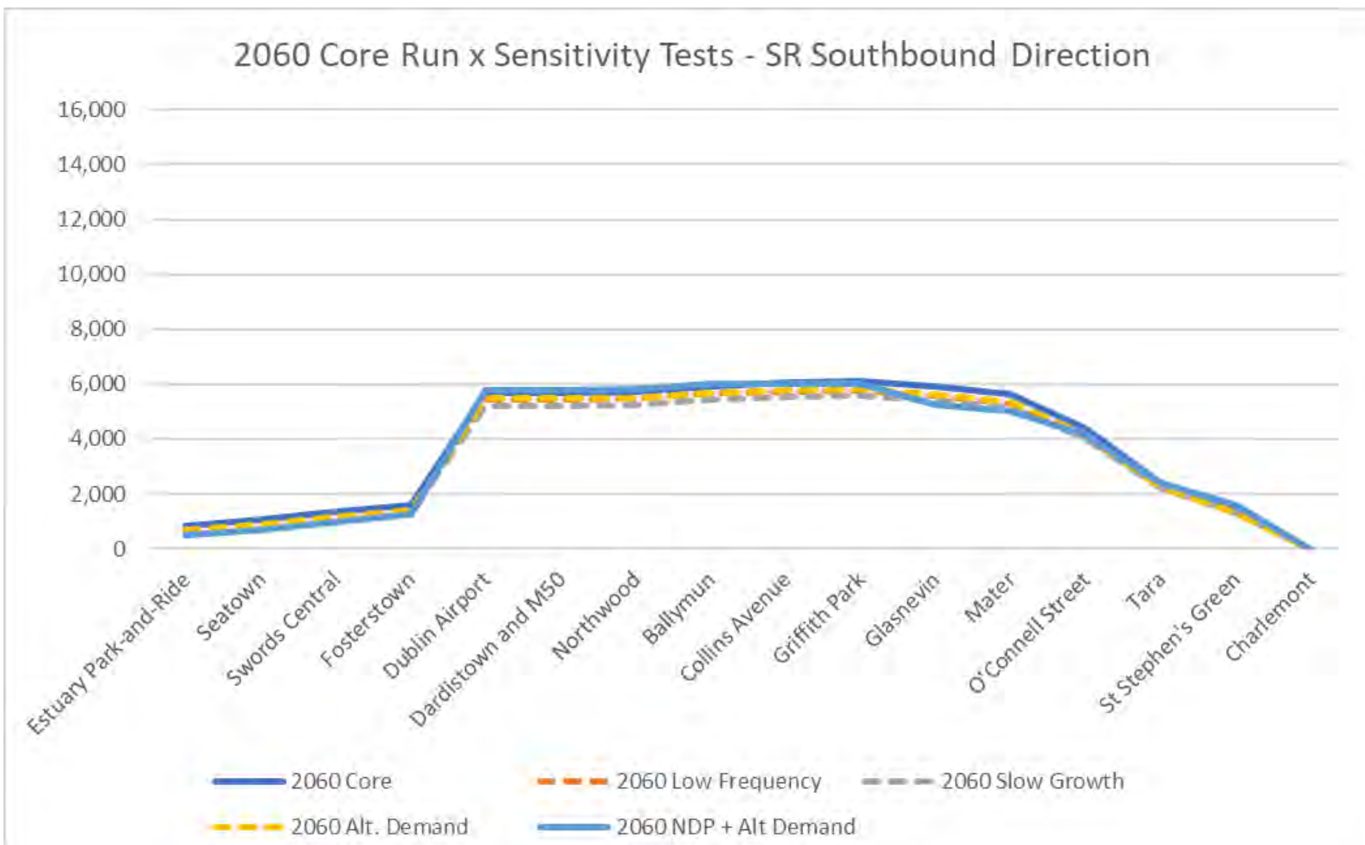
AM Peak Period					
Boarding -Southbound Direction	**2060 Business Case**	**2060 Low Frequency**	**2060 Slow Growth**	**2060 Alternative Demand**	**2060 NDP + Alternative Demand**
Estuary Park-and-Ride	2,503	2,330	2,518	2,031	2,096
Seatown	4,105	3,761	3,934	3,213	3,020
Swords Central	6,086	5,501	5,557	4,583	4,085
Fosterstown	8,678	7,727	7,782	6,486	6,367
Dublin Airport	10,520	9,655	9,372	8,456	8,461
Dardistown and M50	10,520	9,655	9,372	8,456	8,461
Northwood	11,259	10,354	10,073	9,093	9,018
Ballymun	13,398	12,379	12,044	10,909	11,044
Collins Avenue	13,574	12,549	12,271	11,144	11,523
Griffith Park	13,628	12,605	12,336	11,179	11,488
Glasnevin	14,859	13,581	13,560	12,123	11,376
Mater	14,398	13,132	13,206	11,771	10,965
O'Connell Street	12,350	11,235	11,394	10,114	9,541
Tara	7,334	6,614	6,793	6,001	6,039
St Stephen's Green	3,333	2,986	3,023	2,788	3,194
Charlemont	0	0	0	0	0



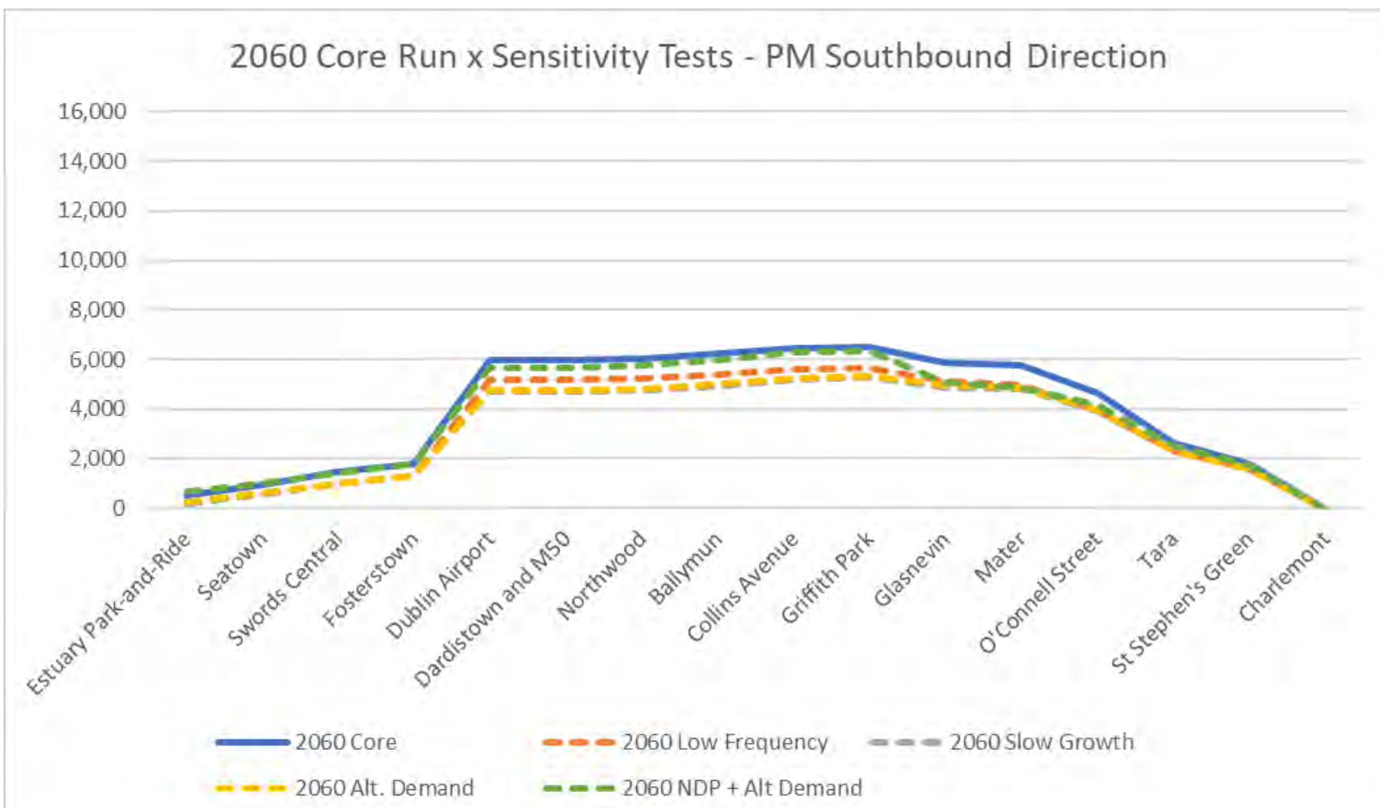
LT Peak Period					
Boarding -Southbound Direction	**2060 Business Case**	**2060 Low Frequency**	**2060 Slow Growth**	**2060 Alternative Demand**	**2060 NDP + Alternative Demand**
Estuary Park-and-Ride	1,438	614	503	1,071	663
Seatown	1,688	879	754	1,287	875
Swords Central	2,076	1,275	1,124	1,616	1,241
Fosterstown	2,402	1,605	1,440	1,884	1,633
Dublin Airport	6,459	5,618	4,788	5,583	5,615
Dardistown and M50	6,459	5,618	4,788	5,583	5,615
Northwood	6,575	5,716	4,898	5,679	5,689
Ballymun	7,011	6,118	5,293	6,069	6,049
Collins Avenue	7,024	6,119	5,324	6,090	5,950
Griffith Park	7,023	6,114	5,327	6,089	5,918
Glasnevin	6,897	5,966	5,256	5,972	5,303
Mater	6,555	5,637	4,990	5,668	5,050
O'Connell Street	5,167	4,397	3,926	4,455	4,202
Tara	2,869	2,491	2,268	2,524	2,431
St Stephen's Green	1,467	1,337	1,246	1,323	1,516
Charlemont	0	0	0	0	0



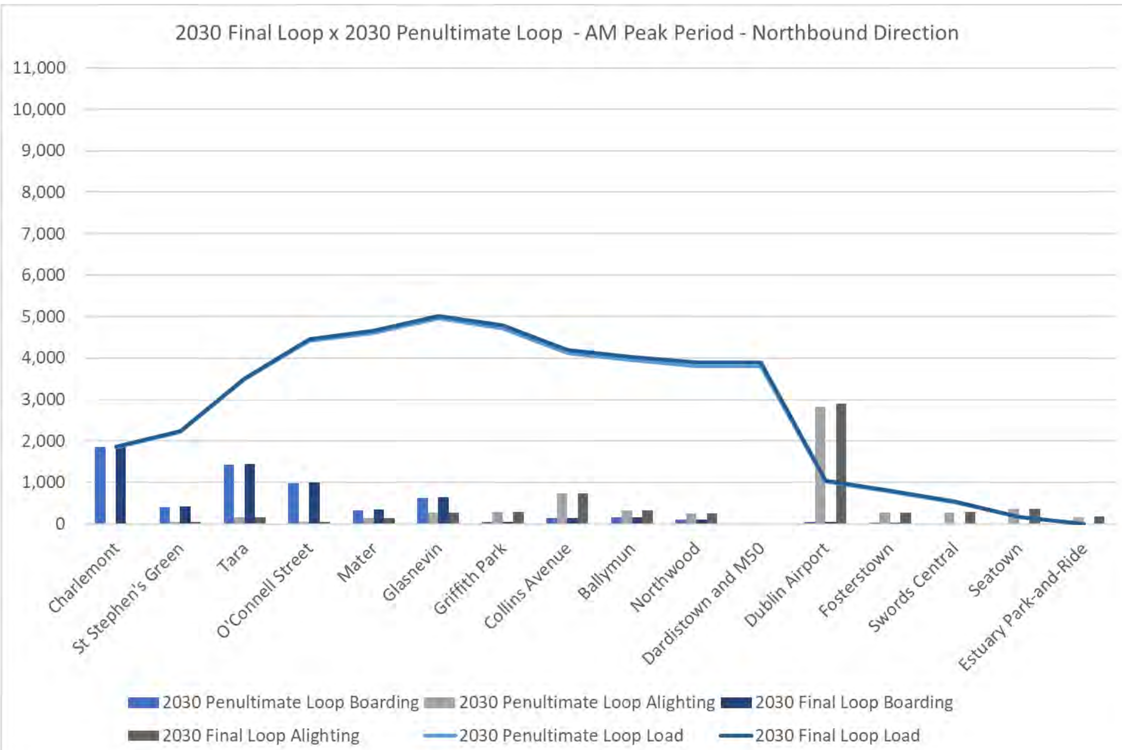
SR Peak Period					
Boarding -Southbound Direction	**2060 Business Case**	**2060 Low Frequency**	**2060 Slow Growth**	**2060 Alternative Demand**	**3060 NDP + Alternative Demand**
Estuary Park-and-Ride	857	567	706	674	513
Seatown	1,074	773	901	890	702
Swords Central	1,356	1,042	1,155	1,188	975
Fosterstown	1,574	1,245	1,349	1,388	1,271
Dublin Airport	5,679	5,450	5,225	5,488	5,798
Dardistown and M50	5,679	5,450	5,225	5,488	5,798
Northwood	5,713	5,471	5,249	5,506	5,826
Ballymun	5,937	5,668	5,444	5,703	6,009
Collins Avenue	6,060	5,740	5,535	5,770	6,024
Griffith Park	6,103	5,773	5,577	5,805	6,028
Glasnevin	5,936	5,586	5,420	5,618	5,231
Mater	5,651	5,322	5,160	5,336	5,002
O'Connell Street	4,402	4,121	4,032	4,153	4,149
Tara	2,417	2,240	2,216	2,266	2,388
St Stephen's Green	1,412	1,318	1,291	1,327	1,572
Charlemont	0	0	0	0	0

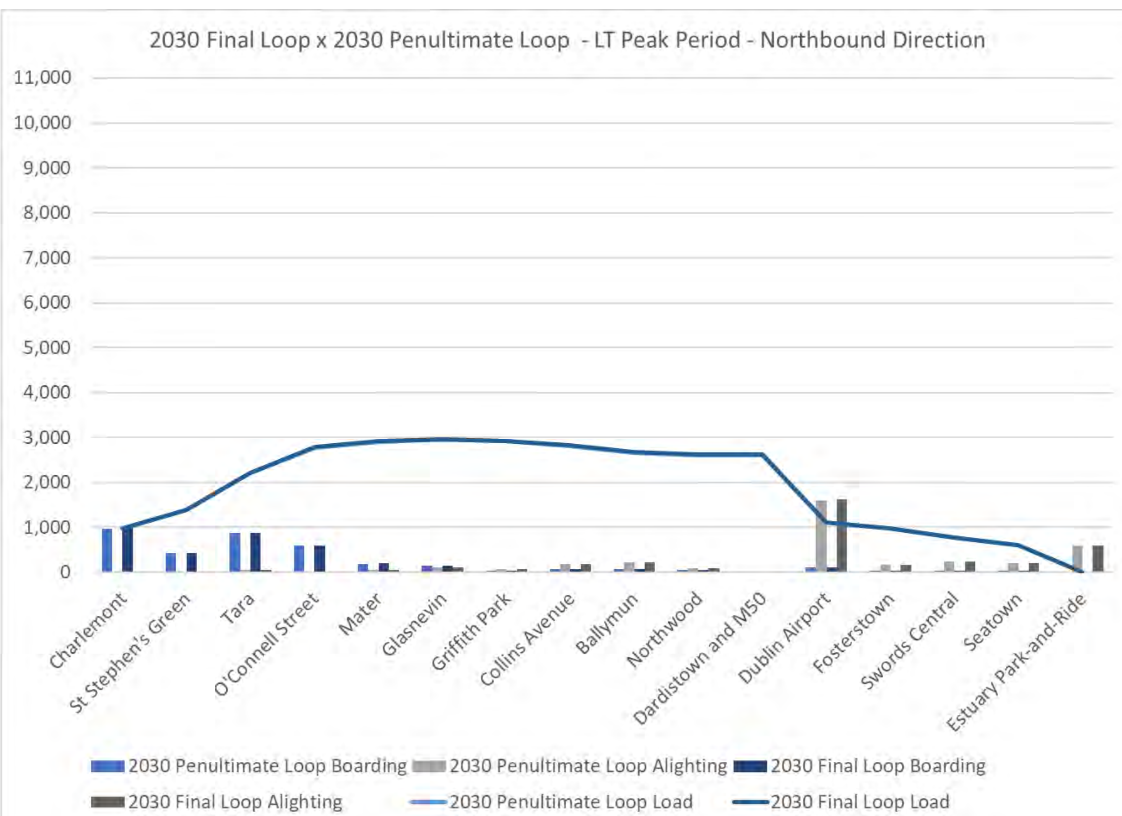


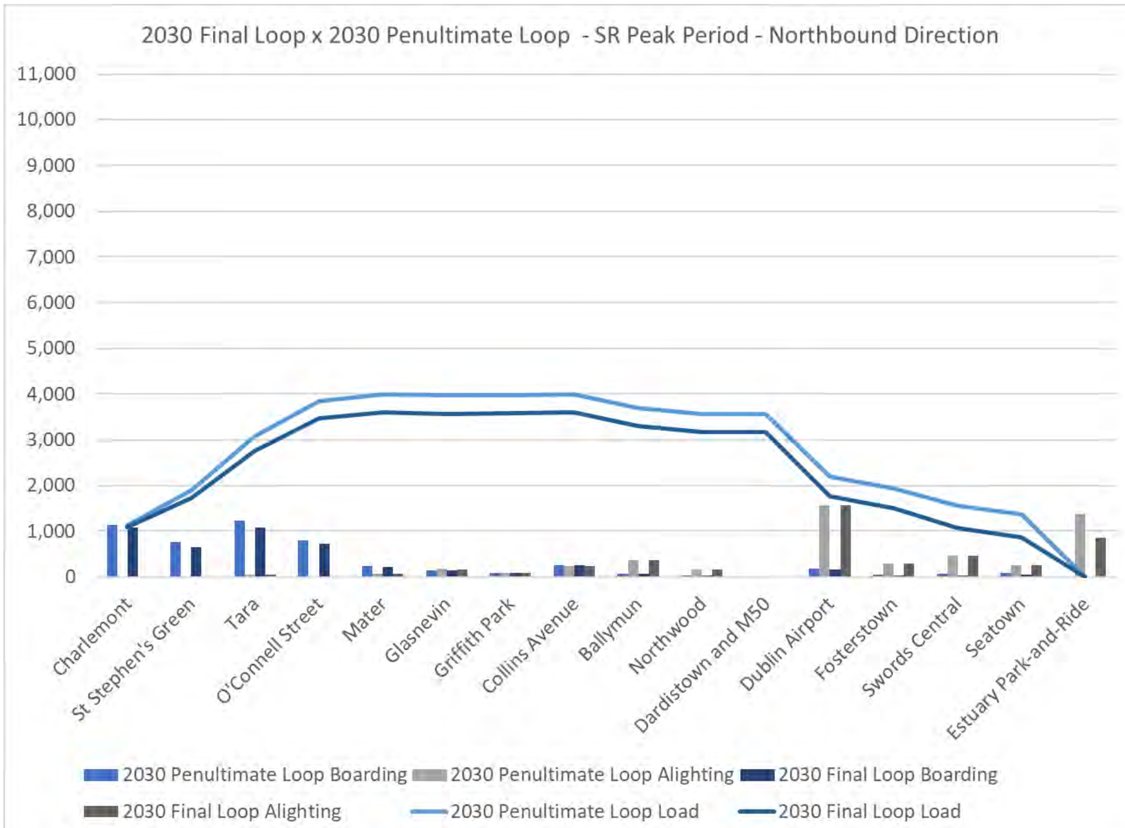
PM Peak Period					
Boarding - Southbound Direction	**2060 Business Case**	**2060 Low Frequency**	**2060 Slow Growth**	**2060 Alternative Demand**	**2060 NDP + Alternative Demand**
Estuary Park-and-Ride	530	182	209	231	659
Seatown	956	573	580	603	989
Swords Central	1,446	1,007	975	1,003	1,384
Fosterstown	1,786	1,320	1,285	1,310	1,778
Dublin Airport	5,990	5,199	4,682	4,771	5,660
Dardistown and M50	5,990	5,199	4,682	4,771	5,660
Northwood	6,026	5,226	4,733	4,821	5,744
Ballymun	6,221	5,401	4,934	5,028	5,990
Collins Avenue	6,433	5,590	5,171	5,249	6,289
Griffith Park	6,529	5,674	5,273	5,345	6,329
Glasnevin	5,880	5,111	4,868	4,942	5,069
Mater	5,758	4,979	4,784	4,838	4,844
O'Connell Street	4,634	3,951	3,895	3,934	4,171
Tara	2,652	2,294	2,318	2,324	2,524
St Stephen's Green	1,801	1,553	1,588	1,558	1,751
Charlemont	0	0	0	0	0

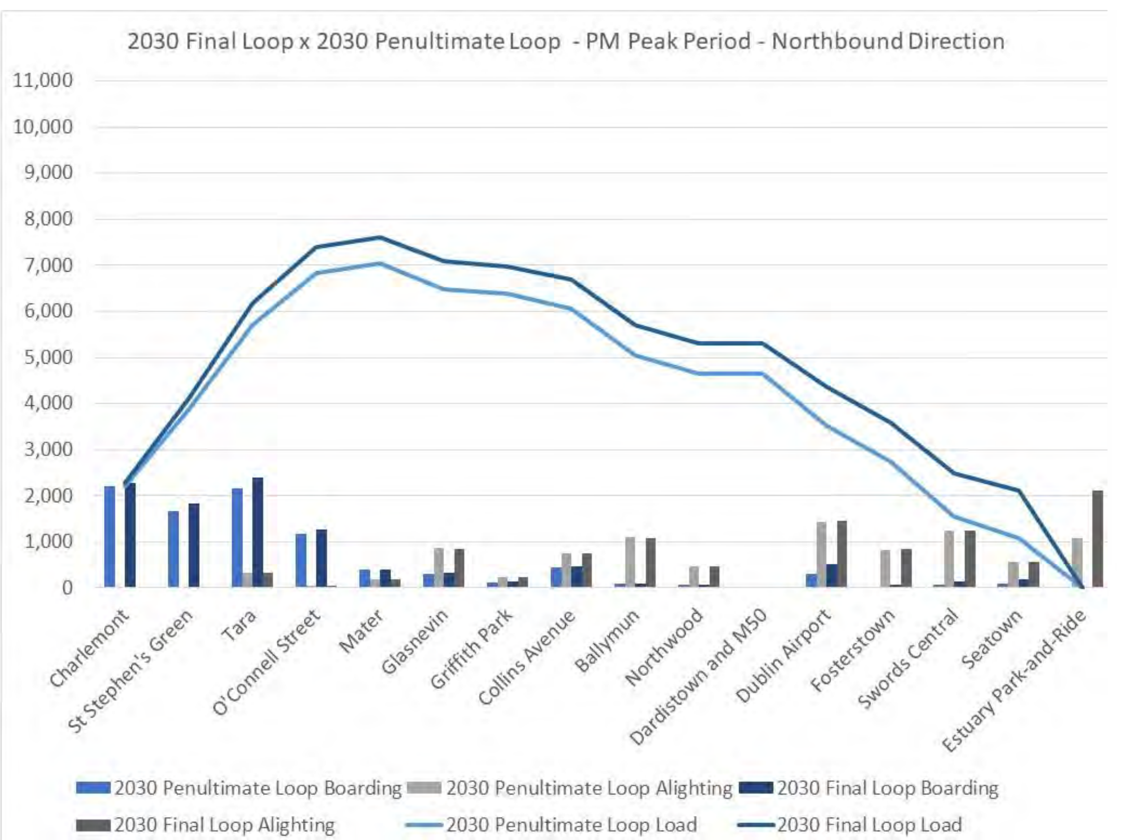


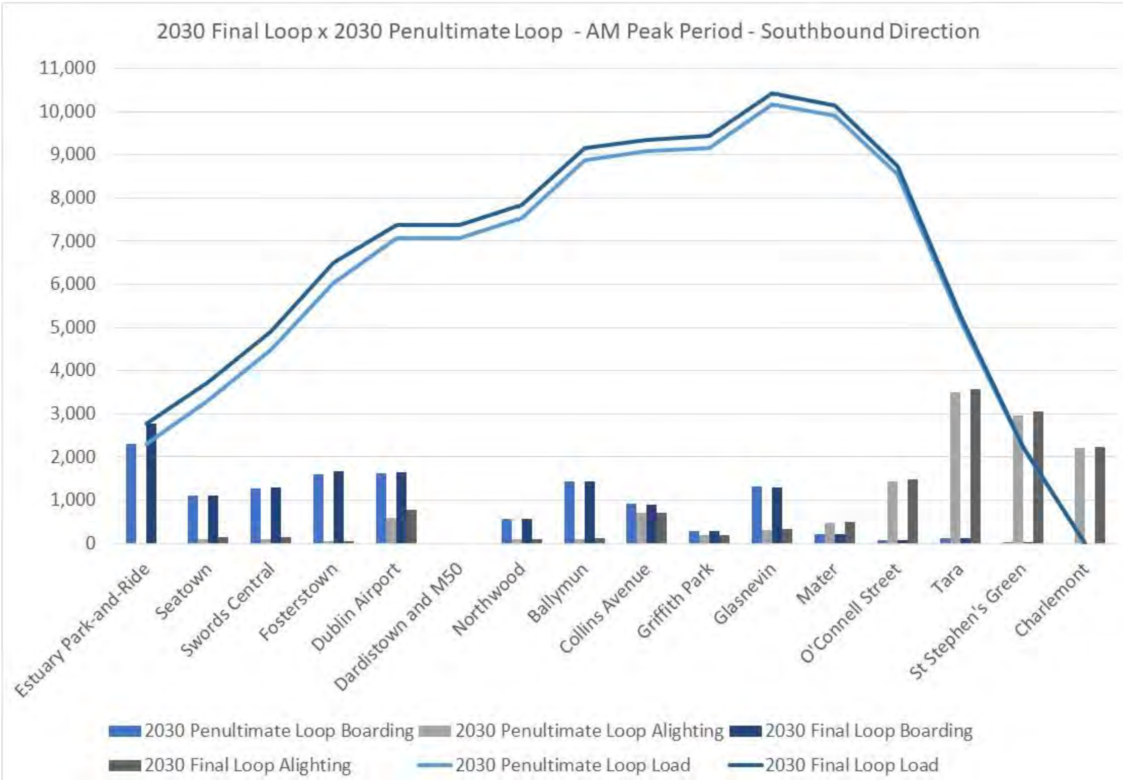
Appendix C. Model Assessment: Penultimate Loop Analysis

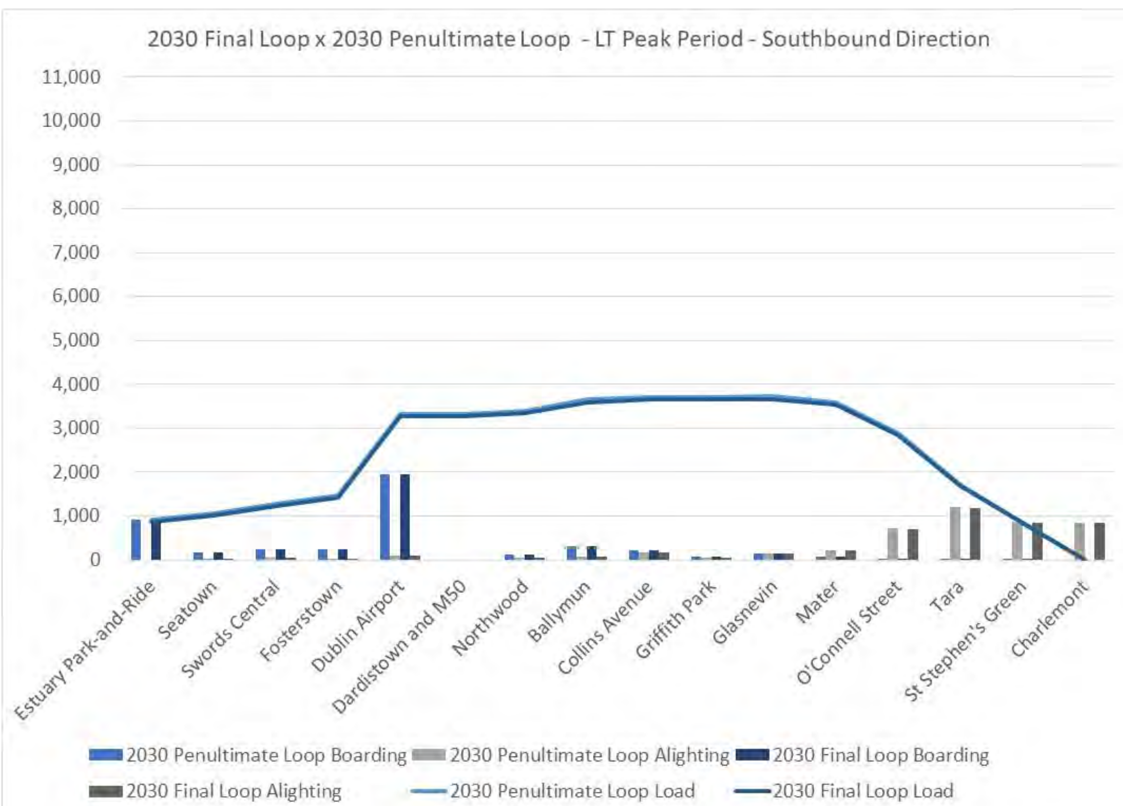





2030 Final Loop x 2030 Penultimate Loop - SR Peak Period - Northbound Direction
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Charlemont
St Stephen's Green
Tara
O'Connell Street
Mater
Glasnevin
Griffith Park
Collins Avenue
Ballymun
Northwood
Dardistown and M50
Dublin Airport
Fosterstown
Swords Central
Seatown
Estuary Park-and-Ride
2030 Penultimate Loop Boarding
2030 Penultimate Loop Alighting
2030 Final Loop Boarding
2030 Final Loop Alighting
2030 Penultimate Loop Load
2030 Final Loop Load


2030 Final Loop x 2030 Penultimate Loop - PM Peak Period - Northbound Direction
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Charlemont
St Stephen's Green
Tara
O'Connell Street
Mater
Glasnevin
Griffith Park
Collins Avenue
Ballymun
Northwood
Dardistown and M50
Dublin Airport
Fosterstown
Swords Central
Seatown
Estuary Park-and-Ride
2030 Penultimate Loop Boarding
2030 Penultimate Loop Alighting
2030 Final Loop Boarding
2030 Final Loop Alighting
2030 Penultimate Loop Load
2030 Final Loop Load


2030 Final Loop x 2030 Penultimate Loop - AM Peak Period - Southbound Direction
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Estuary Park-and-Ride
Seatown
Swords Central
Fosterstown
Dublin Airport
Dardistown and M50
Northwood
Ballymun
Collins Avenue
Griffith Park
Glasnevin
Mater
O'Connell Street
Tara
St Stephen's Green
Charlemont
2030 Penultimate Loop Boarding
2030 Penultimate Loop Alighting
2030 Final Loop Boarding
2030 Final Loop Alighting
2030 Penultimate Loop Load
2030 Final Loop Load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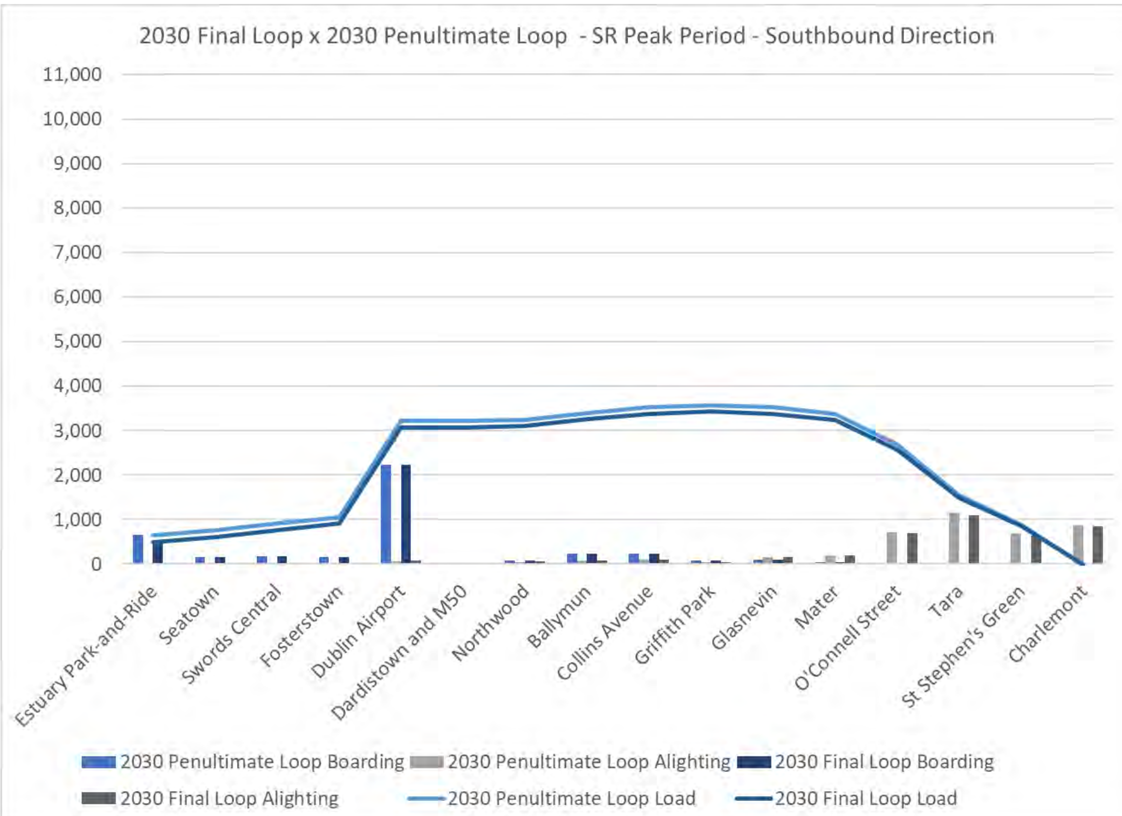
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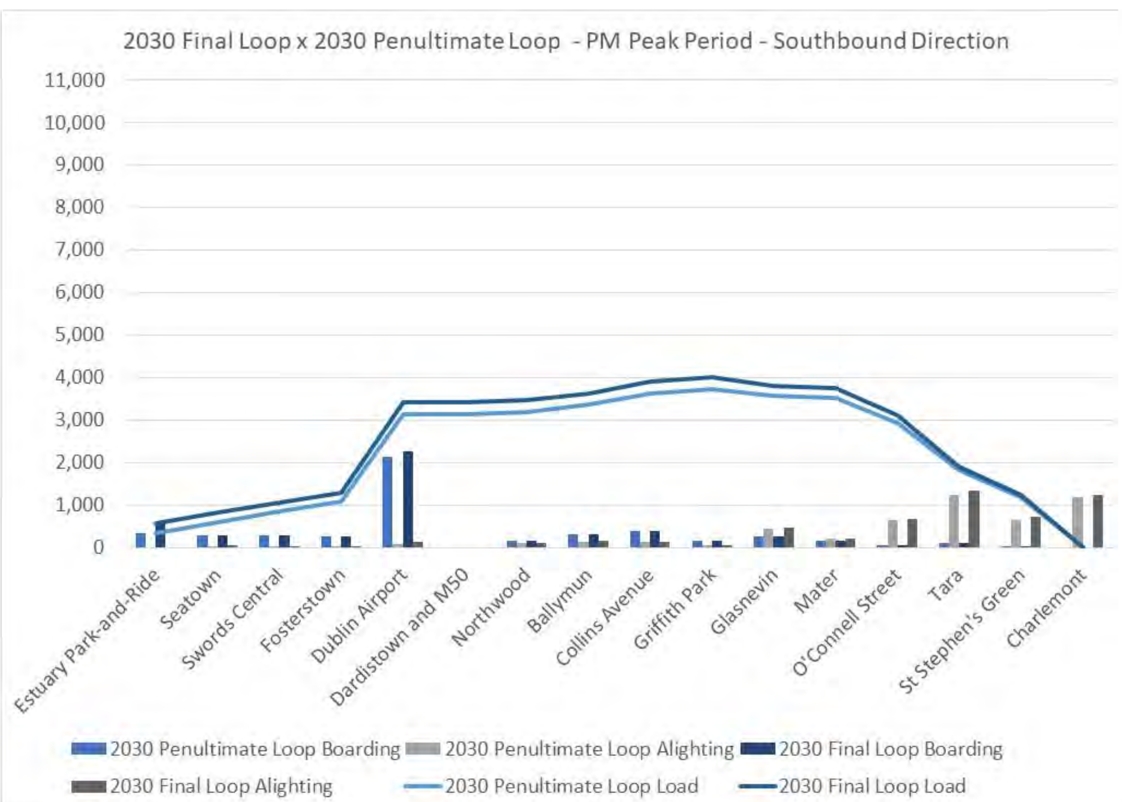
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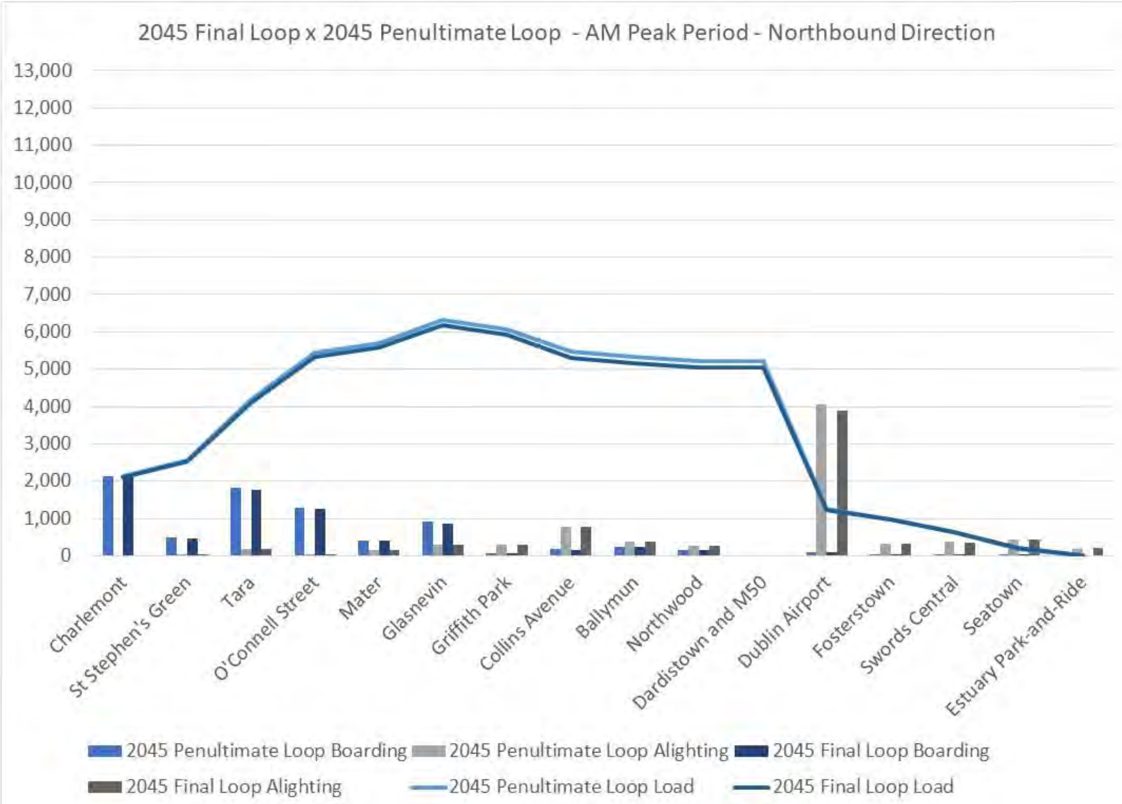
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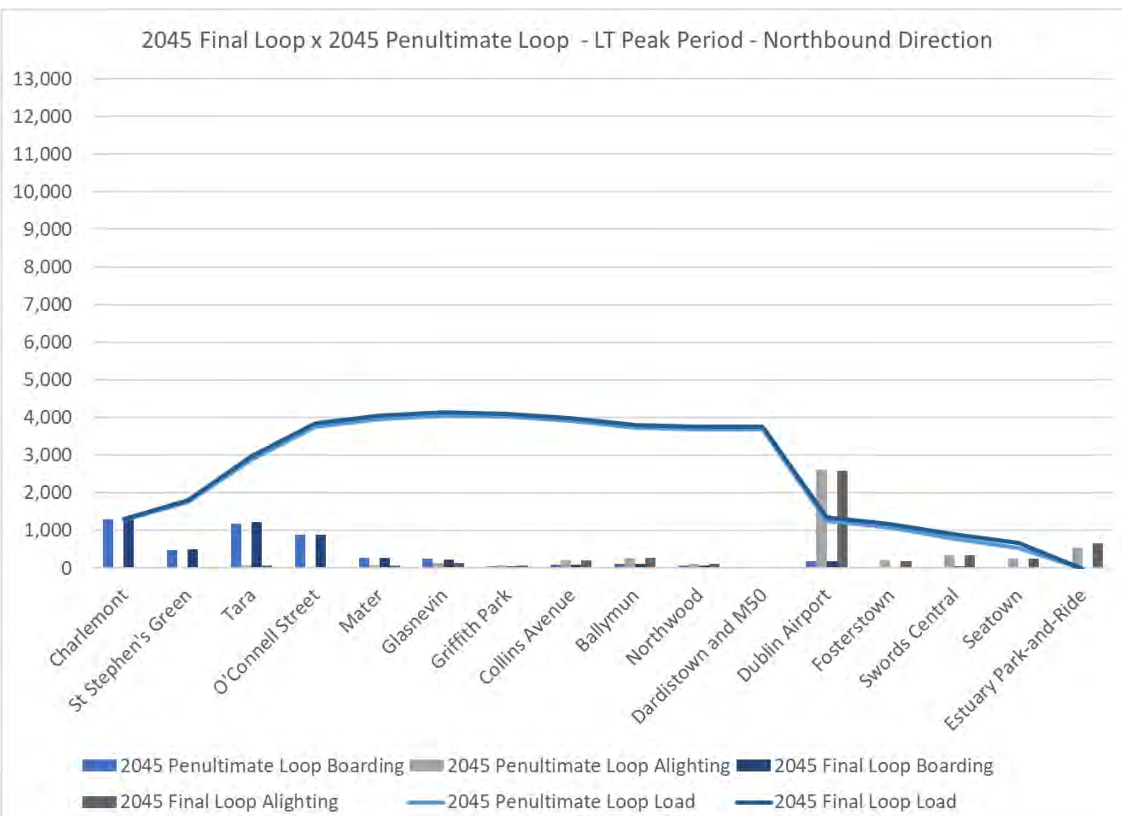
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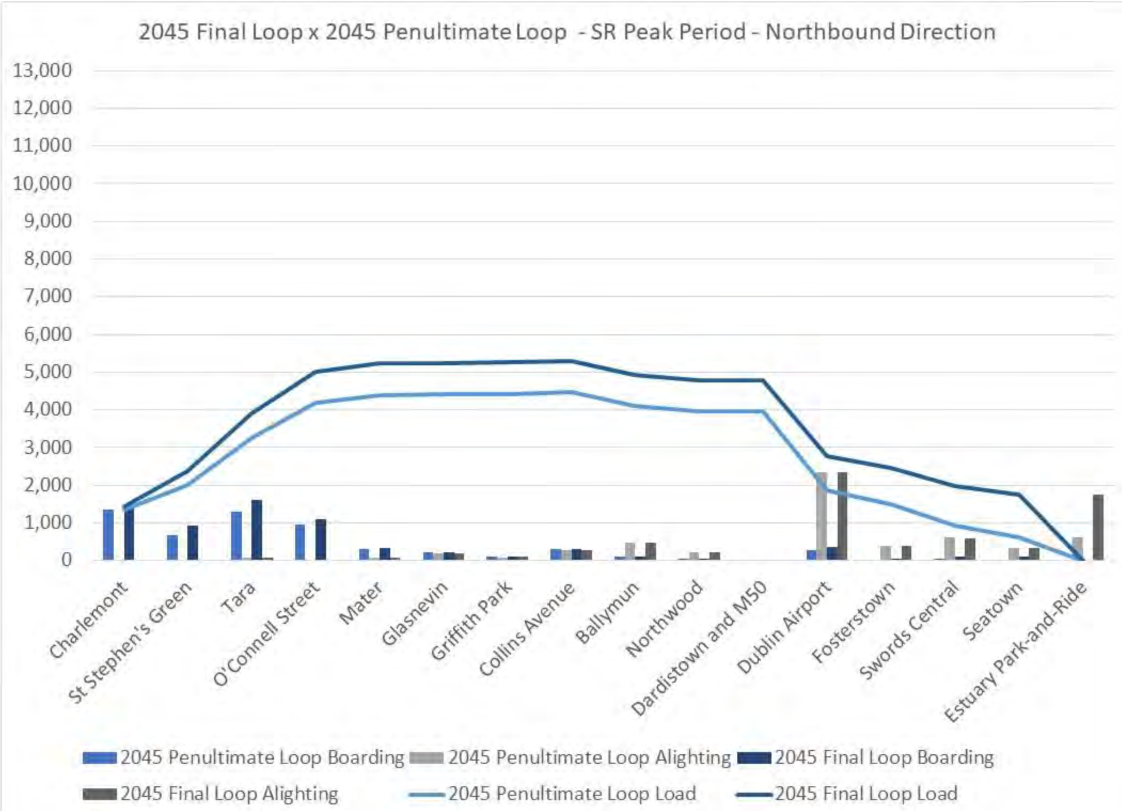
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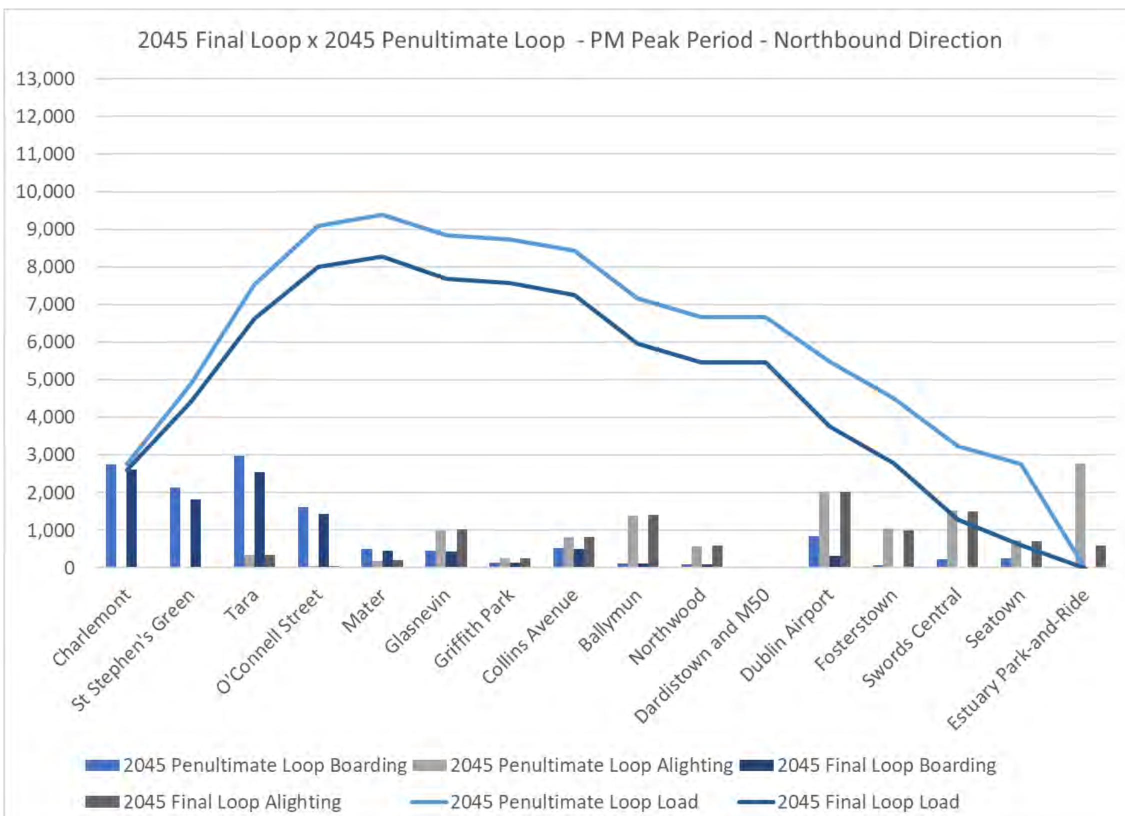
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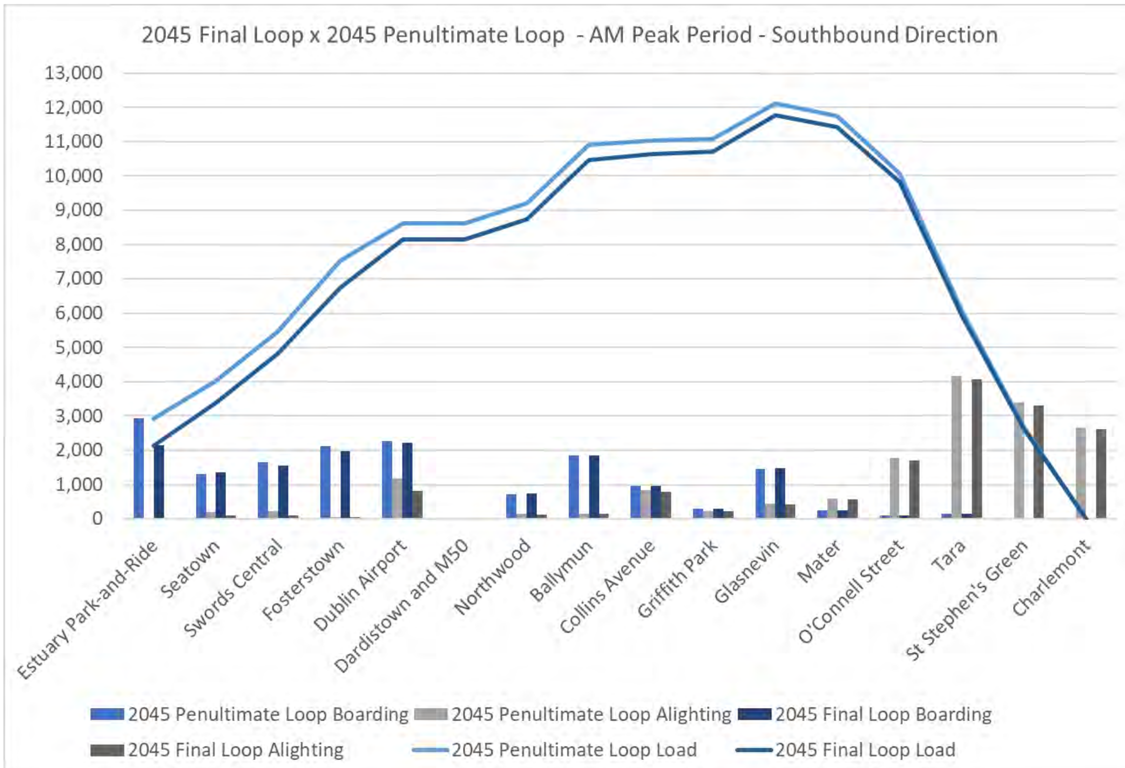
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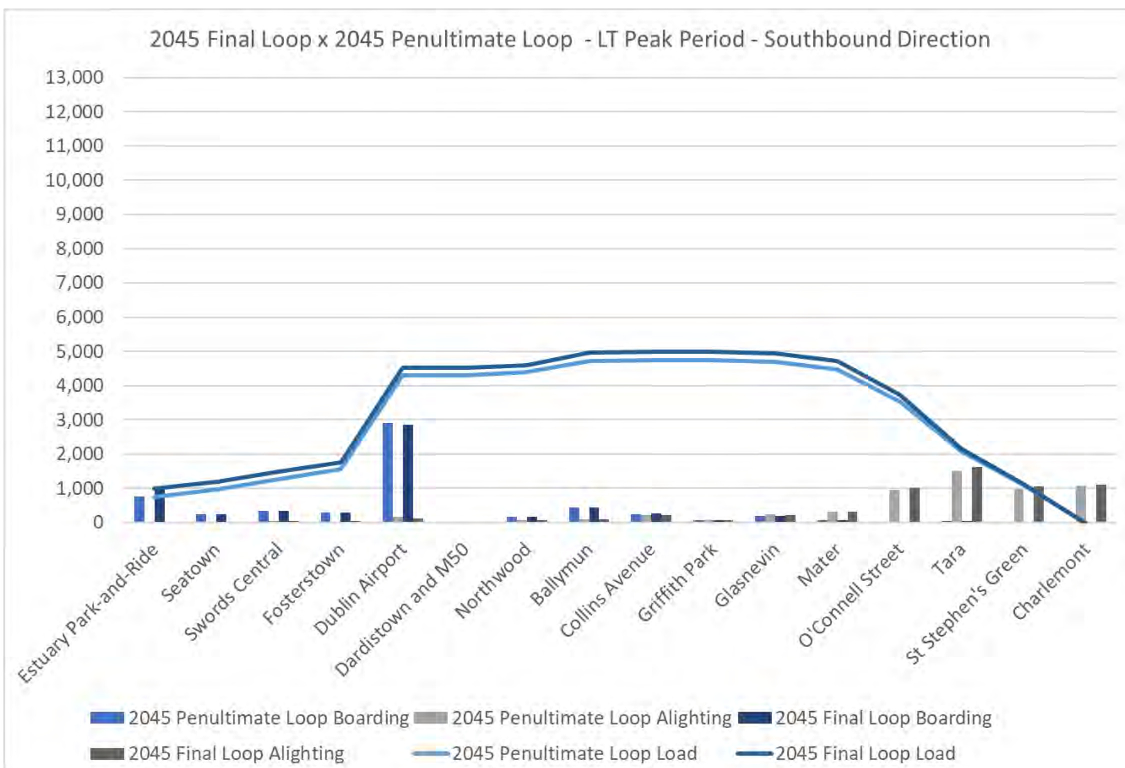
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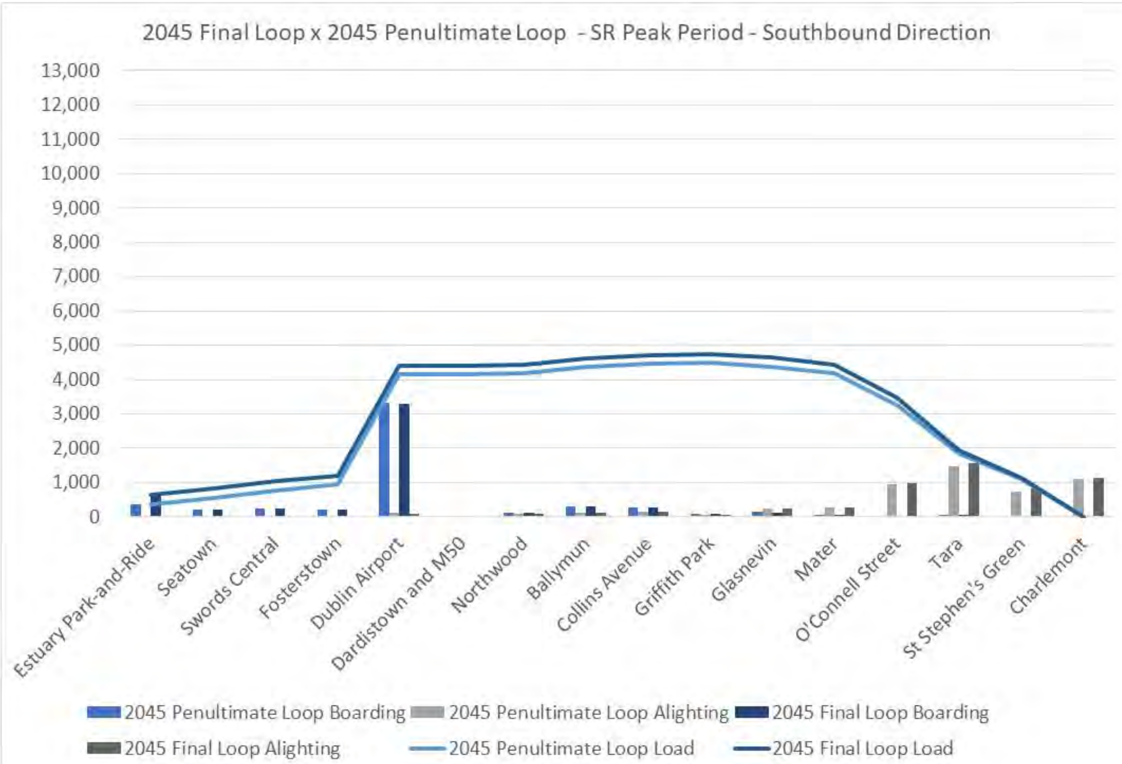
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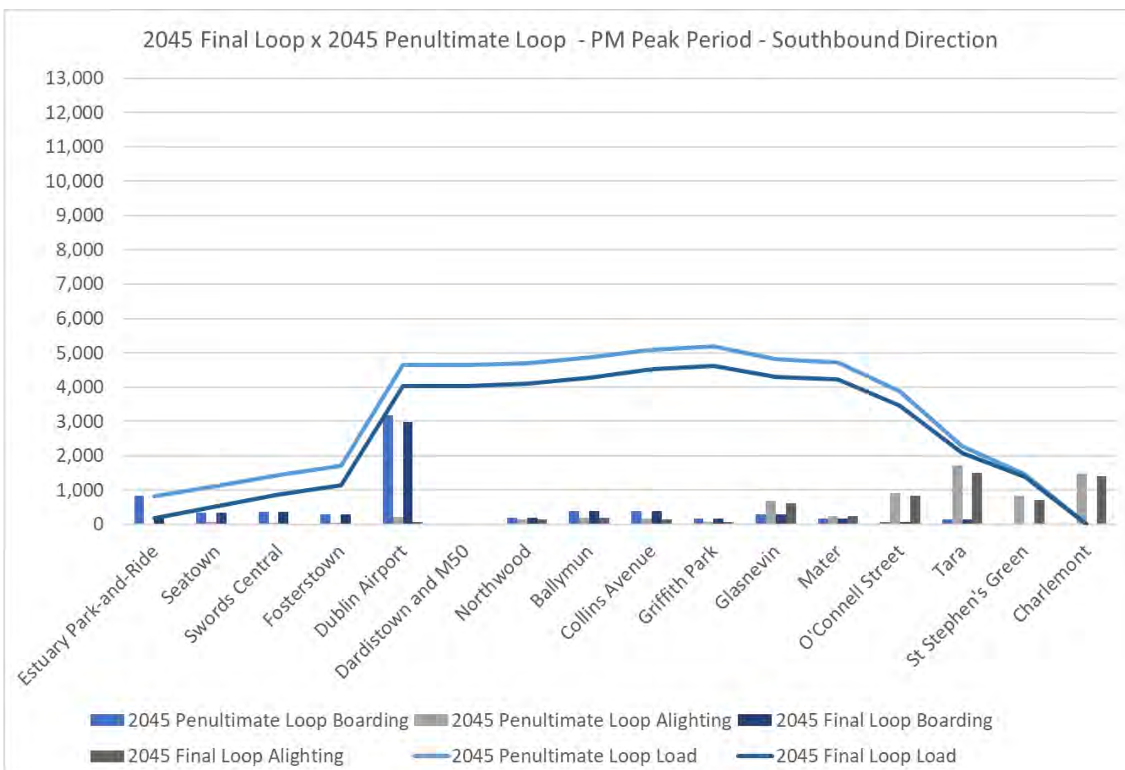
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Appendix N: MetroLink Objective and Sub Objectives

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

METROLINK

MetroLink

Project Objective and Sub Objectives Paper

ML1_TNT-PMG-ROUT_XX-PO-Z-00006

Document Control Information

Document Title	MetroLink Project Objective and Sub Objectives Paper
Filename	MetroLink Project Objective and Sub Objectives Paper

Date	Description	Doc. No.	Rev.	Prepared	Checked	Approved
08 Nov 2021	Final		00	E Brady	A Foley	P Carbone

Table of Contents

List of Tables

List of Figures

Abbreviations

Abbreviation	Definition
NDP	National Development Plan 2018-2027
NPF	National Planning Framework to 2040
NSOs	National Strategic Outcomes
NTA	National Transport Authority
SDGs	Sustainable Development Goals
SMART	specific, measurable, attributable, realistic, and time-bound
TII	Transport Infrastructure Ireland

Table 1 - Abbreviations

1. Background

A metro project connecting Swords and Dublin City Centre has been proposed and suggested for many years. A detailed Metro North proposal was developed for a scheme extending from St. Stephens's Green to Swords and received planning approval from An Bord Pleanála in 2010. However, due to Ireland's subsequent and significant economic downturn, the Government decided to postpone the project in 2011.

In June 2015, the National Transport Authority (NTA) published the Fingal/North Dublin Transport Study Report, which assessed the need for a metro solution against various alternatives that had been identified. It concluded that a metro scheme was the appropriate transport solution to meet the future transport demand of the Swords – Airport – City Centre Corridor. The study recommended an optimised version of Metro North rebranded as New Metro North.

The Transport Strategy for the Greater Dublin Area 2016 – 2035 identified New Metro North as the preferred public transport project to address the transport need of the corridor.

The National Development Plan (NDP) 2018 – 2027 combined the upgrade of the Luas Green Line to a Metro level of Service and New Metro North to form MetroLink. MetroLink, BusConnects and DART expansion are three major transport infrastructure projects included in Project Ireland 2040. Together they will enable the development of reliable, sustainable, affordable, integrated public transport that will support the economy, help Ireland meet its climate change targets and make Dublin a better place to live, work, shop, or visit.

2. Purpose

The preliminary design for the scheme is substantially complete and TII are currently preparing the Preliminary Business case. At this point the overall strategic relevance, rationale and objectives of the project should be reconsidered. The MetroLink project objectives were developed by the NTA in September 2016, since then there have been developments with both internal and external policies which should be considered by MetroLink.

The purpose of this paper is to reassess the consistency of the project objectives as set out by the NTA in September 2016, with national and regional planning policy, national public investment policy, specific sectoral policy, and climate action policy. The paper will reassess the linkage between policy objectives and project objectives. The paper will also apply the SMART test to the project sub objectives to ensure the sub-objectives are SMART.

3. Approach

The approach adopted to reassess the project objectives is as follows:

1. Document the problem.
2. Review national and regional planning policy, national public investment policy, specific sectoral policy and climate action policy and reassess strategic objectives relevant to MetoLink.
3. Clearly set out the MetroLink objective and sub objectives.
4. Demonstrate a clear linkage between project objectives and the policy objectives from which the project objectives have been derived.
5. Ensure that the Project Objective and sub objectives are clear, unambiguous, expressed as simply as possible and SMART – specific, measurable, attributable, realistic, and time-bound.

4. The Problem

In 2015, the NTA's "Fingal / North Dublin Transport Study" examined options for serving travel demand in the northern parts of the Dublin Metropolitan area, extending into Fingal. The study projected that total travel demand within the study area is expected to increase by 39% from 2011 to 2033. This increase in travel demand arises directly as a result of expected population and employment growth.

The 2015 NTA "South East Corridor Study" examined the future transport needs of the South East corridor of the Dublin Metropolitan area. The aim of the study was to explore and identify public transport options that could effectively meet the growth in travel demand to the year 2035, between the South East Study Area and Dublin City Centre. The study projected that total travel demand within the study area is expected to increase by 34%, on average along the corridor, between 2011 and 2035 due to expected population and employment growth.

The studies determined that the existing road and public transport networks in the Fingal / North Dublin and South East corridors are already experiencing capacity issues. This additional trip demand will need to be absorbed by new high capacity public transport solutions.

5. Strategic Policy Context

The below section provides a snapshot of the policies; national and regional planning policy, national public investment policy, specific sectoral policy and climate action policy which have been reviewed as part of this paper and have informed and guided the development of the updated MetroLink objective and sub objectives.

1. Project Ireland 2040 - Building Ireland's Future
2. Project Ireland 2040 - The National Planning Framework
3. Project Ireland 2040 - The National Development Plan 2018 – 2027 (NDP)
4. Smarter Travel, A Sustainable Transport Future - A New Transport Policy for Ireland 2009 – 2020
5. Sustainable Development - Climate action and Sustainable Development Goals (SDGs)
6. Strategic Investment Framework for Land Transport, DTTAS 2014
7. People, Place and Policy, National Tourism Policy, DTTAS 2015
8. Transport Strategy for the GDA 2016 - 2035
9. NTA Statement of Strategy 2018 - 2022
10. Dublin City Development Plan 2016 - 2022
11. Fingal Development Plan 2017 - 2023
12. South Fingal Transport Study - January 2019

5.1. Project Ireland 2040 – Building Ireland's Future

"Project Ireland 2040 is the Government's overarching policy initiative to make Ireland a better country for all of us, a country that reflects the best of who we are and what we aspire to be. Project Ireland 2040 is informed by the Programme for a Partnership Government 2016, which recognises that economic and social progress go hand in hand and is made up of the National Planning Framework to 2040 and the National Development Plan 2018-2027."

5.2. Project Ireland 2040 – The National Planning Framework

The National Planning Framework (NPF) is the Government's high-level strategic plan for shaping the future growth and development of Ireland to 2040. The population of Ireland is expected to grow by approximately one million people in this period, requiring hundreds of thousands of new jobs and new homes. The population of Dublin is projected to increase by between 20% and 25% to 1.4 million.

To plan for this growth and for the demands it will place on the built and natural environment, the NPF sets out the processes to be followed in spatial planning, infrastructure planning, social and economic planning. It also outlines the principles that these plans have to follow, for example around sustainability.

The NPF defines the National Strategic Outcomes (NSOs) to be achieved which help set national strategic investment priorities. Project Ireland 2040 seeks to achieve ten strategic outcomes, building around the overarching themes of wellbeing, equality, and opportunity. These ten shared priorities will ensure a consistent approach between planning objectives under the National Planning Framework and investment commitments under the National Development Plan.

Figure 1 - National Strategic Outcomes and Priorities of the National Development Plan

Source of image: National Planning Framework p13

5.3. Project Ireland 2040 – The National Development Plan 2018 – 2027 (NDP)

The NDP sets out the investment priorities that will underpin the successful implementation of the NPF. It has been devised so as to ensure that public investment is targeted towards projects that will fulfil the objectives of the NPF. It therefore focuses on planned investment in public infrastructure that strengthens Ireland’s human capital and fosters important growth areas in order to attract new investment.

Since work places, housing and transport are inextricably linked, the NDP directs investment towards large scale, integrated public transport infrastructure. For Dublin, the NPF identifies the need to improve strategic infrastructure as part of the Metropolitan Area Strategic Plan (MASP), to include enhanced airport and port access and capacity, expansion and improvement of the bus, DART, Luas networks and MetroLink.

Figure 2 - National Strategic Outcomes and Priorities of the National Development Plan

Source of image: National Planning Framework p13

The key rail projects as set out in the Transport Strategy for the Greater Dublin Area that include MetroLink (and the Luas green line link to MetroLink) are considered by the NPF as key enablers of future growth in the city. This makes MetroLink a strategic investment priority within the NDP.

5.4. Smarter Travel, A Sustainable Transport Future - A New Transport Policy for Ireland 2009 - 2020

Smarter Travel sets out five key goals and five key targets to ensure sustainable travel and transport by 2020. In particular it established a modal share target of 45% for work-related commuting by car. In order to facilitate this shift, and to cater for additional trips by walking, cycling and public transport, the Strategy will require to propose a comprehensive public transport network and service structure, as well as copper-fastening the role of cycling and walking as feasible alternatives for many trips.

5.5. Sustainable Development - Climate action and Sustainable Development Goals (SDGs)

The transport sector has been the fastest growing source of Ireland’s greenhouse gas emissions. Nearly 20 per cent of Ireland’s greenhouse gas emissions come from transport and it accounts for the largest share of energy use. Transport demand and use in Ireland is strongly linked with the economy and - in the case of passenger transport - population and employment.

The Environmental Protection Agency (EPA) projects that without intervention, emissions from transport will increase by 11.3 per cent over the period 2020 to 2035. Investment in environmentally sustainable public transport system (NSO 4; Sustainable mobility) is a primary intervention to move Ireland onto a low carbon pathway and to secure its climate action goals, with MetroLink being one of the specific measures proposed.

The NSO’s are also aligned with the UN Sustainable Development Goals (SDGs) not just in areas such as climate action and clean energy but also in sustainable cities and communities, economic growth, reduced inequalities and innovation and infrastructure, as well as education and health.

Figure 3 - Sustainability Development Goals

Source of image: United Nations Website - https://sustainabledevelopment.un.org/?menu=1300

As a key project outlined in the Project Ireland 2040 strategy, MetroLink is a key enabler of sustainable transport for Dublin and the wider region. MetroLink Sustainability Vision has aligned with emerging global agreements, national sustainable development policies and with TII's own corporate sustainability objectives. By sustainable, we mean that MetroLink considers the wider benefits it can deliver under the three established 'pillars' of sustainability: environment, social and economic.

Forming MetroLink Sustainability Vision

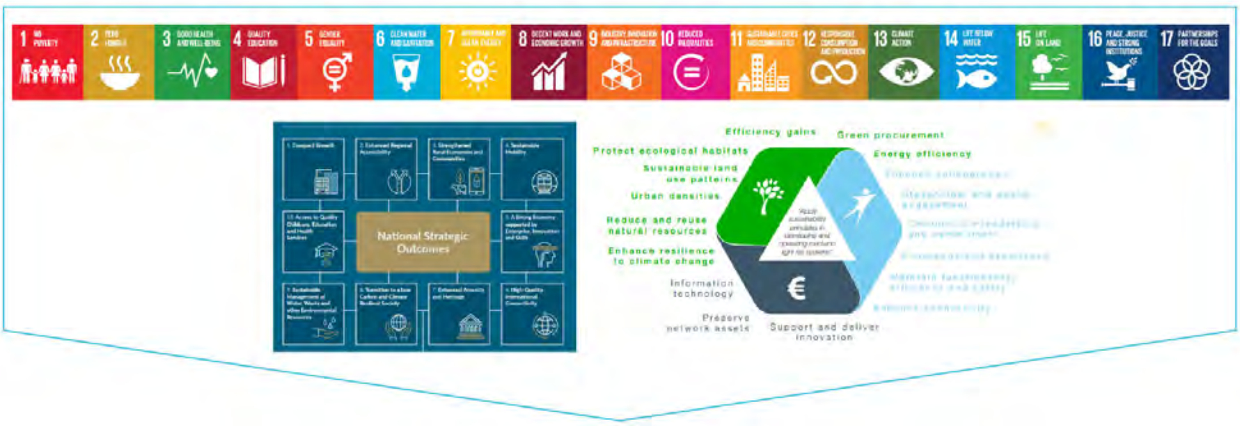

Figure 4 - Forming MetroLink Sustainability Vision

5.6. Strategic Investment Framework for Land Transport, DTTAS 2014

A priority of the Framework is to address urban congestion and improve the efficiency and sustainability of the urban transport system in the Greater Dublin Area. The response will focus on improved and expanded public transport capacity, improved, and expanded walking and cycling infrastructure, the use of an Integrated Ticketing Scheme (ITS) to improve efficiency and sustainability and to increase capacity and on demand management measures. Major new roads are generally not seen as part of the solution to congestion, though capacity enhancements to existing roads coupled with demand management may be justified in limited circumstances.

5.7. People, Place and Policy, National Tourism Policy, DTTAS 2015

The Strategy will include proposals which allow interchange between modes as a means of meeting the National Tourism Policy's objective to facilitate inter-modal connectivity for international visitors.

This is likely to take the form of an enhanced public transport network which will increase the number of trips that can be made by each mode or a combination of modes within the GDA. A policy on the continued roll-out of Leap card, public transport information portals, and their development will be included.

5.8. Transport Strategy for the GDA 2016 -2035

The Strategy purpose is "To contribute to the economic, social and cultural progress of the Greater Dublin Area by providing for efficient, effective and sustainable movement of people and goods". The strategy outlines its intent to further develop the light rail network in the GDA through the implementation of a number of Projects including New Metro North – light rail link from the South city Centre to Swords and serving Dublin Airport, operating in tunnel under the Dublin City Centre, and providing high frequency, high capacity service.

5.9. NTA Statement of Strategy 2018 - 2022

The vision is "To provide high quality, accessible, sustainable transport connecting people across Ireland." To deliver on this vision the Strategy sets out five key missions: Secure the provision of an efficient accessible and integrated transport system in rural and urban Ireland, Transform, and elevate customers' transport experience, regulate privately operated transport services for the benefit of customers, Contribute to the effective integration of transport and land use policies and advance Ireland's transition to a low emissions transport system. Metro, BusConnects and DART Expansion programme have been identified as key projects to deliver on the vision.

5.10. Dublin City Development Plan 2016 - 2022

The city development plan provides an integrated, coherent spatial framework to ensure the city is developed in an inclusive way which improves the quality of life for its citizens, while also being a more attractive place to visit and work. *"…In short, the vision is for a capital city where people will seek to live, work, experience, invest and socialise, as a matter of choice."* p18

5.11. Fingal Development Plan 2017-2023

*"The Fingal Development Plan 2017-2023 sets out the Council's proposed policies and objectives for the development of the County over the Plan period. The Development Plan seeks to develop and improve, in a sustainable manner, the social, economic, environmental and cultural assets of the County"*p3. New Metro North is identified 45 times within the Plan with many of the objectives within the plan actively promoting and supporting the indicative route for new Metro North linking Swords with Dublin Airport and the City Centre. An example of this is set out in the Movement and Infrastructure objective MT01 - *"Support National and Regional transport policies as they apply to Fingal. In particular, the Council supports the Government's commitment to the proposed new Metro North and DART expansion included in Building on Recovery: Infrastructure and Capital Investment 2016-2021. The Council also supports the implementation of sustainable transport solutions."*

5.12. South Fingal Transport Study

"In September 2017, Fingal County Council (FCC) commissioned SYSTRA Ltd. to undertake the South Fingal Transport Study (SFTS). The SFTS is a study of the transport network in South Fingal recommending key transport infrastructure and outline levels of land use development that will enable its sustainable growth leading up to the delivery of MetroLink and beyond."p6.

"The South Fingal Transport Study (SFTS) builds on the broad transport related objectives contained within the Fingal Development Plan (FDP). These objectives are linked to national and regional

policy such as those outlined in the NTA Transport Strategy for the Greater Dublin Area 2016-2035."p73

5.13. Strategic Policy Summary

On reviewing the above documents, it is evident that policies have been in place for many years across many sectors, which aim to increase accessibility and sustainable growth of compact settlements to add value and create more attractive places in which people can live and work. The policies will facilitate economic growth and employment and better integration of land use and transport planning on a national and regional basis, while reducing Ireland's carbon emissions, as we transition to a competitive, low-carbon, climate-resilient and environmentally sustainable economy by 2050.

The strategic goals and objectives relevant to MetroLink are set out in the MetroLink objective and sub objectives section 6 below. Appendix A, B and C of this paper demonstrate a clear linkage between project objective and the policy objectives from which the project objective has been derived.

6. MetroLink Objective and Sub Objectives

Objective

To provide a sustainable, safe, efficient, integrated, and accessible public transport service between Swords, Dublin Airport and Dublin City Centre.

Sub Objectives

- ✓ Cater for existing public transport travel demand and support long-term patronage growth along this corridor through the provision of a high frequency, high capacity public transport service which supports sustainable economic development and population growth
- ✓ Improve accessibility to jobs, education, and other social and economic opportunities through the provision of improved inter-modal connectivity and integration with other public transport services and connectivity for national and international visitors using Dublin Airport
- ✓ Enable compact growth, unlock regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of high capacity Public Transport whilst integrating into the existing public realm
- ✓ Deliver an efficient, low carbon and climate resilient public transport service, which contributes to a reduction in congestion on the road network in the Dublin Region and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets
- ✓ Provide a high standard of customer experience including provision for clean, safe, modern vehicles and a reliable and punctual service with regulated and integrated fares.

7. SMART Objectives

The below section will apply the SMART test to the Project Sub Objectives. As set out in the Public Spending Code "A Guide to Evaluating, Planning and Managing Public Investment" October 2019 – Section 3.2.2 Objectives: *".....Objectives must be SMART – specific, measurable, attributable, realistic and time-bound.*

The SMART Objectives identified below, focus on specific measurables which are further expanded on in the Preliminary Business Case Appendix K: Monitoring and Evaluation Plan. ML1-JAI-LSI-ROUT_XX-RP-Y-00002 | P02

Specific	➢ **Cater for existing public transport travel demand and support long-term patronage growth along this corridor through the provision of a high frequency, high capacity public transport service which supports sustainable economic development and population growth**	
Measurable	➢ Patronage - defined as the number of people using the MetroLink.	
Attributable	➢ **Pre-Operation** o Transport modelling	➢ **During Operations** o Monitoring and Evaluation Plan to allocate responsible owners.
Realistic	➢ Transport Model provides projections at key milestones including: Opening (2030), Design (2045) and Horizon (2060). MetroLink is designed for 20,000 passengers per hour per direction which caters for key milestone projections.	
Time-Bound	➢ Transport Modelling scenarios provide key milestones as the Opening, Design and Horizon 2030, 2045 and 2060 respectively.	
Specific	➢ **Improve accessibility to jobs, education, and other social and economic opportunities through the provision of improved inter-modal connectivity and integration with other public transport services and connectivity for national and international visitors using Dublin Airport**	
Measurable	➢ Increased access to jobs, education centres, Dublin Airport, health, and other socio-economic development facilities	
Attributable	➢ **Pre-Operation** o Transport modelling o Station design connectivity and integration with other transport modes such as DART+, BusConnects, bicycle and Park & Ride.	➢ **During Operations** o Monitoring and Evaluation Plan to allocate responsible owners. o Ticketing Strategy o Census information o Local Authority Plans
Realistic	➢ Transport modelling - number of multi modal trips	
Time-Bound	➢ Patronage and number of multi modal trip against the transport models developed for Opening, Design and Horizon key milestones, 2030, 2045 and 2060 respectively.	

Specific	➢ **Enable compact growth, unlock regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of high capacity Public Transport whilst integrating into the existing public realm**
Measurable	➢ Uplift in population and employment in area of influence of the scheme based on Census results.
Attributable	➢ Review of population and employment statistics within varying areas of influence 1km to 3km radii
Realistic	➢ DCC and FCC to identify and model certain areas for regeneration Pre-Operation and Post Operation
Time-Bound	➢ National Planning Framework and RSES timeframes
Specific	➢ **Deliver an efficient, low carbon and climate resilient public transport service, which contributes to a reduction in congestion on the road network in the Dublin Region and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets**
Measurable	➢ Reduction in harmful emissions – CO_2, NOx, Particulate Matter (PM) and Noise levels
Attributable	➢ **During Construction** o Emission reductions defined by the Project Sustainability Plan o Sustainable procurement ➢ **During Operations** o Energy efficiency for vehicles and facilities. o Procurement (25-year replacement) o Carbon Off-setting
Realistic	➢ Set CO_2, NOx, PM, and Noise levels targets in contract documents
Time-Bound	➢ CO_2, NOx, PM contract performance timelines
Specific	➢ **Provide a high standard of customer experience including provision for clean, safe, modern vehicles and a reliable and punctual service with regulated and integrated fares.**
Measurable	➢ Operator contract KPI performance monitoring and customer survey feedback
Attributable	➢ **Pre-Operation** o Set appropriate performance criteria for services to be procured ➢ **During Operations** o Operator contract KPI / performance matrix
Realistic	➢ Set operator KPI and performance targets in contract documents
Time-Bound	➢ Operator contract performance timelines

Table 2 - SMART Objective

8. Findings

The purpose of this paper is to reassess the consistency of the project objectives with relevant strategic policies and to reassess the linkage between policy objectives and project objectives.

On review of the strategic policy documents relevant to MetroLink (identified in section 5) it is evident that the MetroLink's overall strategic relevance, rationale and objective remain current. The strategic policy goals and objectives relevant to MetroLink are set out in the MetroLink objective and sub objectives. The MetroLink objective and sub objectives demonstrate a clear linkage between project objectives and the policy objectives from which the project objective has been derived.

The SMART test was applied to the five project sub objectives to ensure they are specific, measurable, attributable, realistic and time bound. TII and key project team members, facilitated by Turner & Townsend, worked together to set the high level KPI'S to measure the SMART objectives for the scheme. One to one information gathering sessions and a group workshop with key project team members including representatives from Aecom, Jacobs, Idom, SNC Lavalin, Turner & Townsend and TII were held to agree the set of required measurables and to ensure the sub objectives are SMART. The SMART test (as set out in section 7) was applied to the MetroLink sub objectives and agreement was made that the MetroLink Project Objective and Sub Objectives identified within this paper are SMART.

Appendix A - Strategic Goals and Objectives – Sustainability

National, Public Transport and Local Planning Strategic Objectives Sustainability	
Document	**Goals and Objective relevant to MetroLink**
Project Ireland 2040 NPF & NDP	➢ NSO 1: Compact growth- sustainable growth of compact settlements to add value and create more attractive places in which people can live and work; achieving effective density and consolidation ➢ NSO 1: Compact growth - Increased investment in public and sustainable transport and supporting amenities, can act as crucial growth drivers. ➢ NSO 4: Sustainable mobility - An environmentally sustainable public transport system will enable economic growth and meet significant increases in travel demand while contributing to our national policy of a low-carbon economy. ➢ NSO 4: Sustainable mobility - The expansion of attractive and sustainable public transport alternatives to private based car transport will reduce congestion and emissions ➢ deliver a public transport network that will provide high-quality passenger interchange points, which facilitate convenient transfer between efficient and integrated public transport services ➢ NSO 8: Transition to a low Carbon and Climate Resilient Society - The capital investment priorities will represent a step-change in Ireland's delivery climate-action objectives, providing a significant reduction in carbon emissions over the period to 2030.
Smarter Travel A Sustainable Transport Future 2009 - 2020	➢ maximise the efficiency of the transport network ➢ reduce reliance on fossil fuels ➢ reduce transport emissions
Strategic Framework for Investment in Landside Transport	➢ The use of ITS to improve efficiency and sustainability and to increase the capacity of existing urban transport systems
Climate Action Plan Government's 2014 National Policy	➢ National objective of achieving transition to a competitive, low-carbon, climate-resilient and environmentally sustainable economy by 2050.
Transport Strategy for the GDA 2016 -2035	➢ contribute to the economic, social, and cultural progress of the Great Dublin Area by providing for the efficient, effective, and sustainable movement of people and goods

National, Public Transport and Local Planning Strategic Objectives Sustainability	
Document	**Goals and Objective relevant to MetroLink**
NTA Statement of Strategy 2018 - 2022	➢ Promote a shift from the car to more sustainable modes of transport (public transport, cycling and walking) thereby reducing carbon emissions; ➢ Advance Ireland's transition to a low emissions transport system ➢ Assist in the achievement of Ireland's emission reduction targets. ➢ In line with available funding, implement an effective infrastructure investment programme that delivers sustainable and public transport infrastructure in a cost-effective manner, which is complemented by appropriate traffic and demand ➢ Deliver a low-emission public transport fleet to assist in the delivery of Ireland's emission reduction targets.

Table 3 - Strategic Goals and Objectives – Sustainability

Appendix B - Strategic Goals and Objectives – Integration and accessibility

National, Public Transport and Local Planning Strategic Goals and Objectives Integration and accessibility	
Document	**Goals and Objective relevant to MetroLink**
Project Ireland 2040 NPF & NDP	➢ The principle of integration and accessibility is a key driver of the MetroLink route including connections with Dublin Airport, DART, Iarnród Éireann and Luas. ➢ NSO 2: Improved regional accessibility - to enhance accessibility between key urban centres of population; ➢ provide high-quality passenger interchange points, which facilitate convenient transfer between efficient and integrated public transport services. ➢ NPF - Metropolitan Area Strategic Plan (MASP), to include enhanced airport and port access and capacity, expansion and improvement of the bus, DART, Luas networks and MetroLink.
Smarter Travel A Sustainable Transport Future 2009 - 2020	➢ Land use planning and the provision of transport infrastructure and services will be better integrated ➢ Ease of access to public transport and other sustainable forms of travel will be improved for all citizens, irrespective of location and mobility needs ➢ improve accessibility to transport
Strategic Framework for Investment in Landside Transport	➢ improve connections to key seaports and airports
People, Place and Policy, National Tourism Policy DTTaS 2015	➢ Interchange between modes as a means of meeting the National Tourism Policy's objective to facilitate inter-modal connectivity for international visitors. ➢ continued roll-out of Leap card, public transport information portals and their development will be included
Transport Strategy for the GDA -2035	➢ To contribute to the economic, social, and cultural progress of the Greater Dublin Area by providing for the efficient, effective, and sustainable movement of people and goods. ➢ Provide high quality passenger interchange points, which facilitate convenient transfer between public transport services, p91.
NTA Statement of Strategy 2018 - 2022	➢ Secure the provision of an efficient, accessible, and integrated transport system in rural and urban Ireland ➢ Contribute to the effective integration of transport and land use policies ➢ Enable enhanced integration between transport provision and land use planning that reduces transport demand and promotes and facilitates travel by sustainable transport modes; ➢ Promote the convenience and attractiveness of public transport; and ➢ Provide ticketing systems that allow for easy interchange between services. ➢ Develop an efficient, effective, and safe transport system so that most people,

National, Public Transport and Local Planning Strategic Goals and Objectives Integration and accessibility	
Document	**Goals and Objective relevant to MetroLink**
	including those with a disability or mobility impairment, are within easy reach of a reliable public transport service;
Dublin City Development Plan	➢ Integrated Land-use and Transportation - the integration of land-use and transportation can help reduce the need to travel and facilitate sustainable urban development and city living. ➢ Promoting Modal Change and Active -provide opportunities for people to alter their travel behaviour and increase modal shift to more sustainable modes. ➢ Promoting Active Travel: Cycling & walking… form part of sustainable journeys in conjunction with public transport use. ➢ Accessibility for All - Addressing the pertinent transport / access/egress needs of people with mobility impairment and/or disabilities, including the elderly and people with children, to create a city environment that is safe and accessible to all.

Table 4 - Strategic Goals and Objectives – Integration and accessibility

Appendix C - Strategic Goals and Objectives – Safe and efficient

National, Public Transport and Local Planning Strategic Objectives Safe and Efficient	
Document	**Goals and Objective relevant to MetroLink**
Project Ireland 2040 NPF & NDP	➢ NSO 4: Sustainable mobility - All the planned investment in public transport combined will add greatly to the choice and experience of the travelling public, connecting more people with more places and ease congestion in Ireland's cities.
Smarter Travel A Sustainable Transport Future 2009 - 2020	➢ The present levels of traffic congestion and travel times will be significantly reduced
People, Place and Policy, National Tourism Policy DTTaS 2015	➢ continued roll-out of Leap card, public transport information portals and their development will be included
Transport Strategy for the GDA 2016 -2035	➢ A simplified fare system will be introduced in the Greater Dublin Area, covering bus, rail, Luas, and Metro services, which will also facilitate multi-leg and multi-modal journeys in a cost effective manner; ➢ Provide secure and comfortable waiting facilities for passengers, with shelters and seating within a well-lit environment, and support facilities such as toilets and refreshments where deemed necessary;
NTA Statement of Strategy 2018 - 2022	➢ Transform and elevate customers' transport experience ➢ Promote the convenience and attractiveness of public transport; ➢ Improve the customer experience of public transport by removing barriers to interchange between public transport services; ➢ Develop a deeper awareness of customer experiences, attitudes and needs through regular customer satisfaction surveys and research;

Table 5 - Strategic Goals and Objectives – Safe and efficient

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Appendix O: Evolution of MetroLink Alignment, System Capacity and Design

MetroLink Scheme – Evolution Summary

The Fingal / North Dublin Transport Study (2015) identified Optimised Metro North (LR7) as the preferred modal solution to address public transport needs on the Swords to City Centre corridor.

The current MetroLink scheme has evolved and changed considerably from LR7 envisioned in the Fingal / North Dublin Transport Study (2015). The evolution of the scheme is summarised and set out in chronological order in Table 1.

Evolution of MetroLink			
	Study	Relevance	Key Findings / Recommendations
2015	The Fingal / North Dublin Transport Study.	Determines LR7 is the preferred public transport solution for the corridor.	Recommends a route which runs from Swords to St Stephens Green. LR7 has smaller and fewer stations than Old Metro North. The alignment includes a reduced amount of tunnelling with sections through Ballymun and Swords running at-grade with high-level of priority over other vehicles at all junctions. LR7 is a light rail / Luas solution.
2016	Transport Strategy for the Greater Dublin Area - 2016-2035.	Endorses the findings of the Fingal / North Dublin Transport Study. LR7 is renamed New Metro North (NMN).	The strategy defines NMN as a high speed, high capacity, high frequency public transport link from Dublin City Centre to Dublin Airport and Swords, with the city centre section underground. The strategy proposes the upgrade of the existing Luas Green Line to Metro standard, through the extension of NMN southwards, via a tunnel, enabling the through running of Metro trams from Swords to Brides Glen.
2017	GreenLine Tie In Study (2018).	Identifies the preferred location for the tie- in of NMN to the exiting GreenLine.	Preferred tie-in location identified at Charlemont.
2018	NMN Alignment Options Report	Identifies the emerging preferred route for NMN.	Identifies the emerging preferred route from Swords to St Stephens Green. Interchange with Irish Rail Line moved from Drumcondra to Whitworth Road. (Renamed Glasnevin)

			Scheme renamed MetroLink.
2018	Green Line Metro Upgrade Study	Assesses infrastructure requirement in upgrading the Green Line to Metro Standard	Route further extended to encompass Metro south / upgrade of Luas Green Line for through running metro services to Sandyford.
2018	National Development Plan 2018- 2027.	Includes for the delivery of MetroLink.	Makes provision for the delivery of MetroLink. Swords, via Dublin Airport to Dublin's south city centre (operating in tunnel under the city centre) and onwards to Sandyford using the existing LUAS Green Line to ensure that growth along this corridor can be accommodated.
2018	MetroLink Emerging Preferred Route, Non-Statutory Public Consultation..	Introduces MetroLink to the Public as a scheme which runs from Estuary (North of Swords) to Sandyford. Leaves open the options of twin to single bore tunnel and propose an alternative alignment along the R132.	Significant local opposition to proposals for the upgrade of the Green Line to Metro services. Significant opposition to proposed tunnel drive site at Mobhi Road and elevated alignment on R132.
2019	MetroLink Preferred Route, Non-Statutory Public Consultation.	Emerging preferred route revised to take account of stakeholder concerns and feedback. Revised MetroLink Preferred Route incorporating these changes introduced.	Route changes included removal of Metro south / Green Line upgrade works, turnback infrastructure at Charlemont station, R132 elevated structure in central reservation changed to open cut in Western Verge. Depot location changed to Dardistown, change to single bore configuration, removal of tunnel launch site at Moby Road and its replacement with a tunnel launch site at Northwood.
2021	MetroLink Preliminary Business Case.	Preliminary Business Case prepared for the MetroLink Preferred Route.	Preliminary Business Case approval process underway Aug 2021.

Table 2 – Evolution of the MetroLink Scheme.

Infrastructure Difference between LR7 and MetroLink

The MetroLink scheme has evolved and changed significantly from the original LR7 scheme first published in 2015. The differences between the two schemes are comprehensively set out in the "MetroLink Rough Order of Magnitude Scheme Estimates" June 2021 report. The more significant changes to the scheme are summarised in Table 2.

Description	**2015 FNDTSS2 LR7 Kilometres (km)**	**2020 Prelim. Design Kilometres (km)**
Tunnel Twin Bore	7.46	-
Tunnel Single Bore	-	10.18
Track at-grade	5.12	1.11
Track retained cut	Included in at-grade length	2.98
Track cut & cover	1.20	1.73
Track elevated	2.87	0.36
Stations & Portals	Assumed to be included	1.81
Sub-total Main Route	**16.65**	**18.18**
Other surface level (Access to Depot)	-	2.39
Other tunnel (South of Charlemont)	-	0.39
Total Length	**16.65**	**20.95**

Description	**2015 FNDTSS2 LR7 No**	**2020 Prelim. Design No**
Stations underground	6	11
Stations at-grade	6	1
Stations retained cut	-	3
Stations elevated	2	-
Station's future provision	-	1*
Total	**14**	**16**
Portals	3	3

Table 3 – Key Infrastructure Changes

Other Characteristics – Differences between LR7 and MetroLink

The characteristics of the two schemes differ considerably. The differences between the two schemes are comprehensively set out in the “MetroLink Rough Order of Magnitude Scheme Estimates” June 2021 report and are summarised in Table 3.

Description	2015 FNDTSS2 LR7	2020 Prelim. Design
Route start	Estuary	Estuary
Route finish	St Stephens Green	Charlemont
Main route length (km)	16.65	18.18
Degrees of automation	GoA1	GoA4
Green Luas line connection	No	No
Design capacity (PPHPD)	9,900	20,000
Vehicle frequency (TPH)	30	40
Station platform length (m)	60	65
No. of passenger vehicles (no.)	30	26
Vehicle length (m)	60	64
Passengers per vehicle	330	500
Tunnel type	Twin bore	Single bore
Depot location	Dardistown	Dardistown
Park & ride facilities	Estuary, Fosterstown and Dardistown	Estuary 3,000 spaces
Opening year	2025	2031

Table 4 - Characteristic Difference between LR7 and MetroLink

Costs Comparison – LR7 and MetroLink

The "MetroLink Rough Order of Magnitude Scheme Estimates" June 2021 report also compares the overall costs of the MetroLink and LR7 scheme in 2018. The methodology and assumptions underlying the estimates are also provided in the document

The capital cost estimate for the direct costs of each scheme and the total scheme capital costs (baselined to 2019) are summarised in Table 4 and 5. The overall difference in the comparative costs of the MetroLink scheme and the original LR7 scheme is estimated €2.5bn.

Description	2015 LR7 ROM Estimate € million	2020 Prelim. Design € million
Tunnelling, Portals & Shafts	860	731
Track work	397	651
Stations	1,220	2,079
Park & Ride	30	91
Depot	142	142
Rolling Stock	271	237
Systemwide	367	434
Enabling / Advance Works	115	83
Total	**3,402**	**4,448**

Table 5 - Direct Cost Summary

Description	2015 LR7 ROM Estimate € million	2020 Prelim. Design € million
Direct Costs	3,402	4,448
Indirect Costs	463	605
Property Costs	311	415
Contingency / Risk	2,314	3,030
Inflation	1,484	1,943
Value Added Tax	Excluded	Excluded
Total	**7,975**	**10,442**

Table 6 - Total Project Estimate Summary

MetroLink Evolution from LR7

This section is set out in more detail, the evolution of MetroLink and seeks to explain the evolution of the scheme from the original LR7 original concept, through the route options section phased and eventual adoption of the current preferred MetroLink scheme.

The Fingal/North Dublin Transport Study (2015)

The Fingal / North Dublin Transport Study (2015) identified Optimised Metro North (LR7) as the preferred modal solution to address public transport needs on the corridor. As part of the study 25 alternative modal options were assessed through a multi-stage, multi criteria analysis.

LR7 differs significantly from the current MetroLink scheme. It has smaller and fewer stations than MetroLink. This alignment also includes a reduced amount of tunnelling (7.5km) with sections through Ballymun and Swords running at-grade. LR7 was envisioned to run in twin bore tunnels between St Stephens Green to just south of Collins Avenue where it emerged from tunnel to run predominantly at surface road level to Dardistown station. From Dardistown station the route enters a second section of tunnel running beneath Airport station and emerging from the tunnel just south of Fosterstown station. The route runs at grade along the centre median of the R132 to Estuary, with priority over other vehicles at all junctions. LR7 has smaller and fewer stations than Metro North.

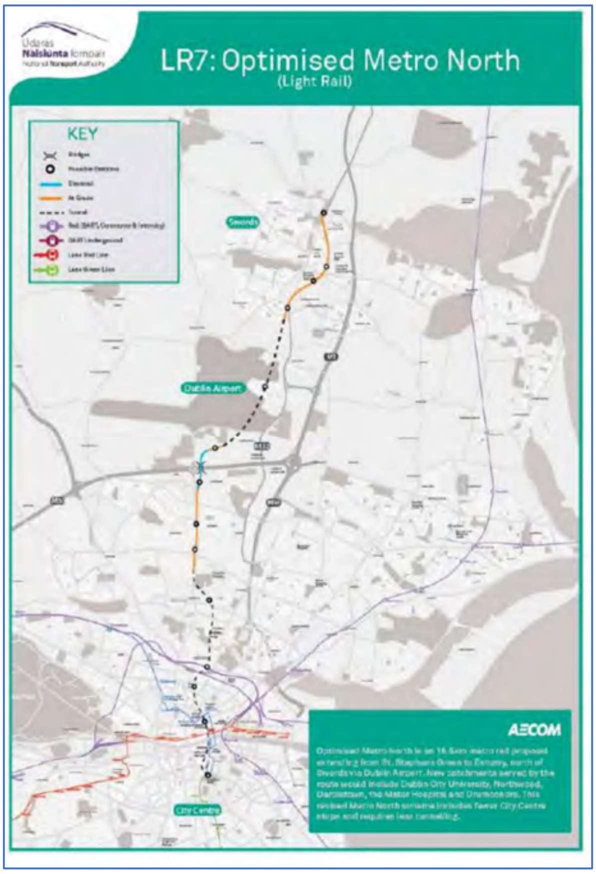


Figure 1 – LR7 Route

The MetroLink scheme by comparison has more tunnelling (11.7km) than LR7. Its runs in single bore tunnel between Charlemont station and Northwood station avoiding major traffic disruption during construction, permanent road realignment and bridge works between Collins Avenue and Northwood. The north portal for the city centre tunnel has been moved from just south of Collins Avenue to a brown field site in Northwood. North of Dublin Airport, the scheme runs on a segregated line prominently in the east verge of the R132. Constructed in open cut, the line is segregated for other transport modes unlike LR7 which requires a high degree of priority running at all R132 junctions.

LR7 would provide capacity to carry 9,900 passengers per direction per hour in line with peak hour passenger demand forecasts along the corridor at the time of the study. LR7 envisioned 60m long, light rail vehicles capable of operating at 30 trains per hr or two minutes headway. LR7 was based on a dual operational concept. In the completely segregated sections trains would operate under a basic block signalling system. This is defined as GoA1 in terms of level of automation. In sections with intersection with traffic at grade, the system would operate on Line of Sight principles similar to the Luas and other Light Rail Transit. This is defined as GoA0 in terms of automation. The level of automation constrains the maximum frequency that the service can achieve and thus the overall capacity. The LR7 alignment is shown in Figure 1.

Transport Strategy for the Greater Dublin Area - 2016-2035

The Transport Strategy for the Greater Dublin Area 2016-2035 was adopted by the Government in 2016 and is an essential component, along with investment programmes in other sectors, for the development of the Greater Dublin Area, which cover Dublin, Meath, Kildare, and Wicklow.

The Fingal / North Dublin Transport Study's recommendations were adopted by the National Transport Authority (NTA) in the Transport Strategy for the Greater Dublin Area 2016-2035 (the strategy). The strategy 'provides a framework for the planning and delivery of transport infrastructure and services in the Greater Dublin Area (GDA) over the next two decades.

During the development of the strategy, LR7 the preferred public transport solution for the corridor from Swords to the City Centre as identified in the Fingal / North Dublin Transport Study, was renamed New Metro North (NMN). NMN is one of a number of Light Rail Infrastructure projects that were proposed to be delivered within the lifetime of the strategy. The strategy defines NMN as a high speed, high capacity, high frequency public transport link from Dublin City Centre to Dublin Airport and Swords, with the city centre section underground.

The strategy also proposed the upgrade of the existing Luas Green Line to Metro standard, through the extension of NMN southwards, via a tunnel, enabling the through running of Metro trams from Swords to Brides Glen.

The recommendation of the Fingal / North Dublin Study regarding the preferred public transport solution for the corridor, did not mean de facto acceptance that the LR7 the definitive scheme on which the preliminary design was to be taken forward. The strategy signalled the intention to move to the route assessment stage. The next stage would require a more detailed assessment of the available route options in the narrow corridor within which LR7 is located and would include LR7 as an assessed option within that corridor. The assessment would be undertaken as part of a Route Options Assessment Study.

GreenLine Tie In Study (2018)

Though providing for the future connection of NMN to an upgraded Luas Green Line, the strategy did not determine the precise location at which NMN would connect to the Luas Green Line. To determine the optimum location for this connection, the NTA commissioned the Green Line Tie In Study.

The objective of this Luas Green Line Tie In Study (LGLTS) was to identify the preferred location for the future tie-in of NMN to the existing Luas Green Line. In April 2016, Transport Infrastructure Ireland (TII), using an internal multi-disciplinary team, commenced work on the LGLTS. A two-stage appraisal methodology was adopted for the study.

The first stage appraisal (stage 1) identified a long list of feasible options between St Stephens Green and Milltown. Following an initial sift of ten options, a long list of seven feasible options were brought forward for preliminary appraisal.

A preliminary appraisal using multi-criteria analysis (MCA) against the criteria of Economy, Environment and Integration was carried out on these options. The preliminary appraisal identified a shortlist of four possible tie-in options, for detailed appraisal (stage 2). During the stage 2 appraisal, designs for the four shortlisted options were further developed to a sufficient level of detail which enabled a more detailed MCA to be carried out on the options, against the criteria of Economy, Environment, Accessibility and Social Inclusion, and Integration.

The LGLTS identified Option 4(B) at Charlemont as the preferred location for the connection of NMN to the Luas Green Line. The LGLTS was published in March 2017.

Emerging Preferred Route and Preferred Route

Following the Fingal/North Dublin Transport Study, NTA/TII commissioned Arup Consulting Engineers to carry out a route options assessment to identify the preferred route for NMN. Building on the work completed as part of the Fingal/North Dublin Transport Study, the "New Metro North Alignment Options Report" published in March 2018 identified an emerging preferred route for New Metro North. The study carried out a comprehensive and robust route option selection process and a total of 34 feasible routes were identified over the length of the corridor. Following an initial assessment, ten of these routes were selected for further detailed assessment, which included a full multi-criteria analysis demand and Cost-Benefit analysis formed part of the assessment. Through this process a single option was identified as the "Emerging Preferred Route."

Figure 4 – MetroLink Preferred Route

The 2018 Emerging Preferred Route for NNM was determined following the conclusion of the NMN Alignment Options study and the Green Line Tie In Study. The overall route for NMN was extended consistent with the objectives of the strategy to include for its connection to the Luas Green Line at Charlemont (Option 4) as per the Green Line Tie In Study (2017). In addition, the upgrade of the Luas Green Line to Metro Standard was included as part of the NMM Emerging Preferred Route enabling through running metro services from Estuary to Brides Glen as envisioned in the strategy.

In advance of a non-statutory public consultation on the Emerging Preferred Route, the scheme was rebranded "MetroLink" and public consultation on the Emerging Preferred took place in March 2018.

The Emerging Preferred Route for MetroLink was announced in March 2018. NTA/TII sought the views of stakeholders through a non-statutory public consultation on the 22nd March 2018.

During the public consultation there was significant public opposition to the upgrade of the Luas Green Line to Metro Standard. The main focus of the opposition to these plans was centred around the significant disruption to existing Green Line services during its upgrade. There was also significant opposition to some of the infrastructure proposed for the upgraded Luas Green Line.

Arising from the public consultation a new strategy was developed for the eventual upgrade of the Luas Greenline to metro standard. The ongoing the Luas Green Line Capacity Enhancement project has potential to provide additional passenger capacity on the line up to 2046, after which demand (11,000ppdh) would exceed capacity on the line. The need therefore to upgrade the line to Metro Standard was not immediate and could therefore be delivered as part of a separate future metro project in or around 2046. In making this decision, NTA/TII were conscious that whilst a significant cohort of stakeholders along the Luas Green Line corridor would welcome this change, other stakeholders not immediately affected by the infrastructure works, but reliant on the line for community from other areas would not welcome the postponement of the upgrade to metro standard.

The upgrade of the Green Line to metro standard was therefore removed from the MetroLink scheme with provision for its future connection at the preferred tie-in location preserved through the continuance of the MetroLink tunnel 200m south of Charlemont station.

The MetroLink Preferred Route

The preferred route for MetroLink was published in 2019. The route incorporated changes arising from the public feedback received on the 2018 Emerging Preferred Route and ongoing design development. Significant changes included the termination of the route just south of Charlemont station, a change from twin bore tunnel to single bore configuration, the replacement of the R132 elevated section to cut and cover running on the eastern verge of the R132.

The preferred route also provided for a change of rolling stock from light rail vehicles (Luas Type vehicles) to Light metro vehicle and then introduction of automated trains to Grade of Automation 4 (GoA4).

Preferred Route compared to LR7

The key differences between the MetroLink and LR7 scheme are summarised in Section 1. Further detail and rationale for these differences are set out in this section.

Extension to Charlemont Tie In Location Retained.

As noted earlier, the Transport Strategy for the Greater Dublin Area 2016 – 2035 requires the upgrading of the existing Green Line to metro standard through the extension of Metro southwards, via a tunnel, to join the Green Line in the Ranelagh area. This would enable the through running of metro trains from Swords to Brides Glen in response to long term demand growth on the Green Line that could not be accommodated through the operation of the Luas extended trams.

Unlike LR7, the MetroLink preferred route makes provision for this possible future upgrade by extending the tunnel from St Stephens Green to Charlemont station. After the commencement of passenger services on MetroLink, Luas trams operating on the Green Line and will provide sufficient capacity in the medium term. At some point in the future, demand will exceed the levels that can be catered for by a light rail service like Luas. It is then envisioned that following completion of the upgrade of the Green Line to metro standard, a short section of tunnel from the Green Line connection point to Charlemont station would be completed to provide through running metro services from Estuary to Brides Glen.

The alternative of terminating the MetroLink at St Stephens Green such that any future connection to the Green Line would be constructed from that point was considered and ruled out, given the sensitive nature of the area surrounding St Stephens Green. The need to construct a large underground turnback facility at this location and the construction impacts and difficulties associated to launching or receiving a new TBM drive south from that location to tie into the existing Green Line were assessed and the conclusion was that locating the southern terminus at Charlemont is the preferred option.

A New Interchange Station at Whitworth Rd (Glasnevin Station)

The “New Metro North Alignment Options Report” identified city centre route “A4” as part of the preferred city centre alignment for MetroLink. This route provided a new integrated rail and metro station at Whitworth Road (Glasnevin Station). LR7 by comparison envisioned the interchange with the heavy rail taking place at Drumcondra close to the existing Irish Rail station. Most importantly the proposed station at Glasnevin due primarily to the closer physical proximity of the GSWR / MGWR[54] line at this location, offers significantly shorter and more efficient passenger transfer between Irish Rail and MetroLink services when compared to Drumcondra.

The proposed Glasnevin MetroLink station is considered to better complement the GDA strategy than one located at Drumcondra, facilitating a seamless transfer / interchange between public transport modes. Drumcondra is and will remain highly accessible by public transport even without a metro station as it is served by the heavy rail and bus network. Furthermore, a metro station located at Glasnevin provides a better opportunity for interchanging with the Maynooth and Kildare lines than at Drumcondra because the Phoenix Park Tunnel and Maynooth lines are at their closest point horizontally and vertically at Whitworth, thereby providing the opportunity for a MetroLink station to capture transfer to and from these lines more effectively than at Drumcondra, due to their proximity.

The proposed Glasnevin MetroLink station also facilitates the construction of an integrated metro station as the two heavy rail lines are beneath the existing ground level, making it possible to connect via an underground concourse to all three rail lines in a short distance. A further advantage of the proposed Glasnevin station is that it is located approximately 1km to the west of Drumcondra. This saves over two minutes in journey time by offering the opportunity for rail passengers travelling to Dublin to transfer sooner from heavy rail to metro at Whitworth to access city centre locations to the south or to the Airport / Swords to the north. The impact of this is that there is an additional 600 transfer boarding's from rail at Whitworth over Drumcondra in the AM peak (equivalent to a 33% increase – in the year of opening).

Designed for Fully Segregated Operations

The LR7 route envisioned the rail service running at grade within the central median of the R132. The existing roundabouts along the central reserve are converted to signalised junctions with high priority given to metro services over other traffic. Whilst a high level of priority would be given to metro services over other traffic, the need to provide a level of priority for pedestrians affects the ultimate head and capacity that can be achieved. The projected demand associated with LR7 could be cater for with this level of service.

Transport modelling which informed the Emerging Preferred Route in 2018 indicated line flows would reach up to peak 18,000 pphpd, during peak hour at city centre stations. Typically, light rail and metro systems are designed to cater for peak hour flows on the route. In deciding on the appropriate design peak hour capacity for MetroLink, a Peak Hour Factor (PHF) is used to convert the hourly traffic volume into the flow rate that represents the busiest 15 minutes of the peak hour. For Luas cross city a PHF of 0.9 has traditionally been agreed with the NTA based on observer traffic analysis. For Metrolink a PHF of 0.9 has been agreed with NTA servicing the required demand of 18,000ppdph.

The International Association of Public Transport (UITP) guidance with respect to the carrying capacity of different modes advises that unsegregated light rail systems have an ability to carry a maximum capacity of 7,000 pphpd increasing to 11,000 pphpd with high level of segregation as intended for LR7. Above those peak hour levels, Transport Authorities tend towards implementing metro / light metro systems, which have a capability of carrying up to 20,000 pphpd and more[55].

NTA / TII do not believe it is desirable to compromise the overall carrying capacity of the line by designing a system constrained by the lower capacity requirements on the northern end of the scheme. For this reason, the Emerging Preferred Route allowed for full segregation also along the R132 corridor. This was to be achieved through the provision of a fully segregated elevated structure along the central median of the R132.

[54] GSWR - Great Southern and Western Railway / MGWR - Midland Great Western *Railway*

[55] By means of reference the Green Line route on Dublin's Light Rail network has a maximum carrying capacity of 8,800 pphpd. The system, which will be upgraded to provide greater segregation in the coming years, however with segregation it is estimated that the system will provide a maximum carrying capacity of 11,000 pphpd

It is intended that a highest level of service will be delivered during peak hour along the entirety of the MetroLink route. The degree to which the level of services can be delivered is affected by the extent of segregation from other transport modes. Where a route is fully segregated the potential to minimise operating headway and maximise service frequency's is limited only by the signalling system deployed. By contrast line segregation as envisioned for the LR7 with high priority at junctions only, can significantly impact the level of service that can be provided. As is the case with Luas lines the headway and frequency required is dependent on priority at junctions being guaranteed which is not often the case. It is also dependent on there being no encroachment onto the tracks by pedestrians and / or other vehicles which is a regular occurrence. This is a frequent issue for Luas services operating on the Ballyogan Road which is comparable to the LR7 configuration envisioned for the R132.

For the above reasons the MetroLink service has been designed as a segregated system capabile of offering a high frequency service offering reliable headways from 3 minutes on opening down to 90 seconds when required.

R132 An Open Cut - Fully Segregated Solution

During public consultation on the Emerging Preferred Route, the concept of an elevated structure providing the required segregation along the R132 faced opposition from local stakeholders. The elevated structure (Figure 3) would place the MetroLink rail line approximately 8 metres above the existing road surface. The poles and overhead contact wires would extend a further 5 metres vertically. At station locations, the canopy for the stations on the elevated line would be over 13 metres above road level. All of which created significant landscape and visual impacts that concerned local residents of Ashley Avenue, Estuary Court, Seatown Villas, Carlton Court Road and Foxwood estates.

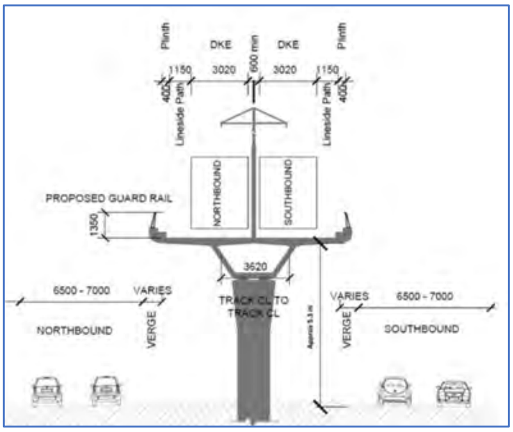


Figure 3 - Elevated Structure

In order to mitigate these impacts NTA / TII considered and ultimately approved a proposal to move the MetroLink alignment along the R132 from the central median into verge on the eastern side of the R132. The new alignment would be placed predominantly in a retained cut structure with discrete sections covered over to facilitate integration and permeability to existing and future planned developments along the R132. The new retained cut proposal removed the visual impact impacts associated with the elevated structure and was estimated to generate a potential significant savings against the elevated route option at that time.

The revised alignment now presents a metro solution which facilitates permeability, connectivity and cycling provision across both sides of the rail line and removes the concept of potential perceived community severance associated to LR7 and trains running in the central median of the R132. The revised alignment enables Fingal County Council to deliver on its strategy to connect the town's urban environment across the R132 by changing the character of the road to a more urban boulevard. The revised station designs associated to the new alignment also provide a more accessible and sheltered environment for customers.

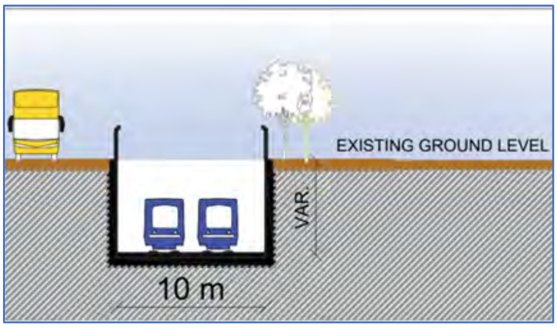


Figure 5 Segregated Running in Retained Cut

The revised proposal to place the alignment in retained cut (Figure 4) on the R132 corridor were received positively during the 2019 non-statutory public consultation and the preliminary design for the scheme was updated accordingly.

Increased Tunnelling

As noted earlier, LR7 had a total tunnelled section of 7.5km consisting of the tunnel drive from St Stephens Green to the southern boundary of Hampstead Park and the tunnel section beneath Dublin Airport between Dardistown and the northern boundary of the Airport. LR7 included for at grade running from the boundary of Hampstead Park on the surface along the R108 Ballymun Road, rising over busy signal-controlled junctions at Santry and Collins Avenue.

MetroLink has more tunnelling than LR7 (11.7km) with additional tunnelling (3.2km) provided beneath R108 (Ballymun Road) in order to avoid the adverse construction, traffic management logistic and environmental impacts associated to running on the surface along the R108. The alternative of at grade running along the R108 was assessed as part of the Arup's Route Options Assessment study and in subsequent studies by NTA / TII. These studies concluded that an at grade option performed poorly against the relevant assessment criteria. In particular the need to construct large underpass / overbridge structures at existing junctions at Collins Avenue, Shangan Road and Santry Avenue, the costs of those structures and the associated impact on local traffic and the wider environment were considered significant when compared to placing the entirety of the route in tunnel beneath the R108.

The extension of the route south to Charlemont to provide for the future connect to the GreenLineadded an extra 1km of tunnelling to the scheme.

The change to Single Bore Tunnel Configuration.

As well as having a shorter section of tunnel, the LR7 tunnel section was intended to be constructed as a twin bore solution with a separate dedicated tunnel for the north and southbound rail lines. The 2018 Emerging Preferred Route also proposed the use of twin bored tunnel for its tunnelled section but left open the possibility that a single bore tunnel could be considered further during the development of the preferred route and preliminary design. In 2018 new consultants appointed to develop the preferred route and preliminary design for the scheme advanced proposals to implement a single bore tunnel solution with the north and southbound rail lines running side by side within the single bore tunnel. Significant advantages associated to single bore were outlined, the "Preferred Route Design Development report (2019), with the specific advantages in relation to Tunnel Fire safety is detailed in the Tunnel Fire Safety: Pros and Cons of a Single Bore Tunnel Arrangement (2021).

Significant advantages associated to implementing a single bore tunnel solution are outlined in this section.

Cost and Programme Savings:

A cost comparison was undertaken to compare the estimated cost of the current single bore tunnel solution against a comparable twin bore tunnel solution. The twin bore tunnel solution was costed based on having an identical number of stations, a slightly shallower tunnel alignment, smaller stations, and tunnel cross passages (for access between each tunnel) at every 250m. The twin bore tunnel solution is currently estimated to cost over €0.6 billion more than the single bore tunnel solution.

The single bore tunnel offered increased service flexibility because it is easier to introduce rail crossovers within the single tunnel configuration allowing trains to turn back or change between the two rail lines if operation on one track is disrupted, accommodating crossovers in a twin bore tunnel solution requires the mining of large cavern spaces, with associated increases in cost, risk, and complexity.

A single bore tunnel can be constructed at lower cost and within a faster timeline than a twin bore solution, primarily due to the fact that there is no requirement to construct cross passages at every 250m as is the case with the twin bore solution and to construct large caverns for the purposes of installing crossover facilities.

Fire Safety and Evacuation

The single bore tunnel facilitates faster train evacuation. Evacuating passengers can exit the train on to the neighbouring rail track area and availing of the entire tunnel floor area passengers can leave the scene in larger numbers, thereby increasing the efficiency and speed of evacuation in the unlikely event of an incident. By comparison twin bore tunnel solutions generally require passengers to exit onto a narrow side walkway in single file until the passengers clear the train length. This can affect the speed with which passengers can evacuate from the incident area.

The benefits of the single bore tunnel from a fire safety perspective are summarised as follows:

- Fast train evacuation. It maximises emergency egress path widths along the trackway, avoiding blockage when alighting from the train and not imposing the speed of the slowest ones to the rest of passengers.
- Provides more space for smoke stratification, which is particularly relevant when the fire is located inside the train.
- Provides a wider side space near and around an incident train for emergency services to deploy and execute their tasks, including assisting passengers evacuating and the access to Fire Hose Connections.
- It improves evacuation guiding in scenarios of fire outside the passenger compartment.
- It avoids the risk of falls from heights from a side passageway and minimizes the psychological sensation of confinement.

For the above reasons the proposal to adopt a single bore tunnel solution for MetroLink was accepted by NTA / TII and the Preliminary Design proceeded on that basis. The full rational for the adoption of the single bore solution is provided in the 2019 Design Development Report.

Additional Underground Stations

MetroLink has a greater section of the route running through tunnels in lieu of the surface level running envisioned for LR7. This has increased the number of underground stations from 6 No (LR7) to 11 No. The change to retained cut running has resulted in 4 of the 5 at grade stations envisioned for LR7 to changing to deep retained cut type stations.

Projected Demand, System Capacity and GoA4 Running

At the time of the Fingal / North Dublin Study (2013) forecasted peak hour demand for the LR7 scheme was predicted to reach 6,245ppdph at peak time (2033) and provided a design capacity of 9,900ppdph. As noted earlier, the LR7 was not a fully segregated system along the entire corridor, it operated at grade on the R132 median with a high level of priority at traffic junctions, operated at maximum two minute headways and provided for a maximum design capacity of 9,900 pphpd.

Subsequently modelling carried out on the route between the publication of the Emerging Preferred Route and Preferred Route, forecast AM southbound line flows in excess of 18,000 pphpd and forecast PM northbound line flows of 13,500ppdph. This increased transport demand is attributed to the fact that demographic, housing density, employment patterns have all changed since the modelling work to support LR7.

Based on the updated transport demand figures NTA / TII agreed that the baseline design capacity should be increased to 20,000pphpd. This (includes circa +10% on model year peak forecast demand in 2057). On this basis NTA / TII defined the appropriate type and level of service for MetroLink.

A Light Metro or Light rail solution?

The capacity of a rail system is the result of the unit capacity delivered by a single vehicle multiplied by the service frequency measured in Trains Per Hour (TPH). The International Association of Public Transport (UITP) published in 2009 a guidance paper with respect to the carrying capacity of different modes. The indication from UITP is that unsegregated rail-based systems have an ability to carry a maximum capacity of 7,000 pphpd increasing to 11,000 pphpd where a high level of segregation can be achieved. This is the operational concept that was used for LR7. Where demand exceeds this levels, Transport Authorities tend towards implementing metro / light metro systems, which have a capability of carrying up to 20,000 pphpd and more.

Figure 6 – Typical Light Metro System

Metro / Light metro systems (Figure 5) differ significantly from light rail systems vehicles, system design and operational concepts are different. Typically, light rail vehicles are low-floor or partially low-floor: elements of the suspension system occupy some space in the saloon, thus preventing passengers from standing in those locations, where seats are installed to make some use of the space.

Metro / Light metro vehicles are typically high floor vehicles, and the saloon is designed to facilitate increased passenger loading. Metros operate on fully segregated tracks and use a signalling system, thus they can provide a more reliable, faster, and higher capacity service

In consideration of the demand and the characteristics of the alignment, the preferred scheme for MetroLink is designed as a high floor light metro system.

Level of Service and Automation.

Standard IEC 62267 defined four Grades of Automation to describe metro operations (Figure 6). A light rail system like Luas, which is based on Line Of Sight would be at the lowest grade, which is GoA0 and is not used by metro systems. The previously mentioned optimised Metro North (LR7) was based on GoA1 operation in segregated sections and GoA0 in sections with traffic junctions at grade.

The highest Grade of Automation is GoA4. In this type of metro, a computerised command and control system controls the operation of the trains, including opening and closing the doors, setting the vehicle in motion, and stopping it and operating trains in case of disruption.

This type of system allows for Unmanned Train Operation (UTO) and in most operations stewards and roving staff are deployed to support customers, protect revenue, and perform maintenance activities. MetroLink is designed an automated metro system (GoA4).

Grade of Automation	Type of train operation	Setting train in motion	Stopping train	Door closure	Operation in event of disruption
GoA1	ATP* with driver	Driver	Driver	Driver	Driver
GoA2	ATP and ATO* with driver	Automatic	Automatic	Driver	Driver
GoA3	Driverless	Automatic	Automatic	Train attendant	Train attendant
GoA4	UTO	Automatic	Automatic	Automatic	Automatic

*ATP - Automatic Train Protection; ATO - Automatic Train Operation

Figure 7 - Grades of Automation

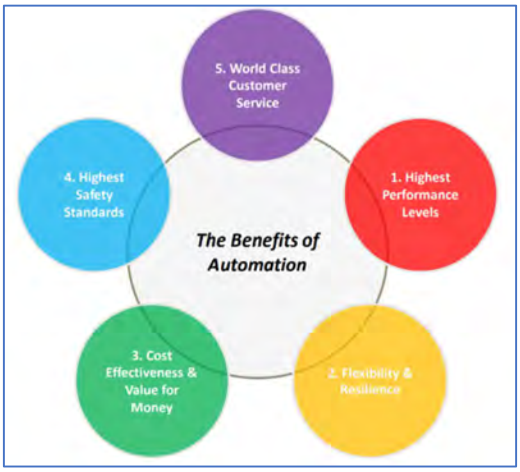
The decision to pursue this grade of automation was driven primarily by the need to provide the required 20,000 pphpd capacity, though high frequency service. As previously outlined, the capacity of a rail system is the result of the unit capacity delivered by a single vehicle multiplied by the service frequency measured in Trains Per Hour (TPH). MetroLink is designed to achieve the required capacity by operating 65m long trains at high frequency up to 40 TPHs or a train every 90s. This results in relatively compact stations[56].

The alternative approach was to build larger stations and longer rolling stock to cater for this future demand. Given the spatial challenges associated with locating stations in a historic medieval city it was felt that station sizes should be kept as compact as possible to minimise the impact on the built environment during construction and reduce the overall all capital cost of the scheme. GoA4 operations would also deliver operational and maintenance savings over the whole life of the project and GoA4 would offer a more efficient service to customers and a better work environment for staff delivering the service.

The first automated metro started passenger service in 1981. In 2018 1000km of automated metros were in operation worldwide and full automation is becoming the mainstream choice for cities that are delivering their first metro. By 2023 over 3000km of automated metros will be operational and the growth is accelerating.

In 75% of the cities with metro networks at least one fully automated line is in operation. Cities with established networks are increasingly choosing automation when they are renewing existing lines. In Europe Brussels, Glasgow, London, Lyon, Marseille, Paris, and Vienna, this is despite the challenges associated with the retrofit and the rationale for the choice is in the benefits that automation deliver.

The benefits of automation are well established. They are described in detailed in Appendix G of the Preliminary Business Case summarised are illustrated in the diagram and explained below[57].



High Performance Levels

To operate the frequent service that Dublin will need, automatic operation (GoA2+) is required. With good discipline, manual driving (GoA1) can be used up to 28tph, but beyond that, delays in response times and lack of driving consistency will cause service instability and recurrent, irrecoverable delays. This allows for a better use of the theoretical frequency that a signalling system can deliver, thus maximising the passenger services that can be delivered in one hour.

GoA3 and GoA4 operation increase capacity further by reducing the time taken to reverse trains in a siding as there is no longer a requirement for a driver to walk from one end of the train to the other for it to change direction. This means that an intensive service can be reversed off fewer sidings, reducing the cost and disruption of operating at high service frequencies, while enhancing reliability (fewer point machines and a less complex track layout) and sustainability (less embodied carbon and smaller construction sites). GoA4 means that no additional platforms are required at termini stations to allow crew changes, comfort breaks and cope with the variability that humans introduce to a system (staff being 30s late for a shift can have significant consequences on the capacity of a high intensity service). A GoA4 system does not require these extra platforms as there are no on-train staff to consider. “MetroLink will be a GoA4 metro, which will allow for Unmanned Train Operation. Staff will be deployed to provide customer support, revenue protection and maintenance of the system.

In the operational start-up phase and during the first introduction of the passenger service, it will be possible to allocate a staff member per train as temporary measure. This will not involve the provision of extra platforms or staff facilities as the system will not be operating at or near the highest frequency that is designed for.

[57] The Benefits of Automation Transport Infrastructure Ireland – SNC 2019

Flexibility and resilience

Fully automated operation enables MetroLink to operate a demand-based rather than a timetable-based service (as traincrew management is no longer a constraint) and enables service levels to be dynamically adjusted to meet the real-time (or predicted) demand or in response to external events.

Cost effectiveness and Value for Money

Automation enables precise optimisation of railway operations, whether in the operation of an individual train, the optimisation of a train service, or the ability to minimise the amount of infrastructure to meet a required level of capacity. Automatic driving will make most efficient use of coasting while maintaining journey time and capacity requirements, and therefore reduce the use of traction power. Automated driving will also co-ordinate train movements to make the most effective use of traction power savings through maximising the opportunities for regenerative braking. The smoother operation and reduced use of braking will reduce wear on system components, reducing the embodied carbon in replacement parts and maintenance activities. As fully automated trains do not require human drivers, train moves to locate drivers (e.g., bringing them back to a depot for the end of a shift or a meal relief) are eliminated, and the ability to change the service pattern to reflect actual demand eliminates energy wastage due to over-provision of train services.

Station automation promotes energy efficiency through the switching of station facilities (e.g., lighting, heating, escalators) in response to measured light levels, temperatures, and customer demand, rather than to a fixed schedule, or when a station supervisor notices that action is required. Stations and the depot may include microgeneration (solar and wind power) where possible, and this will be monitored by the same automation system to ensure peak performance is maintained, and to synchronise the use of energy while it is most abundant.

Highest Safety Standards

During normal operation, automated systems will be undertaking the basic functions of routing trains and supervising the service to identify the first signs of an anomaly. These systems can do this faster and with a lower error rate than a human operator, and without the risk of distraction. This significantly reduces the risk of incidents being initiated by staff error and gives the control centre staff the ability to take a wider view of the service and the infrastructure, potentially identifying issues that an automated system would be less likely to detect and being able to intervene before they threaten the safety of the railway. As detailed in Appendix G, Automated systems also offer significant advantages when operating in degraded and emergency modes. Passenger safety at platforms is greatly enhanced by the platform screen door, generally adopted in most GoA4 systems.

World Class customer service

Railway systems are complex, and like all complex systems, do suffer from performance degradation and breakdowns that have a direct impact on passengers. These failures may be the result of equipment suffering a breakdown, perhaps from a failed component; or may be due to external factors such as a grid power outage or a flooding event. However, failures are frequently a result of human error, a lack of human responsiveness, or staff unavailability. By allowing to focus on supervising the operation and assisting customer, automated systems can largely avoid failures resulting from human errors and shortcomings.

They also remove the variability of human response times and personal preferences, leading to a higher capacity, more consistent railway operation, using analysed and agreed best-practice for every decision. Automated systems are better equipped to deal with equipment failures, and some forms of external influences, through automatically switching to redundant systems with instant service reconfiguration. This enables component failures to be dealt with at times when the customer service will not be disrupted (e.g., overnight) and with less time pressure on the maintenance technician, leading to more in-depth diagnostics and higher-quality corrective work, significantly reducing the risk of a future repeat failure.

By utilising the highest levels of automation on monitoring, detection and control, the passenger benefits from the very highest levels of performance, resilience, and responsiveness. In addition, passengers benefit from the additional flexibility to be gained from releasing train services from staff shift patterns, and safety-related working time limits, that result from the need for train crew. If staff are late, it delays the train service, and the human operators (whether driving a preceding train or using a train to get into position for their next duty) will also be delayed; clearly this can form a vicious circle that causes minor delays to propagate into major disruption. Automated driving will be smoother than traditional manual train operation as hard brake applications will be reduced by the intelligent use of coasting; this will generate customer perception of improved ride quality. The train service reliability will be improved by removing the delays and the vicious cycle of service degradation caused by human operators not being in position. The automated train regulation system will ensure that small service perturbations are managed before they can grow into larger service disruptions; customers will perceive that trains will reliably arrive at regular intervals, and customer load will be evenly spaced between trains.

Finally, Transport Authorities that have adopted automated operation observe a higher degree of job satisfaction among staff than those working on GoA4 automated metros. This primarily due to the fact the driver is required to be present in the cab of the train, with the sole function of opening and closing the train doors. Occasionally the driver may be required to move the train manually during and emergency and therefore the role is perceived as being unskilled, repetitive, and routine leading to high levels of employee boredom and dissatisfaction. This compares with the more customer focused role required of personnel on a GoA4 system. Staff on GoA4 systems are freed of the responsibility of driving the train and are expected to carry out a more varied role which includes engaging with passengers on the train and the stations providing customer service and advice as required. They are also trained to drive the train in manual mode during emergencies. This modal provides for greater employee satisfaction and career advancement within the metro operations company.

For all of the reasons stated above, NTA / TII decided to develop MetroLink as fully automated Metro System.

Why not terminate the route at Tara Street?

The option to terminate the route at Tara Street station offers a significant cost saving. It would reduce the overall tunnel length by 2km and negate the need for two significant stations at St Stephens Green and Charlemont. This would result in an overall saving to the scheme currently assessed at approximately €1.1 billion However, truncating the alignment would result in a number of negative consequences for achieving the full benefits of the scheme including loss of patronage, St Stephens Green and Charlemont stations are amongst some of the busiest MetroLink stations, accounting for 16% of total boarding and over 18% of all alighting. To put that in context, of over 90 million trips estimated in 2060, over 14 million will start at Charlemont and St Stephens Green, and almost 17 million trips have these stations as their destinations. Losing access to these stations will increase journey times and reduce accessibility to these major destination areas. Overall, it is estimated that overall passenger volumes on MetroLink would reduce by 11%. This is considered to reduce the degree to which MetroLink would achieve its stated Intervention Objectives.

Access to key attractors would also be negatively. The proposed St Stephens Green station not only provides direct access to one of Dublin's most cherished and iconic City Centre areas, but it also provides easy access to one of Dublin's busiest shopping and business districts, servicing retail, commercial and cultural trip attractors in the vicinity. St Stephens Green station is also located in area that is particularly important from an employment perspective, providing direct access to one of the largest retail and commercial employment catchment areas in Dublin. If the route were to truncate at Tara Street station direct access to these key areas which include National Gallery of Ireland, National Museum, St Stephens Green and other shopping, leisure and cultural amenities would not be provided.

To assess the impacts on the overall benefits of the scheme associated to truncating the route at Tara Street, NTA / TII carried out a transport model run which considered the reduced overall demand on the system arising from the loss of patronage at St Stephens Green and Charlemont stations. Overall, it is estimated that overall passenger volumes on MetroLink would reduce by 15.64%, with a corresponding reduction in public transport benefits in the range of €1.5 billion (net present value basis).

Airport to Estuary – A Fundamental Part of MetroLink

The main stated objective of MetroLink is *"to provide a sustainable, safe, efficient, integrated and accessible public transport service between Swords, Dublin Airport and Dublin City Centre".* This objective can also be applied to its predecessor Metro North.

Aligned with this objective MetroLink is vital for the transformation of Swords town and County Fingal as a whole, by providing a high-speed, high-capacity, high-frequency public transport link from the city centre to Dublin Airport and Swords.

Fingal is the fastest growing county in Ireland with a population of 296,214 as of Census 2016. The population increased by 77% between 1996 and 2011, and by 22,223 since 2011. This 8.1% increase is the highest of any county or city in the last five years and is over twice the national rate of increase.

Fingal County Council recognises that MetroLink is a key piece of infrastructure to shape and unlock the long-term development of Swords and Fingal. This will be to the benefit of all living and working in Swords and environs. The alignment of the metro service alongside the R132, will influence the built environment along the linear transport corridor. The metro will connect local population and create mixed use development opportunities for large tracts of zoned lands along the metro link route. The metro service will serve as an economic activity corridor. This will provide the local population with vital connectivity and access to jobs, services, accommodation, and local amenities all within close proximity of each other. However, the urban design will need to provide high-quality public spaces with particular attention to urban elevations along road frontages. Focus on character of the built environment, will help create a sense of place.

It is important also to note that the Airport Sword link is a significant contributor to the overall benefits of the MetroLink scheme. In the Opening Year of the scheme over 30,000 (32%) of the 12-hour passenger boarding are from the Airport to Estuary section of the scheme. This increases to 58,000 in 2060 significantly to the overall benefits of the scheme[58].

In summary the development Metrolink and in particular the section between Airport and Estuary will explicitly support:

- The development of high-tech research and development opportunities at Lissenhall East.
- The reduction of car dependency and support sustainable modes of transport / smarter travel.
- Long-term development of Swords and Fingal.
- The role of Dublin Airport as a Global Gateway.
- The role of Dublin Airport as County Fingal's largest employer.

For all of the above reasons providing metro service between Airport and Estuary remains a key component of the MetroLink scheme.

[58] NTA Value for Money exercise, Variant 1 is the route stopping at the Airport 2021 Modelling.