METRO LINK

Integrated Transport. Integrated Life.

Cover Note to Preliminary Business Case

Rialtas na hÉireann Government of Ireland

Tionscadal Éireann Project Ireland 2040

Bonneagar Iompair Éireann Transport Infrastructure Ireland

NTA Údarás Náisiúnta Iompair National Transport Authority

Introduction and purpose

The main preparatory work on the MetroLink Preliminary Business Case (PBC) was carried out during 2020. The cost estimation work was finalised in May 2020, using Q4, 2019 base figures, in order to allow the economic and financial analysis to be undertaken for the Preliminary Business Case.

In addition to the finalisation of costs in mid-2020, the delivery time schedule for the PBC analysis work was also established at that time, with an enforceable railway order projected for Q2 2022, main construction completion anticipated at the end of 2030 with MetroLink taking passengers in 2031

Following its finalisation in 2020, the PBC was subsequently reviewed by the NTA, prior to its submission to the Department of Transport. In the intervening period since the PBC costs and schedule were established, construction inflation has significantly increased, and the originally anticipated timelines are no longer applicable.

This cover note sets out the impact of the revised inflation parameters and the later delivery schedule of MetroLink on the overall project costs. All figures stated exclude VAT.

How to use this cover note

This cover note provides readers with the updated information that was supplied to Government to inform its final decision for Approval in Principle, Decision Gate 1 on 4 July 2022.

In line with the requirements of the Public Spending Code, the PBC is to be published. This PBC document was considered by Government in conjunction with the updated cost, schedule and benefits information set out in this note.

For clarity, these changes have not been reflected throughout the PBC document and where updates as provided in this Cover Note apply to the PBC, these are indicated with a note and / or watermark on the individual chapters / pages of the PBC document.

Key updated details

The key updated details relate primarily to cost, benefits and programme.

Accordingly, readers should note the following details when presented with cost, benefit and programme information in the PBC document.

Updated Timeframes

As identified earlier, the main preparatory work on the MetroLink PBC was carried out during 2020, with cost and time estimates finalised in May of that year in order to allow the economic and financial analysis to be undertaken for the PBC.

With the passage of time, those timelines upon which the PBC was developed are no longer applicable. Accordingly, a revised delivery timeline has been developed which reflects current schedule estimates and takes account of the funding profile in the first period of the National Development Plan 2021-2030.

Having now progressed through Decision Gate 1 Approval in Principle, MetroLink is advancing according to the following timeline:

Table E-2: Key business base milestones – updated from Page iv in PBC

Milestone	Original Anticipated Timeline	Revised Anticipated Timeline
Approval in Principle: Decision Gate 1	Q4 2021	July 2022
Submit Railway Order Application	Q2 2022	Sept' 2022
Detailed Project Brief and Procurement Strategy Submission	Q3 2022	Q2 2023
Pre-Tender Approval: Decision Gate 2	Q2 2023	Q2 2023
Tenders issued	Q2 2023	2024 / 2025

Milestone	Original Anticipated Timeline	Revised Anticipated Timeline
Railway Order granted	Q4 2023	Q1 2024
Final Business Case	2024 / 2025	2025
Approval to Proceed: Decision Gate 3	2024 / 2025	2025
First Taking Passengers	2031	2034

Updated Cost Forecast

Delivery costs in the PBC were generated using Q4 2019 prices, with assumptions for inflation levels then observable used for the forecast cost numbers produced. Prior to approval, updated cost information was generated: firstly, by rebasing prices to Q4 2021 as the most recently observed rates, and then with updated inflation forecasts given the observed impacts of inflation in the current market. In addition, the start of construction assumptions, linked to the receipt of an Enforceable Railway Order, were also updated adding additional inflation to the cost forecast.

These changes result in an increase in the overall cost reported in the PBC, best summarised in the following tables:

Box 4.1: Base Cost Forecast – Updated from page 40 of PBC

Box 4-1: Base cost forecast

Base costs of MetroLink, prior to the addition of risk and inflation allowances is as follows:

	(€ Q4 2021)
Direct Works (Construction):	€4.59 billion
Land & property:	€0.44 billion
Authority Costs:	€0.77 billion
Base Cost Forecast:	€5.80 billion

Box 4.3: Risk allowance range – Updated from page 41 of PBC

Box 4-3: Risk allowance range

P30 Risk Allowance (Q4 2021)	P50 Risk Allowance (Q4 2021)	P80 Risk Allowance (Q4 2021)
€0.41 billion	€1.74 billion	€3.03 billion

Updated summary table – Updated from page 41 of PBC

	P30	P50	P80
Base Costs *(constant prices)*	€5.80 billion	€5.80 billion	€5.80 billion
Risk Allowance	€0.41 billion	€1.74 billion	€3.03 billion
Total Cost (excl. inflation) (€ Q4 2021)	€6.20 billion	€7.54 billion	€8.83 billion

Box 4-4: Inflation Ranges – updated from page 42 of PBC

Box 4-4: Inflation ranges

	P30	P50	P80
Low	€0.96 billion	€1.11 billion	€1.42 billion
Medium	€1.48 billion	€1.96 billion	€2.37 billion
High	€2.07 billion	€2.43 billion	€3.42 billion

Box 4-5: Delivery Cost Summary – updated from Page iii and page 42 of PBC

Box 4-5: Delivery cost summary

		Without inflation (Q4 2021)	With inflation
Management Stretch Target:	P30 Low	€6.20 B	€7.16 B
Management Base Target (Central Cost Forecast):	P50 Med	€7.54 B	€9.50 B
Prudent Client Appraisal Value:	P80 High	€8.83 B	€12.25 B

Updated Benefit-Cost Ratio

The change in the delivery cost forecast, and the changes that led to the updated delivery cost forecast, would also impact the cost benefit analysis set out in the PBC. For example, the shift in the timing of construction will delay the realisation of benefits.

These changes result in an overall adjustment in the economic appraisal results as set out in the following table:

Economic Appraisal Results updated from table in PBC - Page 50

Scenarios	Core	NDP	Low growth	Alt growth	NDP & Alt growth
*PV Benefits Original	15.6	12.9	13.6	13.5	12.6
PV Costs Original	8.6				
Original BCR's	1.8	1.5	1.6	1.6	1.5
Cost +30%	1.4				
Cost -30%	2.5				
*PV Benefits Revised	13.7	11.3	11.9	11.9	11.1
PV Costs Revised	9.9	9.6	9.8	9.9	9.7
Revised BCR's	1.4	1.2	1.2	1.2	1.1
Cost +30%	1.1				
Cost -30%	2.0				

*All values are present value € billions.

In addition, when the sensitives are considered, the range of benefit to cost ratios relevant for MetroLink are between 1.1 and 2.0 for the +/- 30% Cost Sensitivities.

Refer to updated infographic attached, updated from PBC Page iii of the foreword.

Summary

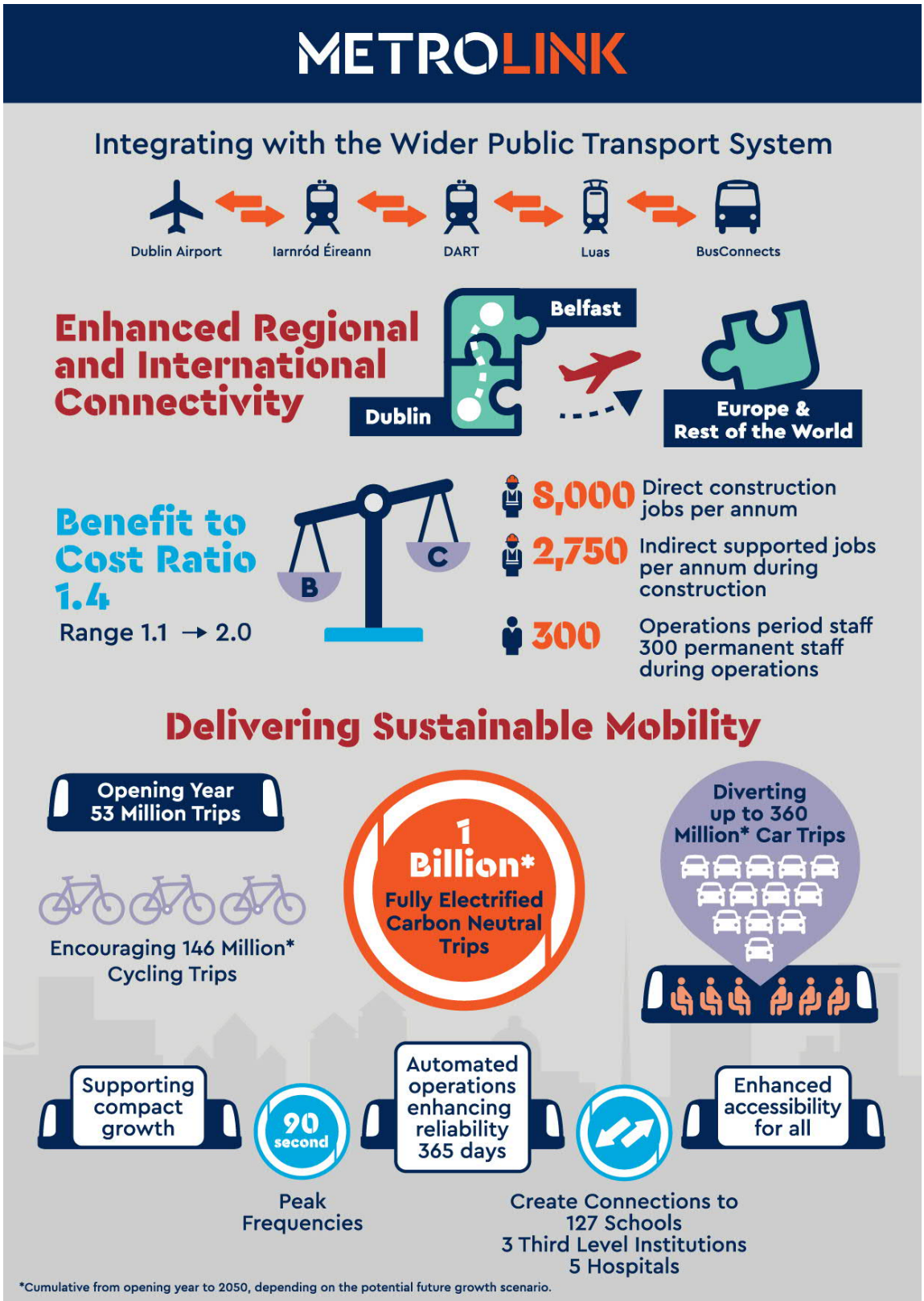
In summary, the key changes are as follows:

- Opening year 2034 subject to an enforceable Railway Order (planning permission granted) Q1 2024
- A capital cost range of between €7.16 billion and €12.25 billion with a central (P50) figure of €9.5 billion nominal (Box 4-5)
- Benefits to the Irish economy and society to the tune of €13.7 billion present value over 60 years

Key chapters and Appendices to which this note applies:

- Chapter 4 and subsequently relied upon in Chapters 5, 7 and as supported by Appendices E, F and I; and
- Chapter 10

Updated Infographic



METROLINK

Integrated Transport. Integrated Life.

Preliminary Business Case

February 2021

Rialtas na hÉireann Government of Ireland

Tionscadal Éireann Project Ireland 2040

Bonneagar Iompair Éireann Transport Infrastructure Ireland

NTA Údarás Náisiúnta Iompair National Transport Authority

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

FOREWORD

MetroLink is the single biggest investment in transport infrastructure in the history of the State.

A project of this scale has the power to transform the lives of the 1.4 million people projected to live in the Dublin region by 2040. The growing population and resulting high-density housing will create demand for a reliable, high-capacity, sustainable public transport system that helps Ireland meet its climate change targets.

MetroLink is, therefore, not a stand-alone transport project, but a key scheme in an overarching strategy to make Dublin a liveable city. Its need has been established in every relevant transport study and policy document including the Transport Strategy for the Greater Dublin Area 2016-2035, the Fingal / North Dublin Transport Study 2014-2015 and the National Development Plan 2018-2027.

It aligns strongly with several of the National Strategic Outcomes of Project Ireland 2040, by enabling compact growth, enhancing regional accessibility, delivering sustainable mobility, contributing to our transition to a low carbon and climate resilient economy and being a significant element of high-quality international connectivity.

Given the scale of the investment and the imperative to deliver benefits that justify its cost, MetroLink represents a unique challenge in the Irish context. For this reason, a unique approach has been taken with this Preliminary Business Case.

MetroLink has been subjected to a vigorous cost forecasting process, in full alignment with the Public Spending Code 2019, benefiting from three independent bottom-up cost forecasts, detailed risk analysis, and external verification through reference class forecasting.

We have collaborated with Professor Bent Flyvbjerg of Oxford Global Projects (OGP), the world's most cited scholar in the field of mega-projects. OGP has benchmarked MetroLink's cost forecast against the cost performance history of over 200 complete projects, predominantly metro and tunnel projects, resulting in a significant contingency being part of the forecast cost of the project. The forecast cost, including contingency, is the figure used in the calculation of the Benefit to Cost Ratio. Expenditure of this contingency is not inevitable. In many of the reference class projects predictable risks materialised. Controlling the risks will require the commitment and co-operation of the many sectors of the state which will have an influence on the delivery of this mega-project.

Benefits have been monetised as part of the economic appraisal, resulting in a Benefit to Cost Ratio range of between 1.4 and 2.5. At this level, the project is a positive investment for the people of Ireland.

In common with other mega-projects, MetroLink will take many years to develop and build, involving multiple public and private stakeholders. This interdependence with other agencies and organisations adds complexity to the forecasting of costs and benefits. An awareness of these externalities is an important issue when considering major schemes like MetroLink.

For example, costs have been forecast based on certain assumptions such as the tunnel boring machine operating on a continuous basis. If, through the planning process or subsequent legal proceedings, the construction methodology is altered, there will be a cost impact and some of the contingency will be required.

Similarly, MetroLink's high capacity is designed to meet demand created by high-density housing in the north Dublin region. Should the residential developments projected for the area fail to materialise, MetroLink's benefits will not be realised to the full extent presented.

MetroLink has the potential to provide a significant contribution to addressing the challenge of achieving compact growth, sustainable transport and the transition to a low carbon society in the Dublin region. However, its maximum potential can only be realised with the support of all sectors of the State, working together to ensure the people of Ireland receive maximum value from this investment and that the project is delivered on-time and on-budget.

I would like to thank the members (current and former) of the joint National Transport Authority / Transport Infrastructure Ireland team that have brought MetroLink to this critical stage. The work to date has been significant. Much more work lies ahead.

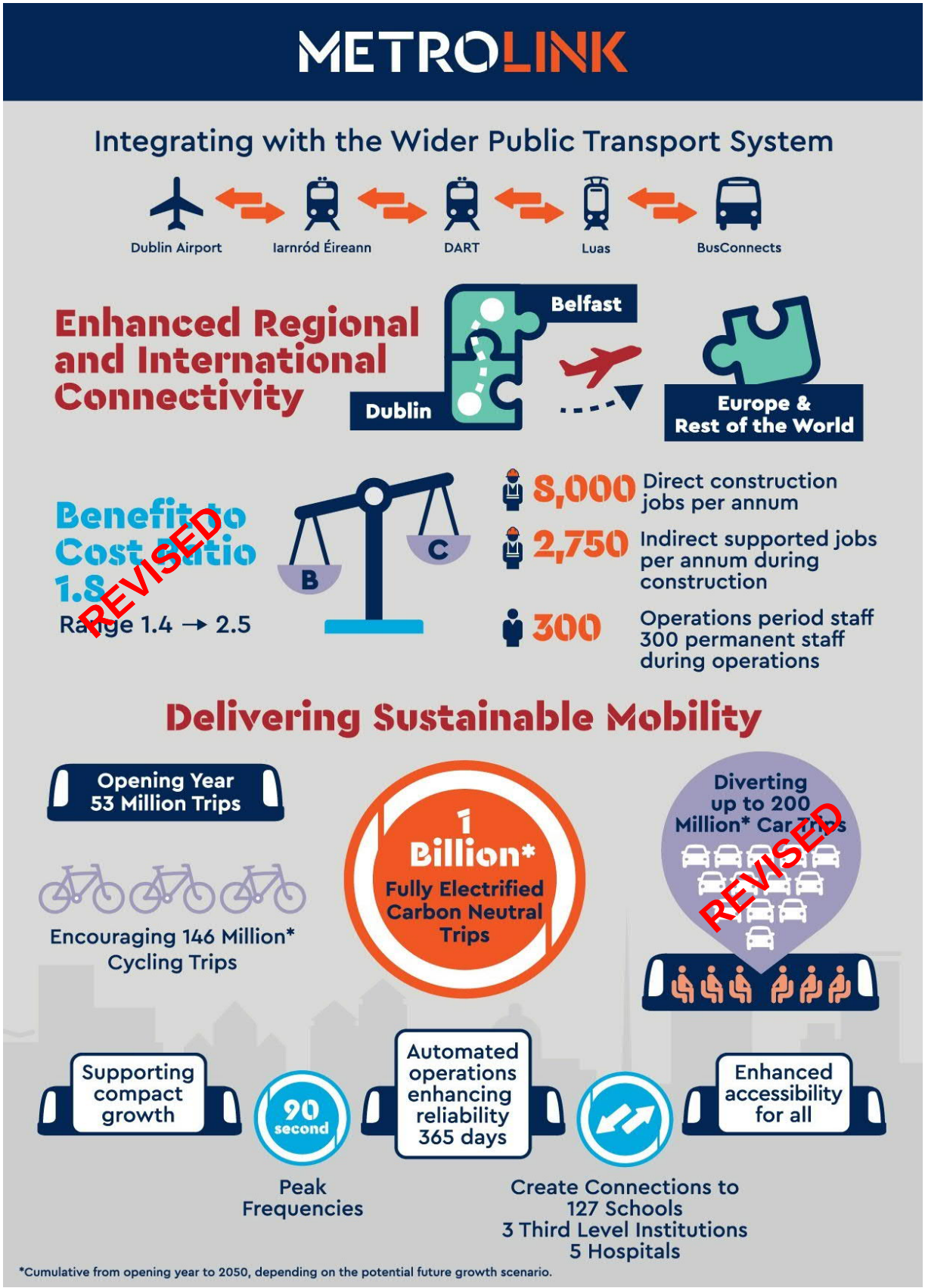
Great care, due diligence and peer reviews have been undertaken to ensure the Preliminary Business Case for MetroLink is a balanced assessment, free of bias and a prudent reflection of the project undertaking, which will enable Government to make an informed decision on what will be an intergenerational legacy for the nation.

Peter Walsh

Chief Executive Officer

Transport Infrastructure Ireland

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



Contents

Executive Summary

Ireland is outgrowing its current transportation infrastructure. In 2019, Dublin was ranked the 17th most congested city in the world (an improvement from 14th in 2018) and 6th in Europe[1]. Without intervention, the problem is anticipated to get worse as the population continues to grow.

At the last census in 2016, Ireland's population stood at just under 4.8 million, having grown by 3.8% since 2011. Dublin City's population grew 5.1% in the same period, while North Dublin's population grew 8.0%. Swords was the second largest town in Ireland, and by 2040, CSO moderate estimates predict that the population of Ireland will grow by an additional one million people.

Meanwhile, the Greater Dublin Area is facing a considerable housing challenge. More houses need to be built to address a deficit of supply (which is keeping current prices high).

The Swords, Dublin Airport, Dublin City Centre corridor is negatively impacted by the noted trends, and, in addition, the corridor plays a critical role in the national economy: it facilitates the efficient functioning of two major international gateways (Dublin Port and Dublin Airport); and provides a key economic link within the Belfast / Dublin Economic Corridor that is flagged for protection in the Project Ireland 2040 National Planning Framework.

It is this combination of need, to address housing and land-use patterns, coupled with maintaining and protecting the economic efficiency of this corridor, that elevates the requirement for a public transport intervention in this area.

The need for intervention on the Swords, Dublin Airport, Dublin City Centre corridor has been the subject of extensive study over the past two decades. Most recently, the Fingal / North Dublin Transport Study 2014-2015 determined that the appropriate intervention was a rail service connecting from north of Swords, through Dublin Airport and to Dublin City Centre. This solution was included in the Transport Strategy for the Greater Dublin Area 2016 – 2035. Since then, thorough and extensive assessment has been undertaken in line with the Public Spending Code (PSC) 2019 and Common Appraisal Framework (CAF), including appraisal of alternative options, route option analysis and demand analysis. Through this process, MetroLink emerged clearly as the preferred public transport intervention for the area and the final design benefits from stakeholder feedback gathered through two non-statutory public consultations (2018 and 2019).

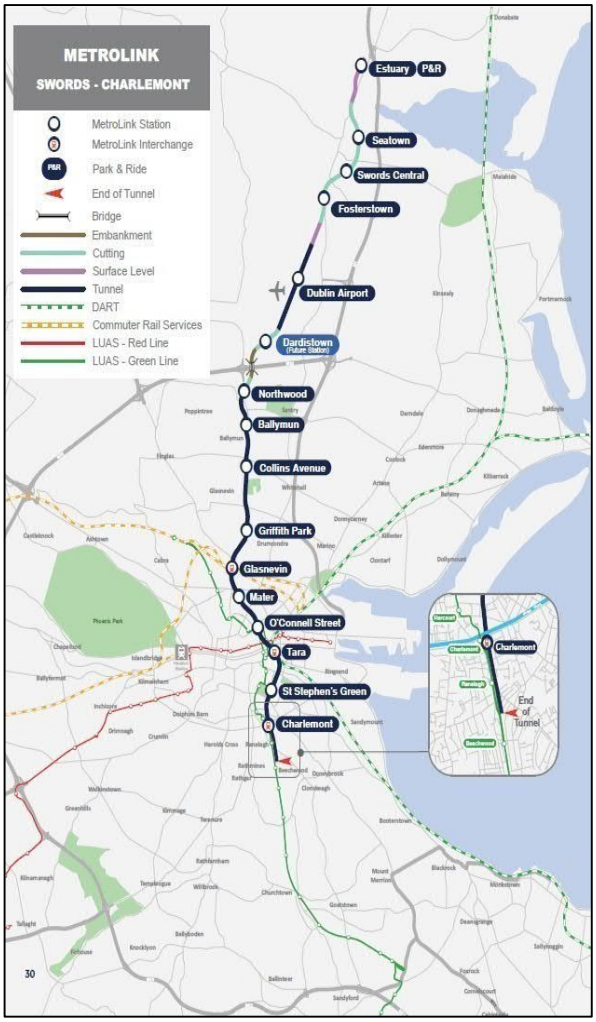


Figure E -1: MetroLink Preferred Route.

Metrolink's primary objective is to provide a sustainable, safe, efficient, integrated and accessible public transport service between Swords, Dublin Airport and Dublin City Centre,

Figure E -1: MetroLink Preferred Route.

[1] Tom Tom

forming a key spine of the proposed integrated public transport system for Dublin which includes DART+ and BusConnects projects. It is fully aligned with the Government's National Planning Framework (including strong alignment to the national strategic outcomes), the Programme for Government, Regional and Local Development Plans, Area Transport Strategies, the Climate Action Plan 2019, Climate Action and Low Carbon Development Bill 2020, and TII's Environmental Strategy. It is also fully aligned with the European Green Deal and UN Sustainable Development Goals.

MetroLink is strongly aligned to the National Strategic Outcomes set out in Project Ireland 2040:

- Sustainable Mobility: MetroLink is the quintessential sustainable mobility solution providing over 1 billion carbon neutral, fully electrified, passenger trips by 2050 and encouraging some 700,000 people within a 10-minute cycling distances from a station to undertake 20,000 cycling trips per day and 120,000 walking trips per day;

- Transition to low carbon future: MetroLink will create the opportunity for diversion of 6.8 million private vehicle journeys per annum in the early years of operation (growing to 12 million by 2045) of MetroLink (approximately 360 million car trips diverted by 2050);

- Compact growth: MetroLink will provide the planning nodal structure to almost 9,500 hectares of land that comes within a 2.5-kilometre radius of its 15 stations that are spaced out along its 19.4-kilometre route. This will encourage compact growth development in housing, another significant factor in addressing the housing market challenges while furthering Ireland's sustainability goals.

- Enhanced regional connectivity: MetroLink will facilitate, for the first time, the ability for anyone to complete a journey from their point of origin to Dublin Airport just using rail, Luas and MetroLink. In addition, travellers and commuters arriving on Irish Rail from all parts of Ireland will be able to access MetroLink and the north / south of the city with the opportunity to interchange at Glasnevin and Tara Street MetroLink Stations.

- High quality international connectivity: MetroLink will support the efficiency and growth of Dublin Port and Dublin Airport by creating an additional passenger access opportunity and allowing for optimisation of the surrounding road and public transport networks.

- A strong economy supported by enterprise innovation and skills: MetroLink will help to stimulate economic activity, encourage innovation and grow our national skills base. MetroLink will support between 7,200 and 9,100 direct construction jobs for each year of construction activity, as well as a further 2,500 to 3,000 indirect supply chain and support related jobs each year. Following construction, MetroLink operations and maintenance will require over 300 permanent skilled jobs, offering further opportunities for continued training and skills development. The operations and maintenance phase will also require continued regional support for infrastructure maintenance activities over its useful life.

In addition to these strongly aligned national strategic outcomes, MetroLink is also supportive of the remaining outcomes of enhanced amenity and heritage, access to quality childcare, education and health services, sustainable management of water, waste and other environmental resources and strengthening rural economies.

In general, when designed well and integrated into land-use planning, public transport is expected to generate important economic, environmental, and societal benefits. Effective and efficient public transport provides people with mobility and access to employment, community resources including educational institutions, medical care, and recreational opportunities. MetroLink will connect passengers to 127 schools, three third level institutions and five hospitals.

Integrated public transport provides significant benefits not only to those who choose to use it, but also those who have no other choice. It provides benefits to those people who choose

to remain either in their private vehicles or to use other active modes such as cycling, and it creates the opportunity for the road transport system to achieve optimum levels of efficiency and effectiveness.

Many of these benefits have been quantified for the purposes of the economic appraisal of MetroLink, resulting in a Benefit to Cost Ratio range of between 1.4 and 2.5. At these levels, MetroLink, is a very positive investment for the people of Ireland, in the country's journey to a low carbon and a more sustainable transport network.

Over 60 years of operation, MetroLink will save the equivalent of almost 3,000 lifetimes of time spent sitting in traffic congestion.

MetroLink will take its first passengers in 2031 and will be a fully automated system, offering high frequency (90 seconds between trains during peak hours), reliable and sustainable trips for 53 million passengers in its first full operating year, and growing to over 100 million passengers per annum in time.

To deliver such a system will take the combined efforts and focus of over 8,000 construction workers every year, together with the support of a further 2,750 or so indirect supply chain related jobs – all striving cohesively for the delivery of this intergenerational asset for Ireland.

Construction is expected to take almost nine years including testing, commissioning and operational start-up.

Because of the scale and, in an Irish context, unique nature of MetroLink, a comprehensive approach has been taken to forecasting cost. The direct works cost of constructing MetroLink has been forecast by the project team using traditional bottom up costing principles, identifying work packages and considering the inputs to deliver the work package in terms of labour time and materials, equipment costs and the cost drivers and unit prices of various work activities. The accuracy of any direct works cost forecast is a function of the level of design and specification development that has been undertaken. Over the last five years, the project team has developed a comprehensive preliminary design, technical specifications and operational and user requirements for MetroLink.

Two additional independent and separate shadow direct works cost forecasts were undertaken, by two independent cost forecasting firms, to test for potential additional variability in the assumptions or approach used for the direct works cost forecast. This verified the robustness of the direct works cost forecast and identified areas for further examination and refinement.

Having considered the direct costs, the project team has also undertaken a vigorous assessment process to establish the risk allowance for the project.

International experience demonstrates that almost no mega-project can be delivered at the forecast base cost figure. In practice all large projects have a myriad of risk factors that can impact on their delivery. For this reason, a risk allowance must be added to the base cost of a project to deal with the cost implications of such risks materialising.

Risks can be assessed individually using a Quantified Risk Assessment methodology and / or can be established by examining the historic cost performance of completed projects of a similar type. This is known as "Reference Class Forecasting", which uses a database of schemes of a similar "class" to ascertain risk allowances to apply to projects.

MetroLink has undertaken both a comprehensive Quantified Risk Assessment and Reference Class Forecasting to validate the project delivery budget range.

Delivery cost summary

	Without inflation (€ Q4 2019)	With inflation
Management Stretch Target:	€5.85 B	€6.28 B
Management Base Target:	€7.11 B	€8.16 B
Prudent Client Appraisal Value:	€8.50 B	€10.44 B

REVISED

Utilising reference class forecasting and quantified risk assessments, TII has established a base management target budget of €7.11 billion (€ Q4 2019, before inflation) and a stretch target to minimise the use of risk contingency, of €5.85 billion (€ Q4 2019, before inflation).

Despite these targets, to avoid potential optimism bias or other related risks, the Preliminary Business Case utilises a Prudent Client Appraisal Value of €8.50 billion (€Q4 2019,

before inflation), to undertake the financial and economic appraisal of MetroLink and to compare it against its benefits. This has ensured that the results of the financial and economic appraisal may be considered to be appropriately conservative for this stage of evaluation.

Utilising the Prudent Client Appraisal Value of €8.5 billion the base case scenario Benefit to Cost Ratio is 1.8 x.

Inflation is a key risk for the project, and an allowance range of between €0.43 billion and €1.94 billion has also been captured in the cost forecast and management budget targets.

The construction and operation of MetroLink will be undertaken jointly by the private sector and TII. As well as advanced and enabling works, it is envisaged that there will be three design build contracts covering the major civil design and construction of MetroLink, together with the procurement of a Service Delivery Partner that will be tasked with the full integration, systems installation, vehicle delivery, operations and maintenance of the line. These procurements will occur in the latter part of 2021 and into 2022 in anticipation of receipt of the enforceable Railway Order for the project to proceed to construction.

The next key milestones are proposed as follows:

Milestone	Anticipated Timeline
Preliminary Business Case Submission	Feb' 2021
Approval in Principle: Decision Gate 1	Q4 2021
Submit Railway Order Application	Q2 2022
Detailed Project Brief and Procurement Strategy Submission	Q3 2022
Pre-Tender Approval: Decision Gate 2	Q2 2023
Tenders issued	Q2 2023
Railway order granted	Q4 2023
Final Business Case	2024 / 2025
Approval to Proceed: Decision Gate 3	2024 / 2025

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Table E-2: Key business case milestones

Any delay in proceeding with MetroLink has significant implications. Dublin's population continues to grow, and traffic continues to get worse. Incremental change is no longer an option and further delays will place a high cost on society. Furthermore, construction costs are also likely to increase in the range of €100 million to €300 million per year of delay due to the impacts of inflation.

MetroLink is fully aligned with the Governments National Strategic Outcomes and is seeking approval in principle to proceed to the next decision gate in line with the Public Spending Code, 2019.

MetroLink will have a transformational impact on Dublin and Ireland. The need for invention is reaching critical levels and post Brexit, our economy and transport network needs investment to improve performance and long-term resilience. MetroLink is crucial to our transition to a low carbon future and offers the most sustainable mobility solution for the Swords, Dublin Airport, Dublin City Centre corridor.

1 Reviewing the challenge

"Give me six hours to chop down a tree and I will spend the first four sharpening the axe"

- Abraham Lincoln

Ireland is outgrowing its current transportation infrastructure. In 2019, Dublin ranked as the 17th most congested city in the world (an improvement from 14th in 2018) and 6th in Europe[2]. A single Dublin commuter will, on average, spend over 213 hours a year stuck in traffic (28 extra minutes each rush hour)[3]. Economists estimate that, without intervention, congestion and lost time will cost the Irish economy €2 billion per annum in 2033[4].

For those with no other choice than to mix with traffic, either on the bus or in their vehicle, this lost time is simply the price one must pay to gain access to viable employment, education, healthcare or other essential needs.

This problem is forecast to be exacerbated as Ireland's population continues to grow. At the last census in 2016, Ireland's population stood at just under 4.8 million, having grown by 3.8% since 2011. Dublin City's population grew 5.1% in the same period, while North Dublin's population grew 8.0%[5]. By 2040, moderate estimates predict that the population of Ireland will grow by an additional one million people[6].

Meanwhile, the Greater Dublin Area is facing a considerable housing challenge. House prices are rising, with average annual price growth from 2012 and 2019 ranging from 8.3% (Fingal) to 10.7% (Dublin City). Average wage growth over this period was only 1.3%, meaning that houses have become increasingly unaffordable, especially for first-time buyers. Along with other policy requirements, more houses need to be built to address a deficit of supply (which is keeping current prices high).

Box 1-1: The lost statistic

While the impact of congestion and the lost hours for travellers is significant, the inefficiency of the transportation system hides a lot of additional socioeconomic costs. The statistics quoted here only reference those willing to endure the peak traffic delays. However, the lack of reliable journey time has other more difficult to measure impacts. For example, system inefficiencies during peak hours can force many to commute at times that avoid the natural peak times. This is sometimes called "peak spreading".

This can often have the effect of making the transportation system look like it is more efficient than it is – and hides other costs. For example, peak spreading puts pressure on families, with one or more parents not being able to make the school run. This leads to increased childcare demands, or the requirement for one parent to remain in the household, which then creates a vicious cycle of reduced employment opportunity, reduced disposable income and socio-economic disadvantage. On the other side, for those that can afford it, it also can generate the desire for multiple vehicles at home (with associated negative environmental and sustainability impacts).

It follows that, an inefficient transportation system will generate other societal and economic inefficiencies, making an efficient, reliable and demand responsive transportation system crucial to a sustainable and resilient economy and society.

Challenge overview

The Swords, Dublin Airport, Dublin City Centre corridor is impacted by the noted trends, but in addition, the corridor plays a critical role in the functioning of the national economy. The corridor facilitates the efficient functioning of two major international gateways (Dublin Port and Dublin Airport) and completes the economic link between Dublin and Belfast (which is part of the Belfast / Dublin Economic Corridor, that is flagged for protection in the Project Ireland 2040 National Planning Framework). The efficiency of economic traffic movements along and around this corridor has implications for the entire nation, which is anticipated to become even more acute from 2021 following Brexit. Indeed, consideration must be given to improving the resilience of our trading corridor and port infrastructure to future economic shocks that may occur in the future.

[2] Tom Tom. as at 29 Nov 2020: https://www.tomtom.com/en_gb/traffic-index/dublin-traffic/
[3] Tom Tom. as at 29 Nov 2020: https://www.tomtom.com/en_gb/traffic-index/dublin-traffic/
[4] The Costs of Congestion: Analysis of the Greater Dublin Area, July '17
[5] Central Statistics Office: Census 2016
[6] Base on Central Statistics Office: Population and Labour Force Projections 2017 – 2051 M2F2 moderate forecast

Congestion is reaching critical levels along the Swords, Dublin Airport, Dublin City Centre corridor – a major artery for our economy (growth in traffic of between 30% and 35% was recorded between 2013 and 2019 on the national roads within the area of Influence of MetroLink such as the M1 and M50). The morning peak journey times for private vehicles from Swords Pavilion to St. Stephen's Green, approximately 19 kilometres, can be as much as 55 minutes or longer. This compares to off-peak times of between 25 and 35 minutes. This relative differential holds broadly for most origin and destination points along the corridor.

Major road infrastructure investments have been made, including Dublin Port Tunnel, the widening of the M50 and M1, and upgrades to the M1 / M50 interchange. Critically, the opportunity for further road infrastructure solutions here are very limited.

Public transport capacity along the corridor is constrained also. At present there are limited express bus services serving the Swords area with many of them covering long and circuitous routes around the Swords area before accessing the motorway network / areas of bus priority. These express services do not have any stops along the Swords, Dublin Airport, Dublin City Centre corridor and therefore only serve demand for travel between the city centre and Swords and do not offer any connectivity to other destinations along the corridor.

It is the combination of need, to address housing and land-use patterns as our population continues to increase, coupled with maintaining and protecting the economic efficiency of this corridor, that elevates the requirement for intervention in this area. The intervention is required and should allow the opportunity for the network to be optimised by freeing up capacity on the existing road network for more efficient goods and service transport and make the transportation network more sustainable and to create a more sustainable and liveable environment. The intervention must not only address the challenges of today – but the potential challenges of the future.

Pursuing sustainability

The United Nations ("UN") has published 17 sustainable development goals that consider sustainability in its widest perspective. These sustainable development goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges humankind faces, including poverty, inequality, climate change, environmental degradation, peace and justice[7].

The UN Sustainable Development Goals have in turn, been reflected and considered in the Project Ireland 2040 National Planning Framework and in the development of Ireland's National Strategic Outcomes.

Transport Infrastructure Ireland ("TII") strives to ensure that Ireland's National Roads and light rail infrastructure are sustainable. Even without considering general population growth, increased densities, or growth in economic activity, existing travel patterns are considered unsustainable. Transportation is the second-highest producer of greenhouse gas ("GHG") emissions in Ireland, contributing to approximately 20% of Ireland's total currently, and forecast to account for an even greater share unless additional measures are undertaken[8].

Ireland has made significant sustainability commitments, first to the European Union ("EU"), agreeing on target reductions of 43% by 2030 (against 2005 levels) for non-trading system emissions (which includes transport GHGs), and an 80% reduction by 2050 (against 1990 levels)[9]. A second commitment has been made through the Climate Action Plan 2019, where targets include a 30% reduction in GHG emissions by the public sector (by 2030) and support of a European Union ambition of net-zero GHG target by 2050.

To do all of this, Ireland's Environmental Protection Agency ("EPA") has estimated that the transportation sector GHG emissions must be

[7] https://www.un.org/sustainabledevelopment/sustainable-development-goals/

[8] Environmental Protection Agency: Ireland's Greenhouse Gas Emissions Projections 2019-2040

[9] Environmental Protection Agency: Environmental Indicators

reduced by roughly 90% from 2018 to 2050. With existing measures (such as the Biofuels Obligation Scheme) the transportation sector emissions will decrease by just 7% over the period 2020 to 2030, while with additional measures, such as increased public transport use, decreases of 37.8% can be achieved[10]. This will continue to leave a challenge in meeting the 2050 targets. Everything must be considered in striving to meet these targets.

A reduction in GHG emissions is just one pillar of sustainability. Improving urban air quality and reducing emissions that are harmful to human health, as well as protecting biodiversity, must also be considered. To do all this, more sustainable transport choices must be offered, such as permanent, fast, reliable, integrated and carbon neutral public transport.

An integrated transport solution

The transportation system is not unlike the human cardiovascular system. It is essential to the health of the economy. Often there are pressures and strains on the system that are evident, but the system does not break, the pressure gets relieved, diverted, or otherwise resolved or patched. The system can continue in this way for many years until one day, a major issue manifests, requiring intervention. With population growth across the country, together with increasing densities in certain areas, the pressure on the transportation system is increasing. Without appropriate intervention, this pressure threatens the entire system.

On account of the challenge, the National Transport Authority ("NTA") commissioned the Fingal / North Dublin Transport Study 2014 - 2015. This study considered the strategic need for an enhanced public transport network in Fingal / North Dublin to address issues relating to and stemming from current and future congestion and associated urban development patterns.

In general, when designed well and integrated into land-use planning, public transport is expected to generate important economic, environmental, and societal benefits. Effective and efficient public transport provides people with mobility and access to employment, community resources, medical care, and recreational opportunities. It provides significant benefits not only to those who choose to use it, but also those who have no other choice. It also provides benefits to those people who choose to remain either in their private vehicles or to use other active modes such as cycling, and it creates the opportunity for the road transport system to achieve optimum levels of efficiency and effectiveness.

The incorporation of effective public transport options, and related considerations, into broader economic and land-use planning can also help a community to expand business opportunities, reduce sprawl, and create a sense of community through integrated transport and land-use development. For these reasons, areas with good public transport systems tend to thrive economically and offer locational advantages to businesses and individuals choosing to work or live near them.

An effective public transport system also creates an opportunity to change the road user mix – which can lead to more efficient and effective use of the road network, improving journey times, air quality, and energy use, all of which benefit both users and non-users alike.

An effective public transport system can deliver important benefits to wider society in respect of:

- Economy: Shorter travel times increase economic efficiency and allow more people to reach educational or employment opportunities in a reasonable amount of time;
- Well-being: Shorter, safer and more reliable trips reduce travel-related stress and the risk of travel-related collisions;
- Access and social inclusion: providing a travel option to those without alternatives, accessible for all abilities, improves societal outcomes, reduces inequity, and encourages a more vibrant and enhanced community

[10] Environmental Protection Agency: Ireland's Greenhouse Gas Emissions Projections 2019-2040

environment for all[11];
- Competitiveness: Effective public transport encourages compact urban development, leading to shorter trips and efficient travel which attracts business and tourism, as well as extending the labour market catchment area for employers; and
- Sustainability: Reducing private vehicle dependency and related vehicle emissions and creating opportunities for more sustainable modal choices.

Appraisal of alternatives

The Public Spending Code, 2019 and Common Appraisal Framework ("CAF") require an appraisal of alternatives to the proposed scheme as part of the preliminary business case.

MetroLink, as presented herein, is the culmination of many years of assessment and appraisal to date. Given the scale of the project undertaking and the timeframes in developing design, preliminary engineering, public consultation, cost forecasting and other activities (see Appendix O for an outline of the evolution of MetroLink alignment, system capacity and design), the appraisal of alternatives has extended over a number of years.

In accordance with project appraisal guidance, the following options are assessed against the common project appraisal criteria set out by the CAF (economy, safety, integration, environment, accessibility):

1. Do nothing (no intervention undertaken);
2. Do alternative modes;
3. Do management-based interventions; and
4. Do the preferred mode.

1. Do nothing:

The do nothing option fails to meet any of the assessment criteria. With no improvements made to the current transport systems, transport travel demand will continue to increase, but the current transport system will not increase its capacity. With this increase in transport travel demand, use of the private car will also increase, leading to an increase in congestion levels and to detrimental environmental impacts. As a result, this is not an environmentally sustainable solution. By doing nothing, there is little improved possibility of interchange between public transport systems as the current systems are not fully integrated. As such, doing nothing is not an option for consideration.

2. Alternative modes:

The Fingal / North Dublin Transport Study, 2014-2015 considered multiple public transport infrastructure solutions as part of an integrated public transport intervention in the study area. The Stage 1 – Appraisal Report assessed a total of 25 different public transport options across the three different technologies (heavy rail, light rail and bus rapid transit) against the CAF common project appraisal criteria. The study utilised a multi-criteria analysis to shortlist six viable options. The Stage 2 – Appraisal Report undertook detailed demand, capacity, and cost analysis leading to the exclusion of two options: a bus rapid transit option and a heavy rail option, as neither could provide enough capacity to manage the anticipated forecast demand levels in the study area. The four remaining options were taken forward for economic assessment.

The four options appraised were:

1. Heavy rail from Clongriffin to Swords (HR2);
2. Tunnelled light rail from Luas Cross City to Swords via the airport (mixed segregation) (TLR3);
3. Tunnelled fully segregated light rail from St. Stephen's Green to Swords via Dublin Airport (LR7); and
4. A heavy rail line from Clongriffin to the airport and a light rail running from Luas Cross City to Swords (C1).

Perhaps the most interesting element of the results shown in Figure 1 - 1 is how different the benefit-cost ratios ("BCR") are for TLR3 and LR7. Both projects involved tunnelling and so were assessed to be of similar relative capital

[11] Accessibility is embedded in MetroLink design and is a core goal for TII. MetroLink follows Universal Design principles. TII has also recently published Walking in a Woman's Shoes which provides important perspectives on how women engage with and access the transport system. Further work across additional cohorts of passengers is anticipated in the future.

expenditure. The major difference between the projects then, was the level of benefits each would produce, linked to their capacity to carry the anticipated passenger demand.

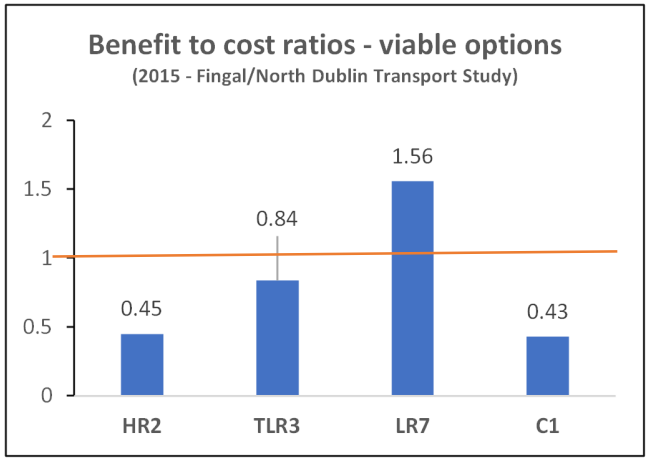


Figure 1 - 1: Benefit to cost ratios of public transport options. Source: Fingal / North Dublin Transport Study 2014 – 2015.

Figure 1 - 1 Explained: the figure profiles as a bar chart, the benefit to cost ratio of each of the four viable public transport options that were subjected to economic appraisal in the Fingal / North Dublin Transport Study 2014 - 2015. The y-axis is the benefit to cost ratio, the x-axis lists the options. Critically, only LR7 has a benefit to cost ratio greater than 1, i.e. the benefits were anticipated to outweigh the costs and generate value for money.

TLR3, being non-segregated (runs with other traffic and is not in its own dedicated right of way) for a portion of its alignment, had a capacity constraint of 7,000 passengers per peak hour in one direction. LR7, being fully segregated (in its own right of way), could significantly reduce headways, increase speed, all while maintaining safety, and so could carry the full anticipated regular demand of the study area estimated to be over 10,000 passengers per peak hour in one direction as part of the study.

Importantly, LR7 was found to be the only option to deliver a BCR which was greater than 1 and therefore at that time, was the only option anticipated to offer value for money. LR7 represents an optimised version of the original Metro North concept[12].

[12] Metro North was the original project concept for the corridor, which received planning approval and was subsequently suspended by the Government during the economic crisis in 2011.

3. Management based intervention:

Management-based intervention was considered on the basis that travel demand in the Fingal / North Dublin area is anticipated to grow by up to 40% by 2033. Although a certain proportion of this growth can be absorbed by the existing public transport network, the road network is likely to experience the highest level of demand.

As a result, various management options can be adopted as a means of further encouraging the use of public transport, as well as reducing the use of the private car. This option proposed a revision of current fare structures in order to flatten transport demand during peak hours. This would involve introducing a reduced flat fare for the use of public transport to attract more users during the off-peak hours and utilise the existing capacity of the services. Additionally, bus or rail services on this and adjacent corridors within the catchment were also increased without enhanced infrastructure in order to maximise public transport capacity. In turn, this would reduce the levels of congestion on the road network during these times.

However, while this may provide a short-term solution for managing travel demand, it is not sustainable in the long term as there is a limited capacity on DART and bus services that can be increased without significant investment in infrastructure, constraining the benefits that this alternative brings. Similarly, there would be issues of connectivity and accessibility to public transport services that restrict its availability to passengers of reduced mobility whereby surface level mixed traffic public transport presents a number of additional accessibility barriers to those of reduced mobility than a fixed schedule, fixed infrastructure, fixed design system such as MetroLink. If this is the case, there may be little benefit to reducing public transport fares.

4. Preferred mode:

While alternative modes and management-based interventions would meet the objectives to an

extent with regard to catering for existing demand and enhancing environmental sustainability in the short term, they do not meet the objectives when considered in the long-term and therefore are not sustainable solutions to the problems being faced. Neither alternative caters for the future demand or has long-term sustainable environmental impacts and so cannot be considered as viable alternatives.

Following the Fingal / North Dublin Transport Study 2014 – 2015 further detailed demand modelling was considered for the corridor. This analysis showed that, over time, peak period capacity requirements would increase from 14,000 in initial years, to be in excess of 18,000 passengers per direction in the future. The only public transport option that can support the timing and level of demand anticipated is a metro system[13].

The preferred mode, a metro solution, is the only alternative that succeeds in meeting all of the CAF common project appraisal criteria . It will not have issues of capacity and therefore will be able to cater for both existing and future levels of transport travel demand, as well as being a more environmentally sustainable option. The outcomes of the Stage 1 appraisal of alternatives is summarised using a five-point scale to indicate how well each alternative meets the CAF common project appraisal criteria.

	Alternative			
	1	2	3	4
Economy				
Safety				
Integration				
Environment				
Accessibility and social inclusion				
TOTAL	Fail	Fail	Fail	Pass

Figure 1- 2: Summary result of consideration of alternatives

assessment. 1 = Do nothing; 2 = alternative modes; 3 = management interventions; 4 = preferred mode.

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

Figure 1- 3: Five-point evaluation scale.

It is noted that, with respect to option two, do alternative modes, that the analysis of the alternative modes was undertaken as part of the Fingal / North Dublin Transport Study, 2014-2015. The Fingal / North Dublin Transport Study, 2014-2015 was a comprehensive options assessment and included detailed economic appraisal assessments of each option on the same cost and assumption basis.

As the preferred mode is the only mode that meets the stated objective in the Fingal / North Dublin Transport Study 2014 – 2015 of catering to current and future long term patronage growth through the provision of high frequency service, TII has determined that, if the options assessment for alternative modes was undertaken again, the conclusions of that study is unlikely to be different. Furthermore, it is important to highlight that, while the options assessment was undertaken, the appraisal against the CAF criteria is being applied as part of this preliminary business case.

Accordingly, it is not anticipated that the appraisal of alternatives as presented herein would produce a different result if the work of the Fingal / North Dublin Transport Study, 2014-2015 were to be revisited. The preferred mode, MetroLink, is the only solution that fully addresses the elements of the CAF appraisal criteria.

Intervention objectives

The objectives and five subobjectives for a public transport infrastructure intervention along the Swords, Dublin Airport, Dublin City Centre corridor (the “Intervention Objectives”) are set out overleaf and in Appendix N. Whilst the Intervention

[13] The level of patronage cannot be met by bus rapid transit or light rail modes, while a potential heavy rail solution would have the capacity to achieve the total demand numbers, the lack of appropriate peak period frequencies would make this a less effective option.

Objectives are broadly aligned with the objectives used in earlier stages of the project, in progressing through the alternative and options selection process, they have been refined to reflect the decision to be made and reflect the refinement of the options under consideration.

In the context of the Fingal / North Dublin Transport Study, the objective was to identify the appropriate public transport solution to meet existing and future demand in the study area. This study identified metro as the appropriate mode.

In the options selection study subsequently undertaken the objectives were refined (as set out by the NTA in 2016) to allow for more specific consideration of the appropriate metro route / system to be selected, while reflecting the high level objectives identified in the Fingal / North Dublin Transport Study.

In the appraisal of the preferred route, which is under consideration in this preliminary business case, the objectives were further refined (resulting in the current Intervention Objectives) to allow for more specific considerations within the preferred route option and ensure that the significant updates to policy that occurred since the Fingal North Dublin Transport Study and the Route Option Selection Study are adequately reflected in the Intervention Objectives.

As the Intervention Objectives were set in September 2016, a recent assessment (see Appendix N) has been completed to check that they are still consistent with current national and regional planning policy, national public investment policy, specific sectoral policy and climate action policy and also to ensure that they are specific, measurable, attributable, realistic and time-bound (SMART) as required by the Public Spending Code. On review, it has been found that MetroLink's overall strategic relevance, rationale and objectives remain current and that the Intervention Objectives are SMART.

The Intervention Objectives are set out in Appendix N and in the figure below.

Figure 1 - 4: Intervention Objectives for Swords, Dublin Airport, Dublin City Centre Corridor public transport infrastructure intervention.

What about 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.

At the time of writing, it is not possible to say how long the pandemic restrictions will remain in place and what the legacy of behavioural and societal changes might be.

On the one hand, it is likely that widespread vaccination of populations over the coming years will allow for a relaxation of social distancing measures. On the other, work from home trends may be expected to become more prevalent in those industries where it is possible, with some spending more days working from home than in the office.

When they consider the medium term, the World Economic Forum, expects that the benefit of cities in a post-COVID-19 society will result in cities remaining essential hubs for the pooling of human capital, innovation, the arts and other societal structures[14]. However alternative views exist also.

In considering any potential future it is important to acknowledge that there are many unknown unknowns associated with potential disruptions that cannot be contemplated today.

This preliminary business case has considered an alternative future scenario[15] as part of the Cost-Benefit Analysis ("CBA"), set out later. It offers a comprehensive assessment of potential societal behaviour set in 2030 and beyond taking consideration of the issues discussed here (see Chapter 5 for more details). This scenario continues to show MetroLink as generating strong economic benefits and a positive benefit to cost ratio.

What about technological change?

Even before COVID-19, investment in public transport infrastructure has needed to proceed with caution due to several technological disruptions and changes. From ride-sharing, car-sharing, e-scooters, and electric bicycles, to a future with autonomous vehicles, drones and virtual reality telecommuting.

Rather than being considered as competitors, it is critical that technology, shared mobility and other trends, are considered and planned for as part of an integrated transportation system.

Any tendency to view these technological changes as reducing the public transport investment case will generally fail to consider the extensive benefits of public transport in terms of equity, access and social inclusion for all regardless of social status and means.

Our population is forecast to increase, while available land will remain static, regardless of these technologies or disruptive global events. Fixed high capacity public transport systems will be essential to the creation of a sustainable and resilient society, and the promotion of compact growth, for many generations to come.

How to read the rest of this Preliminary Business Case

At the conclusion of this Chapter 1, it is understood that a detailed options analysis in 2014/2015 has assessed that a light rail system running from Dublin City Centre to Dublin Airport and onward to Swords is expected to deliver positive benefits in excess of costs.

Chapter 2 introduces MetroLink as the preferred project intervention for addressing the challenges identified in Chapter 1, along the Swords, Dublin Airport, Dublin City Centre corridor.

Chapter 3 explores major project elements and configuration decisions, as well as the anticipated

[14] https://www.weforum.org/agenda/2020/08/future-of-cities-covid-19/

[15] This scenario applies NTA's 'Alternative Future Scenario for Travel Demand', see link at end of chapter.

benefits of MetroLink and its strong alignment with the National Strategic Outcomes set out in the National Planning Framework Project Ireland 2040.

Chapter 4 describes the cost development process and presents cost forecast information for MetroLink.

Chapter 5 presents the economic appraisal.

Chapter 6 considers the emerging contracting and procurement strategy for MetroLink – the approach that may be taken to safeguard value for money and better ensure on-time and within budget delivery.

Chapter 7 includes the financial appraisal activity undertaken to support the project to date.

Chapter 8 details the proposed project governance structure that will be put in place to better ensure the project advances in an expedited manner and that it delivers on the promises of this document.

Chapter 9 seeks to conclude on the rationale for proceeding to the next stage of the project lifecycle.

And finally, Chapter 10 discusses the immediate next steps of the project team and the way forward to project realisation, as well as seeking approval in principle to advance to the next stage and to prepare for Decision Gate 2.

This preliminary business case also contains several appendices which have been compiled to allow more comprehensive consideration of various topics.

Chapter supporting documents

In support of this chapter, a comprehensive history of the project appraisal process is available through the Fingal / North Dublin Transport Study 2014 - 2015, available publicly at the following links:

https://www.nationaltransport.ie/wp-content/uploads/2014/12/Appraisal_Report_19112014_final.pdf

https://www.nationaltransport.ie/wp-content/uploads/2015/09/Fingal_North_Dublin_Transport_Study_Final_June_2015.pdf

https://www.nationaltransport.ie/wp-content/uploads/2021/03/Alternative-Scenario-Development-Note-v-6.1_Final.pdfIn addition to these publicly available source documents, this chapter is supported by appendices:

- Appendix N: MetroLink Objective and Sub-objectives; and
- Appendix O: Evolution of MetroLink Alignment, System Capacity and Design

2 Introducing MetroLink

"The world of great opportunity is available now, as it has always been, only for those with great vision"

- Andrew Carnegie

The Stage 1 appraisal of alternatives, undertaken in accordance with CAF, confirmed a metro solution as the only intervention to pass that evaluation, meeting all the objective criteria. Detailed work now needed to be undertaken to solidify the details of the public transport infrastructure intervention. This included key studies to identify the "emerging preferred route" and the "MetroLink Preferred Route", discussed below. Appendix O (MetroLink Scheme – Evolution summary) includes a table and further details outlining the chronological order of these studies.

2015 - 2018: MetroLink route options appraisal

Following the 2015 study, the project team launched an extensive assessment process to establish the "emerging preferred route" (that would eventually be named MetroLink).

The "New Metro North Alignment Options Report, 2018" was commissioned to identify an emerging preferred route for the new rail service. The report assessed a combination of approximately 60 potential routes for the rail service from Dublin City Centre to Swords. Following an initial assessment of those routes, 10 end-to-end routes were subjected to a full multi-criteria analysis (see Appendix B for results of the multi-criteria analysis process) which included demand, and CBA.

Of the 10 routes, Route 9 was identified as the emerging preferred route. Non-statutory public consultation commenced on "Route 9" in March 2018. Members of the public and other stakeholders were invited to submit their views and observations of the emerging preferred route. The project team received 7,929 responses.

Box 2-1: Public Consultation 2018 / 2019

The views of all stakeholders have been taken on board during the development of MetroLink. Between 22nd March and 11th May 2018, a public stakeholder consultation process was undertaken on the emerging preferred route to ensure that the end users voices were fully considered.

This exercise led to a total of 7,929 responses. These submissions covered a wide range of topics including general interest in the scheme, outright support for the scheme or support in principle subject to specific concerns related to various locations along the length of the route. The impact of the proposed Griffith Park station on the Na Fianna GAA club (5,297) and the Collins Avenue impact on Our Lady of Victories church (1,249) accounted for a large portion of submissions lodged.

These concerns were fully considered at this point and fed into the development of the preferred route. The proposed tunnel boring machine start point, and Griffith Park station were both moved to avoid the Na Fianna GAA club and the Collins Avenue station site was moved south.

In March 2019, further public consultation was conducted on the preferred route, yielding 2,132 submissions. These submissions broke down broadly as individuals (1,518), community groups (20) and other. Again, all comments were fully considered as design was further advanced.

A Joint Oireachtas Committee on Transport, Tourism and Sport took place on Wednesday, 27th March 2019. The following quotes were notable with respect to the public consultation process for MetroLink:

"The interaction with the public is impressive. Significant changes have been made and resulted from a consultation process."

- Fergus O'Dowd T.D., Chairman:

"Speaking on my behalf and of the other Deputies in my constituency we all share a sense of satisfaction with the revision of the plans. I view it as public consultation at its best."

- Noel Rock T.D.:

The emerging preferred route included extending the metro service to Sandyford, by upgrading the Luas Green Line to metro system capacity. However, during consultation it became clear that upgrading the Green Line as part of the MetroLink scheme would create significant network challenges during the years of construction that would be necessary. Together with other route developments that occurred during the time, the public consultation feedback had direct impacts on various parts of the project including its automated nature, the tunnel configurations, development approach, and other elements. It was determined that MetroLink would terminate

at Charlemont, and would include in its design and construction, an opportunity for a future upgrade of the Luas Green Line and a "tie-in" for the continuation of the metro-based system going further south.

2019 / 2020: MetroLink advances

A multi-disciplinary analysis of all submissions and statements received from the March 2018 consultation, informed the development of the MetroLink Preferred Route Design Development Report, 2019 – formally introducing the preferred route, MetroLink.

In March 2019, a further non-statutory public consultation on the preferred route resulted in 2,132 comments. Following this, a project appraisal plan was submitted and accepted by the Department of Transport ("DoT") in May 2019. Subsequently MetroLink has continued the development of preliminary design and Environmental Impact Assessment Report ("EIAR"). All the supporting work to underpin this preliminary business case has been advanced, including cost range estimation and programme details, land requirements, risk analysis and management plans, project governance, demand modelling, system requirements and the formation of an operating service plan.

In addition, throughout 2019, as design progressed, several alternative design solutions were considered and analysed. For example, consideration was given to the number of stations, the overall alignment length, whether tunnelling should be a single or twin bore and whether the alignment should be elevated or run in a retained cut in various locations. Elements of the analysis undertaken are explored in Chapter 7 as part of the affordability assessment for MetroLink.

2020 / 2021: MetroLink finalised for Railway Order Application

All the efforts to date will culminate in Q2 2022 with the determination of the final route for MetroLink, the completion of the preliminary design and EIAR and the submission of Railway Order Application to An Bord Pleanála. Subject to An Bord Pleanála's issuance of an enforceable railway order, MetroLink will proceed to construction in 2023.

The MetroLink vision

MetroLink is part of an integrated transport solution that also includes Dublin BusConnects and the DART +, three of the major transport infrastructure projects included in Project Ireland 2040 and confirmed in Budget 2021. Together they will result in reliable, sustainable, affordable, integrated public transport that will support the economy, help Ireland meet its climate change targets and make Dublin a more liveable and sustainable city.

Figure 2 -1: MetroLink Preferred Route.

After a ramp up period, MetroLink will cater to millions of residents and visitors every year, with over 53 million passengers each year in its early years, rising steadily to over 100 million passengers a year during its first 60 years of operations. It will provide a safe, reliable, comfortable, and fast trip, taking approximately 25 minutes from Swords to Dublin City Centre and 20 minutes from Dublin Airport to Dublin City Centre. During peak periods, a MetroLink train will come through a station every three minutes in the early years and eventually every 90 seconds when demand levels require this frequency. The system will be fully automated, allowing for increased responsiveness to demand levels with the ability to easily change the frequency of service from the control centre. The system also includes platform screen doors to prevent people or objects from potentially entering the track. Together with other system components, the result is a highly reliable and efficient public transport system.

Based on demand modelling for the project, MetroLink will provide a reliable fixed public transport option to an estimated 360,000 people that will live within 2km of the alignment in 2030, as well as millions of national and overseas visitors to Dublin and Ireland each year.

MetroLink will serve Dublin Airport's planned ground transportation hub, offering a convenient additional public transport choice for passengers. MetroLink will improve connectivity between Dublin, Ireland, and the rest of the world, giving regular, reliable and affordable travel to and from Dublin Airport. In the context of Brexit, Ireland's ports and airports are now more important than ever in supporting connectivity and resilience. As Ireland is a small open economy, to continue to prosper it must have frictionless links with the rest of the world and MetroLink will make travel to and from Dublin / Ireland easier, faster, reliable and efficient.

MetroLink will generate wide economic benefits for Swords, Dublin, and Ireland. Economic benefits including:

- Agglomeration impacts: when firms and businesses are located close to one another they benefit from the flow of ideas, staff members, and economies of scale (such as the Grand Canal Docks where major tech firms have located close together). MetroLink increases the effective proximity (in time, rather than distance) of more businesses to each other, as well as staff to those businesses, and so is considered to increase the opportunities for agglomeration impacts. Agglomeration improves the effectiveness of production centres (Swords, Dublin Airport and Dublin City Centre) improves productivity and provides greater access to labour and product markets; and
- Urban regeneration: Fingal County Council has rezoned 390 hectares of land as the "Metro Economic Corridor".

Integrated public transport

The aim of the National Development Plan 2018-2027 (part of Project Ireland 2040) is to ensure that public investment is targeted towards projects that will fulfil the objectives of the Project Ireland 2040 National Planning Framework. With housing and transport so inextricably linked, the National Development Plan 2018-2027 directs investment towards large scale public transport infrastructure in areas where compact growth is targeted. Public transport functions best when it is properly integrated with land use and community needs.

There is work underway throughout the country to advance the development of integrated and sustainable transport networks including the plans for the Dublin area (outlined in the Transport Strategy for the Greater Dublin Area 2016-2035)

Box 2-2: BusConnects and DART+

BusConnects will deliver a transformation of the bus system in Dublin. It will comprise a network of 'next generation' bus corridors on the busiest routes with segregated cycling facilities, "next generation" ticketing and a complete redesign of the bus network. Under BusConnects there will be interchanges along the entire MetroLink route and connections with other transport infrastructure.

DART+ is the expansion programme of a series of projects that will create a full metropolitan area DART network for Dublin with all of the lines linked and connected. The DART+ programme will provide frequent, modern, electrified services to Drogheda on the Northern Line, Hazelhatch - Celbridge on the Kildare Line, Maynooth and M3 Parkway on the Maynooth / Sligo Line, while improving DART services on the South-East Line as far south as Greystones. By extending and modernising the existing network, DART capacity and frequencies can be significantly increased, creating a reliable and sustainable electrified train network that fully integrates with all other modes of public transport in the Greater Dublin Area.

and other large urban areas such as Cork and Galway.

The Transport Strategy for the Greater Dublin Area 2016-2035 contains an integrated transport strategy outlining a suite of infrastructure investment and transport services and integration projects with investment in bus, light rail, metro and heavy rail as core elements.[16]

Budget 2021 highlights support for three projects that align with the Transport Strategy for the Greater Dublin Area 2016-2035, namely Dublin BusConnects, DART+ and MetroLink, and together with other public transport projects, are complementary and supportive of one another, designed to integrate with the future transport system. For example, BusConnects will improve the reliability of public transport bus services, thereby increasing the number of public transport users in general that may also then utilise MetroLink for a portion of their journey. Together, MetroLink and BusConnects will help each other to balance the public transport and road network performance through the provision of modal choice for users.

DART+ will also have the effect of creating more public transport users. It will also better ensure that passengers are minimising the amount of road travel necessary to access the public transport system by extending the access points of the network out into large commuter hubs.

MetroLink will provide high quality interchange opportunities with these and other major transport modes. This will help to create a more seamless travel experience for existing and future public transport passengers in the Greater Dublin Area. This connectivity is critical to the overall transportation network effectiveness, reducing travel times, creating new travel opportunities; and allowing all passengers to travel further within a more accessible, reliable and efficient public transport system. MetroLink will provide seamless interchange opportunities with the Maynooth and Phoenix Park Tunnel lines at Glasnevin, with the coastal DART route at Tara, the LUAS at O'Connell Street, Trinity College, St. Stephen's Green and Charlemont and numerous bus services at all stations, particularly at Dublin Airport. MetroLink will create an interchange hub at Tara Street, bringing together DART, Metro, Luas, Dublin Bus and Iarnród Éireann services.

Access for all

As the solution to the public transport deficit on the corridor, MetroLink will provide an integrated and accessible public transport system which enhances the quality of the environment and the quality of life for all members of the public. "Access for all" is central to any scheme design and operation carried out by TII directly or by third parties, on its behalf. TII uses best international practice in Universal Design and encourages innovative and imaginative solutions to achieve these goals.

The Luas User Group ("LUG") was established prior to the delivery of the first Red and Green Luas Lines. As a forum, it has proved extremely effective in achieving consensus with marginalised groups, in hearing their needs and in applying these, where feasible, at the earliest stages of design. As

Box 2-3: Universal Design and inclusiveness

Universal Design is the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability. An environment (or any building, product, or service in that environment) should be designed to meet the needs of all people who wish to use it. This is not a special requirement, for the benefit of only a minority of the population. It is a fundamental condition of good design. If an environment is accessible, usable, convenient and a pleasure to use, everyone benefits. By considering the diverse needs and abilities of all throughout the design process, universal design creates products, services and environments that meet peoples' needs.

In order to encourage a shift towards the use of public transport, options must be designed with these inclusive characteristics in mind. All members of society must feel that they can safely, conveniently and reliably travel on public transport.

TII has applied Universal Design principles in consideration of the public transport intervention for the Swords, Dublin Airport, Dublin City Centre corridor. See http://universaldesign.ie/ for more information.

[16] NTA: Transport Strategy for Greater Dublin Area 2016-2035

a result, the system is entirely accessible to people with mobility, sight, hearing and cognitive impairment and to the wider public, including those with buggies, luggage or temporary mobility issues, as well as for older people.

LUG advise TII in relation to the accessibility of its transport services and facilities with a view to improving public transport services for everybody in accordance with “Transport Access for All”, the Department’s Sectoral Plan under the Disability Act 2005 and the National Disability Strategy Implementation Plan. LUG identifies and recommends measures to remove barriers that prevent accessibility to the relevant transport service as well as ensuring no future barriers are created.

TII work in partnership and in on-going consultation with LUG and meets at least three times a year. From time to time TII organises targeted site visits and project-specific presentations and members are kept up to date by email with respect to any construction or operational impacts which may occur between these meetings. Members of the group comprise of representatives from the National Council for the Blind of Ireland, Fighting Blindness, Irish Guide Dogs Association, Chime (formerly Deaf Hear), the Irish Wheelchair Association, Enable Ireland and social inclusion groups such as National Adult Literacy Agency and Seniors.ie.

A MetroLink presentation was delivered to the group on September 24th, 2019, where participants were encouraged to engage with the consultation process and to inform their own members of the opportunity to engage. TII also sit on the Department of Transport Accessibility Consultancy Committee, which reports directly to the Minister on matters relating to disability and public transport, including key issues arising from the LUG meetings.

MetroLink is fully aligned with existing policy objectives

MetroLink is strongly aligned with key government policies and objectives, both for Ireland and at EU level. 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 project. Furthermore, in the 2020 Programme for Government, the Government has pledged to prioritise plans for the delivery of MetroLink during its tenure. A detailed assessment of the strategic policy context for MetroLink is included in Appendix C, with an overview assessment set out in Figures 2 – 2 and 2 – 3 below.

Figure 2 – 2: Overview of Irish strategic policy context.

Figure 2 – 3: Overview of EU and International strategic policy context.

Sustainable MetroLink

Sustainability for MetroLink means constructing 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 will provide an electrified mass transport option that can offer a new, carbon neutral modal choice for public transport passengers and road users alike. This will help Ireland in advancing to meet its sustainability and GHG emissions goals.

MetroLink creates this demand through its reliability and frequency of service as well as its accessibility and connectivity to the community. In addition to the sustainability opportunities that MetroLink helps to create, the project itself also aligns with TII's Environmental Strategy. Opportunities for increased biodiversity, water preservation, continuity of wild habitat and greenways, habitat creation, urban canopy development, and other measures are all being considered and advanced under MetroLink's Sustainability Plan. The Sustainability Plan, as contained in Appendix D, highlights that MetroLink will seek to advance TII's leadership position in the areas of climate change mitigation / adaptation, biodiversity, community engagement, delivering value, material and resource use, health and wellbeing, productivity and facilitating growth.

MetroLink design and development is being advanced in line with the ongoing effort of its Environmental Impact Assessment, along with a complete environmental impact monitoring and evaluation programme and Sustainability Implementation Plan.

Alignment to National Strategic Outcomes

MetroLink is directly aligned with the Strategic Investment Priority for environmentally sustainable public transport as identified in Project Ireland 2040 National Planning Framework. Indeed, MetroLink is also supportive of other Strategic Investment Priorities including housing and sustainable urban development, the National Road Network, and airports and ports. The Strategic Investment Priorities are derived from the National Strategic Outcomes as captured in the Project Ireland 2040 National Planning Framework.

The ability for MetroLink to support the National Strategic Outcomes is considered in detail in

Chapter 3.

LR7 to MetroLink: An Evolution

The evolution of the solution to the challenge identified in Chapter 1 and one which meets the Intervention Objectives, has culminated in MetroLink. Whilst many of the design, alignment and system capacity selections in the solution are not always the least costly, they have been selected following the completion of detailed studies, consultation and analysis. The differences between the two schemes and the rationale for the design changes are set out in the following 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 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 MetroLink at St Stephen's 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 Road (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[17] lines 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 the 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

[17] *GSWR - Great Southern and Western Railway / MGWR - Midland Great Western Railway*

lines than at Drumcondra because the Phoenix Park Tunnel and Maynooth lines are at their closest point horizontally and vertically at Glasnevin, 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 Glasnevin 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 Glasnevin 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 headway and capacity that can be achieved. The projected demand associated with LR7 could not be catered 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[18].

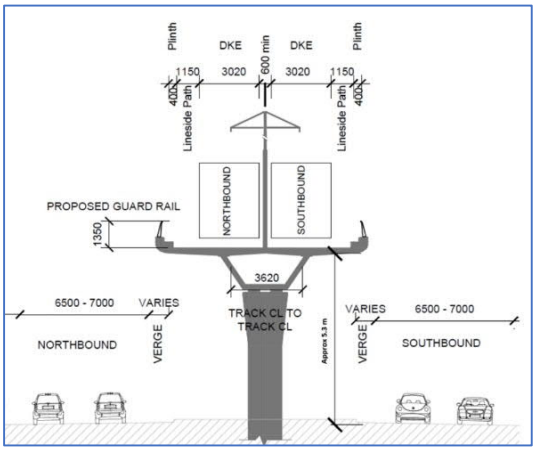


Figure 2 – 4 - Elevated Structure

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

[18] *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*

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.

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 (Green Line South of Sandyford) 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 capable of offering a high frequency service offering reliable headways from 3 minutes on opening down to 90 seconds when required.

R132 A retained 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 4) 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.

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.

The revised proposal to place the alignment in retained cut (Figure 5) on the R132 corridor were received positively during the 2019 non-statutory public consultation and the preliminary design for the scheme was updated accordingly

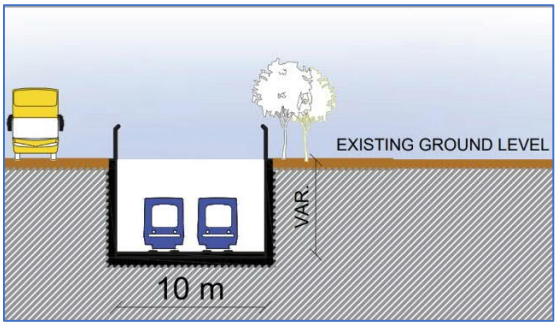


Figure 2 – 5 - Segregated Running in Retained Cut

Change to single bore tunnel

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.

a. 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 bore 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.

b. 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; and
- 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 tunnel 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.

Metro / Light metro systems 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.

Light rail systems can typically operate on the street and share sections of the road with other transport modes. This limits the service frequency in these sections and the ultimate capacity of the system. They are generally easily accessible from the street pavement and distance between stops are shorter distances.

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.

Figure 2-6– Typical Light Metro System

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 2-7). 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.

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 2-7 - Grades of Automation

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).

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[19].

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.

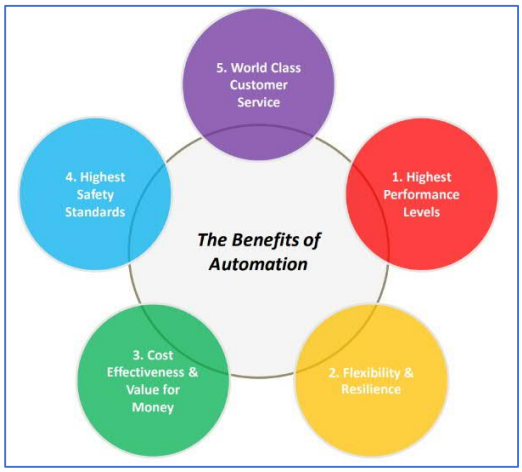


Figure 2-8- Benefits of Automation

The benefits of automation are well established, and include:

- High Performance Levels and Greater Capacity
- Flexibility and Resilience
- Highest Safety Standards
- World Class Customer Service.

These are described in detailed in Appendix G and O of the Preliminary Business Case.

Chapter supporting documents

The summary provided by Chapter 2 is supported by detailed technical studies that are available publicly. These include:

- The New Metro North Alignment Options Report (March 2018), available at: https://archive.metrolink.ie/#/alignment-options-study/1
- Public Consultation Document for the Preferred Route (March 2019) available at: https://www.metrolink.ie/assets/downloads/Public_Consultation_Document_for_the_Preferred_Route_HR.pdf
- Preferred Route Design Development Report (March 2019), available at: https://www.metrolink.ie/assets/downloads/MetroLink_PR_Design_Development.pdf
- The 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
- Project Ireland 2040 National Planning Framework, available at: http://npf.ie/wp-content/uploads/Project-Ireland-2040-NPF.pdf
- The National Development Plan 2018 – 2027, available at: https://www.gov.ie/en/policy-information/07e507-national-development-plan-2018-2027/

In addition to these publicly available source documents, this chapter is supported by appendices:

- Appendix B: MetroLink Route Options Multi-Criteria Analysis Summary (authored by TII's engineering designers Jacobs/Idom)
- Appendix C: Strategic Policy Context Review; and
- Appendix D: Sustainability Plan (authored by TII's advisors AECOM).
- Appendix O: Evolution of MetroLink Alignment, System Capacity and Design

3 Exploring MetroLink

"A rising tide doesn't raise people who don't have a boat. We have to build the boat for them. We have to give them the basic infrastructure to rise with the tide"

- Rahul Gandhi

In this chapter MetroLink is explored to gain a better understanding of the proposed project and what will be required to effectively and efficiently move approximately 53 million passengers (residents and visitors) annually in the initial years of operation.

Once a clear understanding of what MetroLink will be is established, the extensive benefits of the project are also explored.

Operating service plan

Before exploring the infrastructure components of MetroLink, it is helpful to first understand the service that MetroLink will provide. MetroLink is, first and foremost, a public transport service, designed to facilitate the mobility of millions of passengers a year.

MetroLink will operate 19 hours per day, 365 days a year, safely and securely transporting approximately 53 million people annually during its initial years of operation.

Time period	Description
05:30 - 06:59	Off-peak
07:00 - 09:59	Morning Peak
10:00 - 12:59	Morning Interpeak "Lunch Time"
13:00 - 15:59	Afternoon Interpeak "School Run"
16:00 - 18:59	Evening Peak
19:00 - 00:30	Off-peak

Figure 3 - 1: MetroLink daily operating service periods.

During peak periods in the initial years of operations, there will be 20 trains operating per hour at a frequency of three minutes between trains. The initial train fleet on the service commencement date is anticipated to be 26. This offers some flexibility to meet extra peak requirements (such as for special events), as well as allowing for the rotation of trains for maintenance and servicing. Additional trains will be added to the fleet over the course of the first 25 years of operations to meet demand requirements. The maximum fleet size is anticipated to be 47 trains operating on 90 second frequencies for peak hours.

MetroLink will have a high degree of operational flexibility and responsiveness to meet demand levels over the course of each day due to its automated operating system. MetroLink will operate using the Grade of Automation Level 4 ("GoA4"), the highest level of system automation available. This will allow new trains to be inserted into service to meet dynamic demand requirements, with the push of a button. The automated system will maintain travel parameter standards, safety and reliability with machine precision. In addition, the automated system can link into various data sources (for example airport passenger movements), anticipating potential demand events and responding before demand issues arise. Appendix G explores the benefits of automation in metro systems in detail.

With the operation of the trains being automated, this allows operations employees to focus on the most important aspect of world class public transport systems – passenger comfort, safety and satisfaction. MetroLink will benefit from a dedicated team of customer service, operations control and fare enforcement personnel that will have specific service performance standards to meet and exceed for passenger service.

Integrating with the transport system

MetroLink's design and alignment have focused on maximising the quality of interchange opportunities with the wider transport system. Accordingly, the alignment and various infrastructure components have been designed to maximise the quality interchange and seamless links with the wider public transport network.

MetroLink will run from Estuary, north of Swords, for 19.4 kilometres through to Dublin City Centre, to its final stop at Charlemont.

At Estuary, a multi-storey park and ride facility is strategically located with capacity for 3,000

vehicles[20]. This provides passengers the opportunity to drive and park at Estuary and to continue their journey on MetroLink.

At Estuary the alignment will be at surface level (at grade). Proceeding south, from Seatown to Fosterstown the alignment will then be in a "retained cut" which means it runs below surface level either fully or partially but is not enclosed as it would be in a tunnel. After Fosterstown the alignment will descend underground, under Dublin Airport.

Here MetroLink will be integrated with Dublin Airport's proposed ground transportation hub, offering quality interchange opportunities with several bus operations as well as facilitating airport passenger movements directly.

As the alignment continues south of Dublin Airport, it returns to surface level to the Operations and Maintenance Depot at Dardistown and crosses the M50 in a dedicated viaduct. The alignment descends once again underground at Northwood, where it will stay for the remainder of its 9.4 kilometres to Charlemont.

Along this portion of the alignment, MetroLink will once again offer quality and significant interchange opportunities at Glasnevin, O'Connell Street, Tara Street, St. Stephen's Green and Charlemont.

Infrastructure summary

The operating service plan answers the question about how to move 53 million passengers in the initial years (as well as how to keep moving passengers effectively as demand rises to 100 million passengers over the subsequent 60 years).

To enable the operating service plan to be deployed and the demand to be serviced, metro system infrastructure must first be built.

It has already been noted that 26 trains will be necessary in opening years, rising to 47 trains over time. The trains are a major and important component of MetroLink, being a key interface between the system and the passenger. The trains will have a length of approximately 64 metres.

Each train will be capable of carrying 500 passengers at the comfortable loading parameter of four people per square metre.

MetroLink includes the following infrastructure elements:

Core infrastructure:

- Stations: 4 retained cut (1 at Dardistown to be completed and operational after service commencement in line with demand) and 1 at grade station; and 11 underground stations (utilising open and natural light design, where possible); and
- Tunnels: A single tunnel, approximately 8.5 metres internal diameter (9.2 metres external diameter), from Charlemont to Northwood, measuring 9.4 kilometres and another running under Dublin Airport measuring 2.3 kilometres.

Line-wide railway systems and integration:

- An operations and maintenance depot, together with two system control centres, one at Dardistown and the other at Estuary (back-up system);
- Metro trains (rolling stock): 26 vehicles for service commencement and then a further 21 over the next 25 years of operations;
- Platform screen doors;
- Signalling system and automated control systems; and
- Other system essentials.

Other infrastructure:

- A viaduct over the M50;
- A viaduct over the Broad Meadow River;
- Interchange facilities at Dublin Airport, Glasnevin, Tara Street and Charlemont;
- 8 traction power substations to provide energy to the line;
- A 3,000-space multi-storey park and ride facility strategically located at Estuary;
- Bike storage facilities at each station; and
- Intervention Shaft at Albert College Park.

In the sections that follow, further details of these various components are explored, including the

[20] Sizing supported by demand modelling

key characteristics and some of the benefits associated with the constituent parts which form MetroLink,

Core infrastructure

Stations

MetroLink will include 15 stations at the commencement of operations, with a future station at Dardistown to become operational at a later date in line with demand requirements. Station locations have been carefully considered to maximise the catchment area and accessibility, as well as minimise disruption during the construction stage.

Of the four stations on the northern section, three of these will be retained cut (Seatown, Swords Central and Fosterstown) and one, at grade (terminus station at Estuary). The future station at Dardistown will be retained cut. The basic infrastructure requirements for the future station are included in the project budget.

The construction of the 11 underground stations is a large scope element of MetroLink with each such station a significant undertaking. Ten of the underground stations will be in the southern section, from Northwood station to Charlemont, with an underground station also located at Dublin Airport.

Figure 3 – 2: MetroLink underground station.

The MetroLink stations have been designed with safety, sustainability (including bicycle parking facilities), placemaking, community and inclusivity in mind. The level of finish, high safety measures and specification incorporated will help to maintain the stations so that they can be enjoyed by current and future generations alike. The design includes: using high quality materials both in terms of durability but also aesthetics; high specification design which includes the latest considerations for making a metro system run effectively and smoothly e.g. ease of access for all MetroLink users, ease / speed of use through industry leading wayfinding design at stations and a design which incorporates the latest technologies (platform screen doors, etc.) which are best positioned to interact with future developments in the industry.

Box 3-1: Underground station design

MetroLink includes 11 underground stations as part of the proposed works. The stations all follow the same architectural concept design vision with common design elements based on the following principles:

- An open public volume space within the station providing natural light where possible down to platform level using skylights and open aspects;
- Linear circulation to the platforms with a separate upper concourse level and platforms open to mezzanine level; and
- Iconic canopies forming the station entrance.

The 11 underground stations are similar in size, typically 112m long by 25m wide approximately; and have similar function and complexity. Glasnevin is an exception with the added complexity incorporating an interchange with an Irish Rail station, otherwise there are only minor modifications distinguishing them depending upon their specific location and the immediate urban surroundings. The stations are similar in depth (except for Northwood Station), typically around 30m to formation level. All stations include 65m long platforms accessed by stairs, lifts and escalators. At both ends of the station, there are protected shafts providing emergency stairs and separate lift shafts for emergency services use. The underground stations also incorporate ventilation shafts and fans for tunnel ventilation, supporting the MetroLink fire safety strategy.

Station fit out includes the architectural works within the station public areas and back of house such as cladding systems, floor tiles, walls, doors, and ceilings. Station entrances may include a shallow basement within a secant piled area housing the upper machine chamber for the escalators with concrete upstands and steel support frames to secure the entrance glazing panels, canopy lighting and ticketing apparatus. Surface works include the emergency exits, fire fighter entrance points, ventilation louvers, lightwells with upstands and street furniture, bicycle storage and signage. The mechanical and electrical fit-out of the stations will include high and low voltage power distribution, lighting, drainage pumping mains, ventilation, fire-mains and firefighting apparatus.

Within the stations there are a number of systems that integrate the operation of the metro, including medium voltage and traction substation rooms, feeding power to the overhead catenary system along the tunnels and to the station electrical demands; signalling and telecom rooms linking all of the dedicated local systems provided in each station back to the operations control centre; and third party and station incident rooms for use by the Dublin Fire Brigade during incidents. The stations also include radio and wi-fi associated equipment, CCTV cameras and public address systems, voice and fire alarms.

Tunnels

A significant component of MetroLink pertains to the single bore tunnels:

- 2.3 kilometres under Dublin Airport as part of the central section; and
- 9.4 kilometres from Northwood, under the city and continues to the south of the terminus in Charlemont, as part of the southern section.

MetroLink will use a single bore tunnel with two rail lines facilitating north and south travel running side by side within the tunnel.

The single tunnel approach is increasingly implemented for new metro lines worldwide, particularly where automated trains are being specified, as is the case with MetroLink, including for example, Barcelona Metro Line 9, Milan Metro Line 5, Rennes Metro Line B, Metro Sao Paulo Line 4 and Metro Santiago Line 3 & 6, among others.

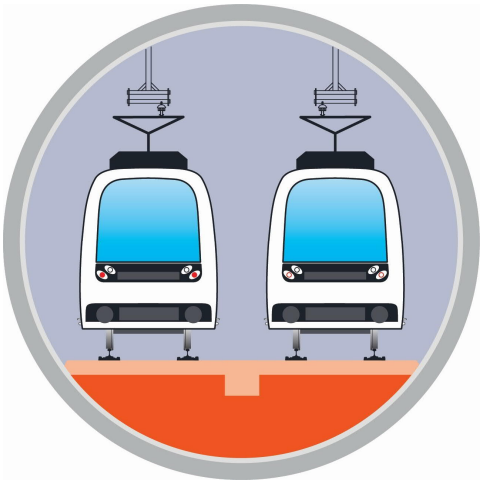


Figure 3 – 3: Single tunnel configuration.

Constructing the Southern and central section tunnels within the required timeline for MetroLink, will require the acquisition of two tunnel boring machines.

Line-wide railway systems and integration

MetroLink will require a host of key railway systems, subsystems and infrastructure which will allow the service to be efficient, sustainable, and safe functioning. In the following sections we have set out the main components which make up the line-wide railway systems and integration infrastructure.

Platform screen doors

Platform screen doors will be installed at each station. These are interlocked screen doors that will only open when a train is stopped at the station. These doors will restrict public access when the train is not in the station, as well as ensuring that the potential for debris or rubbish to enter the trackway is eliminated. It is a key safety feature that allows the train to enter the station at the optimum speed, facilitating more efficient dwell time management and shorter and more reliable journey times between stations, thereby enhancing benefits to users. Also, as the platform screen doors effectively seal the trackway from intrusion or debris, the reliability of the system increases significantly, resulting in more patronage to the system and the realisation of even greater benefits for the system. Platform screen doors contribute to the overall safety, efficiency and capacity of MetroLink.

Figure 3 – 4: MetroLink underground station illustrating platform screen doors.

Platform screen doors are a key feature of many metro systems around the world including the Barcelona Metro Line 9, Paris Metro, Copenhagen Metro, Turkey Metro, Sydney Metro and various systems throughout China, Japan, South Korea and South East Asia.

Figure 3 – 5: MetroLink underground station illustrating platform screen doors and the train (view from the track).

Signalling system and automated control systems

MetroLink will benefit from significant advances in automated train control technology that has been deployed elsewhere in the world for many years. The grade of automation that MetroLink is designed for is level 4, GoA4, which is the highest level of automation.

For MetroLink, GoA4 will be achieved through the integrated operation of various system components, including the signalling system, which is known as CBTC or "communication-based train control". CBTC systems are modern signalling systems that are mainly used in urban railways.

CBTC creates continuous communication between the train and trackside equipment to determine more accurately than traditional signalling systems each train's position, speed, direction of travel and braking distances[21]. This results in a reduction of the section of track that needs to be allocated for train protection to one train (block section). Accordingly, trains can operate safely and reliably at increased frequencies, which in turn maximises the capacity of a line by allowing more frequent services than could be delivered with traditional signalling.

CBTC supports automated operations and most automated metros rely on CBTC to enable safe, efficient and reliable operation. 87% of the automated metros that were launched between 2008 and 2018 were equipped with CBTC, which is becoming standard also for renewals of older metro systems[22].

GoA4 automated systems provide benefits over conventional trains and other less automated trains. These are set out in detail in Appendix G and in summary include:

- Higher performance levels (reliability, efficiency, safety, passenger service and speed); and
- Flexibility and resilience to changing operational requirements.

System essentials

For MetroLink to function it will require essential systems including track, signalling systems and equipment, overhead conductor rail, traction power (8 traction power substations), mechanical and electrical systems.

The integration of the systems is a complex undertaking and will require high levels of collaboration during the planning and delivery stages. An approach to managing and de-risking the delivery of the system essentials has carefully been considered and is discussed in "Contracting and Procurement Strategy", Chapter 6.

Railway systems control

MetroLink operating systems will all be controlled from the operations control centre, located in a state-of-the-art depot at Dardistown. The depot will also include maintenance buildings, train storage space and stabling yards. In addition to the main control centre, a back-up centre will also be located at Estuary.

Exploring MetroLink's alignment to the National Strategic Outcomes

MetroLink is aligned with the National Strategic Outcomes as set out in Project Ireland 2040 National Planning Framework.

[21] For a more technical definition Institute of Electrical and Electronics Engineers standard IEEE 1474

[22] Union Internationale des Transports Publics (UITP), World report on metro automation, 2018

The ten National Strategic Outcomes and the identified alignment with MetroLink is set out herein.

Sustainable mobility:

Project Ireland 2040 National Planning Framework sets out that achieving a low carbon and sustainable future will require a transformative change. This is especially true in the provision of transport across Ireland. Personal vehicles can no longer be the preferred mode of travel across Ireland. To achieve this, viable public and sustainable transport options need to be developed that provide reliable and cost-effective alternatives to private motorised vehicles.

MetroLink is the quintessential sustainable mobility solution to support the Project Ireland 2040 vision. Fully electrified and capable of meeting the passenger demands in initial years of 53 million and scaling to serve over 100 million passengers over time, all within the same project footprint.

Of these passengers, 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 potential reductions in congestion and related harmful emissions, as well as allowing the road network to achieve more effective utilisation patterns.

MetroLink will encourage walking and cycling to and from the stations. Users will need to travel from their home to the closest station and for many this will mean walking or cycling. Cycling will be supported by the inclusion of suitable bike storage facilities at all stations. This should in turn promote an improvement in health for users who combine an active travel mode with using public transport.

In 2030, over 700,000 people and jobs will be within a 10-minute cycle distance of a MetroLink station.

While longer cycling and walking trips are anticipated to reduce, shorter, last kilometre, first kilometre type trips are anticipated to increase. Demand modelling forecasts approximately 8,000

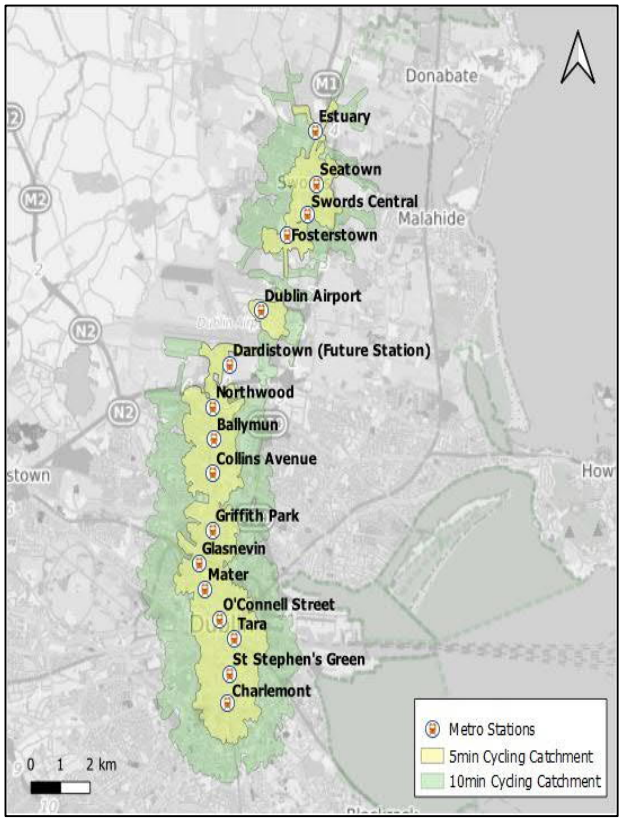


Figure 3 – 6: Cycling distances from MetroLink stations.

longer active trips a day are replaced by MetroLink, which in turn is anticipated to generate 140,000 active trips per day (which includes approximately 20,000 by cycling). This increase in cycling activity has not yet been monetised in the economic appraisal.

MetroLink will therefore encourage more people to avail of active transport, a combination of walking and cycling with the use of public transport, as part of their journey. Active transport has a key role to play in improving health and reducing health inequalities within the community.

The Eastern Regional Transport Model contains a Health Appraisal Tool, that calculates benefits associated with changes in levels of physical activity and absenteeism as a result of more walking and cycling taking place. The basis of the health module is the tool developed by the World Health Organisation ("WHO"), the Health and Economic Appraisal Tool. It calculates the health benefits associated with changes in physical activity resulting from differences in walking and cycling. Application of the tool to the MetroLink

dataset was not possible as part of this preliminary business case due to the timing of modelling activity. The tool will be utilised in the next stage of the project lifecycle to further explore the scale of the health benefits offered by MetroLink.

Compact growth:

MetroLink will support housing and development close to the alignment, supporting density at stations and compact growth patterns in North Dublin. The National Economic & Social Council specifically highlights MetroLink as an ideal catalyst project to support compact growth patterns through transport orientated development[23].

The opportunities for harmonious and supportive land use development are already being pursued, with Fingal County Council for example, having rezoned 390 hectares of land as the "Metro Economic Corridor".

But the scope for compact growth and changes in the current development landscape to be further influenced by MetroLink over time are potentially much larger, with the National Economic & Social Council considering approximately 9,500 hectares to be within MetroLink's catchment influence based on a 2.5 km radius for example[24].

By creating a focal point for compact growth planning, MetroLink can support the development of vibrant, inclusive and resilient communities along its corridor. A focus on living close to public transport solutions should encourage developers to construct compact developments, cutting back on the number of car parking spaces, and putting public transport at the core of their designs. This will provide a natural incentive to deliver sustainable housing projects.

Transition to low carbon and climate-resilient society:

Private vehicles are a significant contributor to Ireland's GHG, and providing an alternative to private vehicle-based journeys is a key benefit of MetroLink.

MetroLink will strive to be a fully sustainable and carbon neutral public transport alternative.

MetroLink, as a sustainable mobility asset, will have a direct and long-lasting impact on Ireland's transition to a low carbon economy. From opening through to 2050 it is anticipated to provide over 1 billion passenger trips.

Demand modelling suggests a diversion of 6.8 million private vehicle journeys per annum in the early years of operation (growing to 12 million by 2045) to MetroLink, that would otherwise be made (approximately 360 million car trips diverted by 2050). Accordingly, MetroLink can support the reduction of three key emissions which are critical to improving sustainability and transitioning to a low carbon society. These are:

1. Carbon Dioxide ("CO_2"): This is the main GHG and reductions are key to meeting climate change targets.
2. Nitrous Oxides ("NOx"): NOx contributes to smog and acid rain and has a detrimental impact on the ozone layer.
3. Particulate Matter ("PM"): PM can cause poor air quality and associated negative health impacts. The most damaging PM is PM2.5 (2.5 micrometres – more than 100 times thinner than a strand of a human hair). High concentrations of PM2.5 can be inhaled and penetrate the lungs causing long-term health implications.

MetroLink will be fully electrified, it will be able to reduce its emissions footprint as Ireland moves increasingly to green energy production. While

[23] National Economic & Social Council, Transport Orientated Development: Assessing the Opportunities for Ireland, June 2019

[24] Ibid – Note that the 2.5km radius used by the National Economic & Social Council is not continued in the preliminary business case. 1 km is the standard radius utilised in the preliminary business case for any land influence or development-based calculations to support the economic appraisal. Note that MetroLink demand levels are a function of the demand area modelling and is not influenced by any radius definition.

MetroLink has a significant power requirement (estimated to be 23 GWh in its early years) the consideration of renewable energy solutions for MetroLink will be undertaken under TII's Energy Management Strategy. It is also important to consider the environmental footprint of MetroLink during its construction and operational stages to ensure that these benefits are not offset by increased outputs from MetroLink. TII is striving to deliver MetroLink as a fully carbon neutral development.

To pursue this, TII is developing MetroLink's Sustainability Plan, aligned with the wider TII sustainability strategy. This will seek to minimise CO_2 emissions and the use of unsustainable materials during the construction and operation of the project. It will also seek to protect and improve biodiversity.

Enhanced regional connectivity:

MetroLink is in many respects, the "missing link" in the public transport system. With MetroLink, residents in Dublin will be able to complete a journey from most parts of the City to the airport, using MetroLink rather than relying on taxis or the existing bus services. These journeys will not only be faster but will also be more reliable and offer more flexibility in time of departure.

MetroLink will facilitate, for the first time, the ability for anyone to complete a journey from their point of origin to Dublin Airport just using rail, Luas and MetroLink. In addition, travellers and commuters arriving on Irish Rail from all parts of Ireland will be able to access MetroLink and the north / south of the city with the opportunity to interchange at Glasnevin and Tara Street MetroLink Stations.

MetroLink will improve the performance of the public transport and road networks in North Dublin, including the critical Dublin-Belfast trade corridor, and the supporting infrastructure for Dublin Port and Dublin Airport, leading to efficiency gains for productivity and the economy. By creating a new mode choice for passengers, MetroLink will enhance regional and international connectivity and help optimise the transport network, to the benefit of the entire Irish economy.

Facilitating more effective traffic patterns at the airport also helps the M50 and M1 motorways optimise traffic flows – which, in turn, improves the economics of moving goods and services to the rest of Ireland. Post-Brexit, with the noted potential inefficiencies in trade and goods movement – any efficiencies that can be gained on the Irish road network will be very welcome. It will also free up road space which can be used for projects such as BusConnects.

High-Quality International Connectivity:

To achieve best performance, our ports and airports need to be served by an efficient and effective transportation network. MetroLink will support the efficiency and growth of Dublin Port and Dublin Airport by creating an additional passenger access opportunity and allowing for optimisation of the surrounding road and public transport networks.

Dublin airport had 30.7m[25] passengers (excluding transfers) in 2019. For outbound passengers, over 40%[26] spent longer than an hour to get to the airport, with the airport covering all regions of Ireland. Outbound passengers also experience significant impact due to unreliability of their journey time to the airport.

TII analysis demonstrates that the M50 / M1 motorway system adjacent to Dublin Airport can at times experience unstable or complete breakdown of flow. In response to the consequential journey time uncertainty, many travellers to the airport will factor in a significant buffer time to ensure that they arrive at the airport in time[27].

[25] Source: CSO

[26] Source: NTA Passenger Transport Surveys at Dublin, Cork and Shannon Airports 2016

[27] https://www.tii.ie/tii-library/strategic-planning/tii-road-network-indicators/TII-National-Roads-Network-Indicators-2019.pdf (Section D2)

Of inbound passengers, over 60% used a car, van, or taxi to leave the airport – contributing to road network congestion. Without MetroLink the use of private vehicles will grow as populations grow and more people fly. Modelling shows that MetroLink will reduce private vehicle journeys to and from the airport by between 931 and 3,012 per hour[28].

MetroLink will improve international connectivity. Now tourists will be able to arrive at Dublin Airport and then access the rest of the rail network efficiently and effectively, confident in the time their journey will take and when they will arrive. Business travellers will be able to access Dublin city centre more easily, increasing and improving the likelihood that international businesses will continue to make Ireland their European base of operations.

A strong economy supported by enterprise innovation and skills:

MetroLink will help to stimulate economic activity, encourage innovation and grow our national skills base. MetroLink will support between 7,200 and 9,100 direct construction jobs for each year of construction activity, as well as a further 2,500 to 3,000 indirect supply chain and support related jobs each year[29].

These jobs will range from apprentice levels to master trades people and will support education and skills development in areas of civil, electrical, mechanical and other engineering disciplines among many other areas.

While Dublin and its surrounds will benefit from the increased jobs and spending activity, so too will regional suppliers, third party consultancies and specialist disciplines, training institutions, education institutions and more.

The complexity of the infrastructure undertaking, the first of its kind in Ireland, as well as the construction duration (in excess of eight years), will promote skills development and enhancement, education and research in support of the project.

Following construction, MetroLink operations and maintenance will require over 300 permanent skilled jobs, offering further opportunities for continued training and skills development. The operations and maintenance phase will also require continued regional support for infrastructure maintenance activities over its useful life.

In addition, MetroLink is anticipated to generate agglomeration impact benefits for existing and new businesses. This is in large part generated by improved productivity and reduced costs for businesses in the vicinity, facilitated by improved journey times on MetroLink. When firms and businesses are located close to one another they benefit from the flow of ideas, staff members, and economies of scale. MetroLink increases the proximity of more businesses to each other (in time, rather than distance), as well as staff to those businesses, and so is considered to increase the opportunities for agglomeration impacts. Agglomeration improves the effectiveness of production centres (Swords, Dublin Airport and Dublin City Centre) improves productivity and provides greater access to labour and product markets.

Enhanced amenity and heritage:

How society engages with its urban public realm[30] and public spaces depends on how pleasant and safe they feel when using them and on how easy services are to access. MetroLink will improve access to these services and over time, enable enhancement of these services in the corridor area.

Currently, the high volumes of traffic in North Dublin is negatively impacting on liveability and the ability to engage with the urban landscape in several ways:

[28] See Appendix I for more details
[29] Ibid
[30] Public realm is commonly defined as any space that is free and open to everyone, such as playgrounds and parks.

- Noise: Noise can affect the quality of life and can result in health impacts in some extreme cases.
- Air quality: PM2.5 can have particularly harmful health impacts, valued at €178,000 per tonne[31]. High levels of such pollutants can also have secondary effects on water quality, including rainwater, which can damage the built landscape, in particular, heritage buildings.
- Safety: Accidents and the perception of accidents, especially pedestrians and cyclists can impact on people's willingness to engage with the public realm. Even minor accidents may deter people from walking or cycling to local amenities, especially for families with children.
- Accessibility: Heavy traffic can make it harder to access services such as doctors' surgeries, schools, shops, etc. especially when roads need to be crossed. This can influence social inclusion within the community and particularly more vulnerable groups that may not have access to private vehicles.

By taking significant volumes of passenger movement underground, MetroLink will support the transformation of the surface level urban environment, making it more attractive for people to engage with. People will be more likely to walk or cycle in the area, increasing health benefits, or to frequent shops or restaurants, increasing economic benefits. The increased ability to walk or cycle will also help to tackle isolation by reducing the need to travel by car.

The stations will also attract a wide range of businesses keen to take advantage of the guaranteed footfall. This will help to boost economic activity and generate an improvement to the urban public realm.

This impact is demonstrated by a recent assessment undertaken by Transport for London[32]. This found that improvements in publicly owned and managed areas of London (including the environs around transport hubs and stations) returned substantial benefits to all residents, both the users of the streets and the occupiers of the offices, shops and restaurants.

Some of the key benefits identified in the study included:

- 4% per annum uplift in office rental values;
- 7.5% per annum uplift in retail rental values;
- 17% relative decline in vacancy rates; and
- 93% boost in walking behaviours.

The key drivers of these benefits identified were:

- having an unpolluted environment;
- distinctive green and comfortable space; and
- adequate space for pedestrian movement.

MetroLink stations will support opportunities to improve the urban environment, as will the associated reduction in vehicle numbers. The attractiveness of the urban environment is also a key determinant in where people choose to live. As MetroLink improves this in North Dublin it will help to attract both people and developers into the area, further encouraging compact growth and sustainable housing developments.

Finally, MetroLink will bring more people closer (in time rather than distance) to our various heritage assets in both Swords and Dublin City Centre.

Access to quality childcare, education and health services:

The 2016 census data shows that there are over 300,000 people that would be within a 2 km[33] catchment area of the alignment (estimated to be 360,000 in 2030)[34]. Of this cohort 41,475 households within the MetroLink corridor have no access to a private vehicle[35]. In addition, 35,792 people in the area have identified as having some form of disability[36].

[31] Price for urban production of PM2.5 (Source: CAF)
[32] Source: http://content.tfl.gov.uk/street-appeal.pdf
[33] Note that demand modelling is not predicated on an established radius for the project and the statistics quoted are for information and context setting purposes only.
[34] See Appendix I
[35] Source: Census 2016
[36] Ibid

Furthermore, many people experience socioeconomic disadvantages due to various reasons. Lack of access to appropriate education, childcare, healthcare, economic opportunity, appropriate housing and so on. Also, there are those disadvantaged by injury or persistent ill-health.

2016 Census data show that over 65,000 people live in socially disadvantaged areas along the MetroLink corridor (15,000 live in areas considered to be significantly disadvantaged[37]). Of the 65,000 people identified, 25,000 identify as being unable to work or unemployed, while 2,350 have no formal education. Some neighbourhoods have an average household income that is 40% lower than the Dublin average.

MetroLink connects this population with five hospitals, 127 schools of which 48 are designated as Delivering Equality of Opportunity Schools and three third-level institutes. By providing a reliable and fast journey time, MetroLink may also help families to access appropriate childcare to meet their needs. It may also alleviate the degree of childcare that may be required, giving more flexibility to passengers in terms of when they leave for work and so on.

While other public transport options also exist, the seamless movement that will be facilitated by MetroLink's permanent and fixed nature will also improve accessibility. Consider for example, the careful planning any journey must take for someone that is visually or mobility impaired. The road surface network offers a dynamic and ever-changing journey. MetroLink will offer the same journey every time. The improvement in reliability of journey time also contributes to MetroLink's sustainability qualifications.

Sustainable management of water, waste, and other environmental resources:

While MetroLink is not being pursued to directly address the sustainable management of water, waste and other environmental resources, it will, as part of its sustainability plan, seek to follow best practices in this regard. MetroLink's Sustainability Plan is seeking to advance TII's goals with respect to the promotion of biodiversity, water conservation and the management of environmental resources.

Strengthened rural economies and communities:

In helping to optimise the road and public transport network in North Dublin, MetroLink will create access opportunities for people in more rural communities (north and west of Swords for example). Through improved access to urban amenities, MetroLink will support the continued strengthening and vibrancy of rural communities and their local economies.

Quantified benefits: Value of time and collision avoidance

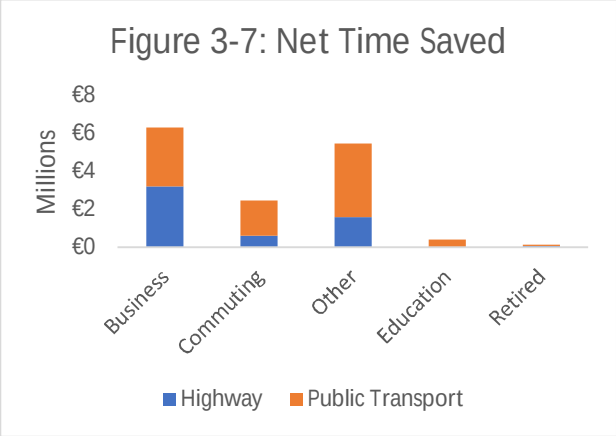
MetroLink will bring benefits to society and the economy by providing additional sustainable mobility choice and connectivity benefits to all transport users in North Dublin and not just commuters travelling into Dublin City Centre.

As can be seen in Figure 3–7 the two largest beneficiaries are businesses (in the form of significant increases in productivity unlocked by travel time savings) and other users (which includes people travelling to and from the airport and other non-commuter users).

[37] Pobal HP Deprivation Index: https://www.pobal.ie/research-analysis/

Figure 3 – 7: Net Time savings by User (€ Ms).

Figure 3 – 7 Explained: the stacked bars indicate the value of the



net time savings by the user on both Highway (blue) and Public Transport (orange). These are grouped on the x-axis by different travel purposes.

Also, MetroLink will reduce the overall number of collisions due to a reduction in the number of road journeys undertaken. Modelling has been used to calculate the reduction in collisions as follows over 60 years:

Type	Without MetroLink	With MetroLink	Total collisions saved
Fatal	2,755	2,740	15
Serious	10,889	10,827	62
Slight	273,659	272,027	1,632

More details on journey time savings and collision savings calculations are included as part of the economic appraisal in Chapter 5 and Appendix I.

The benefits of MetroLink extend much further than journey time and collision economic savings.

With its scale of passengers, MetroLink will have a significant impact on the daily life of people within the alignment corridor and beyond. The project will impact the built environment, where people congregate, where they choose to live, where businesses decide to locate, and how people choose to move around.

Quantified benefits: Public transport users

While it is not unrealistic to say that everyone in Ireland will benefit to an extent from the efficient, reliable and sustainable public transport network that MetroLink facilitates, there will be cohorts of people that MetroLink will benefit directly.

For these people, the benefit that they will experience may not be solely in terms of Euros in their pockets. It will be in changes to how they live their lives and how they engage with Dublin.

Users of MetroLink will be obvious beneficiaries. MetroLink will provide a faster and more reliable service for those who are already reliant on Public Transport to reach their places of work. MetroLink also offers efficient and quality interchange opportunities with the wider bus, light rail, heavy rail and road networks.

For example, the demand modelling suggests MetroLink will improve average journey times (from origin to destination) in the morning peak, in 2045, as follows:

- Swords Pavilion to St. Stephen's Green journey time reduction of 18 minutes; and
- Ballymun to St. Stephen's Green journey time reduction of 14 minutes.

And this is only for those who are currently using public transport. These fast and reliable journey times will also draw in commuters who currently travel on different modes or who do not travel at all. The provision of the Park and Ride Facility at Estuary will support users in switching from their cars to MetroLink to complete their journeys.

As users switch to MetroLink, the entire transport network gains potential efficiency opportunities.

1.5B total hours saved travelling on public transport over 60 years. The equivalent of 2,070 lifetimes*

* A lifetime is defined as the average life expectancy in Ireland, 81.96 years

Quantified benefits: Road network users

For those that do not choose to use MetroLink, the road network performance will benefit also. Subject to other potential projects, road network journey time would be anticipated to improve and become more reliable as a result of MetroLink.

0.6B total hours saved travelling in private transport over 60 years. The equivalent of 906 lifetimes

Sacrifice and disruption?

It is true that MetroLink generates a significant societal benefit. Chapter 5 sets out the results of the monetisation of a subset of the benefits considered in this chapter above, resulting in a BCR of between 1.4 and 2.5. This result reflects the net result for all taxpayers taken as a collective. The BCR analysis considered the net lost revenue to the Exchequer from the changes in travel patterns for example. It also considered the cost to the economy of having to fund MetroLink through tax revenue. And while the result remains significantly positive, the project will result in disruptions and sacrifices for many, especially those along the corridor.

Construction:

The most obvious disruption, albeit a temporary one will be caused by the construction of the project. People living within the vicinity of proposed stations, or along the surface level parts of the alignment, will be particularly impacted. Even those sections that will be underground will have surface level activities that will disrupt people's lives. Heavy construction activity is likely to persist for up to seven years from the City Centre to Dublin Airport, running from late 2022 through to 2029[38]. The section north of Dublin Airport is likely to be shorter by one year, with the timing of the start and finish of works to be within the 2022 to 2029 window also.

This will include traffic diversions, heavy vehicle traffic congestion and safety issues, noise, dust and other construction related inconveniences.

After the heavy works, construction activity will be ongoing, but it will be more focused on systems integration, testing and commissioning and finishing activities which will have a reduced impact on the public.

Construction management and stakeholder engagement will be critical to managing the relationship between MetroLink and the impacted communities, businesses, commuters and wider stakeholder groups during construction. Construction impact mitigation measures, including traffic accommodation plans, will be considered in detail as part of the application to An Bord Pleanála for the railway order.

Environment:

While it is generally acknowledged that the operational environmental benefits of MetroLink will be very positive (particularly through the supply of renewable electricity to energise the line), this will need to pay back the invested carbon footprint of the infrastructure of the project. TII is significantly aware of and planning

Box 3-2: Dublin Tunnel benefits

The construction of Dublin Tunnel in 2006 is a prime example of a transformative project within Dublin City. The prime objective of the project was to remove Heavy Goods Vehicles from Dublin City and the quays by constructing a dedicated Heavy Goods Vehicles corridor and placing a cordon in the city centre.

The key anticipated benefit was to make the City Centre safer due to the reduction of Heavy Goods Vehicles, however the tunnel also led to significant increases in public and sustainable transport options. The freed-up road space was now available for both bus and cycle lanes leading to a shift away from private vehicles.

The improvement in the built environment in the quays, together with other initiatives such as the IFSC, led to an increase in compact urban living accommodations and a vibrant community.

[38] Total construction duration is anticipated to be in the range of eight years, followed by a period of commissioning before service commencement.

for various reductions in the carbon footprint of the project through its continuous environmental assessment process as well as its sustainability plan.

Indeed, MetroLink in its design and concept, and aligned with its sustainability plan, is looking at multiple ways of reducing and enhancing where possible, its construction impact on carbon, ecology and biodiversity.

It will be critical for MetroLink to understand its entire carbon footprint and the payback period for this investment in the context of the operational benefits. This analysis will be more fully complete in the next stage of the project lifecycle and will form part of the information package submitted with the Railway Order application for An Bord Pleanála's consideration.

Disrupted industries:

New public transport invariably disrupts those industries that are focused on the individual transport mode options. Taxis, private bus operators, petrol stations, and others, are all impacted by the move from individual transport modes to mass transport modes. And while the net impact to the Exchequer is captured in the analysis, this does not lessen the impact on the individuals within these industries.

Chapter supporting information

The summary provided by Chapter 3 is supported by the publicly available Preferred Route Design Development Report (March 2019), available at: https://www.metrolink.ie/assets/downloads/MetroLink_PR_Design_Development.pdf

In addition to this publicly available source, this chapter is supported by appendices:

- Appendix G includes a detailed assessment of the benefits of automation (authored by TII's advisors SNC Lavalin); and
- Appendix I includes the economic appraisal (authored by TII's engineering designer Jacobs/Idom).

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

4 Costs

"There are risks and costs to action. But they are far less than the long-range risks of comfortable inaction"

- John F. Kennedy

MetroLink will be a multi-disciplinary, multi-year infrastructure undertaking. Incorporating complex engineering (civil, structural, mechanical, and electrical), governance, risk, procurement, legal, financial, environmental and architectural disciplines, the project must bring together the skills and experience of the local and international major project delivery community to be successful.

The successful construction, testing and commissioning of MetroLink is expected to take just under nine years from the award of the first design and build contract.

MetroLink has three major cost components: delivery costs, operating costs and renewal costs. Each of these is considered further in this chapter.

Delivery cost forecast

Because of the scale and, in an Irish context, unique nature of MetroLink, a comprehensive approach has been taken to the cost forecasting methodology (see Appendix L for full details).

Internal bottom up cost forecasting:

The direct works cost of constructing MetroLink has been forecast by the project team using traditional bottom up costing principles, identifying work packages and considering the inputs to deliver the work package in terms of labour time and materials, equipment costs and the cost drivers and unit prices of various work activities. In some areas, common industry standard percentages are then added, for example to add the costs of insurance, or preliminaries such as site accommodation.

The accuracy of any direct works cost forecast is a function of the level of design and specification development that has been undertaken. Over the last five years, the project team has developed a comprehensive preliminary design, technical specifications and operational and user requirements for MetroLink.

Added to the direct works cost forecast, TII has included forecasts for its costs (authority costs) as well as property acquisition costs. The authority costs have been established based on the resources required and assumptions of the recommended project management model adequate to oversee the delivery of the project and control the associated risks. The final configuration of the project management organisation is subject to the approval of the contracting and procurement strategy.

The property acquisition cost forecast has been established based on the property requirements envisaged for the construction and operation of MetroLink. It has been assessed in accordance with the general scope of entitlement of potential claims to statutory compensation, on a plot by plot basis, and under normal heads of claim, including market-based principles and other eligible provisions typically allowable under the Compulsory Purchase Code. The forecasting process involved TII direct experience of large-scale complex Irish infrastructure, three independent property valuation firms with direct and ongoing experience in the Dublin property market, and Transport for London (Operational Property) peer review and verification of the approach and methodology deployed consistent with international large-scale public transport projects.

Benchmarking:

Top down and bottom up benchmarking processes were employed to develop the direct works cost and by both of the independent cost forecasting firms during the preparation of their estimates. Bottom up benchmarking was utilised to inform a selection of the unit costs and productivity rates. Each of the estimating parties confirmed their estimating approach prior to commencement of the independent estimate process.

Whilst top down benchmarking was utilised to review key aspects of the estimate. The outputs of the top down benchmarking activities were captured in their respective basis of estimate reports with the comparison benchmarks being drawn from a combination of their own in-house

data and published information, published examples being the Case Study: Benchmarking tunnelling costs and production rates in the UK, prepared by the United Kingdom Government's Infrastructure and Projects Authority (IPA) and the Infrastructure Cost Review prepared by the UK HM Treasury.

Further benchmarking will be ongoing through the next stage of the project lifecycle, and results will be updated for any subsequent decision gates.

External independent cost forecast verifications:

Two additional independent and separate shadow direct works cost forecasts were undertaken, by two independent cost forecasting firms, to test for potential additional variability in the assumptions or approach used for the direct works cost forecast. This verified the robustness of the direct works cost forecast and identified areas for further examination and refinement.

Taken together, direct works, authority and land / property costs add up to the base cost forecast.

Box 4-1: Base cost forecast

Base costs of MetroLink, prior to the addition of risk and inflation allowances is as follows:

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	(€ Q4 2019)
Direct Works (Construction):	€4.45 billion
Land & property:	€0.42 billion
Authority Costs:	€0.61 billion
Base Cost Forecast:	€5.47 billion

Risk assessment:

International experience demonstrates that almost no mega-project can be delivered at the forecast base cost figure. In practice all large projects have a myriad of risk factors that can impact on their delivery. For this reason, a risk allowance must be added to the base cost of a project to deal with the cost implications of such risks materialising.

Risks can be assessed individually using a Quantified Risk Assessment methodology[39] and / or

Box 4-2: Validation through Reference Class Forecasting

Working with Bent Flyvbjerg of Oxford Global Projects, the cost estimate (base cost, plus risk and contingency allowance) was benchmarked against reference class forecasting cost curves. The cost curves utilised for MetroLink benchmarking were derived from the cost performance history of over 200 complete projects, predominantly metro and tunnel projects.

Reference Class Forecasting considers the original base costs quoted for these historic projects against their final cost performance, to generate an assessment of uplift percentages that ought to be added to base costs estimates to generate a particular level of confidence that project budgets will be achieved.

can be established by examining the historic cost performance of completed projects of a similar type. This is known as “Reference Class Forecasting”, which uses a database of schemes of a similar “class” to ascertain risk allowances to apply to projects.

MetroLink has undertaken both a comprehensive Quantified Risk Assessment (as summarised in Appendix E) and Reference Class Forecasting (see Appendix L) to validate the project delivery budget range.

The level of risk allowance to add to a base cost is dependent upon the degree of certainty required in relation to delivering a project within a specific budget – the risk appetite.

Risk appetite:

Risk appetite will be a function of the project owner’s experience in undertaking similar projects. A history of successful project undertakings can lead to potential optimism bias in the presentation of costs and risks, particularly as part of economic and financial appraisals, in an effort to achieve project approvals.

The Public Spending Code, 2019 seeks to guard against the risk of optimism bias, while also in turn guarding against the inclusion of excessive risk and contingency allowances.

[39] MetroLink Quantified Risk Assessment to support the risk management of the project is set out in Appendix E

The degree of uncertainty related to very large projects makes the use of a cost forecast range more appropriate.

The risk adjusted cost that provides a 50% probability that the overall outturn cost will be at or less than that figure (and a 50% probability that the overall outturn cost will be greater) is known as a "P50" figure. Similarly, a P80 cost forecast represents the estimate level at which there is an 80% probability that the overall outturn cost will be at or less than the stated figure. And a P30 cost forecast gives a 30% probability of the overall outturn cost being at or lower than the estimated amount. For MetroLink, the estimated P50 risk allowance for example, using Reference Class Forecasting, and having regards to a completed Quantified Risk Assessment, is €1.64 billion.

A range of costs forecasts associated with probabilities from P30 to P80 is deemed to provide an appropriate range for cost forecasting and budgeting purposes.

Box 4-3: Risk allowance range

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P30 Risk Allowance (Q4 2019)	P50 Risk Allowance (Q4 2019)	P80 Risk Allowance (Q4 2019)
€0.38 billion	€1.64 billion	€3.03 billion

MetroLink's Quantified Risk Assessment and Reference Class Forecasting results have been presented to an Expert Judgement Group (composed of experts in major infrastructure delivery), who confirmed that a P80 Quantified Risk Assessment risk allowance represented a best practice number for utilisation in the financial and economic appraisal of the project. Supported by this view, TII has considered the Quantified Risk Assessment P80 risk allowance as an appropriate prudent client appraisal value for utilisation in this economic and financial appraisals set out in this Preliminary Business Case.

TII has also considered that the P50 risk allowance is likely to represent the most appropriate management target budget, subject to Approving Authority considerations.

The MetroLink base cost plus the risk allowance, represents the cost of the project in current day values, meaning the cost of the project in the absence of inflation, and are set out below:

	P30	P50	P80
Base Costs *(constant prices)*	€5.47 billion	€5.47 billion	€5.47 billion
Risk Allowance	€0.38 billion	€1.64 billion	€3.03 billion
Total Cost (excl. inflation) (€ Q4 2019)	€5.85 billion	€7.11 billion	€8.50 billion

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Inflation:

A large project such as MetroLink takes a considerable number of years to construct and the costs of inflation over the full delivery period needs to be estimated and included in the scheme costs for financial planning purposes.

A detailed inflation calculator has been developed to support the MetroLink inflation calculation. The inflation calculator builds up based on 7 sub-indices (drawn from Ireland and the UK predominantly): civil engineering, stations, mechanical and electrical, railway systems, rolling stock, Indirect, Land & Property. Each index is forecast out to 2031 using statistical regression / econometric calculation approach based on historical trend lines[40]. Finally, a Market Condition Factor is applied to allow for the differences that exist between cost price and tender price inflation.

Inflation has been forecast across the 7 individual indices prepared against specific cost elements for MetroLink as an average of 2.72% per annum from 2020 through to 2031 taken as the high forecast average and sensitivity analysis for medium and low reductions by 1 percentage point and 2

[40] The inflation estimate will be required to be updated as part of the submission for Decision Gate 2 to reflect any updates to the programme execution timeframes

percentage points respectively set out in the following table:

	Low Forecast (Average)	Medium Forecast (Average)	High Forecast (Average)
Civil Engineering	0.87%	1.87%	2.87%
Stations (Buildings)	0.83%	1.83%	2.83%
Mechanical & Electrical	0.74%	1.74%	2.74%
Railway Systems	0.83%	1.83%	2.83%
Rolling Stock	0.28%	1.28%	2.28%
Client	0.67%	1.67%	2.67%
Land & Property	0.85%	1.85%	2.85%
Overall Average	0.72%	1.72%	2.72%

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The following table sets out the inflation provision identified for application against the different probability levels:

Box 4-4: Inflation ranges

	P30	P50	P80
Low	€0.43 billion	€0.53 billion	€0.63 billion
Medium	€0.86 billion	€1.05 billion	€1.28 billion
High	€1.32 billion	€1.61 billion	€1.94 billion

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Delivery cost summary

For MetroLink, the total preliminary cost forecast ranges from a low of €6.28 billion, offering a 30% confidence in budget adherence with a low inflation forecast, to a high of €10.44 billion offering an 80% confidence level and high inflation forecast, both figures excluding VAT if applicable.

Management Target (Stretch and Base):

To drive efficiency and promote value for money objectives for the taxpayer, TII expects to establish an internal project budget expectation that reflects the P50 risk assessment, together with the medium inflation assessment. While this is the established management base target, management will in so far as possible, seek out opportunities to achieve the stretch target of P30 with low inflation.

Prudent Client Appraisal Value:

While P30 Low and P50 Medium reflect TII's goals for delivering MetroLink, as a prudent client, TII has utilised the P80 High allowance in its estimation of the overall delivery costs for the purposes of evaluating the economic benefits of the project.

Utilisation of the P80 risk allowance was confirmed as appropriate for this purpose by the Expert Judgement Group.

This helps ensure that a conservative financial and economic appraisal is undertaken within this preliminary business case and that the assessment takes appropriate account of the potential for risk events to arise during the construction phase.

Box 4-5: Delivery cost summary

		Without inflation (Q4 2019)	With inflation
Management Stretch Target:	P30 Low	€5.65 B	€6.28 B
Management Base Target:	P50 Med	€7.11 B	€8.16 B
Prudent Client Appraisal Value:	P80 High	€8.50 B	€10.44 B

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Operating and renewal costs

	2032 (Year 2) € ' m	Total Yr 1-30 € ' m
Operating Costs (Real Q4 2019)		
Staff	19	592
Propulsion Power	2	84
Utilities	1	42
Materials	2	78
Casualty and Liability	2	85
Services and Miscellaneous	3	109
Base Operating Costs	*30*	*989*
Contingency	*10*	*309*
Adjusted Operating Costs	*40*	*1,298*
Inflation	23	2,087

Nominal Operating Costs (ex VAT)	63	3,385
Renewal Costs (Real Q4 2019)		
Rolling Stock	-	214
Infrastructure	-	122
Base Renewal Costs	-	*336*
Contingency	-	*117*
Adjusted Renewal Costs	-	*453*
Inflation	-	550
Total Nominal Renewal Costs (ex VAT)	-	1,003

Once MetroLink has been constructed, tested, and commissioned for operation, the first full year of standard service after a ramp up period will be 2032. In 2032, the nominal annual operating costs are anticipated to be €63 million (ex VAT). This is predominantly composed of wages and salaries for the approximate 335 full-time positions anticipated to be created to run the system at service commencement, including customer service ambassadors, maintenance, cleaning, and other roles.

The other major cost component is the power costs to run the system. At this stage of design development, there are a large number of unknowns that impact the potential energy requirement (and cost) of MetroLink. Power requirements can be considered in two categories, system power and propulsion power. System power relates to the power for the tunnel, operation and maintenance depot and stations systems and subsystems (such as ventilation). At the time of the preliminary business case and based on design development to date, reliable estimates of system power are not available and this is explicitly excluded from the cost analysis.

Propulsion power, which drives the trains in operation is also heavily dependent on the train technology utilised. Reasonable assumptions of propulsion power have been made for the preliminary business case and included herein.

MetroLink's Sustainability Plan (see Appendix D), establishes goals and objectives with respect to minimising MetroLink's power requirement and ensuring that MetroLink is powered substantially by renewable energy.

Estimates available at the time of the preliminary business case suggest that with MetroLink requiring approximately 23 GWh of electricity annually in the early years for propulsion power, growing to over 37 GWh per annum over the first 30 years.

MetroLink will also incur renewal costs relating to the planned maintenance and overhaul of MetroLink rolling stock and infrastructure during the operating period. This is to ensure a fully functioning and attractive public transport service over its useful life. Expenditures are anticipated for various components and systems over the asset life, for example, the replacement of electrical systems, or the refurbishment of the train interiors.

As MetroLink will be newly operational in 2032, no renewal costs are expected in that year and for many of the early years of operation. It is anticipated that renewal expenditures in the first 30 years of MetroLink's life will be limited, amounting to approximately €1.00 billion (including contingency and inflation, ex VAT).

Operating cost estimates

Staff costs:

While MetroLink will be an automated operation, customer service remains essential to its overall success. Accordingly, the operating service plan considers the need for human customer service ambassadors in stations, onboard train support, fare enforcement and security among other roles. These functions are critical to unlocking the benefit of GoA4 automated systems, allowing for the effective deployment of resources to focus on customer service, rather than the act of driving the vehicle.

By allowing for more human interface, security and the perception of security is increased. Accessibility is also increased as passengers can be more readily supported on their journey by a customer service representative. Accordingly, passenger levels are increased, resulting in additional benefits from the system.

To determine the estimated staff cost, TII has developed a bottom up estimate, considering a potential organisation structure and various roles that would need to be filled based on the MetroLink preliminary operating service plan.

Accordingly, the estimate forecasts a need for staff of approximately 335 at the commencement of operations, with over half of these employees working in rolling stock and infrastructure maintenance. The remaining employees will support train and station operations and perform administrative functions such as security, human resources, finance, and information technology services. Staff numbers are anticipated to rise to 364 in 2060.

Staff	2032	2060
Administration	34	34
Operations	122	122
Office of the Chief Engineer	6	6
Rolling Stock Maintenance	71	100
Infrastructure Maintenance	102	102
Total	335	364
Total Real Staff Costs €'m	19	21
Total Nominal Staff Costs €'m	28	69

As a consequence of using the GoA4 automation between the period 2032 and 2060, ridership is anticipated to increase by 82%, while staffing numbers and real staffing costs in the same period increase by 8.6% and 8.2% respectively.

Propulsion power requirement:

MetroLink is powered by electricity. The electricity will be drawn from the grid and regulated through eight traction power substations along the route. Each train has a pantograph that connects to the energised lines (known as catenary) to draw power and move the train. The amount of power consumption is a function of the weight of the train and the number of kilometres travelled (as well as the energy rating for systems and subsystems in the stations). The weight of the train is linked to the train components itself, but also to how busy the train is (on average, a fully loaded train will weigh 35,000 kgs more than an empty train).

Accordingly, at this stage, an average weight expectation has been assumed, resulting in a power consumption estimate of approximately 7.5 kWh per kilometre per full-length train. In addition, the price of electricity is assumed to be €0.093 per kWh (€ Q4, 2019). What this means is, that the 3.1 million kilometres of train journeys in an average year, will trigger an electricity consumption requirement for MetroLink of 23 GWh in its first full year of service.

As the ridership of MetroLink increases, additional trains will have to be introduced to meet demand and this will lead to additional kilometres each year and higher electricity consumption.

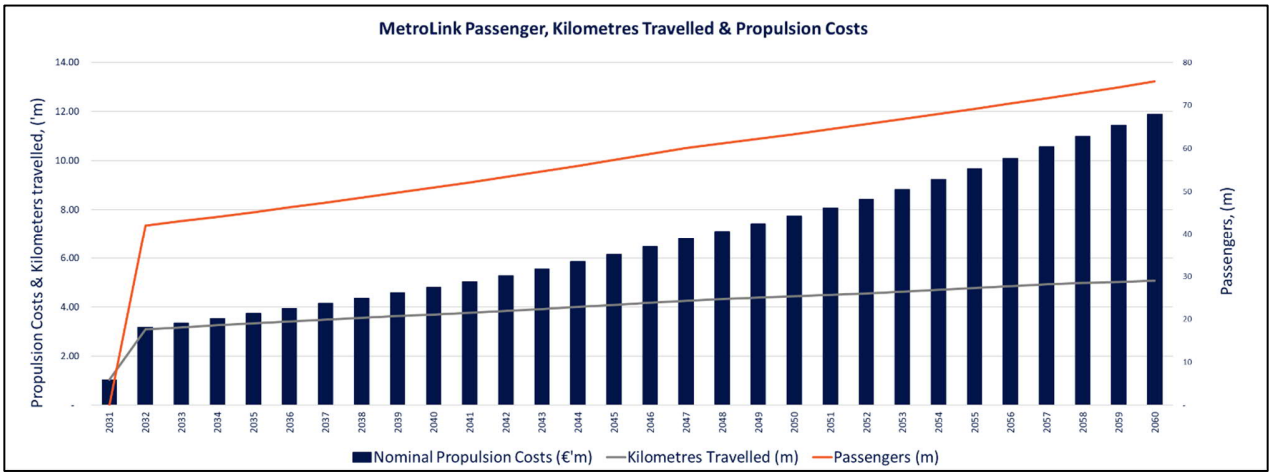

Figure 4 – 1: Relationship between MetroLink passengers, train kilometres travelled and propulsion costs between 2031 and 2060.

Utilities:

MetroLink will also require electricity for operational purposes, other than propulsion power. This includes lighting in the stations, the park and ride facility, offices, and the depot; running of station operations such as ticket machines and the platform screen doors. Escalators and elevators will also require electricity to ensure they remain operational and that the stations remain accessible to all. In addition to electricity charges, utilities also include heating for the offices and depot buildings, as well as costs associated with water and telecommunications.

Materials:

MetroLink trains are forecast to travel 3.1 million train kilometres per annum upon commencement of operations. Providing a high-frequency service will assist in maintaining customer satisfaction and meeting demands; however, this will lead to wear and tear of the infrastructure. Therefore, ongoing maintenance must be carried out on MetroLink to ensure operations continue smoothly and to sustain it's expected useful life of 60 years and beyond. This maintenance will require replacement parts, materials, and consumables.

Casualty and Liability:

During MetroLink's operations, accidents will happen, and passengers may be injured and / or property damaged. Some of these incidents may lead to litigation and / or settlements and MetroLink will have to put in place appropriate insurances to cover such events.

To account for these costs, a factor of €0.05 was applied to each annual passenger (based on the experience of large US metro systems, factored down to account for somewhat lower cost of living in Dublin).

Services and Miscellaneous:

MetroLink's staff will mainly be involved in operations, maintenance, and administrative tasks. Third-party specialists may need to be engaged from time to time as issues arise. These third parties may include engineering consultants, logistics firms, specialised technicians, legal services, etc. to fill any knowledge or capability gaps within the MetroLink organisation. These third-party costs are estimated at 10% of operating costs. Also, MetroLink will incur miscellaneous expenses which have not been captured in any of the other expense categories. These items include work equipment leases, rent, travel, etc. This has been estimated at 1% of the total operating cost.

Renewal cost estimates

Some asset components will need to be renewed to sustain the safe and functioning public transport service at its optimal level and prolong the useful life of the asset. These renewal costs refer to items being refurbished (e.g. seat coverings), overhauled (e.g. train bogeys) or replaced (e.g. rolling stock ventilation system). Overhauls will be

required to renew and extend the life of the train fleet with major overhauls on each train required on or about their 18th year of operation. Following this, a train will likely be replaced after its 35th year of operation. Figure 4 – 2 demonstrates the potential MetroLink fleet renewal and expansion activity over a 60-year period.

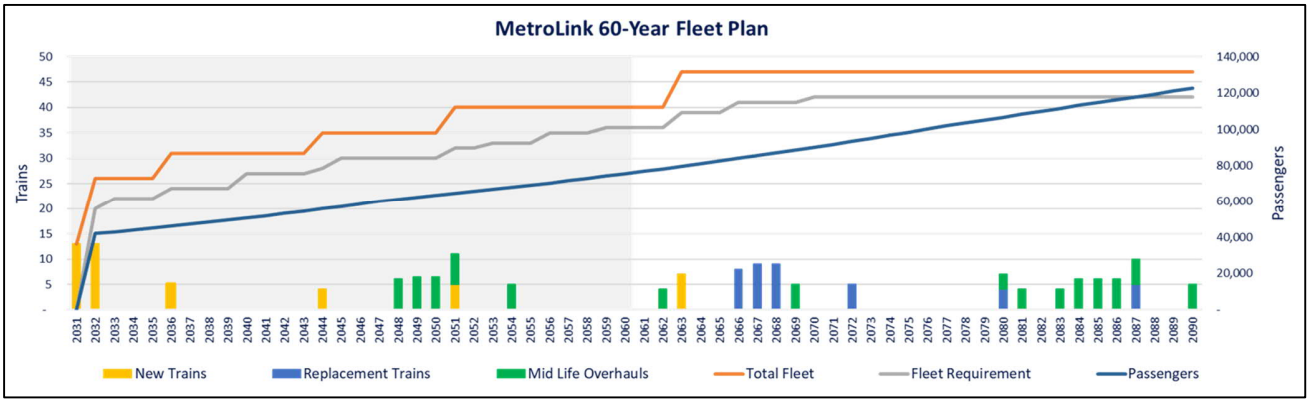

Figure 4 – 2: MetroLink fleet plan.

Figure 4 – 2 Explained: In 2031 when MetroLink enters operation, the rolling stock will consist of 26 trains. As demonstrated in yellow, additional rolling stock will be added to the fleet to meet increasing ridership demand. Trains will require mid-life overhauls every 18 years; this is demonstrated in green. In addition to this, trains will need to be replaced after 35 years, demonstrated in light blue. The cumulative lines illustrate the total trains in the fleet (dark orange) and the number of trains required during peak times (grey). The annual passenger number is represented by the navy line. 2031-2060 is shaded in grey.

Renewing a wider infrastructure system:

The wider MetroLink infrastructure system including power systems, overhead contact wires and rails, signals, lighting, communications, safety systems, track, buildings, stations, escalators, elevators and platform screen doors will be due for major overhaul, renewal or replacement over various intervals over the 60-year planning horizon.

In Figure 4 – 3 below, the anticipated infrastructure renewals over the 60-year MetroLink renewal and expansion plan are illustrated. As is evident, there will be a small amount of renewal activity in year 2047-2053, however, most of the renewal is anticipated to take place after 2057 to sustain MetroLink.

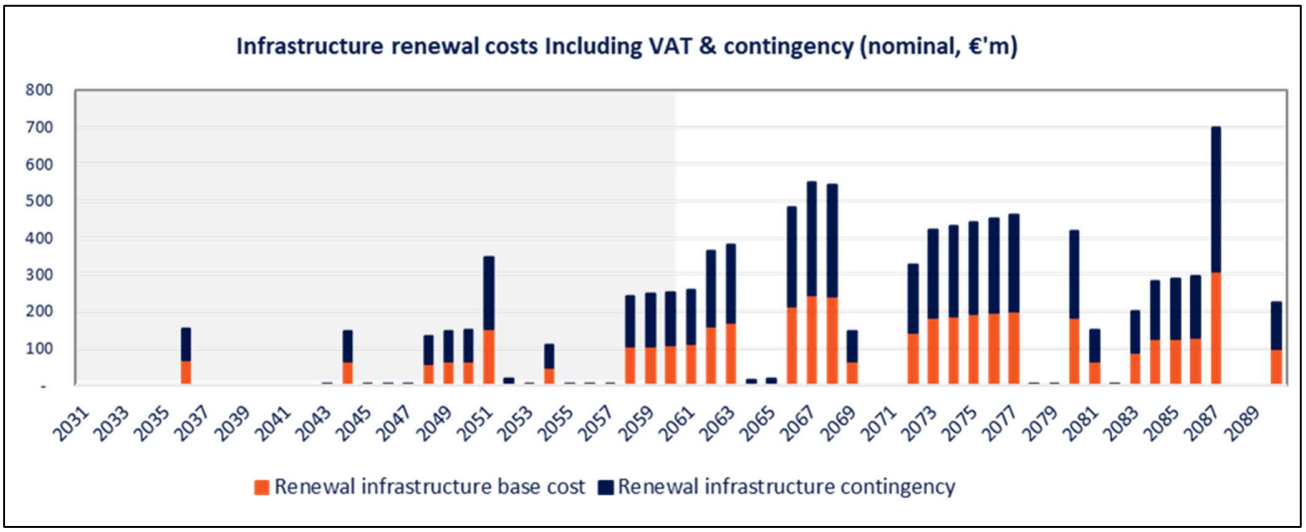

Figure 4 – 3: Infrastructure renewals with inflation and continency.

Figure 4 – 3 Explained: This graph demonstrates infrastructure renewal costs broken down between the base cost and the contingency over the 60-year MetroLink lifecycle. This illustrates the intervals when renewal will occur and how as the infrastructure ages, the renewal costs will increase.

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

Risk and contingency

As with any cost forecast, there is a degree of risk and uncertainty around the operating and renewal costs. To account for this, a contingency was estimated, and allowances have been made for this uncertainty. As the nature of the operating and renewal costs vary significantly, a disaggregated approach to quantifying the contingency was used first. The initial contingencies used in respect of operating costs ranged from 5% to 45%, depending on] the operating cost category.

Monte Carlo analysis was used to check the robustness of the initial contingency cost estimations. It was identified that contingencies for the operating costs were 3.7% below the appropriate level (which included a 7% allowance for unknown unknowns). Accordingly, a further contingency adjustment of 3.7% was applied to the contingencies for operating costs (5% - 45% mentioned above).

This results in a total real contingency for operating costs of €309 million over the period 2031-2060 (35% of the total operating cost excluding contingency and VAT).

In terms of the contingency for fleet renewal and expansion and infrastructure, a 30% cost contingency and an additional 5% for unknown unknowns have been assumed. These contingencies amount to €43 million for fleet renewal and €75 million for infrastructure renewal (both € Q4 2019).

Inflation

Like the delivery base cost and contingencies, the operating and renewal costs will also be subject to inflation. The real costs for MetroLink were developed in Q4 2019 and have been inflated from this date onwards. Inflation is applied to the different cost categories as follows:

- 3% per annum has been applied to operating costs;
- an average rate of 2.4% per annum has been applied to infrastructure renewal costs; and
- 2% per annum has been applied to fleet renewal costs.

Chapter supporting information

This chapter is supported by technical appendices including:

- Appendix E Project level quantified risk assessment summary (supported by risk assessment performed by TII's engineering designer Jacobs / Idom);
- Appendix F scheme costs (prepared by TII's engineering designer Jacobs / Idom); and
- Appendix L cost forecasting methodology (prepared by TII's commercial advisor Turner & Townsend).
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INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER NOTE

5 Economic appraisal

"Well-planned and well-executed public capital investment offers a wide range of social and economic benefits: it enhances well-being and quality of life, underpins better connectivity, improves productivity, and enables more environmentally sustainable development"

- *Public Spending Code, 2019*

MetroLink will deliver significant benefits to society during its lifetime. Some of these benefits, and the associated costs, have been monetised in line with standard CBA methodology as set out in Appendices H and I. The methodology utilised is aligned with both the Public Spending Code 2019 ("PSC") and the CAF[41]. This chapter presents the economic appraisal results. Appendix I includes a Project Appraisal Balance Sheet which draws together information in Chapter 3, together with this chapter.

Understanding the scenarios

Standard practice in undertaking assessments of transport projects requires that a number of demand and network configuration scenarios are generated to provide a range of appraisal results. Each scenario is offering a different assessment of the future by comparing a "do minimum" development scenario with a "do minimum plus MetroLink" (also known as "do something") scenario. This allows for a more robust understanding of the likely impacts of MetroLink across a range of potential future "do minimum" states, as well as gaining more appreciation for the potential trade-offs and behaviours that underpin the demand modelling results.

From a modelling perspective, the benefits of MetroLink are in each case, those incremental benefits generated when compared to the "Do minimum" case in the scenario demand and network configuration under assessment.

Four scenarios have been evaluated as set out in the following table:

Scenario	Do minimum scenario description
1. Core Future	Assumes that all, already committed projects go ahead (see subsequent table). Projects that do not have planning permission or committed funding are excluded. The selection of this scenario is aligned with the requirements for project economic appraisal as set out in CAF.
2. NDP Future	Assumes that all the projects of the Core Future and both Dart + and Dublin Bus Connects are undertaken.
3. Slow Growth Future	Assumes the Core Future projects only and that overall growth in both population and employment is 20% less than in the Core Future.
4. Alt. Growth Future	Assumes the Core Future projects only and demand patterns aligned with the NTA's 'Alternative Future Scenario for Travel Demand'.
5. NDP Future + Alternative growth	Assumes all the projects of the Core Future and both Dart + and Dublin Bus Connects are undertaken and demand patterns aligned with the NTA's 'Alternative Future Scenario for Travel Demand'.

Core future: Projects assumed to be complete
Revised Irish Rail Timetables
Luas Green Line Capacity Enhancement Phase 1
Integrated Ticketing
Pelletstown and Kishogue Train Stations
M7, J9 to J11, widening
Local and Regional Road – including Donabate Distributor Road and R132 Swords Connectivity Improvements.

[41] As at October 2020 update, including revised values of time.

Economic appraisal results

Scenarios	Core	NDP	Low growth	Alt growth	NDP & Alt growth
Public Transport Users	9.4	9.4	8.3	8.0	9.4
Road Network Users	5.5	2.7	4.5	4.7	2.4
Safety	0.03	0.03	0.04	0.03	0.03
Contracting	0.8				
Tax revenues	(0.04)	(0.02)	(0.04)	(0.05)	(0.03)
PV Benefits	15.6	12.9	13.6	13.5	12.6
Investment	7.6				
Operation Cost	0.7				
Revenue[42]	0.3				
PV Costs	8.6				
NPV	7.0	3.5	5.0	4.9	4.0
BCR	1.8	1.5	1.6	1.6	1.5
Sensitivities:					
Cost +30%**	1.4				
Cost -30%	2.5				
Wider Benefits Low	2.2				
Wider Benefits High	2.3				

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* All values are present value € billions.

** This sensitivity is a strong approximation of the P-90 range forecast value for capital costs.

The incremental cost and benefit of MetroLink in the Core Future scenario generates a BCR of 1.8. This means that for every €1 of incremental economic cost, MetroLink delivers €1.80 of incremental economic benefit to Irish economy.

MetroLink will deliver significant monetised benefits, valued at €15.6 billion in the Core Future scenario. As discussed in Chapter 3, there are also anticipated benefits which have not been monetised at this preliminary business case stage. This means that the actual value to society is likely to be greater than the monetised amounts shown here.

The BCR range across the scenarios and sensitivities undertaken to date is between 1.4 and 2.5. Analysis and sensitivity testing will be ongoing through the next stage of the project lifecycle, and results will be updated for any subsequent decision gates.

What the scenarios show is that when growth in passenger demand is slower, or altered due to new mobility patterns, the potential benefits of MetroLink with respect to journey time savings is lower. What is important to note is, that in both slow growth and alternative growth scenarios reviewed, the BCR remains above 1.

Consideration should then be given to the alternative futures whereby DART+ and Dublin BusConnect is completed and then MetroLink is introduced. The impacts of these scenarios require some more consideration.

For this scenario, there is a modest decline in the category of Public Transport User benefits quantified. It is important to recognise again that this is the incremental economic benefit to Public Transport Users of MetroLink in a scenario where DART+ and Dublin BusConnects have already been completed. Viewed in this way, it stands to reason that the scenario would appear as a reduction of Public Transport benefits for MetroLink, given passengers will have additional choices to use DART+ or a BusConnects route, when some of these passengers would choose MetroLink when it is the only fast public transport option (as in the Core Future scenario).

The NDP scenario also shows a large reduction in the benefits for Road Network Users. The main reason for this reduction in benefits is that the opportunities for greater road network optimisations have been reduced through the other schemes. For example, BusConnects will

[42] The positive number Indicates a reduction in overall revenues to the Exchequer. MetroLink is anticipated to result in a reduction in fuel excise tax revenues due to a reduction in car use for example.

require dedicated lanes for the provision of fast bus service on major arterial routes to Dublin City Centre (including along the MetroLink corridor), the scale of benefit that MetroLink can offer the remaining road users is therefore reduced. What is notable however, is that a large quantum of benefits is still generated for those Road Network Users by MetroLink.

The scenario combining the NDP with the Alternative Future provides the lowest level of benefits but the scale of reduction in benefits is contained, and the results suggest that the NDP public transport network is less impacted by these potential future changes in travel.

Sensitivities

The sensitivities have been considered on the core future scenario as follows:

- Increasing the project costs by 30%, while holding all other things equal, would result in a BCR of 1.4. Given the economic appraisal utilises the P80 cost estimate, this sensitivity is considered unlikely;
- decreasing the project costs by 30%, while holding all other things equal, would result in a BCR of 2.5;
- In addition to the benefits calculated by the TUBA and COBALT software[43] that has been utilised to generate the main BCR results, it is also possible to calculate the benefits that wider, non-transport users, will gain from MetroLink. Businesses will gain in terms of the additional output and productivity that is generated through better, faster, and more reliable transport. This benefit is often known as the agglomeration impact (as described in Chapter 2). In addition, wider users will also gain from up-lifts in land values due to the proximity to improved public transport and benefits through the effects of increased competition. In total it is estimated that this will provide a total benefit of between €3.1 billion – €4.4 billion and a BCR range of between 2.2 and 2.3.

More detail in support of all BCR calculations are set out in Appendix I.

Why is the cost information different in Chapter 4?

As discussed in Chapter 4, as the route has been refined, so too have the costs. As is standard in a CBA (following the PSC and CAF methodology guidance) the costs used for the economic appraisal are taken as the economic costs, rather than the financial costs which are presented in Chapter 4.

The main changes are:

1. In this chapter, all values are presented as net present value, to the year 2011, using a 4% discount rate for the first 30 years (including the construction period), 3.5% for the next 30 and then 3% thereafter;
2. All costs have been rebased to 2011 prices; and
3. Values do not include projected inflation or VAT.

In addition to these adjustments, there are further additional economic costs that are captured in the economic appraisal, but which are not considered financial costs. For example, MetroLink construction will need to be funded using public funds, raised through taxes (operational costs will be partly offset by passenger fare revenue, reducing reliance on Exchequer funding). While taxes are clearly required to support any developed economy, it is important to note that taxes have a cost. In line with the PSC a "shadow price" of 30% has been applied to all government funding required for MetroLink. This means that for every €1 of tax-based funding, the cost to society is estimated to be €1.30.

In summary, the present value costs of €8.6 billion utilised in the economic appraisal are derived from the P80 delivery cost estimate, and the operations and renewal cost estimates set out in Chapter 4, adjusted as set out above. More details are provided in Appendix I.

[43] Transport User Benefits Analysis (TUBA) and Cost and Benefits to Accidents Light Touch (COBALT) are software programmes frequently utilised in economic appraisals by the UK and Irish Departments of Transport.

Modelling approach

Demand estimates are at the centre of the CBA. These have been constructed using the NTA National Demand Forecasting Model. This is based on five large-scale, technically complex, detailed and multi-modal regional transport models and a suite of appraisal modules covering the entire national transport network of Ireland. Of the five regional models, the Fingal / North Dublin area is covered by the Eastern Regional Model ("ERM").

The models capture all day travel demand, 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. The regional modelling system is therefore significantly more responsive to future changes in demographics, economic activity and planning interventions, than more traditional models.

The models are hugely complex and detailed. Running scenarios, such as those set out in this chapter, can take several days to configure, then several days to compute and run, as well as several days to understand and validate the outputs. The work to run these models is highly sensitive and specialist and requires significant computing power.

The outputs of the ERM is estimated demand for four modes of transport (walking, cycling, public transport and private vehicles). These ar]e then converted into the CBA results using two standard transport benefit appraisal tools.

1. Transport User Benefit Analysis ("TUBA"); and
2. Cost and Benefits to Accidents Light Touch ("COBALT").

Both tools were developed by the UK Department of Transport for the explicit purpose of undertaking detailed analysis of transport projects. These have then been adjusted by TII and NTA to ensure the values are relevant for the Irish market.

TUBA and COBALT provide a robust, internationally recognised set of outputs which culminate in the production of the CBA results. The TUBA / COBALT models have been utilised to monetise the following:

- Time savings;
- Vehicle operating cost savings;
- The impact on revenues (tolls, fares and other charges);
- The impact to tax revenues; and
- Collisions reduction benefits.

These tools, together with the ERM, have been utilised consistently to investigate the potential public transport intervention along the Swords, Dublin Airport, Dublin City Centre corridor since the Fingal / North Dublin Transport Study, 2014-2015.

Additional benefits and disbenefits may be monetised as part of the next project lifecycle stage. Benefits or disbenefits that may subsequently be monetised include:

- Noise reduction benefits;
- Air quality improvement benefits;
- Emissions, GHG reduction benefits;
- Carbon reduction benefits;
- Improved health and wellness benefits;
- Increased levels of cycling;
- Agglomeration benefits (detailed assessment);
- Compact growth benefits; and
- Accessibility improvement benefits.

Chapter supporting documents:

This chapter is supported by the following technical appendices developed by TII's engineering designer Jacobs / Idom:

- Appendix H: includes the Transport Modelling Plan and related assumptions and approaches to support the various scenarios underpin the quantification of the BCR.
- Appendix I: includes the technical details to support the economic appraisal including a detailed Project Appraisal Balance Sheet.
- Appendix M: includes the detailed traffic modelling results report that underpin the various economic appraisal scenarios.

6 Emerging contracting and procurement strategy

"The short successes that can be gained in a brief time and without difficulty, are not worth much"

- Henry Ford

The comprehensive analysis undertaken and detailed in the earlier chapters has shown that MetroLink will generate value for money. The benefits outweigh the costs. What is more, the benefits anticipated to be derived from MetroLink are significant. This is not a project for a single generation – this is an inter-generational transformative investment in our collective future. MetroLink will be carrying passengers and supporting communities well beyond the turn of the next century.

But it will not just happen. The value for money assessment and BCR presented can only be considered as targets – the ambition of MetroLink at this preliminary business case stage. To secure these benefits will take active project management and execution, of both the construction stage, but also thereafter for decades to come.

A preliminary contracting and procurement strategy is emerging, taking consideration of the risk assessment as presented in Appendix E, for the construction and initial operations of MetroLink. This follows extensive market consultation and is guided by several principles, rooted in the goal of delivering value for money for the taxpayer. How MetroLink might grow and evolve after this initial period will be determined by future governments and may include similar strategies to those outlined here.

Broadly, the emerging procurement strategy intends to procure a series of design-build contracts for the main tunnelling and station works and a "Service Delivery Partner", who will be charged with designing and installing all of the systems of MetroLink and then operating the system for 25 years, with a possible contract extension option of 5 years. The Service Delivery Partner, once procured and retained, will assist TII in finalising the design and construction of the major civil infrastructure – which, in turn, is to be delivered through three separate design-build agreements.

This plan continues to evolve as risk and value for money analysis and further market consultations are ongoing at the time of submission of this preliminary business case.

The remainder of this chapter will provide more detail on how the emerging strategy was developed and what exactly the strategy means. However, it is also important to note that the details provided herein are not all-encompassing, and a detailed procurement strategy will be fully developed and delivered in the next stage of the project lifecycle in support of Decision Gate 2.

The emerging strategy in brief

MetroLink may be delivered as a series of initial contracts, covering the design and construction, as well as the operations and maintenance of the system for 25 years with a possible contract extension option. The emerging contracting structure is summarised as follows:

- A series of advance and enabling works packages designated the M100 series and M300 series, addressing works that, if undertaken early, would allow for faster mobilisation of the larger contracts and specific works undertaken by third parties;
- Three, geographically based design-build contract packages (M401, M402 and M403) for construction of the base civil infrastructure across the entire alignment; and
- A single, availability-based, public private partnership ("PPP") contract (M500) for the delivery of alignment-wide systems, the automated train control metro system, trains, construction of depot and operations control buildings as well as 25-year of operations and maintenance. The partner retained for the M500 PPP contract will be the Service Delivery Partner.

All parties to these contracts would also be signatories to a common interface agreement, to promote issue resolution and minimise the risk of design and construction interface challenges.

- the design, manufacture, installation, testing and commissioning of the platform screen doors and command & control signalling; and
- operation and maintenance of the automated

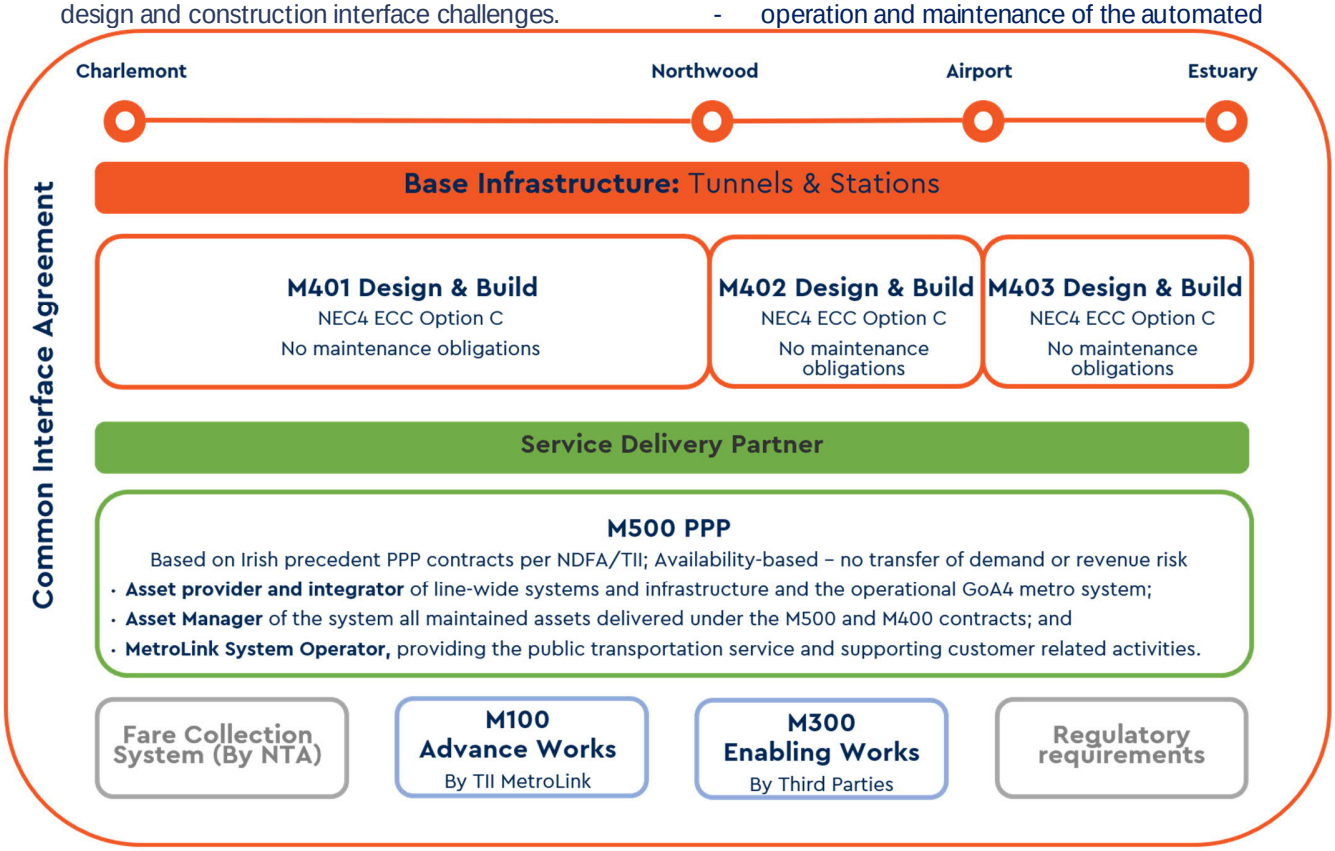

Figure 6 – 1: MetroLink Emerging Contract Strategy.

The PPP Service Delivery Partner

After multiple phases of analysis and market soundings and subject to further value for money testing and validation efforts, an availability-based PPP is being considered for the delivery of the following aspects of MetroLink:

- review, co-ordination, assessment of the M400 series contract scopes and design packages;
- design and construction of the line-wide systems and station fit-out packages;
- the design, manufacture, supply, testing and commissioning and maintenance of rolling stock;
- the design and construction of the depot and operations control centre;
- railway and all civil engineering structures for 25 years.

The rationale for using a PPP contract for MetroLink is motivated by the following opportunities:

- to assign the very significant project integration and contract interface risks to the private partner as the party best placed to manage and mitigate these (and other) risks;
- to gain advantage from the innovation, commercial and management expertise and efficiencies that the private sector can contribute to a project such as MetroLink;
- to incentivise service performance and customer focus through linking payment to

performance and availability over the lifetime of the project; and
- for the built and moveable assets to be maintained properly and returned in good condition with a specified residual life at the end of the contract.

The successful contractor would enter a construction stage plus 25-year availability-based PPP contract, with an additional extension option, and will become TII's Service Delivery Partner for MetroLink.

In this case, the availability risk (the risk that every train, station, escalator, elevator, light bulb and waste bin are ready and available for use on any given day) would be transferred to the Service Delivery Partner, with payments at risk of a deduction for poor service delivery, reliability, punctuality and quality. The performance regime, contractual mechanisms, monitoring and oversight approach for the Service Delivery Partner contract would need to be carefully considered and executed by TII.

The Service Delivery Partner would be responsible for design, construction and commissioning of the operational system and its share of appropriate levels of integration and interface management risk required during this stage. This is considered industry best practice in managing these complex undertakings. Accordingly, the Service Delivery Partner would have international expertise in delivering metro train and automated systems under similar conditions as those proposed for MetroLink.

Given the scale of the risk that is being sought to be transferred, a PPP arrangement is currently considered to be an appropriate contractual basis to align the goals of the Service Delivery Partner with those of TII and more importantly – the customers.

Participants in market sounding exercises, which included leading international firms with experience in the delivery of metro systems, supported this design and build packaging strategy as it could offer a significant advantage and clarity over the transfer of the long-term lifecycle maintenance risk as well as reduce interface risks. It has been assessed that there is a good appetite and market depth for this type of PPP packaging strategy.

The key driver in the PPP suitability assessment is value for money. Appropriately structured PPP arrangements can bring significant benefits to publicly funded infrastructure projects. As previously mentioned, these value for money tests and other validation efforts are ongoing, with results to be incorporated in the final procurement in furtherance of Decision Gate 2.

The risk transfer in the proposed PPP arrangement is underpinned by the strong incentive that no payment will generally be made until revenue service can commence, combined with the linking of payments then to availability, quality, and performance measures. In this regard, it is anticipated that the Service Delivery Partner would receive limited compensation during the construction period in advance of the substantive performance-related payments that only follow on the commencement of operations. As such, it is currently envisaged that the Service Delivery Partner would be required to finance its obligations during the construction stage – receiving repayment from TII through a unitary charge over the term of the first 25 years of operation of the contract. This unitary charge will then be at risk of service performance and quality. If TII exercises the extension option, then the Service Delivery Partner would receive a reduced payment amount to cover operations and renewal obligations only over the extension period.

MetroLink service would be managed and run by the Service Delivery Partner under the PPP contract. The Service Delivery Partner will fulfil three primary functional roles, namely:

- Asset Provider and Integration Manager of line-wide systems and infrastructure and the operational automated metro system;
- Asset Manager of the system, including all built and moveable assets delivered under the M500 and M400 contracts; and
- MetroLink System Operator, providing public transport service and supporting customer-related activities.

Design and build contracts

The M400 series contracts for the base infrastructure will comprise of three, geographically-based, design-build contracts for the civil engineering and stations components of

the project, divided between the Southern Section - Northwood to Charlemont (M401), the Central Section - Airport to Northwood (M402) and the Northern Section – Estuary to Airport (M403). These are anticipated to be procured separately and be based on the NEC4 ECC Option C contract. This contract form includes a target cost with activity schedule.

Payment provisions would be included as part of core clauses, linked to a schedule of cost components and associated with the activity schedule. NEC4 Option C contracts promote a collaborative and proactive approach to contract management whereby parties will notify and agree variations as construction works progress, and cost savings / overruns as compared to the target cost will be shared in pre-agreed proportions between TII and the selected contractors at the end of construction.

This contract format would facilitate collaboration and resolution with respect to interface consideration between each individual M400 series contract and between M400 and M500 series contracts.

The Southern Section (M401) is the largest single section of the project and includes underground work in a compact urban environment, integration with existing building and infrastructure, tunnels, and underground stations, among other elements. In summary, it includes:

- The route length of 9.4 kilometres from Northwood to south of Charlemont, all within a tunnel; and
- 10 underground stations.

The Central Section (M402) is the next largest section of the project and includes:

- The route length of 4.9 kilometres, with 2.3 kilometres of a tunnel running under Dublin Airport;
- 1 underground station and basic infrastructure for 1 retained cut future station; and
- A viaduct crossing the M50 motorway.

Finally, the Northern Section (M403) consists of a 5-kilometre portion north of the airport tunnel portal to the terminus at Estuary. This section includes in summary:

- The route length of 5 kilometres, a combination of retained cut and at grade works;
- 4 stations, 3 retained cut and 1 at grade (terminus station at Estuary);
- A viaduct crossing the Broad Meadow River; and
- 3,000 space multi-storey park and ride facility.

Although market sounding exercises revealed a preference for the combination of packages M401 and M402, further analysis determined that despite

Box 6-1: Why not one large PPP?

In the initial considerations of the procurement and contracting strategy for MetroLink, a single large PPP format was investigated. If it had been packaged as a single PPP, MetroLink would have been considered extremely large in the context of interested and available consortia and the value of the contract.

A contract so large would significantly restrict competition, requiring many contractors to team up to be able to take on the project.

Furthermore, the risk profile of such a contract would have created project financing challenges and may not have generated a strong value for money result.

In any case, market consultation confirmed the lack of market appetite for a contract of that magnitude. With this insight, consideration needed to be given to a contracting and procurement strategy that packaged work in a manner that would encourage competition, while also minimising risks associated with integration and interface challenges and so was likely to result in a strong value for money proposition. The current contracting and procurement strategy is the result of this extensive assessment effort and will be submitted to detailed value for money assessment in the next project phase.

Box 6-2: How was the emerging strategy developed?

A process of data gathering, packaging analysis, procurement options assessment and market validation resulted in the emerging contracting and procurement strategy.

The emerging strategy sought to balance two forces:

1) Creating a large contract to minimise interfaces and maximise benefits of innovation and economies of scale to be gained from one contract package; versus
2) Maximising competition through marketable contract sizing. Market consultation revealed that as size and value increases (particularly in excess of €2 billion), the pool of contractors capable of taking on the job reduces significantly. Maintaining like for like risk profiles and specialism in single contract packages (tunnelling is a very specialist civil construction) was also a key driver. Equally, systems design and installation are very specialist. These two specialisms are rarely mixed and to put them together would force teaming arrangements that would limit competition.

some economies of scale, the market does not have sufficient risk-bearing capacity for such a large value contract. Research also determined that the market participants that would be capable of delivering such a contract are very limited, with only three to four parties being available. This means that the combination of M401 and M402 would be less likely to deliver value for money if combined when compared to delivering these contracts separately.

Advance works

There are anticipated to be up to five M100 series contracts for advance works which will be awarded separately through a tendering process for smaller value works that will precede the main M400 series civil construction contracts. They will include utility diversions, archaeological resolution, vegetation clearance and demolitions—works that if undertaken at an early stage will allow for more immediate mobilisation and execution of the main civil works on a "clear and clean site".

Execution of much of the advance works activity will not be permitted until after the receipt of an enforceable Railway Order, although some works associated with baseline construction monitoring may be carried out in advance. Contracts will be readied in preparation for immediate awards following receipt of the enforceable Railway Order.

Since most of these works cannot begin until receipt of an enforceable Railway Order, the extent to which some or all these works is carried out by contractors other than the M400 series main civil construction contract packages, remains under consideration.

Enabling works

The M300 series contracts for the enabling works will be a series of agreements entered with other third parties whose own project works are directly affected by MetroLink. This includes Irish Rail (Glasnevin and Tara stations) and commercial property developers owning sites at Charlemont and O'Connell Street Stations.

Both temporary and permanent works planned as part of MetroLink will need to be incorporated into these sites and / or the planned works of the third party will need integration into the MetroLink works. Formal contractual agreements are required at these sites to protect MetroLink and address responsibilities for the execution of and payment for the agreed MetroLink works, access and ownership rights, design, construction and maintenance obligations, interfaces, insurances, defect liabilities, environmental and health and safety coordination.

Some of these enabling works are of a significant value. An enabling works strategy has been developed and is under review, which addresses safeguarding of value for money.

Both the advance and enabling works contracts will be utilised to de-risk the M400 and M500

Box 6-3: TII procurement objectives

Governance and Control: to conduct procurement activities in accordance with its governance framework in an efficient, consistent and predictable manner that satisfies the requirements of public accountability and internal control to deliver the Intervention Objectives and effectively manage commercial risk.

Probity and Ethics: to act in a way that ensures that it is trusted and respected by those with whom it seeks to transact and that business is conducted by all parties efficiently, fairly, transparently and in a reasonable manner and is consistent with EU and Irish law and regulations.

Affordable Value for Money: MetroLink will award contracts based on the most economically advantageous offers. MetroLink will contract with financially robust and technically competent suppliers by adopting appropriate selection processes and criteria to assess the financial strength and technical capability.

Sustainability: Sustainability for MetroLink means constructing and operating an efficient, low carbon and climate resilient metro system, which better connects Dublin, unlocks regeneration opportunities, drives international connectivity and enables compact growth for present and future generations.

Collaboration: The complexity and scale of MetroLink will require collaborative behaviours from all parties involved in its delivery. By its policy objectives and behaviours, MetroLink and TII will foster such a culture in contracts, contract management and in all relationships.

Risk Management: As part of MetroLink's risk management programme, it will ensure that procurement and delivery-related risks are identified, evaluated, and allocated appropriately to achieve affordable value for money and that the risk allocation in its contracts is clearly expressed and understood. This approach will support and protect delivery of MetroLink's health, safety and environment policies.

Supply Chain Management: Through early engagement and consultation with the market, build and maintain fair and equitable relationships with suppliers and their supply chains that achieve best affordable value.

series contracts. Some of these works will be better, and more economically managed and delivered by TII rather than through the appointment of contractors, e.g. where stakeholder relationships are well established.

Emerging procurement strategy and timing considerations

As noted previously, all works other than investigative works for the purpose of validating designs (bore holes, archaeological testing) require an enforceable Railway Order to be in effect before they can proceed.

To maintain the project timelines, contracts must be tendered before an enforceable Railway Order is granted, with tendering activity scheduled to commence in Q2 2023[44]. Critically, if an enforceable Railway Order is not forthcoming within the anticipated timeframe (Q4 2023), this may impact tender pricing. This has been identified as a strategic risk to the project in Chapter 8.

The procurement process for the various contracting packages is critical to realising the value for money proposition of MetroLink. A well-run procurement process for each contract will maximise levels of competition, minimise any necessary design changes between contracts after award, and result in the selection of world-class international expert firms and personnel to deliver MetroLink.

The advance and enabling works contracts are expected to be procured first, and for the most part, will be executed and in construction while the competitions for the M400 and M500 series contracts are ongoing.

It is in the M400 and M500 series contract procurements where precision and timing are critical based on the emerging strategy. First – the M400 series contracts is proposed to be procured under two competitions. The M401 (Northwood to Charlemont tunnel and stations) and M402 (tunnel under the airport, over the M50 to Northwood, including stations) contracts would be procured as two separate lots under the same competitive process. Parties to the competition could pursue one or both lots – but would only be awarded one lot. There would be a modest timing delay between the award of M401 and M402, with M401 anticipated to occur first. This would allow for those that may have been unsuccessful in M401 to consider their approach and pricing in M402. It would also allow M402 the benefit of any learnings concerning the risk allocation and the resulting pricing levels experienced on M401.

M403 would be procured separately from M401 and M402. The contractor pool for M403, while it would have many overlapping entities that compete in the M401 and M402 competitions, would also have a wider pool of contractors as the contract would not demand tunnelling expertise. The timing of the M403 procurement will be assessed considering several trade-offs that impact value for money. These include the critical path of construction, inflationary impacts to pricing, the potential for the M400 series contractors to be on uneven timelines, the desire to maximise competition learning and having the associated flexibility to adapt the competitions to better ensure value for money from each contract package.

Meanwhile, the M500 series Service Delivery Partner PPP Contract would be procured in parallel with the series M400 series contracts. It is envisaged that information gained in the M500 series competition would inform potential design changes and enhancements in the M400 series contracts. Each competition would have a process of information "consolidation" wherein all contracts will be harmonised for critical design interface issues while competitive tension remains in the process (before nominating preferred bidders).

It is then envisaged that the M500 series preferred proponent, the preferred Service Delivery Partner, once nominated, would enter a service contract

[44] Note: dependent on receipt of Government approval at Decision Gate 2, which is dependent itself on timely submission of the Detailed Project Brief and Procurement Strategy by TII.

prior to executing the main PPP agreement. Under this contract, the Service Delivery Partner will liaise with the selected tenderers under the M400 series contracts and manage the exchange of design data relevant to the technical and operational interfaces of MetroLink. The service contract would pay the Service Delivery Partner as a professional service provider (like the technical or legal advisor, for example) to engage with the winners of the M400 series contracts for finalising of their designs, as described above. As MetroLink is likely to be delivered in a series of contracts, the risks associated with contract interfaces are greater than they would have been with delivery through a single contract. By signing a service contract with the Service Delivery Partner in advance of execution of the main PPP contract, these interface risks between those contractors delivering the M400 series contracts and the Service Delivery Partner would be addressed, and mitigation strategies could be put in place earlier. In this way, the M400 series contracts would be able to minimise potentially expensive design changes later in the process due to interfaces or integration issues with the M500 series contract.

Once the M500 series contract is executed, the Service Delivery Partner and all of the series M400 contract holders would have entered into an interface agreement with each other – designed to allow each party to share information, resolve design and construction conflicts, and promote collaboration on the project development.

In the emerging strategy it is envisaged that the procurement of each of the M400 and M500 series contracts would take between 18 and 24 months over a period of up to 30 months in total. The procurement process would commence shortly after submission of the Railway Order application. No contract award will take place until after the granting of an enforceable Railway Order. Combining this information with the construction timelines outlined in the preceding chapters means that at least one of the M400 series contracts should be in the market Q2 2023 if approval to proceed is granted at Decision Gate 2 (anticipated Q2 2023).

What comes next?

Market consultation on the emerging contracting and procurement strategy remains ongoing. Given the scale of MetroLink, the market must be consistently and continuously engaged as the industry is moving quickly on various topics such as the degree of risk transfer that can be tolerated, the impact of COVID-19 on risk-sharing and pricing provisions, the bankability of contracts and other major factors.

In addition, detailed value for money analysis must be undertaken to validate the emerging contracting and procurement strategy and this in turn may generate necessary changes to the strategy.

Finally, with the ever-changing nature of today's economic, social and financial environment, changes will likely be required moving forward. However, these changes will be driven by the market itself to ensure that they are in line with market expectations, preferences and risk-bearing capacity at the time that the contract packages go to tender – all to better ensure maximum value for money is attained for the taxpayer.

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

7 Financial appraisal

"Reliable and smart infrastructure is key for economic growth, sustainability and the creation of jobs. It is also crucial in ensuring Europe's competitiveness"

- *European Investment Bank*

The Public Spending Code, 2019, requires a financial appraisal setting out the affordability and financial impact of MetroLink to the Exchequer.

TII has considered the quantum of total costs which need to be funded to deliver MetroLink. Much of this work has been completed in the contracting and procurement strategy development which assessed the right-sizing and splitting of the contracts to better ensure value for money through maximum competitive tension.

Exchequer cash requirements

The M100, M300 and M400 series construction contracts are all anticipated to be fully Exchequer funded, resulting in required Exchequer cashflows for MetroLink during the construction period as work progresses.

Separately, the contracting strategy includes a proposed availability-based PPP (M500 series) for the delivery of alignment-wide systems and infrastructure, as well as operating and renewing the system for 25 years.

For the purposes of the preliminary business case, it is assumed that all construction period works under the M500 series contract will be financed by the PPP Service Delivery Partner, and as such, will not require a cash flow from the Exchequer during the construction period. Rather, the PPP Service Delivery Partner will have its capital investment repaid, along with operating, maintenance and renewal cost compensation, by the Exchequer, during the 25-year operating period of the contract. This payment is called the unitary charge and is expected to be in the range of €0.3 billion in 2032 based on preliminary analysis. Based on these assumptions, TII understands that the cash flow profile of MetroLink:

1) Extends beyond the timeframe of the current National Development Plan 2018-2027; and
2) Exceeds the cashflow spend profile that the current National Development Plan assumed for the project in the period 2018-2027.

Financial appraisal

In line with the PSC and CAF, a financial appraisal is undertaken. The financial appraisal for the preliminary business case is developed from the perspective of TII as Sponsoring Agency and reflects those elements of cash flow for which TII has clarity and control at this stage of the project lifecycle. For financial appraisal purposes, the NDFA has recommended utilising a nominal discount rate of 2.5% to discount the exchequer cashflows to January 2020. The financial appraisal assumes the following timing for modelling purposes only[45]:

Stage	Timings
Construction Start	Q3 2022
Operations Start	Q1 2031
Operational Period	30 years
PPP Unitary Charge Payment	25 years commencing 2031

REVISED

The financial appraisal result (ex VAT) is as follows:

Cashflow	Nominal	NPV
M100, M300, and M400 series Construction, Authority and Land & Property Costs (P80)	€ 7.8 billion	€6.6 billion
Unitary charge* *including M500 series construction costs at P80, associated private financing, operations, maintenance and renewal costs Yr. 1 to 25	€ 3.7 billion	€4.5 billion
Operations, maintenance and renewal costs Yr. 25 to 30	€ 1.1 billion	€0.4 billion
		€11.5 billion

REVISED

[45] Note that the financial appraisal will be updated as part of the submission for Decision Gate 2

The financial appraisal results in a net present value of €11.5 billion. Based on the current project schedule, procurement and contracting strategy, and cost estimate for appraisal purposes (P80 with high inflation), the peak exchequer funding request, net of VAT, will occur in 2024, for approximately €1.5 billion. This represents a peak activity year, with all contracts procured and all project activity underway. There are three further years (2025, 2026 and 2027) where the funding requirement is anticipated to exceed €1 billion. Most of the heavy construction will conclude in 2028, leaving more minor integration and construction finishing works to be funded by the Exchequer in 2029 and 2030 before in 2031, commencing the unitary charge payment to the PPP Service Delivery Partner[46].

The average exchequer draws to support MetroLink from 2022 to 2060, excluding VAT, is €0.44 billion.

The financial appraisal sets out a conservative case, utilising the P80 with high inflation delivery cost assumptions in order to test affordability at its perceived top level.

TII is targeting a delivery budget that is approximately €2.3 billion lower (23% lower) than the amount assessed in the financial appraisal. The net present value of achieving this target, with resulting reductions in PPP financing costs, is €2.6 billion, or a financial appraisal result of €8.9 billion.

As part of Decision Gate 2, a more detailed financial appraisal will be advanced to include revenue analysis as well as multiple sensitivities. It is also noted that a detailed value for money assessment will be prepared and will align with the financial appraisal update at that time.

Once tender prices are received, Decision Gate 3 of the Public Spending Code will consider the final assessment of affordability before granting approval to proceed with contract awards.

Potential revenue sources

Detailed revenue analysis has not been undertaken to support the financial appraisal in this preliminary business case. Revenue is anticipated to be generated in a number of instances by the project, as follows:

- Fare revenue from over 53 million passengers in early years and rising to over 100 million passengers over the project life. Depending on the fare policy adopted over time, fare revenues could substantially, if not fully cover operating expenditures (approximately €63 million[47] in early years);
- Advertising revenue on trains and in stations, together with the significant passenger flows could offer opportunities for material advertising revenues to be generated;
- Potential for the introduction of a development levies scheme will be explored with relevant authorities which could contribute funding toward capital expenditure; and
- At the end of construction, TII may hold a number of strategic and highly sought-after excess properties which can be sold, the sales contribution from which may offset some of the funding requirements.

Detailed assessments of these revenue sources and the potential for their generation to offset Exchequer funding requirements will be undertaken as part of the next stage of the project lifecycle.

[46] For the purposes of the financial appraisal the National Development Finance Agency has undertaken a preliminary estimate of the potential unitary charge based on inputs received from TII. The unitary charge estimate is subject to due diligence and value for money analysis as part of the next project lifecycle stage.

[47] The estimated figure of €63m in early years of fare revenue is based on the following: 53 million passengers; Average fare of €2 (NTA 90 minute trip €2.50 adjusted based on fare cohort passenger mix evident from LUAS and including allowance for fare evasion experience); Adjusted to allow for public transport-based transfers of 40% (passengers that originate from other public transport and so have already paid the 90 minute fare and are interchanging to MetroLink).

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

Examination of PPP funding impact:

Figure 7 - 1 sets out the cost profile for MetroLink before considering funding sources. If the project were to be 100% funding by the Exchequer, and if VAT is applicable during construction, this would be the likely profile of funding flow requests from TII.

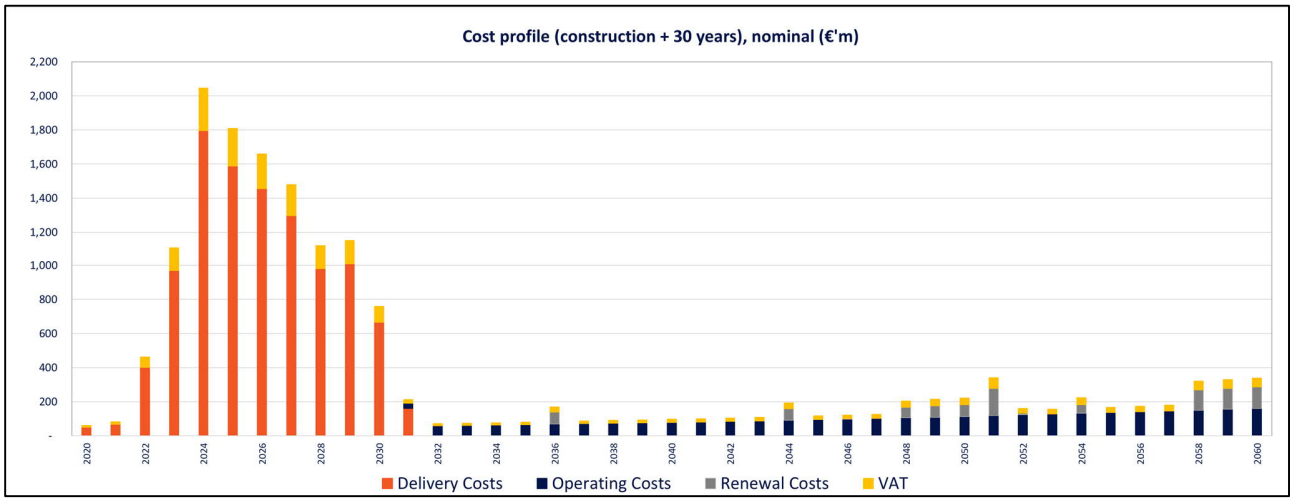

Figure 7 - 1: MetroLink cost profile for construction and Years 1 to 30 of operations.

Based on the current contracting and procurement strategy, a portion of the construction costs would be financed by the PPP Service Delivery Partner, thereby reducing the request for Exchequer funding flows during construction and instead, requiring funding to support the repayment of the PPP financing through a unitary charge for 25 years. Figure 7 - 2 shows this effect in motion (hatched PPP amounts in construction move to become the unitary charge (PPP Payment) during operations). Figure 7 - 3 presents the Exchequer funding requirement under the proposed PPP approach.

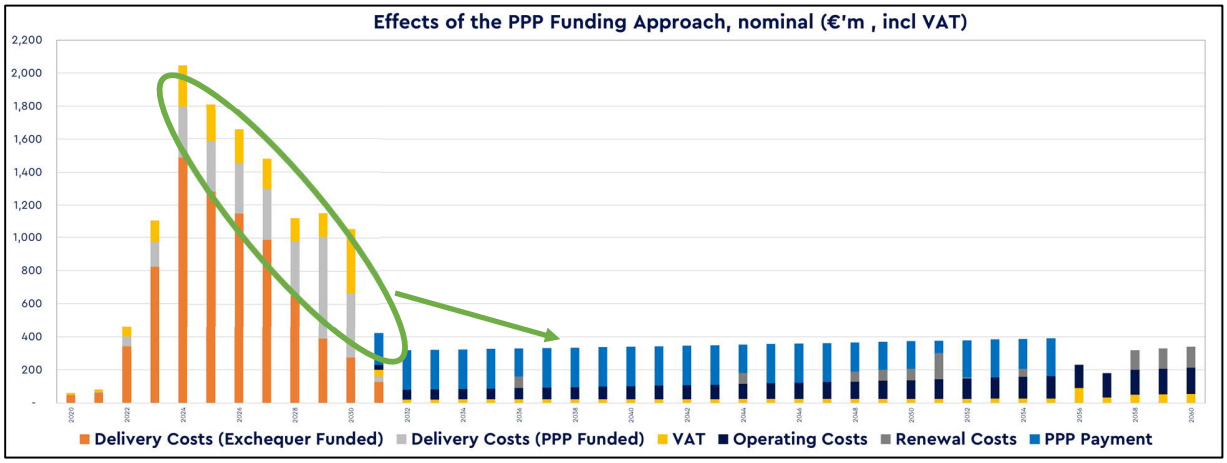

Figure 7 - 2: Exchequer cashflow impact of PPP Funding Approach.

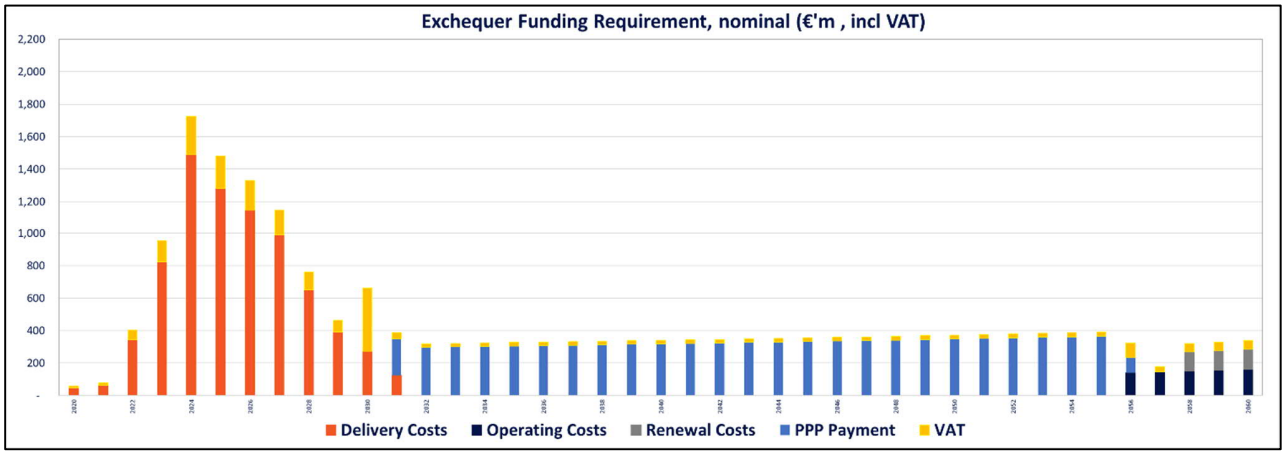

Figure 7 - 3: Total nominal Exchequer funding requirement for MetroLink using the current proposed part-funded PPP model.

Finally, VAT has a potentially large impact on the cost profile. As the effects of VAT are all circular to the Exchequer, Figure 7 – 4 includes the Exchequer funding profile of the PPP without the effects of VAT. This reflects the true affordability assessment profile.

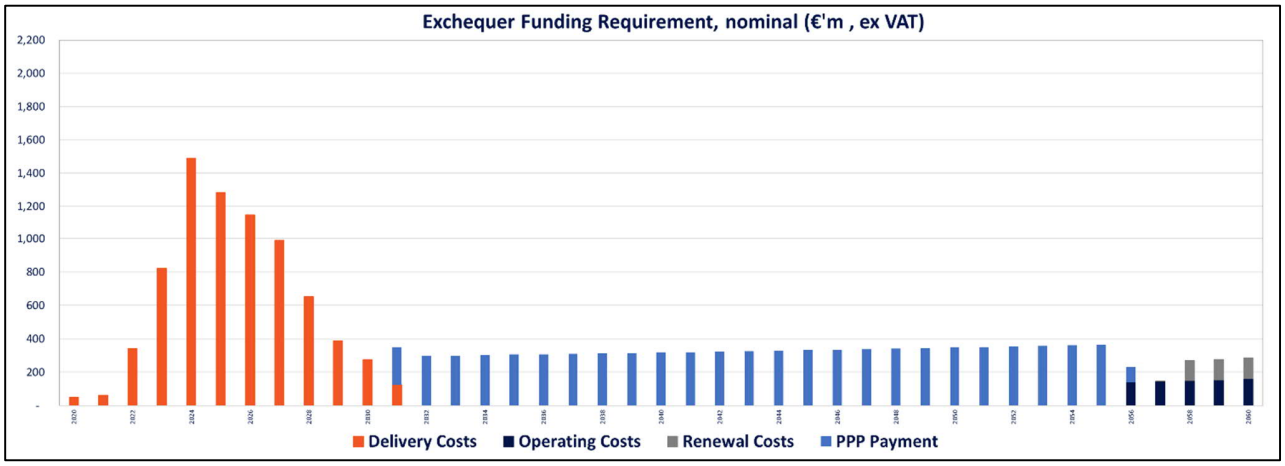

Figure 7 - 4: Total nominal Exchequer funding requirement for MetroLink using the current proposed part-funded PPP model – excluding VAT.

The evolution of LR7 to MetroLink - cost implications

The evolution of the solution to the challenge identified in Chapter 1 and one which meets the Intervention Objectives, has culminated in MetroLink. Whilst many of the design, alignment and system capacity selections in the solution are not always the least costly, they have been selected following the completion of detailed studies, consultation and analysis.

MetroLink has evolved from the original LR7 scheme design (discussed in alternative modes in Appraisal of Alternatives in Chapter 1). Figure 7-5 compares the overall project cost estimates of LR7 and MetroLink (baselined to [2019]) and the cost categories which have increased as a result of the changes in design and alignment. The overall difference in the comparative costs of the MetroLink scheme and the original LR7 scheme is estimated at approximately €2.5bn.

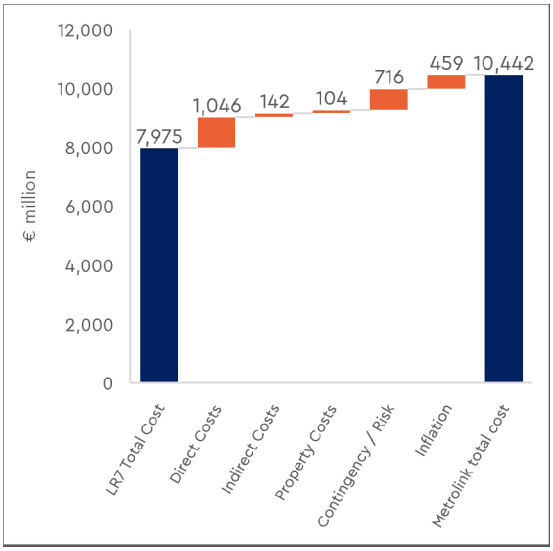

Figure 7- 5: Total Project Estimate Summary – excluding VAT

The main differences (including the order of magnitude cost estimate differences) between the two schemes (and the 2010 Metro North scheme) and underlying assumptions are comprehensively set out in Appendix O. However, in summary the main differences between LR7 and MetroLink are:

- MetroLink preferred route makes provision for the possible future upgrade by extending the tunnel from St Stephens Green to Charlemont station;
- MetroLink provided a new integrated rail and metro station at Whitworth Road (Glasnevin Station). LR7 by comparison envisioned the interchange with the heavy rail at Drumcondra close to the existing Irish Rail station. The proposed station at Glasnevin due to the closer physical proximity of the rail lines at this location, offers significantly shorter and more efficient passenger transfer between Irish Rail and MetroLink services when compared to Drumcondra;
- MetroLink service has been designed as a segregated system capable of offering a high frequency service without setting lower limit on the capacity requirements on the northern end of the scheme. Unlike MetroLink, the LR7 route envisioned the rail service running at grade within the central median of the R132, with the need to provide a level of priority for pedestrians which would affect the ultimate headway and capacity that could be achieved;
- Certain sections of LR7 design considered elevated structures as these are typically quicker to build and can be cheaper than retained cut or tunnelled equivalent. However, environmental and urban integration challenges are difficult to overcome and would likely face significant opposition from stakeholders in the areas concerned. In response, MetroLink has adopted retained cut alignment;
- MetroLink with 11.7 km has more tunnelling work than LR7 with additional tunnelling of 3.2km provided beneath R108 (Ballymun Road) and the extension of the route south to Charlemont adding further 1km of tunnelling to the scheme;
- 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. MetroLink will implement a single bore tunnel solution with the north and southbound rail lines running side by side, delivering significant advantages in terms of cost, speed of construction, and operational benefits; and
- Due to the greater length of tunnels in MetroLink, the number of underground stations has increased from six (LR7) to 11.

The capital cost estimate for the direct costs of each scheme and the total scheme capital costs (baselined to Q4 2019) are summarised in Table 7-3 and 7-4. The overall difference in the comparative costs of the MetroLink scheme and the original LR7 scheme is estimated €2.5bn.

Description	2015 LR7 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 7-3 - Direct Cost Summary

Description	2015 LR7 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 7-4 - *Total Project Estimate Summary*

These design considerations are also discussed below under 'Affordability considerations' where relevant.

Affordability considerations

Affordability has been a persistent consideration for MetroLink and TII. MetroLink is the best performing project to deliver on the established Intervention Objectives and to maximise the benefits to be realised by meeting the anticipated demand for a fast, sustainable and resilient public transport solution along the Swords, Dublin Airport, Dublin City Centre corridor.

In furthering the design, as well as through public consultation and stakeholder engagement, various configuration decisions have been made to more appropriately align MetroLink with the stated Intervention Objectives for the public transport solution (see Chapter 1, Figure 1 – 1 and Appendix N). Some of these decisions have reduced the overall cost of the project materially without negatively impacting benefits anticipated, while some have resulted in increased costs to ensure objectives are met and long-term benefits are realised. The project team initiated a review of the MetroLink design to consider proposed design solutions and configurations which might have the potential to offer a range of cost reductions.

Ultimately, the conclusion of the review of each of these options has determined that the current configuration of MetroLink is the best performing project for achieving the Intervention Objectives.

As part of the review over 30 alternative design configurations/solutions were identified across the five categories listed below:

1. Changing the tunnel configuration from a Single to Twin Bore;
2. The use of elevated rail structures, where it is currently proposed to construct the route in either tunnel or retained cut;
3. Truncating the overall length of the project;
4. Removing stations with anticipated low patronage;
5. Reducing the size of and optimising the design/size of specific stations.

Each of these considerations was assessed in detail, with alternative costs and review of demand modelling as well as for alignment to scheme objectives. The various design decisions themselves were subject to assessment against CAF criteria with the goal of ensuring the MetroLink Project Balanced Scorecard was overall

positive. For example, some decisions have been driven by safety factors rather than demand maximisation.

A summary of the assessments of each consideration is set out below. Detailed discussion on these and other key design, system capacity alignment considerations is available in Appendix O.

Single bore tunnels (current scheme) versus twin bore tunnels (alternative):

MetroLink will have two rail lines running side by side within a single tunnel, known as a "single bore tunnel solution". This is distinct from having the north rail line in one tunnel and the south rail line in another separate tunnel, which is known as a "twin bore tunnel solution".

There are significant advantages in implementing a single bore tunnel solution for MetroLink, in terms of cost, speed of construction, and operational benefits. 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[48] (for access between each tunnel) at every 250m.

The twin bore tunnel solution is currently assessed at approximately an incremental €0.6 billion, over the single bore tunnel solution. The decision to proceed with the single bore tunnel design solution also considered factors other than the noted cost savings:

- Operational flexibility: The ease with which rail cross overs can be introduced within the single tunnel configuration (allowing trains to turn back or change between the two rail lines if a blockage or issue were to emerge, or a section of rail needed maintenance during operations), facilitating greater service flexibility. Accommodating crossovers in a twin bore tunnel solution requires the mining of large cavern spaces, with associated increases in cost, risk and complexity.;
- Construction Programme: A single-bore tunnel can be constructed at lower cost and within a faster timeline than a twin bore solution. This is primarily due to the fact that a single-bore tunnel can be constructed more quickly as there is no requirement to construct cross passages at every 250m as is the case with the twin bore solution or any requirement to construct large caverns for the purposes of installing railway cross over points;
- Evacuation efficiencies: The single bore tunnel facilitates more efficient 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; and
- Reduced environmental impacts: The single bore tunnel solution also allows for a reduced environmental impact during the construction stage when compared to the twin bore tunnel solution, particularly regarding the quantity of materials to be excavated and transported from site.

Accordingly, the single bore tunnel solution is considered to meet the Intervention Objectives for MetroLink, from a cost, operations and environmental perspective.

Tunnel / Retained cut alignment (current scheme) versus elevated alignment (alternative):

During the design review, consideration was given to running certain sections of the MetroLink line on elevated structures. Placing sections of the line on elevated structures as opposed to in a retained cut or a cut and cover tunnel, can offer some

[48] Twin bore tunnelling solutions typically allow for shorter more compact stations arising from the ability to install a central platform to service both rail lines and the need for ventilation / extraction fans to only one end of the station box.

advantages. Typically, these structures are quicker to build and can be significantly cheaper when compared to a retained cut or tunnelled equivalent. They can also offer the potential to reduce some environmental impacts during construction, in terms of spoil removal, ground water flow and local road traffic disruption.

These advantages must be considered against the potential environmental impacts these types of structures would have from a landscape and visual perspective. An elevated structure would place the MetroLink rail line approximately 8 metres above the existing road surface. The poles and overhead power lines 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 creates significant landscape and visual impacts that would be difficult to mitigate appropriately.

If such a structure were to be considered for the R132 (Swords Eastern By-Pass) for instance, it would result in significant visual impacts on many sensitive receptors along the R132 including residential and business properties. Residential properties at Boroimhe Willows and Ashley Avenue would potentially be within 15 and 40 metres respectively of the structure and the visual impact on these properties would be significant. A structure of this height would also result in a visual impact on residents in Estuary Court, Seatown Villas, Carlton Court Road and Foxwood estates.

Similarly, an elevated structure along the R108 (Ballymun Road) may be feasible to construct from just south of Collins Avenue to the station at Northwood. However, locating it in such an established urban setting would be extremely problematic from a visual intrusion perspective with some sensitive receptors including residential and business properties along its route being within 10 to 20 metres (From Albert College Lawn, Shangan Road to Swords Avenue) of the structure. Structures of this type in these locations, would significantly alter the character of the current urban environment and would likely face significant local opposition.

During the operational phase, there is also potential for significant noise and light pollution associated with elevated rail structures when located in close proximity to sensitive receptors such as residential properties. It should also be noted that elevated rail structures can present challenges to creating a metro solution which facilitates permeability, connectivity and cycling provision across both sides of the rail line and can result in perceived severance of the communities it is designed to serve. An elevated metro solution also presents significant constraints on integration with its urban context, introducing hard infrastructural and utility works to the streetscape, particularly at stations. Inside the M50, this will affect established streets and constrain further urban improvements. Outside the M50, notably along the R132 in Swords, an elevated solution restricts the ability of Fingal County Council to deliver on its aspiration to connect the town's urban environment across the R132 by changing the character of the road to a more urban boulevard.

Notwithstanding the above, the design review included an initial cost comparison between the cost of the current retained cut design on the R132 (Swords Eastern By-Pass) and an elevated structure solution. That initial costs comparison found that the elevated structure could offer savings of between €0.25 and €0.45 billion. It should be noted that the forecasts cost for the retained cut solution is based on advanced design and preliminary engineering, while the costed elevated solution is at concept design level only. The project team will in the coming months develop the elevated design solution to determine the potential savings more accurately.

Though the potential for cost saving is substantial, elevated structures present considerable environmental and urban integration challenges, which are difficult to overcome and would likely face significant opposition from stakeholders in the areas concerned.

Full alignment (current scheme) versus truncating options (alternative):

MetroLink will run for 19.4 km from Estuary to Charlemont Station where interchange will be possible between the Luas Green line and Metro services. The design review also looked at several options which would truncate the route, including the possibility of terminating the route at Dublin Airport and terminating the route at Tara Street

Station.

The option to terminate the route at Tara Street Station offered the most significant cost saving. This design solution reduces the overall tunnel by 2km and negates the need for two significant stations at St Stephen's Green and Charlemont. This would result in an overall saving to the scheme currently assessed at approximately €1.1 billion (13% of the management delivery budget).

However, truncating the alignment would result in a number of negative consequences for achieving the full benefits of the scheme:

- 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. Stephen's 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 objectives;
- Access to Key Attractors: The proposed St Stephens Green station not only provides direct access to one of Dublin's most cherished and iconic City Centre areas, 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. 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 Stephen's Green and other shopping, leisure and cultural amenities would not be provided;
- Future Southern Extension: The current MetroLink alignment allows for future extension of Metro services from Charlemont Station onwards through the proposed upgrade of the Green Line to metro status, or through alternative route alignments. Truncating the MetroLink at Tara Street Station could make this objective significantly more difficult to achieve in the future. Extending the route south from Tara Street Station at some time in the future will require the construction of a tunnel shaft in close proximity to the completed MetroLink station from which the new tunnel can be bored southwards. This would necessitate the closure of Townsend Street with associated traffic circulation disruption for Dublin City Centre. Furthermore, the creation of the tunnel shaft would necessitate the relocation of the Dublin trunk sewer line. This would be a significant infrastructure project in its own right. Alternatively, if the connection were to be achieved via a new tunnel arriving from the south, a large mined underground cavern immediately south of the connection point would need to be constructed. Either solution could require significant construction works in what is a highly constrained and built-up area of the city; and
- Impact on the overall scheme benefits: To assess the impacts on the overall benefits of the scheme associated to truncating the route at Tara Street, NTA 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).

Notwithstanding the potential cost savings that might accrue to the overall scheme, the current proposed alignment is preferred as it maximises the passenger demand, more fully meets the objectives of providing a fast public transport option to places where a large portion of passengers wish to go, and creates future flexibility for a further expansion of the system.

The assessment of the option to truncate the alignment at Tara Street (and other truncating options) concludes that there are significant cost savings associated with shortening the overall length of the MetroLink route. However, the negative consequences associated with the shortening of the route, which include a reduction in overall benefits of the scheme and a reduction in the BCR, and the fact that some of the options

to truncate the scheme do not fully align with MetroLink's Intervention Objectives, have informed the decision not to pursue any option to truncate or shorten the scheme.

Removing low passenger stations:

Certain MetroLink stations are projected to have low passenger boarding and alighting activity and some of these stations may have a material impact in reducing the costs of delivering MetroLink without a proportional impact on benefit realisation. The removal of a station also has a benefit for those passengers already on MetroLink, increasing journey speeds. However, this is balanced with the removal of destination choice for those already on MetroLink, as well as reducing access and choice to those that would have been served by a station. Currently station boarding and alighting activity is anticipated to breakdown across the stations as follows:

Station	Boarding	Alighting
Charlemont	11.16%	9.56%
St Stephen's Green	5.11%	8.93%
Tara	11.99%	15.44%
O'Connell Street	8.28%	8.35%
Mater	2.99%	3.20%
Glasnevin	5.15%	4.65%
Griffith Park	1.24%	1.45%
Collins Avenue	3.52%	4.17%
Ballymun	5.10%	4.19%
Northwood	2.26%	2.21%
Dardistown (future)	0.00%	0.00%
Dublin Airport	25.05%	22.68%
Fosterstown	3.73%	2.73%
Swords Central	3.99%	4.43%
Seatown	2.90%	2.81%
Estuary	7.53%	5.18%
	100.00%	100.00%

Accordingly, detailed consideration is given to the inclusion of those stations that have forecast either low boarding or alighting demand expectations. Two such stations for example, would be Seatown Station and Griffith Park Station, and both have remained within the MetroLink scheme for different reasons.

Griffith Park has the lowest forecast passenger activity of all stations along the alignment. Griffith Park has just 1.24% of total boardings and 1.45% of total alightings. This compares to Collins Avenue Station immediately North at 3.52% and 4.17% respectively, and Glasnevin immediately to the South at 5.15% and 4.65%. The core rationale for the inclusion of the Griffith Park Station is to create the functional passenger opportunity for the area, given that an intervention shaft construction would be necessary in the absence of the station (with associated negative impacts on local stakeholders during construction). In addition, Griffith Park Station offers improved accessibility for MetroLink passengers to three local schools, an adult education facility and important leisure and sporting facilities in the area.

Incremental cost savings of removing Griffith Park Station and replacing it with an intervention shaft are currently assessed at approximately €0.1 billion.

Seatown Station accounts for under 3% of forecast passenger activity on the alignment (boardings and alightings), making it the third least busy station along the alignment. Like Griffith Park, Seatown has two busier stations to its North and South, namely, Estuary (which also has the park and ride facility for 3,000 vehicles) which accounts for over 7% of all boardings and Swords Central which accounts for a further 4% of boardings.

Seatown Station is central to the goals of compact growth and sustainable urban development in the area. The station surrounds are zoned for residential development and the station has been considered in Fingal County Council's Development Plan 2017 – 2023. By including the station, MetroLink will be fulfilling one of its Intervention Objectives in supporting compact sustainable growth. Without the Seatown Station, the traffic from the residential developments that are planned, would utilise the road network to access either Swords or Estuary. At Estuary, this additional traffic would compete with the wide catchment of longer distance travellers that will utilise the park and ride facility. Alternatively, this traffic would enter Swords village and create associated negative congestion issues.

Accordingly, removing Seatown Station is likely to

have negative impacts on the performance of the road network and the adjacent stations, as well as likely result in fewer public transport users as residents choose to stay in their personal vehicles.

The incremental cost savings of removing Seatown Station have been assessed to be negligible as it is a retained cut station.

Accordingly, removing either of these stations was concluded to not align with the Intervention Objectives for MetroLink.

It is noted that Northwood station also has low patronage figures when compared to other similar stations. However, the station's location is key to Dublin City Council's planned development of the local area and provides a key role in connecting development on both sides of the R108. As such, it was not considered for removal as part of the assessment.

Reducing the size / optimising design of specific stations:

The MetroLink team explored the potential to reduce the overall size of certain underground stations. There are 11 underground stations. Six of the stations: Dublin Airport, Glasnevin, O'Connell Street, Tara, St. Stephen's Green and Charlemont, have unique characteristics (the constrained nature of their sites, and the need to integrate with public transport and other development) that limit the opportunity for significant cost reduction at this stage of their design.

The remaining 5 stations (Northwood, Ballymun, Collins Avenue, Griffith Park and Mater) however share a common design. The review of the MetroLink design found that it may be possible to reduce the estimated costs of these common stations by compressing their overall size and altering the architectural design. Concept designs for an optimised station of this type are being developed and if adopted could result in savings to the overall base cost of the scheme.

Truncate the scheme at Dublin Airport:

Notwithstanding the stated project objective is "to provide a sustainable, safe, efficient, integrated and accessible public transport service between Swords, Dublin Airport and Dublin City Centre", TII also considered the implications for the scheme of terminating the route at Dublin Airport, which would in itself offer a significant reduction of the overall cost of the scheme of up to €1.9bn.

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 Swords 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[49].

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; and
- 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

Phased implementation:

It would be possible to consider a phased implementation for MetroLink, however this is not without significant risk. Any phased delivery would impart considerable integration risk into the project, both from a procurement perspective and most importantly from an overall systems integration perspective. Ultimately, a phased delivery of the project would increase the overall costs of delivering MetroLink. Further subdividing of contracts would decrease the implementation speed due to procurement and delivery complexity with the overall delivery timeline for the scheme, significantly increased.

Phased delivery of the scheme could also have a detrimental effect on the project benefits. If the Airport to Swords section were to be constructed significantly later than currently anticipated as part of a phased approach the effect on the calculated benefits of the scheme would be severe. The Airport to Estuary link is a significant contributor to the overall benefits of MetroLink[50].

The best performing result

Ultimately, the objectives for MetroLink extend beyond simply moving passengers quickly from one end of the alignment to the other.

MetroLink as presented is the result of years of detailed consideration of design and construction choices and alternatives analysis, seeking to find the best result to balance the demand requirements, public consultation expectations, stakeholder considerations, benefits realisation, Intervention Objectives and affordability.

Next steps

The development of the financial case for MetroLink is ongoing. The costings included within this preliminary business case are based on the available information at this time of writing and will be further refined. Key steps which will require an update as part of Decision Gate 2 and need to be completed in advance of the final assessment of affordability at Decision Gate 3 include:

- Development of estimates for revenue to be generated by MetroLink in operations which are expected to materially offset much of the operating costs;
- Review and refinement of costs components and design elements to determine if there is scope to reduce costs;
- Risk allocation between contractors and its implications;
- Finalisation of the PPP M500 series procurement strategy, including if pre-financed bids will be required or if it is preferable to hold a financing competition at preferred bidder stage;
- Understanding the VAT treatment of costs;
- Considering if advance payments to the PPP Service Delivery Partner could provide greater value for money while also considering implications for balance sheet accounting

[49] *NTA Value for Money exercise, Variant 1 is the route stopping at the Airport 2021 Modelling.*

[50] 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 and contributes significantly to the overall benefits of MetroLink.

treatments;
- The funding / financing position will continue to be assessed in conjunction with TII, NTA and National Development Finance Agency with respect to the availability of finance both public/ private, including consultation with the private sector to establish funding capacity therein;
- Balance sheet treatment to be established; and
- Completion of a value for money assessment.

Chapter supporting documents

The summary provided by Chapter 7 is supported by detailed technical studies including:

- Comparative Scheme Estimates – June 2021

This chapter is supported by the following technical appendix:

- Appendix O: Evolution of MetroLink Alignment, System Capacity and Design

8 Project accountability, decision making and strategic risk

"The real mechanism for corporate governance is the active involvement of owners"

- Lou Gerstner

MetroLink will see the deployment of thousands of resources, across multiple contracts, working for multiple companies, all striving for the common goal of delivering a world-class automated metro system for Dublin and for Ireland.

With so much activity and so many resources deployed, the project must be controlled through very clear and direct accountability and decision-making structures. This is critical to the delivery of value for money for taxpayers and in managing the project risks.

When you consider that on average, the project will expend approximately €4 million a week once construction is in full activity, unnecessary delays in decision making and reporting could prove very costly.

Contractors will consider the governance of the project very carefully to understand the level of client decision making risks that could exist. These contractors will want to understand how much budget they need to include in their price – for decision-making delays, errors and omission and other factors related to client maturity.

Accordingly – having a strong, credible, fit for purpose and robust governance structure, designed for the needs of the project undertaking, will drive value for money in two ways:

1. By generating confidence and de-risking decision-making processes for the contractors – reducing potential contingencies in their budgets for client maturity assessment; and
2. By promoting strong project management and risk management structures and the opportunity for accountability and decision making to drive the project forward with value for money as the central goal.

Good project governance can make projects look easy. The right people, with the right capabilities, in the right roles with the right levels of responsibility. Even if one or two of these components is not quite right, good governance can allow the project team to fully function in a manner that promotes value for money. The opposite is also true. Bad project governance will make projects look very difficult.

MetroLink, being a large and transformative infrastructure project undertaking – will invite significant scrutiny and pressure for the parties that are accountable as well as ultimately responsible. Good project governance structures will be able to absorb this pressure and allow the team that is charged with delivering the project for the Irish people to do their jobs with confidence. This will allow the various stakeholders to the process to maintain the governance structure and to focus on the right level of issues for their level in the governance structure.

Good governance empowers decision making at the level that possesses the correct level of information and insight for the decision.

Good project governance is essential to project success, to achieving the project objectives, and to promoting accountability and decision making that will enhance value for money – and not erode it.

This is a critical aspect of the project undertaking.

Governance framework

To ensure efficient and effective governance and to gain the associated benefits, a purpose-built MetroLink governance framework has been established that aligns with the requirements of the Government's PSC and integrates with the corporate governance requirements of TII (as the Sponsoring Agency) and the NTA (as Approving Authority).

This framework as set out herein, describes the involved parties and the framework for approvals and reporting requirements during the delivery of MetroLink.

Involved parties:

The involved parties and their associated roles in the MetroLink governance framework are as follows:

Involved parties	Role	Responsibility
Government	Ultimate Approving Authority	Government approval is required at specified decision gates.
Department of Public Expenditure and Reform	Technical Review	An independent technical review will be carried out at specified decision gates.
Department of Transport	The Parent Department	It is the responsibility of the Parent Department to facilitate seeking Government approval at specified decision gates. The Parent Department is also responsible for managing overall capital budgets and ensuring that policies and procedures are in place to comply with the Public Spending Code, 2019.
Major Projects Governance Oversight Group	Major Transport Investment in Bus and Rail	Oversight group (chaired by Department of Transport) provides challenge at a central Government level.
National Transport Authority	Approving Authority	The Approving Authority has ultimate responsibility for MetroLink.
Transport Infrastructure Ireland	Sponsoring Agency	The Sponsoring Agency has primary responsibility for evaluating, planning, and managing MetroLink.
Project Board	MetroLink Specific	The MetroLink Project Board is a governance function whose role is to oversee the project and is the main decision-making body on matters not reserved for the Approving Authority's and Sponsoring Agency's Boards or Government.
Co-ordination Committee	MetroLink Specific	The Coordination Committee is consulted where appropriate to keep the participating agencies informed and seek advice on any constraints and areas of concern.
Expert Panel	MetroLink Specific	The Expert Panel provides objective advice and challenge to the Project Team and Project Board about strategic decisions from now through to construction and implementation. .

Approving framework:

NTA is the Approving Authority for day to day approving authority functions, however, in line with the PSC, Government approval is required at the following three Decision Gates:

1. Preliminary Business Case (Decision Gate 1)
2. Design & Planning and Procurement to proceed to tender (Decision Gate 2)
3. Final Business Case to award the contract (Decision Gate 3)

As required by the Public Spending Code, at each of the above Decision Gates, Government approval will be facilitated by the Department of Transport, which has put in place arrangements, including external assurance of project documentation and the establishment of a Major Projects Governance Oversight Group, to assist in the discharge of its obligations under the Public Spending Code. The Public Spending Code currently requires that the Preliminary Business Case be subject to a technical review by the Department of Public Expenditure and Reform prior to consideration by Government.

Reporting framework:

Throughout the lifecycle of the project, the MetroLink Project Board (Chaired by a TII Executive Management representative) will be the primarily responsible body for MetroLink on all matters not reserved for the Approving Authority's and Sponsoring Agency's Boards or Government and will be given the necessary delegated authority to carry out this function by the TII and NTA Boards.

The MetroLink Project Board (composed of senior executive NTA and TII representatives) will be responsible for regularly updating and informing NTA and TII throughout the life cycle of the programme.

This governance framework does not replace the existing corporate governance arrangements specifically outlined in the Code of Practice for the Governance of State Bodies.

The MetroLink governance framework (supported by a comprehensive monitoring and evaluation plan) has been established to ensure good governance which facilitates oversight, scrutiny and informed decision making. Amongst other things, this framework will provide:

- Informed decision making: Well defined reporting protocols and procedures will allow for the timely dissemination of information to inform decision making;
- Oversight: The governance framework clearly identifies the day-to-day reporting framework for the programme, highlighting the decision and information flows between stakeholders at each level including NTA as the Approving Authority and TII as the Sponsoring Agency. The reporting framework ensures that the MetroLink Project Board, the TII Board and the NTA Board (via the members of the MetroLink Project Board), Department of Transport through the Major Projects Governance Oversight Group and the Government will be aware of project developments in a timely manner, allowing for early intervention and action;
- Scrutiny and challenge: The Expert Panel will provide scrutiny and challenge the Project Team and Project Board in relation to strategic decisions. Robust challenge will also come from a central Government level, through the Department of Transport's Major Projects Governance Oversight Group; and
- Accountability: A programme specific governance framework has been established, clearly identifying the roles and responsibilities of each stakeholder. This framework ensures risk can be managed in a controlled manner and that appropriate levels of authority and accountability are assigned to enable key decisions to be made throughout the lifecycle. A strong leadership team is being put in place with clear, single point accountabilities to enable the Project Director to take a strategic role – ensuring the key strategies and plans are in place, with a focus on managing upwards and outwards and looking ahead to deal with upcoming risks / issues before they impact.

MetroLink specific roles and responsibilities

The Project Board is a key approver for most decisions on MetroLink which do not require elevation to the NTA as the Approving Authority or beyond. The Project Board will take responsibility for forming the MetroLink strategy and overseeing the delivery of MetroLink. It will endorse all documents required to be referred to the TII Board, NTA Board, or Government and will be responsible for communication with the other key stakeholders identified above.

The day to day leadership for the project will be undertaken by the Project Director. This role is to:

Box 8-1: Lessons learned

Good governance is about defining the chain of accountability, providing effective decision making and assigning authority to make decisions and commitment; maintaining alignment between corporate strategy / objectives and those of the project; and defining the disclosure of information required to assure stakeholders that the project is set to meet its objectives, or inform corrective action if not.

As part of the TII Client Support Procurement Strategy & Plan a review was undertaken which looked at other infrastructure projects such as Crossrail Project Delivery Partner, HS2 Phase 1 Development Partner and LUL Sub-Surface Upgrade Programme ATC Programme Support Partner, to ensure that the Project Execution Plan and Governance Framework gains the benefit of the lessons on how those projects were set up, managed and budgeted for.

Key lessons learned from these infrastructure projects include ensuring flexibility to accommodate changing needs within the client team that evolve over time; aligning the objectives of the client and the client support contracts through incentive arrangements, for example; creating and integrated client team with clear roles and responsibilities; avoiding unmanageable conflicts of interest that may lead to reputational and other delivery risks; and, ensuring strong emphasis is placed on team-working and collaboration.

A number of major capital projects have encountered significant issues around governance and / or the control environment. MetroLink has the benefit of these lessons.

- Act as “sponsor”, own the case for investment and is accountable for the outcomes and benefits;
- Direct and manage the delivery of the project to meet MetroLink’s Intervention Objectives;
- Ensure compliance with relevant legislation and regulations;
- Liaise with the Project Board, TII, NTA and other stakeholders;
- Adhere to Quality and Safety guidelines;
- Ensure the project delivers value for money; and
- Perform such other duties as are necessary.

The Project Director will act as the nexus between the Project Board and the project team.

More detail on the roles and responsibilities of the MetroLink project team, including a Responsible, Accountable, Consulted, Informed Matrix (“RACI”) is included in Appendix J, TII MetroLink Governance Framework Report.

MetroLink delivery team

While TII and its predecessor organisations have a strong track record of delivering major transport projects, the scale and complexity of MetroLink is greater than anything delivered previously. TII has carefully considered the capabilities which the MetroLink project team will need, in order to be able to deliver a successful project, including consideration of an appropriate client model and organisational structure to enable delivery.

TII has concluded that it will need to procure a “Client Partner” and a “Project Delivery Partner”, as set out below, both of whom will form part of MetroLink project team:

- Client Partner will offer highly flexible programme management skills and experience that will integrate with the existing MetroLink project team to provide all the client functions needed to successfully manage and control the MetroLink programme and provide technical oversight in relation to the detailed design and systems integration of the project.
- Project Delivery Partner will help manage the various MetroLink contracts (design and build, PPP, etc.), including the provision of project directors, project managers and contract administrators to suit the contract form and site supervision needs.

A detailed organisation structure has been developed for MetroLink, based on the key disciplines / capabilities required to deliver the project, the identified client type and the approach to procuring partner resources (i.e. Client Partner and Project Delivery Partner). Job specifications for key roles have also been developed. The organisation structure will be implemented in stepped phases with Client Partner roles first to be filled / implemented, followed by Project Delivery Partner roles from 2022 onwards.

As well as the Client Partner and Project Delivery Partner, TII has retained a commercial advisor (Turner & Townsend), engineering designer (Jacobs / Idom), operations advisor (SNC Lavalin) and financial advisor (the NDFA) among other specialists.

There may also be requirements for other advisory support to undertake discrete requirements, analysis or activities as the project moves through the project lifecycle and these will be considered in conjunction with the Client Partner and Project Deliver Partner as appropriate.

Box 8-2: Information security

In the context of MetroLink, TII will ensure there are robust confidentiality protocols and information security measures in place throughout the project lifecycle to ensure against the risk of confidential information being accessed or compromised. Such measures will extend to designing and implementing controls to ensure a safe, robust and resilient operating infrastructure capable of supporting the high levels of availability required when operating a metro system.

Given MetroLink’s scale and potential impact to the State and public transport system, it will be subject to high levels of public interest. Therefore, TII and the MetroLink Project Board will set up clear communication channels and robust information security policies and procedures, which will protect confidential information and data relating to the project as well as ensuring the safety, availability and integrity of the MetroLink operating environment.

Strategic risks

TII maintain an active project risk register (as discussed in Appendix E). On a monthly basis, the project risk register is reviewed and updated for strategic level risks, issues and activities to facilitate senior management tracking and management of strategic matters associated with MetroLink. There are a number of strategic level risks which persist for MetroLink over long durations, being fundamental items to project progress or success.

Set out below are the current strategic risks identified for MetroLink, ordered broadly in terms of their timing of potential resolution or manifestation. The risks are assessed against the following probability / consequence evaluation matrix:

		Insignificant	Minor	Moderate	Major	Catastrophic
	Rating	1	2	3	4	5
Almost Certain	5	M	H	H	E	E
Likely	4	M	M	H	H	E
Possible	3	L	M	M	H	H
Unlikely	2	L	L	M	M	H
Rare	1	L	L	L	M	M

L = Low Risk, M = Medium Risk, H= High Risk, E = Extreme Risk

Risk	Cause / event / effect	Impact	Mitigation
Failure to submit the Railway Order application in Q2 2022	Failure to receive approval in principle for Decision Gate 1 in time to allow submission as well as failure to have application package ready to submit.	Delay to project with inflation and associated management cost impacts. *Probability:* Possible (3) *Consequence:* Moderate (3) *Overall:* Medium Risk	Management focus (including establishment of fortnightly senior executive meetings) on achieving the revised Railway Order submission date. Weekly critical issues meetings also taking place.
Railway Order approval process takes longer than anticipated (15 months) or is subject to judicial review or is refused.	An Bord Pleanála may take longer than 15 months to grant a Railway Order for various reasons. Their decision may be subject to judicial review proceeding which would also cause delay, or, they may refuse the order, resulting in the need for either a resubmission or project cancellation.	Depending on the nature of such delay or refusal this may result in delays and related costs (associated costs of inflation and management expenditures) or cancellation of the project, with the impact of associated sunk costs to that date. *Probability:* Possible (3) *Consequence:* Moderate (3) *Overall:* Medium Risk	Steps to mitigate this risk have and are being taken including undertaking two non-statutory public engagement activities for the project, continued active engagement with affected communities and representative bodies, and ultimately the development of a comprehensive Railway Order submission – where extra time is been taken to ensure the most positive reception. The Railway Order application documentation are undergoing comprehensive legal and technical review to ensure that there are no ambiguities and is in compliance with all applicable legislation.
Market competition is low for some / all procurements	Due to a lack of an Enforceable Railway Order or lack of other clear commitments, or due to economic and market activities or due to poorly considered contracting strategy, terms and conditions for the current	Procurement failures or a lack of competitive pricing generating affordability constraints. *Probability:* Unlikely (2) *Consequence:* Moderate (3)	The contracting strategy is being carefully considered to package the required works, appropriately to maximise their attractiveness to market (while providing value for money). Further to this, the procurement documents will be developed to ensure clear requirements

Risk	Cause / event / effect	Impact	Mitigation
	market.	*Overall:* Medium Risk	and clear commitments (to the extent possible). Comprehensive and robust market sounding to generate high levels of competitive interest / tension.
Project deemed unaffordable	Due to economic and financial position of the State and or other political / social requirements. This risk is acknowledged to persist for the entire project lifecycle.	Delay to allow for rescoping, resubmission of Railway Order applications etc, or project cancellation. *Probability:* Possible (3) *Consequence:* Catastrophic (5) *Overall:* High Risk	The Public Spending Code is the set of rules and procedures that ensure the best possible value for money is obtained. TII is developing MetroLink with a view to maximising value for money while developing the public transport solution.
Severe impact low probability events	There may be global events or issues that impact the project in achieving its objectives including on-time and on-budget delivery. These external factors include events such as COVID-19 or other world shock, or events such as Brexit.	Severe impact and low probability events have the potential to generate immediate affordability issues for the project, as well as trigger reviews of business cases and other rationale, leading to delays and associate costs or project cancellations with associated impact of sunk costs at that point in time. *Probability:* Rare (1) *Consequence:* Catastrophic (5) *Overall:* Medium Risk	Risk management structures are in place to actively identify and manage such risks as they occur and develop. active risk responses. Risk management includes weekly risk meetings and a live risk register (including mitigants) which is updated on an ongoing basis.
Failure to reach agreements to acquire key lands	This may occur for a variety of reasons when engaging with third parties.	Project delays due to exercise of compulsory purchase orders or court challenges. Budget increases. *Probability:* Unlikely (2) *Consequence:* Moderate (3) *Overall:* Medium Risk	Early and active engagement with land owners to acquire key lands required to deliver MetroLink.
Client organisational readiness	A major infrastructure project undertaking requires a skilled and robust client organisation to give the greatest probability of a successful outcome. Lack of support and funding to create the right client organisation for the project may impact success. Changes in key personnel can have a negative impact if the client organisation is not set up to account for succession management.	Project delays if team does not have the right experience or capacity to dedicate to the project delivery schedule and associated requirements. Increased client management risks impact tender prices and confidence in the procurement processes. *Probability:* Possible (3) *Consequence:* Major (4) *Overall:* High Risk	TII will procure a Client Partner and Project Delivery Partner to ensure it has the skills and experience required to deliver MetroLink. Furthermore, TII is also assessing organisation readiness to ensure that TII is best positioned to successfully deliver MetroLink.
Contractor performance and implementation	Contractors, for a variety of reasons, may not behave in accordance with the contracts or may fail in the performance of their duties therein.	Contractor performance can result in delay, legal proceedings, cost increases, impacts on quality and operational performance. Retendering due to default or termination events will trigger delays in construction completion. *Probability:* Possible (3) *Consequence:* Major (4) *Overall:* High Risk	TII has extensive experience in managing contractor performance and implementation and will have the assistance of the Client Partner and Project Delivery Partner who will also be experienced in managing this risk.
Construction sector constraints	Constraints in the Irish construction sector including	Delay and cost impacts. *Probability:* Possible (3)	This wider issue is being addressed someway at a macro / Government level

Risk	Cause / event / effect	Impact	Mitigation
	labour shortages can have a negative impact in terms of delays and / or increased costs due to market dynamics.	Consequence: Moderate (3) *Overall:* Medium Risk	whereby DPER is clearly communicating the Government's investment plans (and creating confidence) through the NDP 2021-2030, but also in initiatives such as the Investment Projects and Programmes Tracker which provides an indication of the pipeline of public investment capital projects. This should encourage investment (in innovation and resources) in the construction sector. TII will also actively interact with the market players (both national and international), to ensure there is confidence in the programme of works and to encourage as much interest in the contracts as possible. The contractual frameworks which are put in place, will also act as an impetus to ensure the successful tenderers have the resources to hand to deliver their respective programmes of work. The Client Partner and Project Delivery Partner will also be on hand to assist TII in managing this risk.
Tunnelling risk	Ground conditions and unforeseen obstructions may lead to tunnelling delay. Tunnelling works are critical path and as such, any material delays will delay service commencement.	Delay and cost impacts associated with tunnelling risks and potential events can have critical impacts to project budgets and timelines. *Probability:* Likely (4) *Consequence:* Major (4) *Overall:* High Risk	A comprehensive programme of survey and ground investigations has been completed to date to understand geotechnical conditions. Risk is to be managed through appropriate provisions in the contracting strategy.
Unforeseen ground conditions	Contamination, water table, soils quality, settlement issues may all impact underground works, including tunnelling and station development. They may also impact surface works such as rail bed / track slab settlement.	Unforeseen ground conditions may trigger various mitigation and monitoring requirements to meet environmental and structural concerns that may impact the project – generating additional costs and delays. *Probability:* Likely (4) *Consequence:* Moderate (3) *Overall:* High Risk	A comprehensive programme of survey and ground investigations has been completed to date to understand conditions. Risk is to be managed through appropriate provisions in the contracting strategy.
Contractual interfaces generate excessive claims and disputes	MetroLink is a large programme and the potential for interface issues to manifest between the contracts is higher than if a single contracting entity was to be engaged.	Delays, claims and / or issues with integrated testing and commissioning of the system. *Probability:* Possible (3) *Consequence:* Moderate (3) *Overall:* Medium Risk	Risk to be mitigated through the securing of a world class experienced Client Partner and Project Delivery Partner to manage the multiple contractual interfaces and coordination requirements. Risk also to be mitigated by securing a world class experienced Service Delivery Partner with strong experience in managing the integration risk.
Railway systems integration	Railway systems implementation is complex, requiring integration between the trains and the infrastructure. Communications, signalling, radio, control centre and so on all have the potential to experience systems	Systems integration has the potential to create delays and associated costs in service commencement. *Probability:* Possible (3) *Consequence:* Moderate (3) *Overall:* Medium Risk	Risk to be mitigated by securing a world class experienced Service Delivery Partner with strong experience in managing this risk.

Risk	Cause / event / effect	Impact	Mitigation
	integration challenges. In addition, technology obsolescence may impact initial planned systems and require different solutions at the time of implementation.		
Safety commissioning failure / operating licence not granted.	Following the construction stage, testing and commission could reveal safety issues that result in the withdrawal / denial of the operating licence.	Project rework, delays in service commencement. *Probability:* Unlikely (2) *Consequence:* Moderate (3) *Overall:* Medium Risk	Risk to be mitigated by securing a world class experienced Service Delivery Partner with strong experience in managing this risk. TII has extensive experience in managing the operation and delivery of light rail schemes and will have the assistance of the Client Partner and Project Delivery Partner who will also be experienced in managing this risk.

Management of these risks is important to project progress and success. Each risk has a designated risk owner within TII senior management, and all items have control measure, mitigation strategies and plans that inform and direct the project team's current and future work. Proactive and vigorous risk management is critical to any project undertaking but is further elevated in importance for major infrastructure undertakings such as MetroLink.

Risk management

Comprehensive risk management, policies, processes, and structures are in place for MetroLink, designed to identify, mitigate, control and manage risks to minimise their impact on cost / time of delivery.

As the project progresses, there will be specific risk events that do not manifest themselves, and in such cases, the specific risk allocation for that risk event will transfer to the allowance for unknown risks. Also, new risks may be identified, requiring an allocation from unknown risks to known specific risks.

Clear lines of responsibility for the management of risk is a central part of effective risk management. Key risk management roles are summarised below:

Role	Key responsibilities
Project Board	The Project Board is the decision-making forum for MetroLink. From a risk perspective, this includes reviewing project risks escalated to the Project Board via the risk register and implementing risk responses, where appropriate.
TII Project Director	The Project Director is responsible for establishing and taking overall ownership of the MetroLink risk management activity, including: - monthly reviews of the risk register; - quality of the information within the register; - and assigning risks to risk treatment owners and ensuring they are effective in managing the risks
TII Risk Specialist	The Risk Specialist is responsible for the technical direction and effectiveness of the risk management process.
TII Project Managers	Project Managers are responsible for identifying and managing all risk applicable to their activities on a day-to-day basis.
Risk owners	Risk owners are named individuals accountable for managing individual risks that may be assigned.

A 4-stage process is used to manage risks to MetroLink: identify; analyse and evaluate (assessment); treat; and review. This process is summarised below in Figure 8 - 1 with each of the stages described beneath.

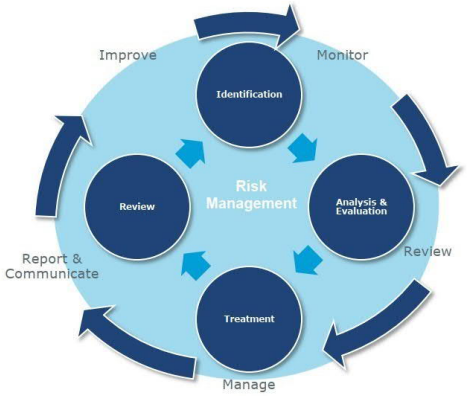

Figure 8 - 1: Risk management process.

Identification:

Identification is the process of identifying all risks with the potential to affect MetroLink project objectives. This includes both “threats” (those risks with a negative effect on objectives) and “opportunities” (those risks with a positive effect on objectives). It is the responsibility of all project team members to raise risks to the attention of the TII Risk Specialist who records the risks.

As part of the identification step, a risk register has been developed through a series of extensive (regular and ongoing) risk review workshops. The register groups risk across several risk categories such as archaeology, construction, contract, design, environment, heritage and procurement, amongst others. To date at this preliminary design stage, 345 project risks have been identified and recorded in the risk register.

Risk assessment:

Risk assessment is the second step in the risk management cycle and relates to the process of determining the significance of identified / known risks, using both qualitative and quantitative methods. MetroLink will utilise the current level

assessment[51] to set the project risk allowance and track risk exposure. This is to avoid overly optimistic risk exposure calculations, which are based on assumed mitigation action success.

Treatment:

Risk treatment is the third step in the risk management cycle and relates to the process of modifying individual and overall risk levels to within tolerable limits through control measures that reduce the probability of the risk occurring, and mitigation measures that would reduce the impact if the risk does manifest. Risk control and mitigation strategies are selected for each individual risk based on several factors, such as the manageability of the risk and the balance of the risk response cost / benefit.

Control measures, mitigation measures and smart risk transfer are a key focus during treatment. For instance, an additional negotiating effort with a contractor may result in more efficient risk transfer or more directed and effective mitigation actions. Prompt expenditure on control measures may well serve to eliminate a risk, while similarly, expenditure on mitigation measures may reduce the impact of that risk, thus creating a tangible saving and further avoiding the further complexities that could have resulted if the risk event either had occurred, or if it had occurred without mitigation measures being in place.

Review:

This step relates to the continual review of both the risk management process information and the risk management activity. Risk information (such as risk registers, risk reports and subsequent risk analysis) is reviewed on an on-going basis to take cognisance of project progress and to facilitate risk-based decision making using the most up to date and accurate information available.

Managing risk going forward

MetroLink is currently at the preliminary design stage. As MetroLink progresses, the project team's understanding of specific risks will develop and grow, and these risks as well as opportunities, will be monitored, managed, and mitigated accordingly.

Work on the contracting and procurement strategy is ongoing. Accordingly, an updated risk assessment may be required as part of the confirmation of value for money for the final contracting and procurement strategy. A vital part of the risk workstream will also involve the transfer and apportionment of risks and liabilities between TII and the contractors which will form a central part of the detailed risk management strategy. Both areas, vital to risk management going forward, will be developed in advance of decision gate 2 (prior to procurement launch).

As part of ongoing risk management, the impact of COVID-19 on the construction of MetroLink will be carefully considered and monitored to understand and quantify any potential impacts on costs and delivery schedules.

Monitoring, evaluating and benefit realisation approach using SMART objectives

A key component of the governance strategy is to ensure that the programme delivers against the objectives that the costs are minimised, and benefits are maximised, as set out in the previous chapters.

MetroLink will need to deliver against both the national strategic outcomes (as set out in Project Ireland 2040) and the Intervention Objectives which include an overarching objective to provide a sustainable, safe, efficient, integrated and accessible public transport service between Swords, Dublin Airport and Dublin City Centre and the below sub objectives:

1. Cater for existing transport demand and support long term growth
2. Deliver an efficient, low carbon and climate-resilient public transport system

[51] Current level assessment is reflective of the level of risk with the effects of existing controls / mitigations implemented to date, not potential mitigations which could be implemented.

3. Provide a high standard of customer experience
4. Improve accessibility to jobs, education, and other social opportunities
5. Enable compact growth, unlock regeneration opportunities and more effective land use

As part of the monitoring and evaluation programme and in line with the Public Spending Code, the Intervention Objectives have been tested to ensure they are specific, measurable, attributable, realistic and time-bound (SMART), as set out in Appendix N. The measurement of the Intervention Objectives is set through a range of SMART criteria used for the monitoring and evaluation of the scheme.

Developing various metrics and KPIs aligned to the Intervention Objectives will be undertaken as part of the next stage of the project lifecycle when the following will be developed: a project evaluation plan to identify accountable and responsible parties and both the monitoring and evaluation activities for each sub objective; and a benefits realisation plan.

Ensuring that the Intervention Objectives are achieved will require proactive KPI monitoring and management to ensure that KPIs are achieved and when they are not met, putting in place plans in a timely manner to address same so that benefits can be fully realised. This will apply to both construction and operational stage KPIs.

The evaluation and benefit realisation plans are focused on three key activities:

1. Monitoring: MetroLink will be routinely monitored throughout its lifetime using Key Performance Indicators ("KPIs") linked to the Intervention Objectives;
2. Benefit realisation: These KPIs will be used to ensure that the wider benefits set out in Chapter 3 and 5, such as time savings, are realised throughout the lifetime of the project; and
3. Evaluation: A post-project evaluation will be carried out to measure the effectiveness of the investment and any lessons that can be learnt.

The activities will be based on the logic model set out in Figure 8 - 2.

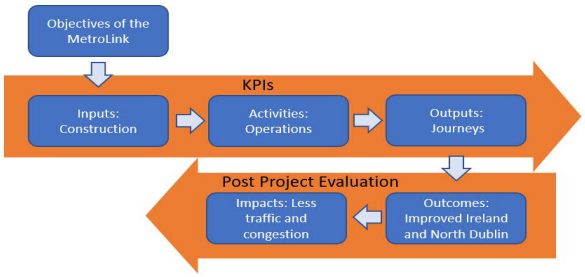

Figure 8 - 2: Evaluation Logic Model.

This logic model works through the steps needed to achieve the objectives and benefits of MetroLink. It begins with the inputs - the timely and affordable design and construction of MetroLink. Once MetroLink has been constructed, it will run a regular, reliable, and high-quality service to meet demand. If this is achieved, then the output of this will be high demand and patronage for MetroLink and many passenger journeys. All these stages can be monitored through KPI's.

These outputs should then lead to a diversion of existing journeys from road-based transport, leading to faster and more reliable journeys for all road users, regardless of their mode of transport. This impact should then lead to benefits to North Dublin and Ireland, and the achievement of the Intervention Objectives. This element will be assessed during the post-project evaluation.

Box 8-3: KPIs for managing contractor performance

The use of KPIs will be fundamental to managing contractors both during the construction and operational stages and will be embedded in all the contracts used to deliver MetroLink to drive value and incentivise contractors. The use of KPI's to incentivise contractors to meet their obligations is customary in infrastructure contracts of this nature whereby KPI levels can be designed and set to clearly articulate the performance expectation.

The existence and monitoring of KPIs which relate to cost (e.g. cumulative cost to date, etc.) and construction progress / milestones are essential tools for determining where underperformance has occurred and where applicable, allow for compensation events to TII. Thus, the contractors are incentivised to meet their MetroLink contractual obligations, and procedures will allow for the timely dissemination of information to inform decision making.

Stages	Areas for potential KPI measurement
Construction stage	• Forecast to complete costs • Programme milestones • Health, safety, environment, and community • Sustainability • Engineering and design parameters • Quality • Change and requirements management • Impact on the local community
Operational stage	• Service levels • Maintenance activities • Capital replacement activities • Remaining useful life • Passenger management (ridership, demographics, overcrowding, safety, satisfaction) • Disruptions to service • Health, Safety, Environment and Community • Staffing Levels and training • Station standards and cleanliness • Sustainability / emissions / energy usage • Expenditure / PSO levels • The technical performance of trains / lines

Monitoring:

KPI's will be reported regularly to monitor MetroLink's progress against these objectives, firstly during construction stage and then when MetroLink is operational.

During the construction stage, regular KPI reporting and monitoring will be central to ensuring that the construction programme is executed efficiently, within budget, to the required standard, and on time. Monitoring of KPI's will also help identify adverse developments in a timely manner, which will inform the project team and relevant governance stakeholders to manage such issues / risks as they arise through the robust governance structures set out in this chapter. This monitoring process can also be supported by an independent Project Assurance function, to provide confidence to the wider stakeholder groups that KPI reporting is robust and accurate, as well as to support issue resolution before items result in critical path failures.

Once MetroLink is operational, the regular monitoring of KPIs will be just as important to ensure that the system operates as efficiently as possible and provides the outcomes / benefits which are anticipated. In line with the approach to the construction stage, the PPP will be incentivised to operate this public transport asset to the highest efficiency to meet the MetroLink objectives and prolong the life of the asset.

KPIs will be designed to capture all the key elements required to manage the project effectively through construction and operation. Firstly, to ensure MetroLink is appropriately monitored, thus facilitating decision making, oversight and project scrutiny, and secondly to achieve value for money by incentivising the contractors to cost-effectively deliver the project by driving innovation and efficiency.

The exact KPIs will be developed as part of the Final Business Case. A potential sample include:

The KPIs will be developed in detail to include baselines, specific details as to what each KPI will be measured against, and the periodicity for reporting on same as part of the final business case.

A draft monitoring and evaluation plan is set out in Appendix K.

Benefit realisation:

Benefit realisation will be a key component of ensuring that the project delivers ex-post value for money for taxpayers. However, benefits realisation cannot be taken for granted. Accordingly, the benefits realisation plan will link the Intervention Objectives to the benefits to ensure that they can be managed using the KPIs. As mentioned above, proactive KPI management will be implemented with early intervention in any areas where KPIs are not meeting expectations, both during construction and operations.

As with the KPIs, the benefits realisation plan will be developed as part of the Final Business Case. This will initially involve mapping the KPIs to the benefits, via the Intervention Objectives, so that there is a clear understanding of what needs to be achieved to maximise benefits.

Once this has been set out, baseline values will be set for each relevant KPI. This will set the minimum value for each KPI which needs to be achieved for the final anticipated benefit to be realised.

Evaluation:

In addition to the ongoing benefit realisation approach, it will be important to ensure that an ex-post evaluation is undertaken which takes the long-term view of whether MetroLink has achieved its objectives and what lessons can be learnt for future projects.

Many of the objectives for MetroLink (such as enabling compact urban growth) will take several years to be apparent. To ensure that these are fully captured, two evaluations are proposed. The first will take place five years following the opening of MetroLink and will be used to help inform the next wave of capital investments. A second evaluation will be carried out at the 10-year point to ensure that every benefit has been captured, even those which took many years to develop. If possible, this evaluation will be timed around the 5-yearly Census and associated release of anonymised Census data which can take up to 18 months. This anonymised data will be the primary source of data on population, employment, travel and other socio demographic indicators, which are intrinsically linked to the benefits of MetroLink and for which a longitudinal and comparable dataset exists. For this reason, the ex-post evaluation may not fall perfectly into five and 10-year periods.

In order to ensure that the results of the ex-post evaluation are reliable, it will be vital to develop an updated counter-factual at this point – what would have happened without MetroLink. This will take the counterfactual which was developed for the CBA assessment in Chapter 5 and further develop this to capture, for instance, impacts on the housing market.

Due to the complexity associated with developing and modelling this, it is not possible to do this on a routine basis. Therefore, the ex-post evaluation will be done on a one-off basis. Further detail on the ex-post evaluation, including a wider economic benefit realisation plan will be set out in the Final Business Case.

Stakeholder engagement

Delivering MetroLink will require the active support of a wide range of stakeholders, from Government to local businesses. While MetroLink will deliver considerable benefits to all of Dublin and Ireland, during the construction stage it will also lead to disruption. The stakeholder engagement plan is designed to achieve three key objectives:

1. Ensure all communications with stakeholders are timely, consistent and coherent;
2. To build and maintain relationships with key stakeholders; and
3. To ensure that the Project team is a trusted source of information.

The key elements of the plan to achieve this are set out in Figure 8 - 3 below:

Figure 8 - 3: Stakeholder communication strategy overview.

As part of this, a register of key stakeholders has been constructed. Detailed mapping of these stakeholders has been undertaken to appreciate the issues that may be of most importance to each. A Smart Stakeholder management system is being utilised to ensure all engagements with stakeholders are tracked and monitored to ensure consistent messaging and appropriate response. The key stakeholder groups are set out in Figure 8 - 4:

Figure 8 - 4: Key stakeholder groups.

Given the high-profile nature of the project, MetroLink must maintain its social licence through clear, consistent and open communication with the wider public.

Chapter supporting documents

This chapter is supported by the following technical appendices:

- Appendix J TII MetroLink Governance Framework Report; and
- Appendix K Monitoring and Evaluation Plan (prepared by TII's engineering designer Jacobs / Idom).
- Appendix N: MetroLink Objective and Subobjectives

9 Rationale for advancing MetroLink

"Someone is sitting in the shade today because someone planted a tree a long time ago"

- Warren Buffett

MetroLink is anticipated to generate significant benefits for the people of Ireland. With a formal BCR of between 1.4 and 2.5, the monetised benefits more than outweigh the costs. Sensitivity and scenario modelling confirm that the BCR will be greater than 1. The non-monetised benefits of MetroLink are extensive, providing valuable insight into the positive impact this intergenerational project can have on our society.

Following robust assessment, analysis and planning, set out by the Public Spending Code, 2019, it is recommended that MetroLink is to be advanced.

The robustness of the cost forecasting process applied to MetroLink, combined with prudence in establishing management allowances has resulted in a high degree of confidence in the cost forecast for MetroLink. The discussion and assessment of benefits highlight the significant societal gains to be attained from MetroLink, while the cost-benefit analysis then undertakes a conservative monetisation of a subset of those benefits that can be directly assignable to MetroLink at this stage.

As the project seeks to gain Approval in Principle to move through Decision Gate 1 of the Public Spending Code, 2019, the project offers a high degree of confidence that it will result in positive value for money for taxpayers.

Robust due diligence complete

In the six years since the initial studies sought to investigate the most sustainable ways to address the public transport deficit in the Fingal / North Dublin area, considerable work has been advanced that confirms and ensures that MetroLink is the preferred solution.

Significant demand modelling has taken place. The extensive route analysis and transport modelling undertaken to assess the preferred route ensures that it will capture the highest level of forecast passenger demand.

The design for MetroLink has also been developed as the understanding of the project has evolved. This has led to far greater clarity around the scope of the project and the associated costs.

All of this has been applied to ongoing options appraisal. This started with the Fingal / North Dublin Transport Study, 2014-2015, in which 25 technical options which were down selected to 4 viable options, with the LR7 (Metro North Optimised) solution being the only solution with a BCR of greater than 1.

As required by the Public Spending Code, 2019 all of these options have been subject to detailed analysis, both in terms of multi-criteria analysis and cost-benefit analysis.

Following the 2014 / 2015 study, work was advanced to assess the emerging preferred route, wherein 10 route options were considered with the goal of maximising demand and quality integration and interchange opportunities with the wider transport network. Demand modelling confirmed significant anticipated capacity requirements of 14,000 peak hour passengers per direction in initial years and growing to in excess of 18,000 over time. Accordingly, a metro based public transport solution became the only solution capable of fulfilling the goals and objectives for intervention along the corridor.

To conclude that MetroLink is the solution, the key steps and requirements set out for project evaluation by the Public Spending Code, 2019 have been followed:

Requirement		How is it addressed
Confirmation of the strategic relevance of the proposal	√	Chapter 1 demonstrates that MetroLink aligns with the strategic objectives of Ireland's sustainability goals, Project Ireland 2040, and other policy objectives.
Specification of objectives, measuring the problem	√	Chapter 1 sets out MetroLink Intervention Objectives.

Requirement		How is it addressed
Description of the short-list of potential options to deliver the objectives	√	Fingal / North Dublin Transport Study, 2014-2015: reviewed 25 options to address the congestion and sustainable land use challenges in the study area. Through MCA, shortlisted to four solutions which are described in detail therein.
Detailed demand analysis and description of underlying assumptions	√	Detailed demand analysis for MetroLink undertaken using NTA's Eastern Regional Transport Model (see Appendix I).
Detailed options appraisal, including both financial and economic appraisal	√	Detailed options appraisal undertaken in the Fingal / North Dublin Transport Study, 2014-2015 to confirm MetroLink solution among four shortlisted assumptions. Solution refined and updated through 2018 Route Options Assessment, public consultation. All analysis supported by demand modelling and economic appraisals (Chapter 1 and 5 and Appendices B, H and I).
Analysis of affordability within existing resources	√	Financial appraisal and funding considerations set out in Chapter 7.

The correct strategic option

The strategic case for MetroLink remains strong, as is set out in Chapter 1. As the population and demand for travel in Ireland continue to increase, the need to provide more sustainable public transport options has and will continue to grow ever more important.

Following from detailed options analysis, demand modelling, route refinements, design development, cost estimation and CBA assessments, it is understood that MetroLink will deliver value for money to the Irish economy for decades to come.

Indeed, MetroLink represents the only viable case to address the identified challenges in the Fingal / North Dublin transport system. There is no viable road solution due to the constraints of the network (which has in the past received investment for upgrades and signature projects such as the Dublin Port Tunnel and M50 upgrades). Furthermore, amongst the range of alternatives considered, MetroLink is the only public transport solution anticipated to return a positive BCR and therefore value for money, as well as addressing the significant demand expectations of the area.

Ireland cannot transform its economy and deliver against its ambitious National Strategic Outcomes, as outlined in the National Planning Framework, along with it's clear Sustainable Development Goals, as set out in Project Ireland 2040, without advancing transformational projects. As set out in Chapter 2, MetroLink will not only help deliver against National Strategic Outcome 4: Sustainable Mobility but will also make an indirect contribution to all outcomes.

The analysis presented in the previous chapters shows the significant benefits which it can deliver and the pressing requirement for this to be delivered as quickly as possible.

The implications of delay or inaction

The need to address strategic land use policy and associated congestion in the Fingal / North Dublin area has been resolved in large part through the implementation of the recommendations of the Fingal / North Dublin Transport Study, 2014-2015. Since then, the population of the area has grown at rates higher than the rest of Dublin and Ireland, reinforcing the identified need for a permanent and sustainable transport intervention.

During the time of significant study and review, development patterns have continued to evolve in unsustainable ways, exacerbating the challenge and heightening the demand for the MetroLink intervention.

Decisive action is necessary now. Delaying the project incurs a significant cost, both through the impacts of inflation on the potential pricing of MetroLink (between €100 million and €300 million per annum for each year of delay) – but also in the delay of benefits realisation from MetroLink.

Delay in implementing MetroLink will stymie the ability to address the public transport deficit in Fingal / North Dublin and limit the potential for future growth and prosperity. Alternatively, growth in the area will be displaced to other areas and undermine compact growth goals, reinforcing the negative effects of urban sprawl. North Dublin, the fastest growing area in Ireland will, inevitably,

rely predominantly on the road network to meet its transportation needs, exacerbating the challenges on the network that are already occurring.

Finally, long delay or uncertainty in the decision to advance MetroLink will have negative impacts on Ireland's reputation in the international development and construction markets. This can have a potential impact on future competition levels and associated pricing. Accordingly, quick, and decisive decision making, whether to advance with the project or not, is more aligned to the overall goals of MetroLink than long delays or inaction.

Internal readiness

The Public Spending Code, 2019 requires that the preliminary business case demonstrates that the preferred option can be delivered in a manner that will ensure that value for money is attained.

The MetroLink project team is prepared to execute the plans set out. In order to meet the timeframes, set out herein, the next major deliverable is the submission of the Railway Order application which, subject to receiving approval in principle, will be made in Q2 2022.

This preliminary business case provides the necessary details to support the Public Spending Code, 2019 requirements with respect to internal readiness as follows:

Requirement		How is it addressed
Considerations of deliverability	✓	See Chapters 6 and 8
Risk assessment and allowance for optimism bias	✓	While captured in Chapter 4, explored in Chapter 8 and Appendix E.
Outline the procurement strategy	✓	See Chapter 6
Analysis of options for implementation and operation	✓	See Chapter 8

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

10 The way forward and next steps

"Have a bias towards action – let's see something happen now. You can break that big plan into small steps and take the first step right away."

- Indira Gandhi

The delivery of this Preliminary Business Case is an important milestone for MetroLink as it sets out to all stakeholders, a summary of where MetroLink progress is today, and the large degree of work and diligence conducted to date, including:

- Development of the preliminary design and identification of the best performing route and technology;
- Risk management plans and detailed understanding of the issues and known risks and initial mitigation strategies for same;
- A relatively high degree of certainty with regards to the project costs (including risk impacts) and an appropriate risk allowance for unknown risks;
- Significant benefits which MetroLink can deliver with a BCR range of between 1.4 and 2.5 under various sensitivities and scenarios and a core case result of 1.8; and
- A robust rationale for proceeding in line with CAF for transport projects and the PSC.

Aligned with the PSC, this MetroLink Preliminary Business Case is required to be reviewed by the Department of Public Expenditure and Reform.

Together with the review report from the Department of Public Expenditure and Reform, this Preliminary Business Case will seek "Approval in principle" from NTA and Government, to proceed through Decision Gate 1 of the Public Spending Code, 2019.

Key milestones

There are several key near-term milestones for MetroLink, which need to be achieved to maintain the MetroLink schedule and avoid unnecessary inflationary pressures on the project budget:

Milestone	Anticipated Timeline
Preliminary Business Case Submission	Feb' 2021
Approval in Principle: Decision Gate 1	Q1 2022
Submit Railway Order Application	Q2 2022
Detailed Project Brief and Procurement Strategy Submission	Q4 2022
Pre-Tender Approval: Decision Gate 2	Q2 2023
Tenders issued	Q2 2023
Railway order granted	Q4 2023
Final Business Case	2024 / 2025
Approval to Proceed: Decision Gate 3	2024 / 2025

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Table 10-1: Key business case milestones

Delivering on the milestones

If Approval in Principle is received, the next major milestone for MetroLink is the submission of the Railway Order Application. To be able to meet this milestone and to maintain overall project schedule, work on the Railway Order Application will be ongoing during the period of review of the Preliminary Business Case.

Other workstreams, that support tender document development, project brief and procurement strategy refinement, or obligations of the project for other reports such as the environmental impact reporting – will be advancing during the review of the Preliminary Business Case. This will allow the project to maintain its timetable on the assumption of a positive approval in principle in Q1 2022.

After the submission of the Railway Order, but before tenders are issued, MetroLink will submit its Detailed Project Brief and full Procurement Strategy to support decision making at Decision Gate 2. Only with approval to proceed at Decision Gate 2 will MetroLink issue tenders for works.

Once preferred tenders are identified, the Final Business Case can be prepared for consideration in the final Decision Gate 3. Having received tender prices, MetroLink's value for money expectation will be updated, along with benefit realisation plans and associated monitoring and evaluation plans. No tender can be awarded until the project receives an Enforceable Railway Order.

The importance of moving to the next stage on time cannot be overstated. Significant work lies ahead to deliver MetroLink in the manner anticipated by this Preliminary Business Case. And the cost of delay is very high – with a year of inflation costing potentially between €100 and €300 million.

Decision Gate 2

A large body of diligent work has been undertaken to support the Preliminary Business Case. There remains, however, further work to undertake concerning the next Decision Gate including:

- A detailed project brief (including refined project budget and risk assessment);
- A detailed procurement strategy and timetable (supported by further market engagement and sounding as well as value for money assessment);
- A project execution plan; and
- Further details related to governance and assurance structures.

Detailed project brief:

The detailed project brief will inform the decision to proceed with procurement or cancel MetroLink. It is therefore essential that this document is complete and states all output requirements needed for the project, defining design and quality requirements. This document will be used to measure the development of the project and will also form the basis of the construction contract packages.

A refined budget for MetroLink will also be prepared, based on the detailed project brief. Finalisation of the procurement strategy will also allow for the identification of where risks will be allocated and as risk mitigation plans become better understood, these factors will further inform the overall project budget.

Procurement strategy:

The procurement strategy will aim to maximise value for money through the procurement of the various contract packages required to deliver MetroLink. The strategy for the procurement of these contracts will need to be finalised in advance of Decision Gate 2 as it is anticipated that tendering documentation will be issued shortly thereafter. As the procurement strategy and rationale for the selected strategy is well developed (discussed in detail in Chapter 6), at this stage, the focus will be on the refinement of the strategy and allocation of risks, integration and interface identification and management strategies, together with detailed value for money assessment to confirm the procurement strategy is in the best interests of taxpayers.

As MetroLink will need to be procured in line with EU and Irish laws and regulations which govern the procurement of large infrastructure works, including TII's legal obligation to achieve value for money when awarding the contracts, this will need to be accounted for when finalising these procurement plans.

Project execution plan:

The MetroLink project execution plan has been established and sets out overall timelines for completions and milestones in design and construction, together with long-term maintenance and replacement requirements. A well-considered, clear, and realistic project execution plan ensures there is a credible roadmap for the delivery of MetroLink. The project execution plan is a living document and changes will be made throughout the delivery of MetroLink.

Governance structures:

A MetroLink governance framework has already been developed and the robust structures and groups to appropriately govern the project have been implemented. The framework is designed to ensure that: decision-making is informed; oversight, scrutiny and challenge are ever-present; and accountability is maintained. Specific MetroLink governance structures will be supported by the proven governance arrangements both at TII and NTA. It is therefore not anticipated that there will be material development of further MetroLink governance and

assurance arrangements but rather a fine-tuning of current systems.

Decision Gate 3

After passing through both Decision Gate 1 and 2, running the competitive tender processes, and identifying and notifying preferred tenderers and receiving an Enforceable Railway Order, the Final Business Case will need to be updated accordingly and finalised for submission. This stage will consider the tenders received for each contract package along with prices and particulars.

A process of refinement of the evaluation and benefits realisation plans, and any assumptions or changes made since the delivery of this Preliminary Business Case will occur to ensure that only the most relevant and up to date information is presented. Additionally, there will be a heavy focus on any changes to the costs, benefits and risks that arise because of the procurement process. At a minimum, the Final Business Case will contain the following:

1. Strategic relevance and objectives
2. Updated detailed project brief
3. Economic and financial appraisal
4. Detailed sensitivity and scenario Analysis
5. Risk management strategy
6. Assessment of affordability
7. Benefits realisation plan
8. Evaluation plan

If approval is granted at Decision Gate 3 then MetroLink will proceed to the implementation stage.

Seeking approval in principle

This Preliminary Business Case is submitted seeking approval in principle to continue to advance MetroLink.

The process from Preliminary Business Case (Decision Gate 1) to Final Business Case (Decision Gate 3) is a structured set of steps designed to ensure that a project is designed and prepared to the highest possible standard to minimise project costs, maximise value for money and project impact.

Passing through Decision Gate 1 does not create an obligation on the part of the approving bodies to automatically allow for MetroLink to pass through subsequent gates which will be and should be assessed based on the merits of the updated documentation submitted.

TII is fully aware of this and it is on this basis that it is pleased to submit this Preliminary Business Case for review and acceptance.

Appendices

Appendix A: Glossary of Terms

Glossary of Terms	
BCR	Benefit to Cost Ratio
CAF	Common Appraisal Framework
CBA	Cost Benefit Analysis
CBTC	Communication-Based Train Control
CO_2	Carbon Dioxide
COBALT	Cost and Benefits to Accidents Light Touch
DoT	Department of Transport
EIAR	Environmental Impact Assessment Report
EPA	Ireland's Environmental Protection Agency
ERM	Eastern Regional Model
EU	European Union
GHG	Greenhouse Gases
GoA4	Grade of Automation, Level 4
KPI	Key Performance Indicator
LUG	Luas User Group
MCA	Multi Criteria Analysis
NOx	Nitrous Oxide
NPV	Net Present Value
NTA	National Transport Authority
PM	Particulate Matter
PPP	Public-Private Partnership
PSC	Public Spending Code, 2019
RACI	Responsible, Accountable, Consulted, Informed Matrix
TII	Transport Infrastructure Ireland
TUBA	Transport User Benefit Analysis
UN	United Nations
VAT	Value Added Tax
WHO	World Health Organisation