Luas Broombridge

Updated Detailed Business Case

9th November 2012

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1 EXECUTIVE SUMMARY

1.1 Introduction

Development of an extensive Luas network for the Greater Dublin Area is a key element of the strategy for tackling congestion in Dublin, enhancing economic competitiveness and ensuring a sustainable, attractive city.

RPA has successfully delivered the first two lines of this system along with their extensions to Docklands, to Citywest and to Cherrywood.

Although the Luas extensions recently built extend Luas to a wider catchment, light rail in Dublin in the absence of Luas Broombridge will remain essentially as two discrete lines and their extensions and spurs, rather than a network.

There is considerable demand for cross city trips on both the Red and Green Lines. Luas Broombridge will fulfil this need and form the backbone of what will be a true light rail network for the city. This demand is generated over the entire Luas Green Line and thus Luas Broombridge helps maximise the benefits of the previous investment in Luas.

This Updated Detailed Business Case (UDBC) for Luas Broombridge draws together the many aspects of work undertaken to date on the project including its costs and benefits, demand and capacity, risks and choice of procurement strategy. It also reflects the outcome of the statutory process comprising the grant of Railway Order by An Bord Pleanála on 2 August 2012.

The UDBC demonstrates that there is a strong economic case for the implementation of Luas Broombridge under a range of different future population and employment scenarios. A benefit to cost ratio (BCR) of 2.28:1 is achieved in the base case comprising moderate growth over the appraisal period of 30 years.

When the shadow price of public funds (SPPF) of 150% is applied to the capital costs and renewal costs, the BCR still shows an attractive 1.54:1. Including Wider Impacts in this scenario increases the BCR to 1.83:1.

1.2 Background

In late 2004, and based on the early success of the Luas Red and Green lines which had been brought into service that year, RPA prepared a transport case setting out the merits of linking the two lines. This concluded that the proposal to link the Luas Red and Green lines would be wholly in keeping with the transport and land use policies of the Dublin Transportation Office (DTO), Dublin City Council and other relevant agencies and bodies for the following reasons:

- the creation of a Luas network;
- the enhanced integration and interchange opportunities;
- the wider trip penetration commensurate with the developing city centre; and
- the changing city centre traffic environment.

In 2005 the Government's 10-year investment strategy for transport to 2015, Transport 21, was announced and this incorporated plans to implement seven new Luas lines for Dublin along with two new Metro lines.

The plan included a proposal to extend the Luas Green Line, initially further into the city centre, and then to continue this line to Liffey Junction (Broombridge) where it would interchange with Maynooth railway line services.

The importance of integrated public transport in facilitating more concentrated patterns of development, in order to reduce reliance on the car and to achieve more sustainable forms of development, is now firmly reflected in land use planning policies. For example, the Regional Planning Guidelines and the National Spatial Strategy seek to achieve sustainable development and recognise the benefit of linking transport provision with land use development. In addition the plans of the Grangegorman Development Agency to develop a unified DIT campus facility at Grangegorman, which would be served directly by Luas Broombridge, represent a best practice example of integrated transport and land use planning.

In November 2011 a Government wide review of Infrastructure and capital investment policy was carried out within the context of tight fiscal constraints. The review concluded that amongst its main priorities for economic infrastructure over the medium term will be the development of the cross city Luas line, Luas Broombridge.

Luas Broombridge represents the 'missing link' in the creation of a Luas network for Dublin with trips between the Luas Red and Green Lines (and their extensions) now made possible through intersecting lines in the city centre.

If Luas Broombridge were postponed the result would be a disconnected terminus in the city centre for the Green Line and, rather than a tram network, the city would be left with a series of spurs and branches off the discrete Red and Green Lines. This scenario would be fundamentally at variance with the objective of providing a truly integrated public transport system and would have significant consequences for the strategic vision for the city's public transport.

Luas Broombridge is also an opportunity to radically enhance the urban realm of Dublin city centre through attractive and sympathetic integration into the streetscape and revised traffic management with greater emphasis on sustainable modes. Luas is ideally suited to such a city centre environment and is very accessible to customers.

1.3 Project Definition

A BRT alternative to Luas Broombridge was considered and the conclusion was that Light Rail is superior to BRT on most evaluation criteria and that a bus-based alternative should not be considered further as an alternative to Luas Broombridge.

The preferred route of Luas Broombridge was selected following detailed assessment including multi-criteria analysis together with the consideration of the views of the public and interested parties during the public consultation process.

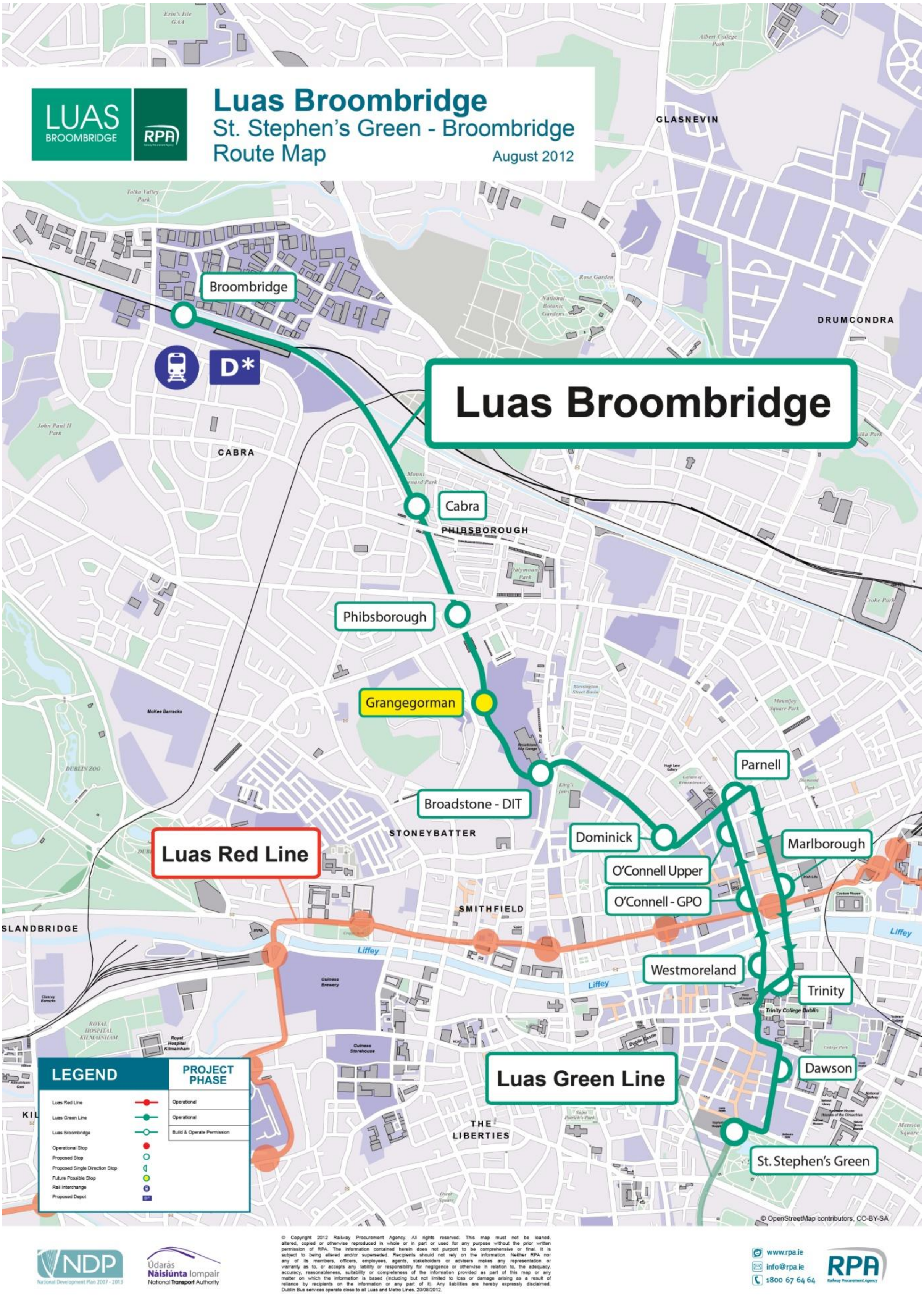

Figure 1-1 Luas Broombridge Preferred Route

The proposed route crosses the city centre from the current terminus of the Luas Green line at St. Stephen's Green and provides an interchange link between the Luas Red and Green lines before extending north via Broadstone and Grangegorman to interchange with the suburban rail services at Broombridge station on the Maynooth railway line.

The proposed route of 5.6 km will comprise the essential link that creates a Luas network and will offer interchange opportunities with the other public transport modes at a number of locations.

The proposed route reinstates a transport corridor in the northwest of the city centre along the former Broadstone railway cutting and provides increased access to the communities of Phibsborough and Cabra as well as the planned unified DIT campus facility at Grangegorman. Figure 1-1 illustrates the preferred route.

The system concept will be similar to the existing Luas system with Luas Broombridge designed to operate as a seamless continuation of the Luas Green Line into the city centre and onwards to Broombridge. There are 13 stops proposed and there will be two new substations along the line.

1.4 Transport Planning

Luas Broombridge is designed to achieve greater penetration of the city area than exists with the present Luas system, with frequent stop spacing, platforms integrated into the streetscape, and high permeability of the city centre. The provision of Luas Broombridge is considered a critical element in reducing traffic congestion in Dublin city centre.

The demand forecasts indicate that the introduction of Luas Broombridge will add 10.5 million passenger boardings to the Luas network.

Part of these new Luas passenger boardings come from other public transport modes where existing public transport passengers transfer to Luas due to the implementation of Luas Broombridge.

This generates significant benefits for passengers who are travelling further into the city centre when Luas Broombridge is in place and results in more journeys being made on public transport.

The results illustrate that during the morning peak period, there will be approximately 400,000 fewer trips by car per annum after the introduction of Luas Broombridge.

The results of the demand analysis demonstrate that there is a strong demand and need for Luas Broombridge under all the different scenarios tested.

Improved penetration of the city centre impacts on public transport demand. In the case of Luas Broombridge, it generates increased demand over the entire Luas Green Line and thereby leverages additional benefit from previous investment.

After the introduction of Luas Broombridge, the maximum forecast line flow past any point on the Green Line is approximately 5,270 passengers at Ranelagh stop. The service pattern that would accommodate this demand requirement would comprise 20 trams per hour, with 10 of the trams terminating at Broombridge and the remaining 10 utilising the city centre loop.

1.5 Capital Costing

The direct capital cost of Luas Broombridge is estimated to be €218m excl.VAT in 2012 prices.

When direct and indirect costs together with escalation are included the total capital costs amount to €368m excl.VAT.

A quantitative cost risk analysis (QCRA) has been carried out to identify and quantify significant project risks and to support the estimate for risk provision in the capital costings.

Reflecting the current economic climate, a realistic assessment of the rates of inflation has been assumed and this includes 0% for the remainder of 2012, 3% for 2013 through to the end of 2016 and 5% for 2017 to 2018. Escalation accounts for €32m of the total costs.

The cost of acquisition of CIE lands is not included within the total capital costs of the project as it is assumed that these lands will be made available free of charge to the project.

1.6 Risk

RPA is applying its standard Risk and Value Management Methodology to the Luas Broombridge project. The top project risks are identified under technical, commercial, third party, project management and residual risk categories. They include the complex issues associated with construction of utility diversions in a dense city centre environment; the risks associated with the cellars; CIÉ interfaces; and agreements with third parties.

As the project scope is further clarified through the ongoing design development phase these risk estimates will continue to be updated and used in further QCRAs thereby lending further accuracy to projections of out-turn costs and project duration.

1.7 Economic Appraisal

The Luas Broombridge project displays strong economic benefits substantially in excess of the costs. The results of the cost benefit analysis (prepared in accordance with Department of Transport guidelines), shown in Table 1-1 Luas Broombridge Base Case Economic Appraisal Results – Discounted to 2002, demonstrate a strong economic case for the project.

Table 1-1 Luas Broombridge Base Case Economic Appraisal Results – Discounted to 2002

	Present Value (€m)
Total Benefits	528
Total Costs	231
Net Present Value	296
Benefit to Cost Ratio (BCR)	2.28:1

The scheme displays an economic benefit to cost ratio of 2.28:1, and an economic net present value of €296m in 2002 prices. The scheme therefore represents very good value for money.

To test the robustness of the project, a number of sensitivity tests were carried out using different scenarios. This testing indicates that the economic worth of the scheme is not particularly sensitive to assumptions regarding related projects going ahead or future employment growth.

When the shadow price of public funds of 150% is applied to the capital cost and renewals costs, the scheme delivers a BCR of 1.54:1 in the base case and reduces the net present value from €296m to €186m.

A conservative estimate of the magnitude of wider economic benefits has been assessed as a sensitivity test applied to the SPFF sensitivity test, and this reveals that the BCR increases from 1.54:1 to 1.83:1 with the net present value increasing from €186m to €284m.

1.8 Project Finance and Cashflows

The projected level of Exchequer grant funding required in nominal terms is €368m over the period 2006 to 2018, which amounts to 100% of the capital cost of the project. It is expected that at 31 December 2012 €17.7m of this sum will have already been expended.

It is not expected that contributions under a Section 49 Development Levy scheme will be available for this project. There is a possibility that a Section 49 Development Levy scheme, if introduced by Dublin City Council, could generate in the order of €5m which would be used to assist the funding of the scheme.

Projections (Table 1-2) show that incremental patronage as a result of this project will generate sufficient revenues to cover incremental operating costs from the first year of operations. Thus it is unlikely that an operating subvention will be required.

Projections also show that operating surpluses should be sufficient to cover the renewal costs of the infrastructure over a 30 year operating timescale. Demand would be required to fall 46% below forecast to eliminate the operating surplus.

The results, also show that Luas Broombridge has an operating surplus in present value terms of €93 million when measured over a 30 year time frame.

Table 1-2 Operating Cash-flows (Present Values)

Cash-flow	€ millions
Total operating revenue including advertising	205
Total operating costs	-95
Total operating surplus	**110**
Less; Life cycle asset renewals costs	-17
Operating surplus after funding life cycle asset renewal costs	**93**

1.9 Procurement Strategy

RPA has reviewed a number of options for procuring the project including the potential for adoption of a Public Private Partnership approach to implementation and operation. A PPP form of procurement would not be suited, primarily due to the operational interfaces with the existing system and also because of the necessity to specify detailed requirements in respect of the city centre design interfaces.

The procurement model that best suits RPA's requirements is based on the Luas Line B1 (Cherrywood) model (Option B, Contractor Design – Build), viz. initial client design for heritage, basement modifications and utility diversion works followed by a design build package for the main infrastructure works.

This represents a change in procurement approach to that which was included In the Outline Business case wherein it was concluded that the light rail infrastructure works should be procured using a client design form of contract. This change came about through a process of internal risk reviews, further project definition and consultation with external stakeholders, DCC and CIE in particular. RPA will develop very detailed reference designs which will be reviewed by DCC / CIE for approval in advance of contract award. While it is acknowledged that there may be additional design costs associated with this approach the benefits of transferring design risk to a contractor for the construction stage are seen to out-weigh these costs. This is particularly relevant in a dense city centre environment such as is represented by Luas Broombridge, where the design interfaces are many and complex.

This model can incorporate the lessons learned from the implementation of Luas. It also provides a flexible and balanced approach to risk.

This procurement option is compliant with all procurement rules, can maintain competitive tension and is sufficiently flexible to accommodate legacy infrastructure and systems.

1.10 Programme and Way Forward

Construction is expected to commence in 2013 and is dependent on the following:

- Timely approval of this updated Detailed Business Case; and
- Provision of necessary funding in line with the implementation programme.

Based on a 2013 construction start date for the project, the construction will be completed in 2017 with operations commencing by end-2017.

The design and procurement process and the finalisation of the funding arrangements are core activities to be progressed prior to construction commencement in 2013.

Timely approval of the Updated Detailed Business Case and timely implementation of the activities described are essential for the project to remain on target for completion at the end of 2017.

The implementation of an effective and coherent communications strategy will play an essential part in maintaining the support of key stakeholders during the construction phase.

2 BACKGROUND

2.1 Chapter Summary

- The development of an extensive Luas network throughout Dublin has been Government policy for over a decade.
- The first phases of this Luas system have now been delivered and has proven to be very successful with 29.1 million passengers using the system in 2011.
- Extensions to the network that have opened are Luas Lines B1 to Cherrywood, C1 to the Point and Line A1 extension of the Red Line from Belgard to Citywest
- The attractiveness of Light Rail is now clearly demonstrated given the established patronage levels experienced.
- Transport 21 proposed extending the Luas Green Line through the city centre and onwards to Broombridge (Liffey Junction) to interchange with suburban rail line services. This new line will for the first time establish a Luas network in Dublin with trips between the Luas Red and Green lines (and their extensions) now made possible through intersecting lines in the city centre.
- In November 2011 a Government wide review of Infrastructure and capital investment policy was carried out within the context of tight fiscal constraints. The review concluded that one of its main priorities for economic infrastructure over the medium term would be the development of the cross city Luas line, Luas Broombridge.
- The NTA Draft Transport Strategy sets out the proposed long term strategy for transport investment in the Greater Dublin Area (GDA). It recognises that Luas Broombridge will strengthen the connectivity of the city centre, provide access to the proposed Grangegorman campus and provide further integration with existing Luas and Heavy Rail passenger services.
- Dublin City Council fully supports the realisation of an extended Luas system for Dublin. Other land use plans and policies endorse the implementation of a sustainable rail based mode of transport in the city underpinning the city's economic vitality.
- The Grangegorman Development Agency is a statutory agency tasked with planning and implementing a new education campus for more than 22,000 DIT students and associated staff at St, Brendan's Hospital, Grangegorman, together with community health facilities for the Health Services Executive. The Grangegorman Development Agency fully supports the implementation of Luas Broombridge which will provide much needed access to this consolidated campus facility.

2.2 Light Rail in Dublin

In 2001, construction of phase 1 of the Luas network began and the Luas Green Line between the City Centre and Sandyford opened to passengers in June 2004. The Red Line, which runs from Connolly Station in the City Centre to Tallaght, began carrying passengers in September 2004. Since its introduction Luas has proven itself as an attractive and popular means of transport for Dublin and has met and surpassed its projected patronage since then. There were 29.1 million passenger trips on Luas in 2011.

In November 2001 the Dublin Transportation Office (DTO) published *A Platform for Change – Outline of an Integrated Transportation Strategy for the Greater Dublin Area – 2000 to 2016*. This report was an update of the DTI report of 1994 and was developed as a consequence of the unprecedented economic growth and associated traffic congestion experienced in Dublin in the late 1990s. The DTO recognised that the DTI strategy of 1994 had significantly underestimated the growth in population and employment in the city and thus the transport and land use strategy of the DTI would not now achieve its original objectives.

The DTO strategy recognised the large reliance on private car transport in Dublin and developed a strategy to deliver a viable public transport alternative with the objective of reducing car transport and associated congestion. The DTO strategy identified the need for a rail and light rail network founded on the existing system and more extensive than that proposed in the DTI report. Figure 2-1 illustrates the Rail Proposals defined in *A Platform for Change*.

Figure 2-1 A Platform for Change - Rail Proposals

Source: A Platform for Change, November 2001

Luas Broombridge is compatible with the principles of A Platform for Change, in particular by reducing the need for commuting by car; improving the accessibility to the city centre; promoting sustainable land uses and travel; and optimising the use of existing infrastructure.

The 1997 application for a Railway Order by the Light Rail Project Office of CIÉ for a continuous Luas line from Tallaght to Balally through the city centre was withdrawn on the grounds of perceived congestion effects that Luas trams would have on other road vehicles.

Since that time however environmental traffic cells have been piloted and implemented; the banning of turns at certain junctions has been introduced to discourage private car movements at George's Street and at Dawson Street; O'Connell Street has been reduced in width by 1 lane of traffic along its length northbound and southbound; and a HGV ban has been introduced into the city. Other enabling measures implemented by Dublin City Council include the Dublin Port Tunnel from which private cars have largely been discouraged through a high user charge for that class of vehicle; and the Macken Street Bridge.

Thus the background traffic context since 1998 has changed radically.

In late 2004, based on the early success of the Luas Red and Green lines which were brought into service that year, RPA prepared a transport case setting out the merits of linking the two lines. This concluded that the proposal to link the Luas Red and Green lines would be wholly in keeping with the transport and land use policies of the DTO, Dublin City Council and other relevant agencies and bodies for the following reasons:

- The creation of a Luas network;
- The enhanced integration and interchange opportunities;
- The wider trip penetration to the city centre; and
- The changing city centre traffic environment.

In January 2005, RPA conducted a survey of Luas Red and Green line passengers which revealed overwhelming support for the cross city extension of Luas with:

- 35% of respondents stating they would use both lines for their trip purpose;
- 30% stating they would use an extended line; and
- 31% would use the link to access Heuston and Connolly stations.

The attitudinal survey also demonstrated that:

- There is a considerable number of cross city trips being made from the Red Line to and from the South East Inner City (Trinity and St Stephens Green). Recent analysis supports this outcome in revealing that the south-east quadrant of the city centre remains the predominant destination for employment;
- There is a considerable number of cross city trips being made from the Green Line to and from the Trinity, Grafton St. and Westmoreland St. areas; and
- There is a considerable number of cross city trips being made from the Green Line to and from the North Inner City (O' Connell, Abbey, Jervis and IFSC).

The Government's 10-year investment strategy for public transport announced in November 2005, Transport 21, included proposals to extend the Luas Green Line initially into the city centre, and then to Liffey Junction (Broombridge) where it would interchange with Maynooth railway line services. Together, these two extensions make up the Luas Broombridge project.

In November 2011 a Government wide review of Infrastructure and capital investment policy was carried out within the context of tight fiscal constraints. This was led by the Department of Public Expenditure and Reform. This review aimed to identify new priorities for investment given the reduced level of resources available.

Economic infrastructure has accounted for the major share of Exchequer and semi-State capital investment in recent years and this is reflected in the enhanced quality of the various networks now in place. The review concluded that one of its main priorities for economic infrastructure over the medium term would be the development of the cross city Luas line, Luas Broombridge.

2.3 Land Use and Transport Policy

Land use and transport policy at a national level is captured in the *Infrastructure and Capital Investment 2012 – 2016: Medium Term Exchequer Framework*, *Transport 21 (2005),* the *National Development Plan 2007 – 2013, Smarter Travel 2009* and the *National Spatial Strategy, 2002*. The *Regional Planning Guidelines Greater Dublin Area 2010-2022 (RPGs)*, the *Greater Dublin Area Draft Transport Strategy* 2030 Vision and the *Dublin City Development Plan 2005 – 2011* and other local policies form the framework for development at a local level.

2.3.1 Medium Term Exchequer Framework

Infrastructure and Capital Investment 2012 – 2016: Medium Term Exchequer Framework is the result of a review of infrastructure and capital investment policy carried out in November 2011 within the context of tight fiscal constraints. Projects which had been included in the previous development plan were postponed for consideration in the next capital expenditure programme to be drawn up in 2015. These projects included Metro North, DART Underground and also the extension of heavy rail to Navan, Luas to Lucan and Bray and Metro West.

Public transport is afforded high priority in the Programme for Government. (Section 3 of the framework). Development of the Luas Broombridge cross city Luas line was identified as one of the main priorities over the medium term for capital investment. This framework recognises that Luas Broombridge will “strengthen the commercial heart of the city” along with facilitating longer commuter trips across the city with only one interchange.

2.3.2 Transport 21

Transport 21(2006 – 2016) set out the Government’s 10 year plan for transport infrastructure across the nation amounting to €34 billion of capital investment in roads, public transport and regional airports.

The strategy envisaged the provision of an efficient, reliable and sustainable national transport network which would underpin Ireland’s economic growth and competitiveness. Environmental and economic sustainability, increased accessibility, increased use of public transport, increases in capacity, and enhanced quality comprised the main aims of the strategy.

Several new Luas projects were included in Transport 21 along with two Metro projects – Metro North and Metro West. The Luas projects were:

- Extension of the Luas Red line to Docklands;
- A spur from the Luas Red line to Citywest;
- Extension of the Luas Green line southwards, initially to Cherrywood and thereafter to Bray;
- Extension of the Luas Green line northwards, initially to the city centre to link with the Luas Red line and thereafter to Liffey Junction (Broombridge) via Broadstone / Grangegorman; and
- A new Luas line from Lucan to the city centre.

Importantly the strategy aimed to deliver an integrated public transport plan, with a bus network both fully coordinated with and complementing the rail network.

Luas Broombridge was an integral part of this strategy and together with the planned implementation of other rail elements, offered the opportunity for a radical reconfiguration of the bus network in the city centre.

2.3.3 National Development Plan

The National Development Plan 2007 – 2013 included amongst its key themes: the elimination of major infrastructure deficits to improve the quality of life for all; the protection, preservation and improvement of the natural environment with long term sustainable development; commitments on social inclusion; reinforcement of the Regional Planning Guidelines; and adherence to value for money in the implementation of the plan.

Investment in transport infrastructure over the period of the Plan totalled nearly €33 billion nationwide, of which €12.9 billion was earmarked for public transport, particularly in the Greater Dublin Area, where the delivery of a radically upgraded and more integrated public transport system was identified.

Specifically with regard to the urban areas, the Plan noted that it is not sustainable to promote road and car transport as the major long-term mode of passenger transport. The growth in population and employment, together with the environmental imperative to reduce carbon emissions, demands a major modal shift from car to public transport. It is vital, the Plan stated, that the workforce has access to reliable and efficient means of transport which is environmentally sustainable.

2.3.4 Smarter Travel

Smarter Travel – A new transport policy for Ireland 2009 – 2020 sets out a broad vision for the future and establishes objectives and targets for transportation. The main objectives are to reduce dependency on car travel and long distance commuting by increasing public transport modal share and encouraging walking and cycling, improving quality of life and accessibility for all, improving economic competitiveness through maximising the efficiency of the transport system, and alleviating congestion and infrastructural bottlenecks. The aim is that by 2020 future population and economic growth will have to take place predominantly in sustainable compact urban and rural areas.

2.3.5 National Spatial Strategy

The National Spatial Strategy (NSS) for Ireland 2002 – 2020 is a 20 year planning framework for all parts of Ireland. While not an infrastructural investment plan, the future development of a spatial strategy will be underpinned by a national transport framework to facilitate planning for an improved network of roads and public transport services.

The NSS endorses the principle of increased use of public transport in major urban areas and notes that for balanced development the performance of the Greater Dublin Area should be built upon and physically consolidated and that the Greater Dublin Area's vital national role is secured in terms of improved mobility, urban design quality, social mix, international and regional connections.

In particular, the Strategy promotes:

- the continued development of infrastructure connecting Dublin to the regions through an improved network of roads and rail;
- the expansion of the transport network to enable interchange facilities between the national transport network and the international airports and sea ports; and
- an increase in public transport and so-called slow (cycling and walking) mode share.

2.3.6 Regional Planning Guidelines

The Regional Planning Guidelines (RPGs) for the Greater Dublin Area 2010 – 2022 aim to direct the future growth of the GDA, and work to implement the strategic planning framework outlined in the NSS at a regional and area-specific level.

The RPGs identify the critical relationship between land use development and infrastructure provision. Key documents playing a central role in the transport element of the RPGs include the DTO *Platform for Change*, Transport 21 and the National Development Plan 2007-2013, *Smarter Travel* (2009), the *National Cycle Policy Framework* and the NTA *2030 Vision*. The RPGs recognise the importance of building critical mass along transport corridors '*in order to support the capacity requirements that make particular public transport investments feasible, sustainable and cost effective.'*

2.3.7 2030 vision

The Greater Dublin Area Draft Transport Strategy 2011-2030: 2030 vision sets out the National Transport Authority's proposed long term strategy for transport investment in the Greater Dublin Area (GDA). The main focus of the strategy is to promote integrated land use and transport planning, improve the walking and cycling environment, provide better public transport and to improve traffic management of the road network.

Five overarching objectives were agreed for the strategy. These are to:

- Build and strengthen communities;
- Improve economic competitiveness;

- Improve the built environment;
- Respect and sustain the natural environment; and
- Reduce personal stress.

Regarding public transport the strategy sets out measures to improve the integration of services, simplify fare and ticketing arrangements and improve access to the network by walking and cycling from surrounding areas.

The draft strategy recognises that Luas Broombridge will strengthen the connectivity of the city centre, provide access to the proposed Grangegorman campus and provide further integration with existing Luas and heavy rail passenger services.

2.3.8 Dublin City Development Plan 2011 – 2017

The Dublin City Development Plan 2011 – 2017 was adopted by Dublin City Council and came into effect in December 2010. The overall vision for the city as outlined in the core strategy is that:

"Within the next 25 to 30 years, Dublin will have an established international reputation as one of the most sustainable, dynamic and resourceful city regions in Europe. Dublin, through the shared vision of its citizens and civic leaders, will be a beautiful, compact city, with a distinct character, a vibrant culture and a diverse, smart, green, innovation-based economy. It will be a socially inclusive city of urban neighbourhoods, all connected by an exemplary public transport, cycling and walking system and interwoven with a quality bio-diverse greenspace network. In short, the vision is for a capital city where people will seek to live, work and experience as a matter of choice."

Chapter 5 of the Development Plan addresses transportation issues within the context of infrastructure provision. The development plan proposes to increase capacity on public transport in order to promote modal change to more sustainable modes.

Policy SI2 is *'to continue to promote the modal shift from private car use towards increased use of more sustainable forms of transport such as cycling, walking, and public transport and to implement the initiatives contained in the government's 'Smarter Travel, A Sustainable Transport Future 2009 – 2020'*

In relation to public transport the Development Plan fully supports the further enhancement of Luas, Quality Bus Corridor and other projects, with the overall aim of a fully integrated transport network for Dublin. A number of policies are in place to promote and support the development of this infrastructure. These include:

Policy SI3 – To support and facilitate the development of an integrated public transport network with efficient interchange between transport modes, to serve the existing and future needs of the city in association with relevant transport providers, agencies and stakeholders.

Policy SI4 – To promote and facilitate the provision of Metro North, DART Underground, the electrification of the Maynooth Line, the expansion of Luas and the Quality Bus Network in order to achieve the strategic transport objectives of the National Transportation Authority's 'A Platform for Change' and support the implementation of the Transport 21 Programme for Dublin.

In addition to the policies that are directly related to Luas Broombridge, a number of general traffic and transport policies are important and have been taken into consideration:

- The traffic management policy recognises the varying needs of the city through the day such as commuter peaks, shopping and business, service and delivery, etc.;
- In assessing priority, account will be taken of the number of people who travel and not exclusively the number of vehicle movements;
- It is an objective of Dublin City Council to tackle the adverse environmental and road safety impacts of traffic in the city;
- It is the policy of Dublin City Council to improve facilities and encourage relevant transport agencies/transport providers to provide for the needs of people with mobility impairment and/or disabilities including the elderly and parents with children; and
- The imposition of increased restrictions on the use of road space, for road works or general construction, should be undertaken in accordance with the ”Directions for the control and management of road works”.

Dominick Street has been identified as a key strategic development and regeneration area in the Development Plan. Luas Broombridge on Lower Dominick Street will facilitate and encourage this development.

Luas Broombridge therefore complies with and supports the policies detailed in Dublin City Council’s Development Plan 2011 – 2017 and is itself endorsed within the plan.

2.3.9 Dublin – A City of Possibilities

Dublin – A City of Possibilities; Economic, Social and Cultural Strategy 2002 – 2012 is a strategy for economic, social and cultural development prepared by Dublin City Development Board. It is a ten year strategy and provides a framework for guiding all public services and development activities within the administrative area of Dublin City Council. Its vision is that Dublin city is accessible to all by transport systems that are efficient, safe, affordable, accessible, and integrated and that maximise sustainable social and economic development and minimise negative environmental impacts. The Strategy fully supports the implementation of the DTO *Platform for Change* Strategy.

2.3.10 Grangegorman Development Agency Strategic Plan 2011

The Grangegorman Development Agency is the statutory body established in 2005 to develop the Grangegorman site for education and health facilities. Over time it will oversee the development of a single DIT (Dublin Institute of Technology) campus facility catering for 22,000 staff and students who are currently dispersed in a number of facilities throughout the city.

The Strategic Plan, which includes a Masterplan, has been prepared to guide the development of the site. Provision for Luas Broombridge including pedestrian linkages to the campus have been incorporated into this Masterplan. It is an objective of the Strategic Plan to ‘*work with ...RPA... and other key transportation bodies to* *secure the optimum provision of public transportation connectivity and service for the Quarter.....and in particular to achieve an inter-modal transport hub at Broadstone Gate.'*

In May, 2012 the Strategic Development Zone (SDZ) application was approved by An Bord Pleanála and work has now commenced on the planning applications for the development.

Luas Broombridge will provide an essential transportation element to the successful realisation of the Agency's Strategic Plan with plans for two stops located in close proximity to the campus development.

DIT Grangegorman is also identified as one of the Key Developing Areas in the core strategy of the Dublin City Development Plan 2011 – 2017.

2.4 Conclusions

The implementation of the Luas Red and Green lines has proven to be a commercial success with passenger demand exceeding forecasts and with the service operating successfully for over 8 years without the need for an operating subvention. Further extensions and spurs to Cherrywood, the Point and Citywest have extended Luas services to a wider catchment area.

The Regional Planning Guidelines (RPGs) and the National Spatial Strategy (NSS) seek to deliver sustainable development and recognise the benefit of linking transport provision with land use development. Transport 21 sought to build on the delivery of the Luas Phase 1 system and sought to develop a transportation network over the next ten years comprising of Luas, Metro, heavy rail and bus. Luas Broombridge was a key part of this network.

A review of infrastructure and capital investment policy was carried out in November 2011 within the context of tight fiscal constraints. Development of the Luas Broombridge cross city Luas line was identified as one of the main priorities over the medium term for capital investment. This framework recognises that Luas Broombridge will "strengthen the commercial heart of the city" along with facilitating longer commuter trips across the city with only one interchange.

The NTA's Greater Dublin Area Draft Transport Strategy recognises that Luas Broombridge will strengthen the connectivity of the city centre, provide access to the proposed Grangegorman campus and provide further integration with existing Luas and Heavy Rail passenger services. Dublin City Council supports Luas Broombridge and is currently co-operating with RPA to deliver this scheme.

The plans of the Grangegorman Development Agency to deliver a single unified DIT campus facility will alter in a dramatic manner the northwest inner city area. Dublin City Council plans for the regeneration of Dominick Street will be supported by the implementation of Luas Broombridge on Dominick Street Lower. Strong transport links to these key locations and the rest of the transport system will be important in ensuring their viability. Luas Broombridge will provide this link.

3 PROJECT DEFINITION

3.1 Chapter Summary

- Luas Broombridge will create the missing link in the Luas network and extend the Luas system to the north of Dublin city centre. There will be an increase in the number of trips on public transport and a greater integration of Luas, rail and bus systems in Dublin.
- The provision of the scheme will realise a reduction in city centre congestion with the economic benefits of enhanced mobility.
- The implementation of Luas Broombridge will present an enhanced image of Dublin as a shopping, tourist and business destination leading to increases in investment and economic activity. The associated upgrading of the city centre realm will represent an improved quality of life for Dubliners and visitors to the city.
- A BRT alternative to Luas Broombridge was considered and the conclusion was that Light Rail is superior to BRT on most evaluation criteria and that a bus-based alternative should not be considered further as an alternative to Luas Broombridge.
- The preferred route of Luas Broombridge was selected following detailed assessment including multi-criteria analysis and the consideration of views expressed by members of the public and interested parties during the public consultation process.
- The proposed route crosses the city centre from the current terminus of the Green line at St. Stephen’s Green and provides an interchange link between the Luas Red and Green lines before extending north via Broadstone and Grangegorman to interchange with the suburban rail services at Broombridge station on the Maynooth railway line.
- The proposed route of 5.6km will comprise the essential link that creates a Luas network and will offer enhanced interchange opportunities with heavy rail and, bus and the future Metro North and DART Underground.
- The proposed route reinstates a transport corridor at the northwest of the city centre along the former Broadstone railway cutting and provides increased access to the communities of Phibsborough and Cabra as well as the planned unified DIT campus facility at Grangegorman which will accommodate over 20,000 students and staff and which has recently been given Government approval to proceed to construction on a phased basis.
- The system concept will be similar to the existing Luas system with Luas Broombridge designed to operate as a seamless continuation of the Green Line into the city centre and onwards to Broombridge.
- There are 13 stops proposed. One of these stops on a section of double track line on Dawson Street will have just a single platform face serving southbound passengers, arising out of a condition imposed by An Bord Pleanála on the grant of Railway Order.

3.2 Project Needs and Objectives

Luas Broombridge will extend the existing Luas Green Line into the city centre providing a convenient, high quality public transport service and offering increased accessibility to the city centre and beyond.

Luas Broombridge is the long-needed missing link that will create a genuine Luas network, allowing passengers to readily interchange between Luas lines, and significantly enhancing the benefits of the investment in the original Luas lines.

It will provide essential access for the approved development of a single campus facility at Grangegorman for the Dublin Institute of Technology. It will re-use the former railway cutting at Broadstone and will provide excellent interchange with the western suburban railway line at Broombridge, thus opening up a new transport corridor to the benefit of citizens in Phibsborough and Cabra, and along the suburban railway line to Clonsilla, Leixlip, Maynooth and beyond.

The need for the proposed scheme can thus be summarised as follows:

- to cater for the existing and future demand for cross city trips and to offer greater penetration into the city centre with enhanced accessibility to employment areas, educational institutions, retail areas and historic and cultural attractions; and
- to create a Luas network and in the process an integrated public transport network which supports national, regional and local policies aimed at reducing the reliance on private car trips; encouraging the use of sustainable transport modes, and providing for sustainable development.

At present there is a considerable demand for cross city trips which is not adequately catered for by the existing public transport provision within the city centre. For example, a passenger wishing to complete a cross city trip on the Red or Green Luas Line has to transfer between modes to complete this journey.

In order to assess and measure the effectiveness of the proposed scheme it is necessary to firstly identify the scheme objectives. The following objectives have been set for Luas Broombridge.

3.2.1 Promote Economic Growth

Luas Broombridge is a critical investment in the competitiveness and productivity of the Dublin economy, and by extension, the Irish economy. Increasingly economic growth is being driven by city regions which compete with each other to attract and retain the best human capital, in terms of education levels, creativity and entrepreneurship. By positively impacting on the quality of life, sustainability, attractiveness and connectivity of Dublin, particularly by creating the missing link in the Luas network, Luas Broombridge will enhance Dublin's competitive edge in the challenge to attract internationally mobile human capital and investment and will capture further added value from the monies previously invested in the existing Luas lines.

3.2.2 Reduce the Cost of Congestion

Dublin suffers from serious traffic congestion which costs the state enormously in terms of lost productivity, higher cost of conducting business, loss of inward investment, environmental emissions and high accident rates. Luas Broombridge will reduce traffic congestion and offer a fast, frequent and reliable alternative to the private car for travelling to the city centre along the corridor to Broombridge and more importantly along the corridors served by the existing Luas Red and Green Lines. Luas Broombridge is designed to accommodate a high level of existing demand which cannot be catered for by existing modes.

3.2.3 Integrate the Public Transport Network

Luas Broombridge will create a genuine light rail network, thereby increasing the benefits gained in the areas already served.

The current lack of a Luas network not alone inconveniences many existing customers, but also results in the system being underutilised as many potential customers who would make journeys over the two lines are deterred by the prospect of a 10–15 minute walk from St. Stephen's Green to Abbey Street or Jervis Stop. Since investment in light rail was first mooted for Dublin in the early 1990's, it was envisaged that a fully connected network would be built. This network objective has consistently been preserved in all the development strategies that were adopted post Dublin Transportation Initiative: A Platform for Change and the NTA's draft strategy 2030 Vision (2011–2030). By their very nature, networks always give rise to substantially greater system utilisation than would be generated by the individual lines operating on a stand-alone basis, as the catchment area of each line is effectively extended to encompass the catchment of the entire network.

Luas Broombridge will integrate with existing and future transport services particularly the Luas Red and Green Lines, rail services from Maynooth and Dunboyne and the majority of existing Quality Bus schemes which enter or cross Dublin City Centre. Luas Broombridge will also interchange with future projects such as Metro North, DART Underground and Luas extensions to Lucan. Luas Broombridge will allow trips to be made over the entire Dublin region without the need for multiple interchanges on different modes of transport. This integration of existing systems will offer further economic benefits which extend beyond the immediate corridor of the route.

3.2.4 Increase the Commercial Success of Luas

In addition to connecting the existing Luas Lines, Luas Broombridge will extend the effective catchment of the Luas system attracting greater passengers to public transport and away from cars. These new public transport passengers are expected to come not only from the corridor of the route, but also from the corridor of the existing Luas lines and of the other transport lines with which it interchanges. Luas Broombridge is forecast to substantially increase passengers on the Luas system and other public transport modes.

As with the existing Luas lines, it is expected that Luas Broombridge will operate at a profit and will not require an operating subvention from Government. The revenue generated will considerably improve the operating position of the overall Luas network.

3.2.5 Facilitate Sustainable Development and Regeneration

Luas Broombridge will serve both existing and new developments and will help contribute to the regeneration of long-neglected areas in the north city such as Dominick Street, Marlborough Street, Parnell Street, Grangegorman and Broombridge. The redevelopment of these areas will provide key social and economic benefits to the region and Luas Broombridge will allow these areas to develop, grow and prosper in a way that is less reliant on the private car and will thus be environmentally and economically sustainable. Luas Broombridge will also serve the proposed consolidated campus for the DIT at Grangegorman which when fully realised will accommodate 20,000 students and staff.

3.2.6 Enhance the Public Realm

Luas Broombridge will enhance the streetscape and public realm along the route through which it travels. Areas such as Marlborough Street and Parnell Street which have experienced decline over the years will benefit significantly from implementation of the Luas along these streets. The enhancement of the city centre realm will help to increase Dublin as a tourist, shopping and cultural destination.

3.2.7 The outputs expected from the project

Luas Broombridge when completed will provide an extension of the Luas Green Line from St Stephens Green to Broombridge via Dublin City Centre, Broadstone and Cabra. The project outputs, with further details in the chapters of this updated Detailed Business Case that follow, are:

- Creation of the missing link in the Luas network;
- Extension of the Luas system to the north of Dublin city centre;
- Increased public transport share in the region with up to 10.5 million additional Luas journeys per annum in the base case;
- Continued avoidance of operating subvention through increased Luas operating revenues and enhanced commercial performance of the Luas network;
- Greater integration of Luas, Rail and bus systems in Dublin;
- Reduced city centre congestion and economic benefits of enhanced mobility, as measured in the cost benefit analysis;
- Reduce CO2 and other greenhouse emissions and costs thereof as measured in the cost benefit analysis;
- Enhanced image of Dublin as a shopping, tourist and business destination leading to increases in investment and economic activity;
- Enhancement in city centre realm and improved quality of life for Dubliners and visitors to the city;
- Creation of 60 direct and indirect sustainable jobs to operate and maintain the system; and
- Catalyst for regeneration of city centre areas and sustainable new development of vacant city centre sites.

3.3 Consideration of Bus-based Alternative

The function of Luas Broombridge is to extend the Luas Green line further northwards providing better penetration into the commercial heart of the city centre, as well as to provide a link between the Luas Red and Green lines. It will also provide a new transportation corridor to the north west suburbs of the city and facilitate much needed access to the planned DIT campus development at Grangegorman.

Luas Broombridge is critical in creating a Luas network. In its absence the city would be left with a series of spurs and branches off the Luas Red and Green Lines. This does not satisfy passenger demand nor realise the policy objectives for public transport integration and enhanced interchange policies.

During the development of the Railway Order application, bus-based alternatives were considered as a possible alternative along the proposed alignment of Luas Broombridge.

Bus Rapid Transit (BRT) has emerged in recent years as an effective, cost efficient and high quality public transport system. As BRT is a relatively new mode of transport there are various definitions and interpretations as to what BRT comprises and there are many different forms of BRT systems in operation worldwide. Definitions of BRT range from a Quality Bus Corridor (QBC) to being a fully guided, fully segregated bus system. BRT systems are generally of a higher standard than a QBC (Quality Bus Corridor) in that they offer greater reliability, which requires additional investment and improvement in infrastructure, vehicles and systems.

The key issue relating to any public transport system including BRT is its ability to have sufficient carrying capacity to meet existing demand and reserve capacity to meet future demand and to fulfil its transportation needs and objectives. Also it is important that any significant investment in the provision of a public transport system contributes to the realisation of an overall strategic plan for the Greater Dublin area. Line Broombridge is included in the National Transport Authority's Draft Transport Strategy for Dublin whereas BRT was seen as not being an appropriate mode for this corridor.

Based on the experience to date on Luas, the key factors of success are the predictability in terms of frequency and journey times as well as reliability and consistent performance. These factors are critical to determining capacity. If these factors are reduced the performance and the quality of the system is reduced and it then becomes unattractive to passengers and will not achieve the modal shift from private car. This implies a need for low dwell times at stops, priority at traffic lights, and a high level of segregation being achieved.

With regards to establishing an appropriate capacity threshold for a BRT system on a particular corridor, the decision depends primarily on the size of the vehicle and the frequency of service. Capacity is measured by the number of passengers past a point per direction per hour. Based on a maximum reliable frequency of 30 vehicles per hour using a typical BRT vehicle approximately 18m long with a capacity of 120 passengers, this will give an ultimate capacity of 3,600 passengers per direction per hour (ppdph).

Two bus-based options were considered. They were a shuttle bus using a conventional bus type service and a BRT service offering a similar level of comfort and service to light rail and running on a dedicated BRT lane segregated from general traffic.

As mentioned previously the function of Luas Broombridge is to extend the Luas Green line further northwards providing better penetration into the commercial heart of the city centre without the need for interchange, as well as to provide a link between the Luas Red and Green lines.

The bus-based options cannot meet with this requirement. It would necessitate passengers transferring from the existing Luas Green line at St. Stephen's Green to continue their journey further into the city centre. The BRT system will not provide this interoperability and no matter how good and seamless that interchange facility it will reduce the forecast passenger demand on the system.

Based on a capacity of 3,600 ppdph a BRT system may be able to meet the initial demand required on the Luas Broombridge section of the extended Green line (as shown in Chapter 4 Transport Planning) by running a very high number of vehicles but it would unlikely to be able to do so reliably. A BRT system would have little if any capacity reserve to meet the anticipated future growth in demand compared to Luas Broombridge and would be unlikely to attract the same level of demand as Luas Broombridge in the first instance.

It would not be possible however, for a BRT system to meet or realise the latent demand on the existing Green Line. The introduction of Luas Broombridge results in a peak lineflow of approximately 5,270 passengers at Ranelagh due its introduction. A BRT system would not be capable of replicating this demand as it will not offer this single extended journey and would require interchange to complete this journey reducing the attractiveness and hence the latent demand. Should this latent demand be realised the BRT system would not have the capacity to meet this demand.

Running a BRT system at such a high frequency through the heart of the city centre to meet the forecast demand can result in reduced reliability and performance, particularly at road junctions and would likely result in a lower level of priority or no priority at all. At these frequencies removal of priority would lead to bunching of services and a complete deterioration of reliability and quality. An increase in frequency would also increase the operating and maintenance costs.

With a BRT system there would be very limited system reserve capacity available as the vehicles are not modular in nature. Capacity increase is significantly easier with a Light rail system due to the modular design of the vehicles.

A further consideration rests with the ability to turn vehicles back into service at St. Stephens Green, chiefly the provision of a turning area for buses, which is considered impracticable at this location.

This work on bus-based alternatives concluded that Light Rail is superior to BRT on most criteria and in particular on the environment and integration aspects. Evidence would also suggest that light rail systems have a greater positive impact on business investment decisions than BRT systems due to the perceived permanence of the infrastructure.

Thus a bus-based alternative was not considered further as an alternative to the proposed scheme.

3.4 Identification of Preferred Route

The process of selecting a preferred route corridor for the Luas Broombridge project commenced with an assessment of options for, in the first instance, the segment of the route between the St. Stephen's Green terminus of the Luas Green Line and the Red Line.

A total of five potential route options were initially evaluated with each of these options terminating in the city centre at either O'Connell Street or Marlborough Street as illustrated in Appendix 1.

The assessment of the route options was conducted using multi-criteria analysis, as described in Table 3-1.

Table 3-1 Multi Criteria Analysis

Criteria	Assessment methodology
Impacts on the environment and quality of life	The potential impact of the scheme on the environment involved assessing the direct and indirect impacts on both users and non-users.
Economy	The economy objective focussed on assessing the degree to which the economic efficiency of transport can be improved through implementation of the scheme.
Accessibility	Accessibility is related to the ability with which people can reach different locations and facilities by different modes and whether or not this would be impacted upon through implementation of the project. Consideration has also been given to areas of the city which are socially and economically disadvantaged and the benefits that would accrue as a result of increased accessibility through provision of the transport infrastructure.
Policy and transport integration	The assessment of policy and transport integration aims to ensure that all decisions are taken in the context of the Government's policy on transport, the City Development Plan and other regional and local plans. The degree to which public and stakeholder support for the various options was forthcoming was also considered.
Safety	The safety criterion is concerned with assessing the potential reduction in loss of life and injuries resulting from transport incidents through implementation of the scheme.

The capital costs of the five route options ranged from €86m to €168m with Benefit to Cost Ratios (BCR) values ranging from -0.4:1 to 4.77:1.

Amongst these five options, Option A, a route corridor via College Green on to O'Connell Street emerged as a clear favourite principally, upon the grounds that it was the shortest route length, had the lowest capital cost, the highest demand and achieved the highest BCR value at 4.77:1.

The alternatives to Option A did not accomplish the same degree of operational efficiency largely on account of the requirement to entertain increased levels of shared running with other road vehicles. Additionally, those alternatives that terminated on Marlborough Street were not considered to be practicable in the context of the heavy utilisation of that street for bus routings while a route option via Westland Row and Pearse Street was not deemed feasible due to the low height clearances under the railway bridges.

Following a detailed consultation process with key stakeholders including Dublin City Council and transport agencies, Option A was modified and, together with a new sixth option, Option F, was brought forward to further public consultation.

Following the outcome of the public consultation process both of these Options, A and F were then subjected to further evaluation and appraisal.

This evaluation concluded that while the modified Option A had a lower cost of €102m when set against the €140m of Option F, and also a higher BCR value and though both options represented good value for money, the feasibility of this modified Option A in operational terms was discounted on the basis of the extensive lengths of bi-directional running on O'Connell Street which would effectively negate reliability, present potential increased safety issues and act as a disincentive to travel. Furthermore Option F was substantially more accessible due to the broader penetration of the city centre, the greater number of stops, and the potential for regeneration of Marlborough Street (MCA Table 3.2).

Thus Option F, comprising a single track loop arrangement along O'Connell Street and Marlborough Street was selected as the preferred route corridor for the segment of the overall corridor between St. Stephen's Green and the Red Line.

Attention then focussed on the assessment of route alternatives for the section of the overall corridor between the city centre and Liffey Junction/Broombridge.

The disused former railway cutting between Broadstone and Broombridge was an obvious alignment and presented benefits of reduced costs, higher average speed, greater safety in operations due to absence of interaction with road vehicles, and speedier implementation.

Between O'Connell Street and Broadstone, two main alignment corridors were identified in close proximity to one another – via Parnell Square West/Western Way and via Dominick Street Lower/Dominick Street Upper (Appendix 1)

Table 3-2 St.Stephen's Green – Red Line Modified Option A and F Multi-Criteria Assessment

Primary Criteria	Secondary Criteria	Tertiary Criteria	Revised Option A Impact	Revised Option A Score	Option F Impact	Option F Score
Economy	Costs	Capital Cost	High Cost	2	Highest Cost	1
	Benefits	Journey Time	8 minutes	4	8 minutes	4
		Operational Reliability	significant shared running.Complex junction crossings	2	Shared running sections with less complex junction arrangements.	4
		Patronage	Approximately 12mppa	4	Approximately 12mppa	4
		CBA		5		4
				17		**17**
Safety	Accidents	Road Safety	reduced veh km on highway	4	reduced veh km on highway	4
	Security		Neutral	3	Slight improvement	4
				7		**8**
Environment	Air Quality		neutral	3	neutral	3
	Noise and Vibration		neutral	3	neutral	1
	Townscape and Visual		negative	1	slight negative	2
	Cultural Heritage		slightly negative	2	negative	1
	Land Use		No change	3	Improvement	4
				12		**11**
Accessibility and Social Inclusion	RAPID Areas / Regeneration		Slight improvemer	4	Greater improvement	5
	Vulnerable Groups		No Change	3	No Change	3
	Catchment served (residential)		improvement	4	Greater improvement	5
	Trip attractors / generators		improvement	4	Greater improvement	5
				15		**18**
Integration	Transport Integration	Interchanges	Good interchange	4	Good interchange O'Connell with MN and Red Line. Buses along route.	5
		Policy	Compliant	5	Compliant	5
		Bus Impact	Impacts on existing bus services	2	Slightly greater impacts; opportunities via new bridge	1
	Land Use Integration	Development Plans	Supported	4	Supported	4
	Geographic Integration	Connections	No change	3	No change	3
				18		**18**
Public and Stakeholder Support	Public Support	Local Authorities	No support yet	1	No support yet	1
	Stakeholder Support	Business	Not supportive	2	supportive	4
		Bus Operators	No support	1	No support	1
				4		**6**
			Totals	**73**		**78**

The proximity of these two corridors to one another meant the difference in capital cost between both was in the order of no more that €100,000 and as the modelling results revealed no difference in demand, the resulting economic performance for both options were deemed to have similar outcomes for all the key assessment criteria.

It should be noted that the form of connection to the St. Stephen's Green – Red Line segment, being either via Parnell Street or Cathal Brugha Street was also factored into this analysis.

A multi-criteria assessment for the route options from Broadstone to link with the St. Stephen's Green / Red Line segment was carried out (Appendix 1) and resulted in the selection of the route corridor via Parnell Street and Dominick Street as the preferred option. This was due largely to the adverse impacts of a routing via Parnell Square West on traffic movements and bus stops; the potential archaeological impacts of a corridor routing via Parnell Square West; the proximity of a stop on Parnell Street to the cultural attractions of Parnell Square; and the views of Dublin City Council, which stated a desire for a routing via Parnell Street / Dominick Street.

On concluding on the preferred routing for that segment of the route corridor between the Red Line / O'Connell Street and Broombridge, the overall preferred route alignment was confirmed.

In each case, the assessment of the route options was conducted using multi-criteria analysis, as described in Table 3-1.

The resulting preferred corridors for the two segments of the line were those that achieved the highest rating when set against these criteria.

The progression of the segment between St. Stephen's Green and the city centre beyond selection of preferred route corridor to development of application for a Railway Order was delayed significantly as a result of the extensive degree of consultation which was undertaken with stakeholders in the city centre. This consultation was focussed extensively on the potential impacts of the scheme on Dublin Bus and wider issues associated with strategic traffic management in the city centre.

In early 2008 the Minister for Transport decided that RPA would proceed to make an application for a Railway Order for this initial segment or a combined application for the complete Luas Broombridge line as it considered appropriate.

RPA considered it appropriate to proceed with a combined application for the entire line from St. Stephen's Green through the city centre to Broombridge (Luas Broombridge) on the basis that this represented a more efficient approach to the implementation which would otherwise constitute 'project splitting'.

In conclusion RPA considers that in its review of all route options identified, there are no environmental, transport strategy, or economic reasons why the development of the preferred corridor for Luas Broombridge should not proceed.

3.5 Description of the Chosen Alignment

For ease of reference the geographic setting of the alignment is described in two areas. The first area represents that section of the alignment between St. Stephen's Green and the northern extents of the Broadstone Bus Éireann depot. It is predominantly urban in nature, with the road traffic and pedestrian interfaces typical of an on-street running environment. There is also shared running with road vehicles at some locations. The second area comprises the remainder of the alignment from the bus depot to Broombridge railway station on the Maynooth suburban railway line and runs broadly along the length of the former Broadstone railway. It is a completely segregated track alignment with no road traffic or pedestrian interfaces.

There are 13 new Luas stops being provided along the line as illustrated in Figure 3-1.

The description of the alignment and stop locations that follows is set out as one proceeds from the current terminus of the Luas Green line at St. Stephen's Green north to Broombridge, the exception to this being the description of the return loop via Parnell Street – Marlborough Street which follows the opposite direction (i.e. from Parnell Street south to St. Stephen's Green).

3.5.1 Area 1

Luas Broombridge commences at the existing **St. Stephen's Green Stop** terminus of the Luas Green Line at St. Stephen's Green West. The existing stop platform will be extended in length to 53m to facilitate the possible future provision of longer trams as demand dictates over time. This extended length is in keeping with the design of all platforms for Luas Broombridge.

The existing underground substation on St. Stephen's Green West will be upgraded to accommodate power requirements for Luas Broombridge in this area.

From St. Stephen's Green West, the line turns east on to St. Stephen's Green North where a connection will be provided into a single track shunt area east of the Dawson Street junction and on the south side of St. Stephen's Green North. This shunt area will permit operational flexibility in offering the ability, as circumstances may dictate, to turn back trams from the extended Green Line.

The existing westbound road traffic movement on St. Stephen's Green North will be retained albeit with some reduction in carriageway width to facilitate the implementation and operation of the scheme. The existing taxi stand on St. Stephen's Green North west of Dawson Street will be removed and alternative locations identified in consultation with NTA and Dublin City Council.

The overhead catenary system on St. Stephen's Green North and St. Stephen's Green West will be supported by a combination of building fixings and lateral poles.

From St. Stephen's Green North the twin track alignment proceeds through the St. Stephen's Green North / Dawson Street junction and enters Dawson Street. Between St. Stephen's Green North and Nassau Street, the northbound (Broombridge direction) track incorporates a shared running surface for road vehicles along the entire length of Dawson Street. The southbound (Cherrywood direction) track will be shared running with road vehicles between Duke Street and Molesworth Street only.

Dawson Stop comprises a single platform face serving southbound passengers only. The Railway Order granted by An Bord Pleanála required that the northbound stop platform, located on the west side of Dawson Street between Anne Street and Duke Street, be omitted.

Facilities for servicing of premises along with provision for bus stops will be retained on the west side of Dawson Street between St. Stephen's Green North and South Anne Street and also between Duke Street and Nassau Street.

The existing taxi ranks on the west side of the street will require to be relocated. Traffic management arrangements to support the implementation of Luas

Broombridge along Dawson Street will be such as to limit road vehicle movements on the street largely to buses, taxis and local access. Kildare Street will be made two-way to its junction with Molesworth Street and during the construction stage a contra flow bus lane will operate between Molesworth Street and Sth. Leinster Street. These measures will be facilitated through the implementation by Dublin City Council of strategic traffic management initiatives on St. Stephen's Green East enabling a right turn movement onto Merrion Row.

The overhead catenary support system in Dawson Street will comprise mostly building fixings save for the junctions with St. Stephen's Green North and Nassau Street where lateral pole supports will also be provided.

At the northern end of Dawson Street the twin track alignment turns westbound into Nassau Street where there will be shared running in both directions with road vehicles. Pole supports for the overhead catenary will be sited on the south side of Nassau Street with a single pole proposed to be located within the grounds of Trinity College.

At the junction with Grafton Street and Suffolk Street the alignment turns north into the lower part of Grafton Street with only other southbound public transport and local access vehicles sharing the track. The existing inset on the west side of the street accommodating a taxi rank and loading bay will be reduced in length. The bus stops located on the east side of the street will require to be relocated. Pole supports to the overhead catenary will be located on both sides of Grafton Street.

The route then crosses College Green with the northbound track sharing with inbound road vehicles on College Green and the southbound track emerging from College Street and sharing with road vehicles (public transport and local access only).

At College Green the twin track splits to form a single track loop arrangement around Westmoreland Street, O'Connell Street Lower, O'Connell Street Upper, Parnell Street, Marlborough Street, across the new bridge over the Liffey (currently under construction by Dublin City Council), Hawkins Street and on to College Street and back to the twin track at College Green. The route of this single track loop is now described.

The northbound track crosses College Green and enters Westmoreland Street across the mouth of the junction with College Street. The track will encroach into the traffic island separating College Street, College Green and Westmoreland Street. This traffic island will require to be reconfigured to accommodate the proposed alignment.

On Westmoreland Street the single track occupies a position on the east side of the street passing in front of the Westin Hotel from where the existing coach pull-in will require to be relocated in agreement with the statutory authorities.

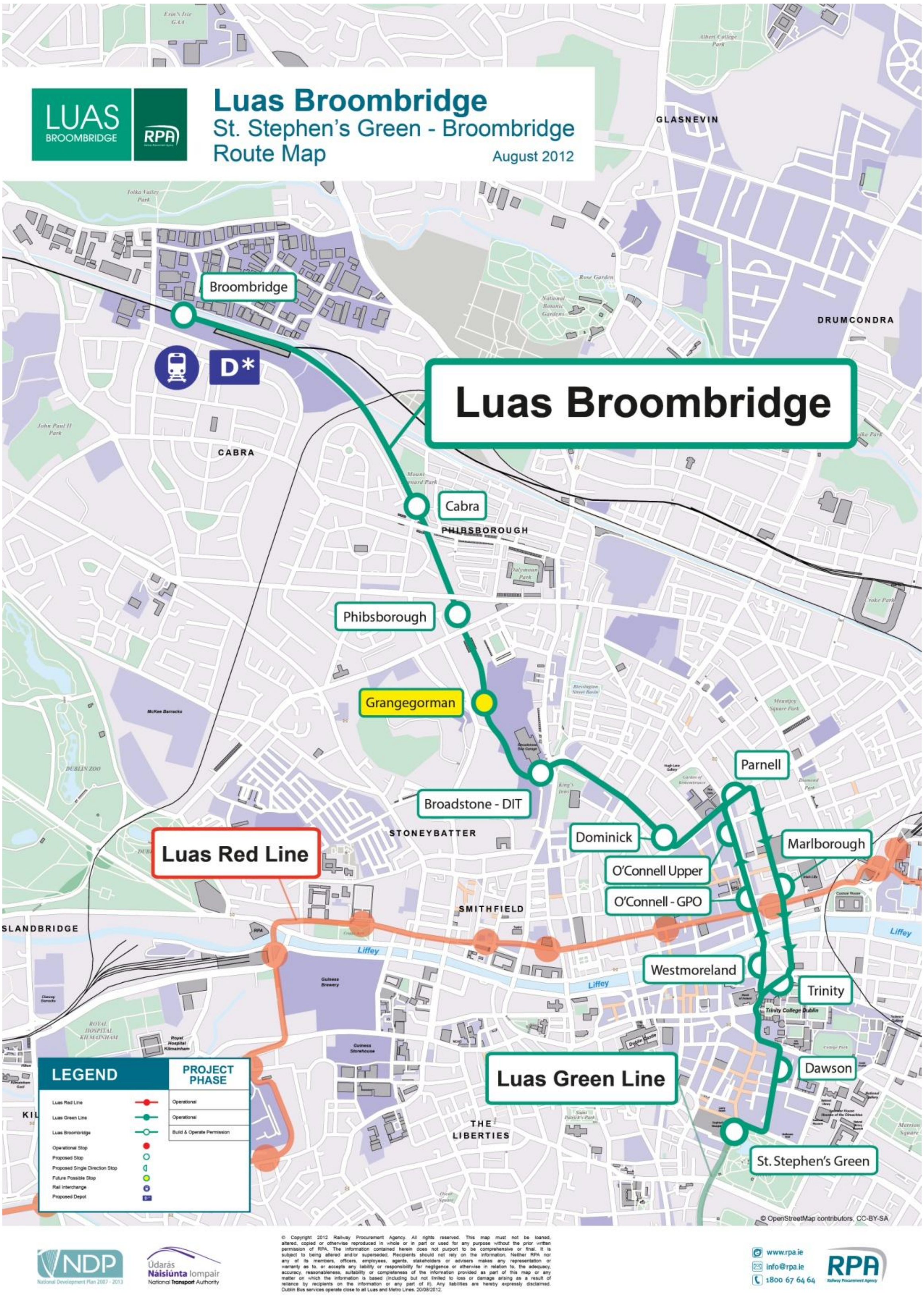

Figure 3-1 Luas Broombridge Preferred Route

Passing across the Fleet Street junction where a new set of traffic signals will be installed to control traffic and tram movements, the route continues along the east side of Westmoreland Street where the single platform for the **Westmoreland Stop** will be located. The taxi rank will require to be relocated. Cantilever poles will support the overhead catenary along Westmoreland Street.

The alignment then crosses Burgh Quay and O'Connell Bridge where the centre median will be widened to facilitate pedestrian movements. There will be shared running with road vehicles across O'Connell Bridge.

The alignment then crosses Bachelor's Walk and enters O'Connell Street Lower with the track bed running adjacent and on the west side of the centre median. There will be shared running with road vehicles on this single northbound track between Burgh Quay and the Spire. The route crosses Middle Abbey Street and the Luas Red Line, where a connection westbound onto the Red Line will be provided to enable movement of trams from the Green Line onto the Red Line for engineering purposes.

A mixture of cantilever poles and building fixings will support the overhead catenary for the single track along O'Connell Street.

The existing Luas substation on O'Connell Street Lower, south of Middle Abbey Street, will be upgraded to provide for the power requirements of the proposed scheme in this area.

O'Connell – GPO Stop will be located within the centre median north of Middle Abbey Street and will provide convenient interchange with the Luas Red Line at Abbey Street Stop.

The location of the O'Connell – GPO stop will require the removal of two bus stops in this area.

The route continues along O'Connell Street Lower and along the west side of the centre median before entering into the centre median north of the Spire and runs in a segregated manner removed from the influence of road vehicles. **O'Connell Upper Stop** will be located close to the Cathal Brugha Street junction. The current right turn into Cathal Brugha Street off O'Connell Street Upper will be prohibited and the centre median widened at this location. The existing taxi ranks on both sides of the centre median will require to be relocated along with some bus stops on the west side of O'Connell Street Upper. Additionally, the Father Mathew Statue in the centre median will require to be relocated in discussion with Dublin City Council and the Capuchin Order.

At the north end of O'Connell Street Upper a delta junction will be provided which will allow trams to turn west into Parnell Street providing services to Broombridge or alternatively turn east into Parnell Street allowing trams to return to the Green Line via the southbound track on Marlborough Street.

The return single track to the Green Line is now described.

On Parnell Street the alignment abuts the north side kerbline and **Parnell Stop** is located between Parnell Square East and Parnell Place. The existing bus stops along this length will require to be relocated. Building fixings for the most part support the overhead catenary system along Parnell Street.

A new signalised junction will be provided at the junction of Parnell Street and Marlborough Street. The existing right turn movement into Marlborough Street will be prohibited.

The alignment is located on the east side of Marlborough Street and crosses the existing signalised junction at Cathal Brugha Street. It continues along the east side of Marlborough Street for its entire length with bus and car parking requiring removal at locations. A single lane of traffic is provided alongside to facilitate access and bus movements. Access will be provided into Cathedral Street off Marlborough Street to facilitate an exit northbound via Thomas Lane. A new signalised junction will be provided at Marlborough Street / Talbot Street and a one-way only entry into North Earl Street will be implemented for servicing purposes. Marlborough Street will be southbound.

South of Talbot Street, the alignment continues along the east side of the street with Marlborough Stop located adjacent to the junction with Sackville Place and close to the Lower Abbey Street junction. The **Marlborough Stop** will be conveniently located to provide interchange with the Luas Red Line at Abbey Street Stop. The bus layover and set down located in this area will require to be removed.

The alignment crosses the Luas Red Line at Lower Abbey Street and then runs along the west side of Marlborough Street as far as Eden Quay. A track connection from the Red Line is provided to enable movement of trams from the Red Line on to the Green Line for engineering purposes.

Building fixings will be the predominant method of support for the overhead catenary along Marlborough Street.

The route crosses Eden Quay and on to the new public transport bridge across the River Liffey which is currently being constructed by Dublin City Council. The alignment will run along the centre of the structure segregated from other road traffic and with a lane of traffic on either side for southbound bus or taxi movements.

The overhead catenary system will be supported by combined lighting / power supply poles suitably placed at either end of the bridge structure.

The alignment then crosses Burgh Quay where a signalised junction will be provided in association with the public transport bridge. It enters Hawkins Street where it runs segregated along the west side of the street as far as Townsend Street and crosses through the median to enter the south side of College Street where Trinity Stop is located, close to the junction with College Green. The track is segregated on College Street. Existing bus stops on College Street between D'Olier Street and College Green will require to be relocated. The route then meets up with the twin track section at College Green.

The twin track from O'Connell Street Upper to Broombridge is now described.

After leaving O'Connell Street Upper, the twin track alignment runs adjacent to the north side footpath on Parnell Street as far as Dominick Street Lower. Between Parnell Square West and Dominick Street Lower, the alignment occupies the full width of the current eastbound carriageway of the Parnell Street dual carriageway. The remaining westbound carriageway will be altered to provide for a single lane of traffic in each direction. Supports for the overhead catenary system on Parnell Street are mostly building fixings with occasional poles as required.

The alignment then turns north into Dominick Street Lower where **Dominick Stop** is located. An emergency crossover is provided on the north side of the Dominick Stop to permit operational flexibility. The alignment is fully segregated along the length of Dominick Street Lower with an adjacent parallel lane of southbound road traffic provided with some associated parking provision.

The alignment continues along the west side of Dominick Street Lower and crosses Dorset Street into Dominick Street Upper where shared running in both directions is provided as far as Mountjoy Street. The alignment in this area occupies the width of the street.

From Mountjoy Street to Palmerston Place, shared running is maintained in the southbound direction only.

Support for the catenary system on Dominick Street Upper is provided by means of both building fixings and lateral poles.

The alignment then crosses Constitution Hill at-grade. No entry for road vehicles is permitted from Western Way onto Dominick Street Upper or to / from Temple Villas via Dominick Street Upper. A new alternative access road will be provided between Constitution Hill and Temple Villas.

Entering in front of Broadstone the track-bed is in open cut section with **Broadstone Stop** at road level and accessed off Constitution Hill. A future access to the planned Grangegorman development is provided adjacent to the Luas track-bed in a cut-and-cover section. This will be the access point into the planned DIT campus from the Luas stop pending development of the wider area by the Grangegorman Development Agency and incorporating a major access to the DIT facilities.

The existing bus access road into the Broadstone Bus Éireann depot is relocated further west to enable vehicular passage above the overhead wires.

Beyond Broadstone Stop the alignment then begins to rise to existing ground level within the confines of the existing bus depot and along its western perimeter. A substation is proposed west of the alignment with access provided off the Upper Grangegorman Road.

A possible future **Grangegorman Stop** will be developed as additional demand from the future DIT facility materialises. Pedestrian access to this stop will be provided from Upper Grangegorman Road.

The alignment of the proposed scheme now enters Area 2.

3.5.2 Area 2

Between Constitution Hill and the terminus at Broombridge the alignment is completely segregated from road traffic.

From the possible future Grangegorman Stop the alignment proceeds into the railway cutting of the former Midland and Great Western Railway.

It crosses under the North Circular Road and Cabra Road by means of the existing masonry arch overbridges which are protected structures. **Phibsborough Stop** comprising two lateral platforms is located between North Circular Road and Cabra Road with stair and lift access into the stop from both roads.

The existing retaining walls of the cutting will be stabilised and strengthened by means of soil nailing.

The alignment then continues along the railway cutting and crosses under Fassaugh Road Bridge before coming to **Cabra Stop** located immediately north of Fassaugh Road. A pedestrian ramp and stairs is provided from Fassaugh Road into the lateral platforms of Cabra Stop.

The alignment proceeds north from Cabra Stop along the old railway alignment to the terminus at **Broombridge Stop**. This terminus stop is located adjacent to the existing Broombridge station on the Irish Rail Maynooth suburban railway line offering convenient interchange facilities.

A depot is located at Broombridge south of the running lines and provides stabling for a fleet of 19 trams. Facilities include a sanding plant, sand silo and tram wash. A substation will also be located in this area as well as a radio mast for communications.

Two pit lanes are provided within the depot shed to enable light maintenance along with associated workshops, stores and offices. It is intended that heavy maintenance activities will be undertaken at the existing Sandyford depot.

Staff car parking, a ‘Kiss and Ride’ facility, bus stop / turnaround and taxi set down complete the arrangements.

Support for the overhead line system along the railway cutting and formation is generally provided by means of centre poles between the inbound and outbound tracks north of Cabra Stop and in the depot area. South of Cabra Stop a mixture of centre poles and lateral poles is proposed.

The terminus stop is located in such a position as to allow a future crossing of the Maynooth railway line and Royal Canal to enable an onward extension to Finglas.

This completes the description of the alignment.

3.6 System Concept

Luas Broombridge will be designed to operate as a continuation of the Luas Green Line into the city centre and onwards to Broombridge. Some of the critical design considerations to ensure full compatibility include:

- The structures gauge can accommodate vehicles up to 2.4 metres wide. This is the same as that used on the Luas Red and Green Lines;
- The vehicles will be 100% low floor similar to existing rolling stock on the Luas Green Line;
- A minimum track radius of 25 metres is proposed, which is consistent with the minimum radius used to date on the Luas Red and Green lines;
- All the platforms are designed to cater for future generation 53 metre long vehicles;
- The traction system is designed using an overhead contact system of 750 V DC using a tram wire arrangement;
- The substations will each have a capacity of 2MVa;
- It is an open system with at-grade crossings on public roads which facilitates integration into the urban environment and local street network;
- Provision is made for ticket vending machines and smart card validators at stops. Respecting the integrity of the historic city centre streetscape, there will be a requirement to limit street furniture at some locations; and
- A new generation of stop furniture will be employed along Luas Broombridge.

In addition provision will be made for control systems which are fully compatible with those in place on the existing lines, including:

- An automatic vehicle location system. This will automatically monitor the location of trams in service and display their location in the control centre at Red Cow depot. This can be used as an input into other systems such as a passenger information system and line signalling system as well as for the monitoring of the operation of the system as a whole;
- A passenger information display system, displaying relevant information for passengers in the trams and at stop locations;
- A SCADA (Supervisory Control and Data Acquisition) system to monitor the power supply system and some of the fixed equipment;
- A radio system providing communication between the control centre and operational staff and also the passengers; and
- A video monitoring system and an emergency telephone system at stops, to improve passenger security and reduce the potential for vandalism.

3.7 Conclusions

There is a compelling case for the implementation of Luas Broombridge.

It will create the missing link in the Luas network and extend the Luas system to the north of Dublin city centre. There will be an increase in the number of trips on public transport and a greater integration of Luas, rail and bus systems in Dublin.

The provision of the scheme will realise a reduction in city centre congestion with the economic benefits of enhanced mobility.

The implementation of Luas Broombridge will present an enhanced image of Dublin as a shopping, tourist and business destination leading to increases in investment and economic activity. The associated upgrading in city centre realm will represent an improved quality of life for Dubliners and visitors to the city.

A BRT alternative to Luas Broombridge was considered and the conclusion was that Light Rail is superior to BRT on most evaluation criteria and in particular on the environment and integration aspects, although the relative advantage is not substantial. Evidence would also suggest that light rail systems have a greater positive impact on business investment decisions than BRT systems due to the perceived permanence of the infrastructure. The appraisal and analysis concluded that a bus-based alternative should not be considered further as an alternative to Luas Broombridge.

A number of route options were identified for Luas Broombridge. These route options were evaluated against criteria and sub-criteria under the following headings:

- Impacts on the Environment and Quality of Life;
- Economy;
- Accessibility;
- Policy and Transport Integration; and
- Safety.

The preferred alignment for Luas Broombridge was chosen following a multi-criteria analysis of all feasible routes and taking account of the views expressed by major shareholders and interested parties during the public consultation process.

The chosen route extends the existing Luas Green Line from the current terminus at St. Stephen’s Green further into the city centre via Dawson Street, Nassau Street and College Green. At College Green the twin track splits with a single track proceeding north into O’Connell Street where a track turnout with the Red Line will be provided and where interchange with the Luas Red Line is facilitated. The single track continues north on O’Connell Street Upper past the Spire and turns east into Parnell Street before returning towards College Green via Marlborough Street, the proposed new bridge over the River Liffey, Hawkins Street and College Street.

North of O’Connell Street Upper, the twin track to Broombridge routes via Parnell Street, Dominick Street Lower and Dominick Street Upper to Broadstone, where the route crosses Constitution Hill at grade.

The route emerges from the lower level in front of the Broadstone building into the existing Bus Éireann depot and continues along the western perimeter to reach the former Broadstone railway cutting. From here, the route uses the old cutting to travel the remaining length to Broombridge stop terminus where a depot will also be sited.

Approximately half of the total 5.6 km length is on-street with the remainder being segregated from road traffic within the Broadstone site and the old railway cutting.

There are thirteen stops proposed along this alignment at the locations listed below:

- Dawson;
- Westmoreland;
- O’Connell-GPO;

- O'Connell Upper;
- Parnell;
- Marlborough;
- Trinity;
- Dominick;
- Broadstone;
- Grangegorman (possible future stop);
- Phibsborough;
- Cabra; and
- Broombridge.

Luas Broombridge will extend the Green Line into the city centre providing a convenient, quality public transport service and offering increased accessibility to the city centre and beyond.

It will be the link that creates a Luas network whereby passengers can readily interchange between Luas lines and will provide much needed access opportunities for the planned development of a single campus facility at Grangegorman for DIT. It will re-use the former railway cutting at Broadstone and open up a new transport corridor to the benefit of citizens in Phibsborough and Cabra.

This line will be an attractive and efficient means of public transport for the area and will ensure its sustainable development in the future.

4 TRANSPORT PLANNING

4.1 Chapter Summary

- The function of Luas Broombridge is to extend the Luas Green line further northwards providing better penetration into the commercial heart of the city centre, as well as to provide a link between the Luas Red and Green lines.
- Luas Broombridge is critical in creating a Luas network. In its absence the city would be left with a series of spurs and extensions to the Luas Red and Green Lines. This does not satisfy passenger demand nor realise the policy objectives for public transport integration and enhanced interchange policies.
- It provides the platform for the development of this integrated public transport network. In its absence it would be more difficult to encourage the modal shift to public transport and delay the prioritisation of public transport over car.
- A catchment analysis was undertaken to identify the population and employment trends over the 3 selected timeframes of 2006, 2011 and 2030 and was used to develop an understanding of the potential likely demand for Luas Broombridge in the defined catchment area.
- There has been an increase in the city centre population to be served by Luas Broombridge between 2006 and 2011.
- To assess the effect of Luas Broombridge the NTA multimodal transport model has been applied to a number of specific tests. Sensitivity tests examining the impact of different landuse and infrastructure scenarios were done.
- The demand forecasts indicate that the introduction of Luas Broombridge will add 10.5 million passenger boardings to the Luas Network in the Base Case.
- These results show that, during the peak period, approximately 400,000 fewer trips by car will be made per year after the introduction of Luas Broombridge.
- The majority of the passenger boardings on Luas Broombridge come from other public transport modes where existing public transport passengers have transferred due to the implementation of Luas Broombridge.
- The results show a very slight decrease in boardings made on the heavy rail network when Luas Broombridge is introduced due to some existing rail users transferring to Luas because of the increased permeability of the city centre offered through interchange at Luas Broombridge.
- A decrease in boardings on the bus network can be attributed to bus users transferring over to Luas, as some bus routes run parallel to Luas Broombridge and services on these bus routes will not be as frequent and reliable as Luas.
- The results of the demand analysis demonstrate that there is strong demand and need for Luas Broombridge under all the different scenarios tested.
- The implementation of Luas Broombridge generates benefits for passengers through greater penetration of the city centre and also presents further opportunities for travel afforded by completion of the light rail network.

4.2 Introduction

Development of a reliable, efficient and integrated public transport network for the Greater Dublin Area is a key element to achieving a modal shift from private car thereby tackling congestion in Dublin, enhancing economic competiveness and ensuring a sustainable, attractive city for generations to come.

A key contributing factor to the demand for any public transport service is the degree of integration with other transport infrastructure. There are currently a number of other transport projects in various planning and implementation phases, which through integration will have a direct influence on the potential patronage of Luas Broombridge.

The creation of an integrated public transport system facilitates more concentrated and consolidated patterns of development and reduces reliance on the private car. Luas Broombridge plays a critical and essential role in the development of this public transport network.

The function of Luas Broombridge is to extend the Luas Green line further northwards providing better penetration into the commercial heart of the city centre, as well as to provide the critical missing link between the Luas Red and Green lines. . It will also provide a new transportation corridor to the north west suburbs of the city and facilitate much needed access to the planned DIT campus development at Grangegorman.

In addition to extending the Luas Green Line northwards into the city centre and beyond, Luas Broombridge will provide and enable interchange with the Maynooth railway line, the Luas Red Line (including Luas Citywest and Luas Docklands services), the existing and planned Bus network, and the future Metro North and DART Underground services.

Luas Broombridge represents significantly more than just a link between the existing Luas lines and the benefits extend much further than the immediate catchment of the proposed scheme. Luas Broombridge will be a catalyst for urban regeneration and social inclusion. One major benefit of Luas Broombridge will be that it will strengthen the commercial heart of the city. Investment can be attracted into the areas served by Luas Broombridge and new commercial and service facilities can be developed. Luas Broombridge can contribute to sustaining the business and competitiveness of the capital city and provide long-term sustainable infrastructure to support the city for future generations.

In addition to serving the city centre commuter market, Luas Broombridge will also serve the important retail market in the city centre, facilitating shopping and leisure trips for people wishing to move between the traditional city centre retail areas of Henry Street north of the Liffey to the Grafton Street area south of the river.

Most importantly, Luas Broombridge plays a pivotal role in the creation of a Luas network. In its absence the city would be left with a series of disconnected lines and spurs. The vital importance of this network effect is demonstrated by the substantial increase in patronage as a result of Luas Broombridge, compared to the modest increase in the size of the network. Luas Broombridge thus plays a major role in realising the full potential of the investment to date in the Luas Red and Green lines.

However, Luas Broombridge will not only integrate the existing Luas Red and Green lines: it also provides the city centre destination for future Luas lines to the north and west of the city thus providing a platform for the development of an integrated public transport network. In its absence passenger demand is not satisfied and it would be more difficult to encourage the modal shift to public transport and delay the prioritisation of public transport over car.

Since Luas began passenger service in 2004 the consistently high passenger numbers have demonstrated that the public will avail of public transport when there is assurance that sufficient capacity and a reliable service will be provided. In particular Luas has enhanced the perception of public transport and has confirmed that successful public transport does more than address problems of traffic congestion during the peak periods. This is particularly apparent at times of the day traditionally regarded as off-peak for public transport. Luas has proven that in providing a high quality public transport service people now have the confidence to embrace a less car dependent approach to commuting to work, education, recreation and shopping.

4.3 Overview

This chapter examines the effect of Luas Broombridge on the demand for public transport. In order to undertake this assessment, RPA has developed passenger demand forecasts for Luas Broombridge using the National Transport Authority's (NTA) multimodal transport model (2006 base year).

This model generates forecasts of future trips on public transport including Luas for a forecast year of 2030. RPA has applied this forecast model to test the effect of Luas Broombridge in terms of additional trips generation and user benefits in terms of time savings.

The principal test is called the Base Case. In addition to the Base Case a number of different sensitivities were also tested to provide a rigorous and robust appraisal of Luas Broombridge. These sensitivity tests examined different scenarios in relation to changes in landuse and infrastructure provision.

A model is a simplified representation of a system. Travel demand models are used to represent the key elements of the travel demand process using mathematical equations. The multimodal transport model was used to examine the effect that Luas Broombridge will have on trip making and mode choice and the change in public transport accessibility as result of its implementation.

The model takes as inputs, population and employment statistics to generate estimates for present and future trip demand by public transport.

In order to assess the effect of Luas Broombridge the transport model is run with two different scenarios. The first scenario is called the Do-Minimum. This scenario assumes that the projected land use forecasts are met without Luas Broombridge included.

A second scenario is then run where Luas Broombridge is included. This is called the Do-Something scenario and this scenario includes all the assumptions of the Do-Minimum scenario plus Luas Broombridge. The difference between one scenario and the other gives us an indication of the effect of Luas Broombridge.

4.4 Catchment Analysis of Luas Broombridge

A catchment analysis was undertaken to identify the population and employment trends over 3 selected timeframes of 2006, 2011 and 2030 and this was used to develop an understanding of the potential likely demand for Luas Broombridge in that area. The catchment analysis was undertaken using two different methods. The first method is based on information of population and employment from both the 2006 Census and 2011 Census carried out by the Central Statistics Office (CSO) at Electoral Divisions (EDs). The second method is based on analysing the Geodirectory dataset within the defined catchment areas of Luas Broombridge. The Geodirectory dataset provides address points for residential and commercial premises that can be used to ascertain the number of premises within a defined catchment area.

4.4.1 Introduction to Catchment Analysis

Two catchment areas chosen for this assessment were a 500m and 1km radius from each stop. 500m is the suggested desirable walking distance and 1000m is the suggested acceptable walking distance for commuting in the IHT's (Institute of Highways and Transportation) "Guidelines for Providing for Journeys on Foot".

4.4.2 Method and Results – Census Data

The inputs to the analysis are stop location data and Electoral Divisions (EDs) data. The EDs data included population and employment data from the 2006 Census of the population, population from the 2011 Census of the population, and population and employment for future scenarios based on NTA projections (Higher Growth scenario) and a Moderate growth scenario based on the Central Statistics Office (CSO's) M0F1 forecasts. The moderate growth scenario is explained in greater detail in section 4.5.3 and 4.5.4.

The NTA growth projections are based on a NTA land use forecast that was developed for the draft National Transport Authority transport strategy for the GDA for the period up to 2030. In terms of forecasting settlement patterns within the GDA for the transport strategy, two distinct distribution scenarios were explored by NTA; Scenario A – "Compliance with minimum Regional Planning Guidelines (RPG) targets and policies" and Scenario B – "Large town and rail focussed development, also compliant with RPG policies".

As Scenario B is more likely to support the sustainable integration of transport and land use it was used by NTA for forecasts of growth distribution and settlement patterns and to inform the transport strategy for the GDA. The NTA strategy landuse has been used in the UDBC as the higher growth landuse scenario.

The population and employment density of each of the EDs within the catchment is used to estimate the population and employment along the catchment. This is an approximate method as the density of each ED may not be uniform.

A sample of the EDs for the Luas Broombridge 1000m catchment is presented in Figure 4-1, below and the output results of the catchment analysis using this approach is presented in Table 4-1.

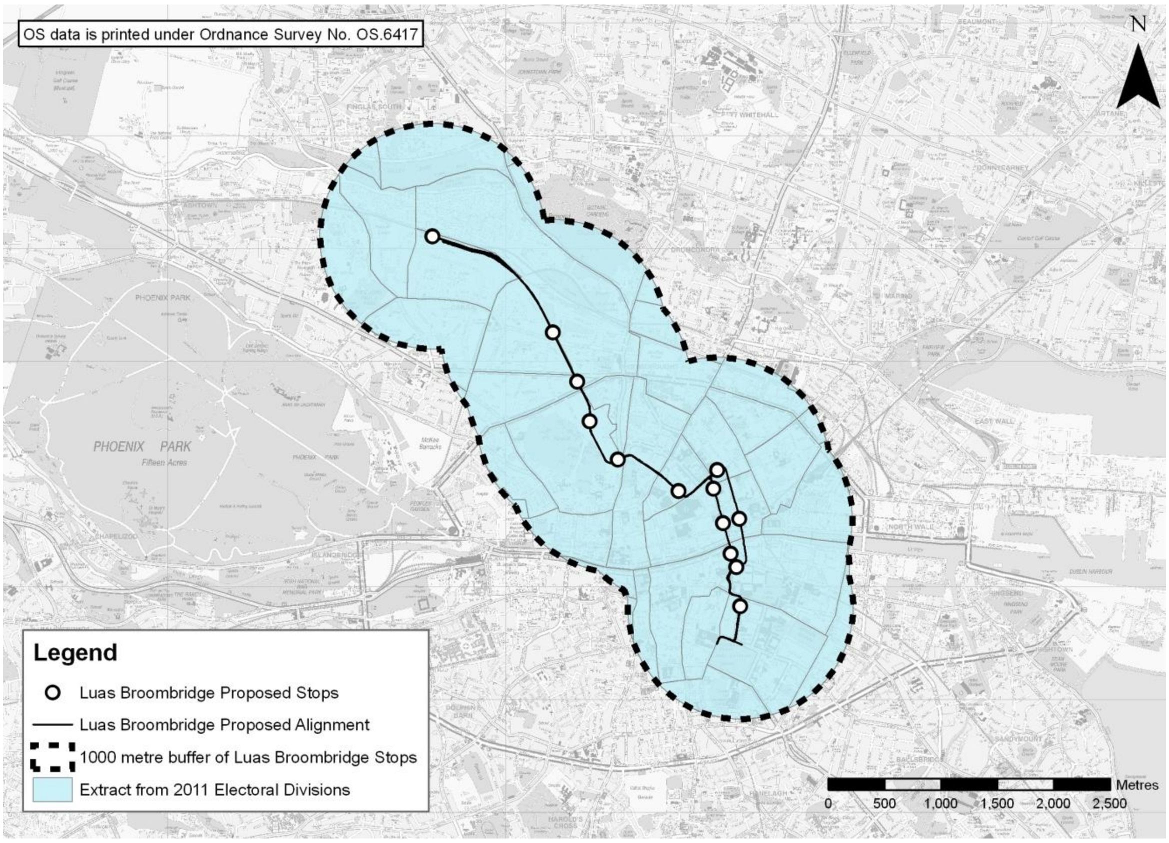

Figure 4-1 Electoral Divisions for Luas Broombridge

Table 4-1 Luas Broombridge Railway Order Catchment Analysis

Buffer	2006 Population	2006 Employment	2011 Population	2026 Moderate Growth Population	2026 Moderate Growth Employment	2030 Population Strategy Landuse	2030 Employment Strategy Landuse
500m	32,989	76,999	37,397	39,637	88,087	50,324	103,999
1000m	83,596	148,249	90,045	96,002	166,568	115,961	192,841

The recently published results from the 2011 Census of population shows that the population of Ireland increased by 8.2% overall during the period between 2006 and 2011. This increase is concentrated in urban areas with a population increase in urban areas of 11% compared with the overall increase of 8.2%.

In the Dublin City Council (DCC) administrative area the population increased by 4.2% to 527,612 persons. This can be compared with the 6.2% increase in the population of Dublin City and its suburbs.

In line with the increases shown for urban areas during the period there has been an increase in the city centre population to be served by Luas Broombridge between 2006 and 2011. The population increased by approximately 4,408 within 500m of the proposed stops and by 6,449 within 1000m. The 2011 population is slightly lower than the moderate growth scenario population and significantly lower than the NTA

2030 Strategy Landuse projections. The employment growth projected is modest in the moderate growth projection above the 2006 employment figures.

The Updated Detailed Business Case (UDBC) assumes employment growth in the Dublin region between 2006 and 2026 of 15.3%. This figure derives from work completed by Goodbody Economic Consultants on behalf of the Department of Transport (DoT) to prepare population and employment projections for use in business cases which reflects the changed economic outlook in Ireland. The employment projection is derived from the CSO national labour force projection consistent with the M0F1 population projection, and assumes that Dublin retains its share of employment within the Greater Dublin Area (GDA).

There has been significant reduction in employment in the region since 2006. However, taking this into account, the employment assumptions in the UDBC represent an average annual growth rate of 1.54% between now and 2026 which is similar to the long term average growth rate in the region.

The achievement of the long run average growth in employment between now and 2026 seems reasonable, given that employment levels are stabilising and there is significant spare capacity built up in the economy over the recession which will aid future growth.

4.4.3 Method and Results – Geodirectory

The Geodirectory method is carried out to cross check and supplement the information that is contained in the method above which utilises Census data at ED level. The inputs required to carry out this method are the proposed stop location data and the Geodirectory dataset. This data included the exact number of address points for residential and commercial premises as at Quarter 4 2011. These can then be counted to ascertain the number of commercial and residential premises within the catchment. A sample of the Geodirectory point data for the Luas Broombridge 1,000m catchment is shown in Figure 4-2 Geodirectory data for Luas Broombridge' below and the output results of this catchment analysis is presented in Table 4-2'.

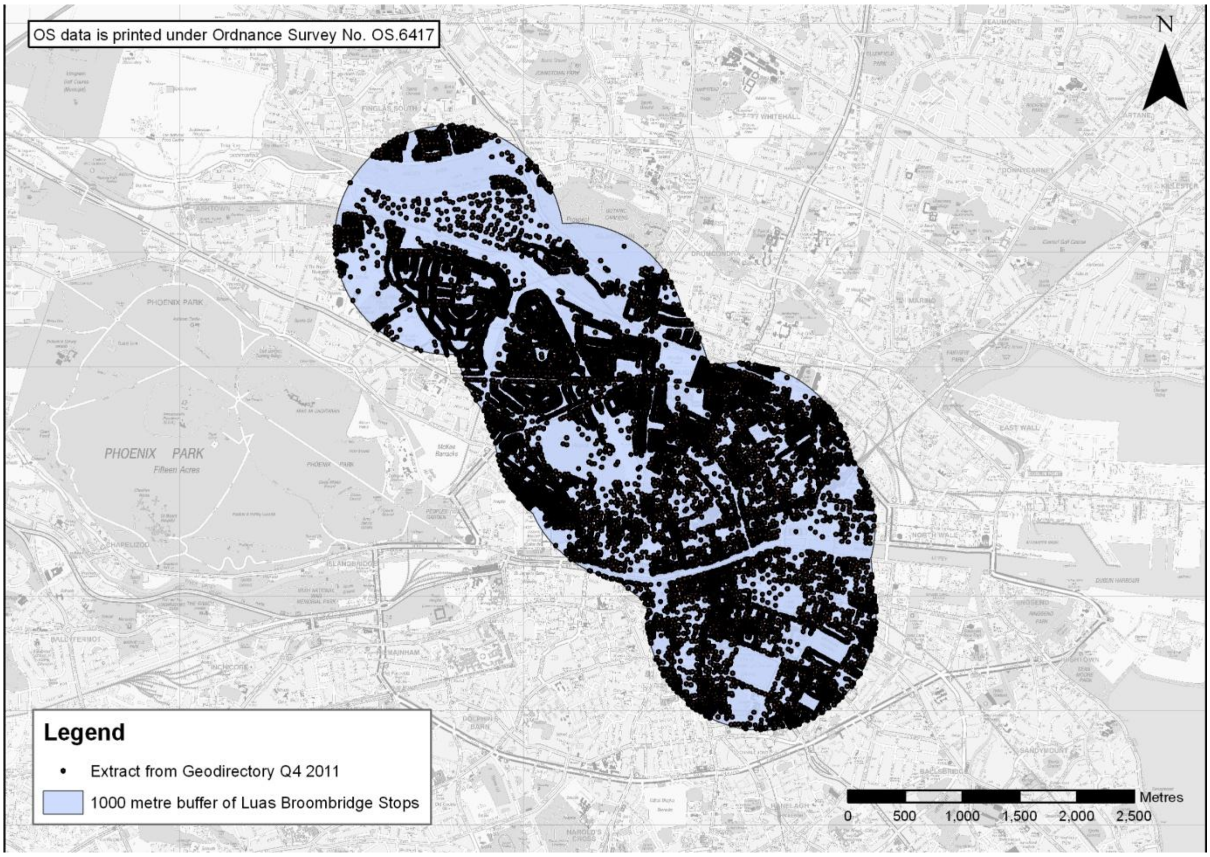

Figure 4-2 Geodirectory data for Luas Broombridge

Table 4-2 Catchment Analysis of Geodirectory

	Residential	Commercial
500m buffer	16,761	5,863
1000m buffer	42,402	11,491

As stated above the Geodirectory was queried to complement the Census population data available. The number of residential addresses was multiplied by the average occupancy rate of 2.7 persons per household to estimate the population for 2011, as shown in Table 4-3.

Table 4-3 Geodirectory Converted to Persons

Catchment	Persons (Residential address points*2.7)	Commercial
500m buffer *2.7	45,255	5,863
1000m buffer*2.7	114,485	11,491

This estimate of the population is greater using the Geodirectory methodology than the estimate using the Census information and EDs, by 7,858 for the 500m catchment and by 24,440 for the 1000m catchment. In the absence of employment data at ED level from the Census data currently available the Geodirectory is also a good indicator of employment destinations as it shows the number of commercial premises within the catchment.

4.5 Demand Analysis

4.5.1 Overview

A series of scenarios were tested using the NTA multimodal transport model (2006 Base Year) in order to assess the future demand on Luas Broombridge and evaluate the robustness of the transport case and to provide rigour to the appraisal.

4.5.2 Inputs and Assumptions

The demand analysis was conducted using the NTA multimodal transport model (2006 base year). This model forecasts demand for Luas Broombridge by assessing the travel time and costs associated with its introduction and allocating demand from existing modes when Luas Broombridge service offers an improvement or benefit. Demand for both the AM Peak period (7am-10am) and an off peak hour (2pm-3pm) is calculated as part of the model runs. This demand is then factored up to produce an annual demand estimate for Luas Broombridge.

The NTA transport model is a multimodal transport model which predicts future year passenger demand on public transport in the Greater Dublin Area (GDA). The model comprises a highway model, a public transport model and a mode choice model and its overall purpose is to accurately replicate and forecast the effect of the key factors that influence the demand for travel.

In essence, the demand model is a simplified representation of a real-world transport system. The model’s overall purpose is to accurately replicate and forecast the effect and interaction of key factors known to influence the demand for travel across a pre-defined area. These factors include existing and future landuse patterns (e.g. the distribution of population and employment in the area); the characteristics of the area’s transport network (i.e. the costs of travelling through the system by various modes including the various public transport modes and cars) and the distribution of travel patterns in the area (i.e. where people are travelling to/from).

Travel choices are accounted for within the model assignment by comparison of generalised costs of journeys between origins and destinations by the various modes modelled.

To assess the effect of Luas Broombridge the NTA multimodal transport model has been applied to a number of specific tests. The principal test is called the Base Case. In addition to the Base Case test a number of different sensitivities were also tested to provide a rigorous and robust appraisal of Luas Broombridge. These sensitivity tests examine different scenarios in relation to changes in landuse and infrastructure.

When the Outline Business Case (OBC) was produced in June 2009 there was a different timeline and order of priority for public transport projects to what now exists. In addition, there were different projections to the quantum of development that was predicted to occur and the timeframe for its realisation. By way of example the base case test in the OBC the "do minimum" scenario had both Metro North and DART Underground schemes included with a higher growth landuse, all being in place by 2016. Sensitivities on the base case test centred around service patterns, the realisation of Transport 21 investment framework and a low growth (pessimistic) scenario.

Subsequent to the development of the OBC a memo was produced by the DoT in consultation with stakeholders including both RPA and NTA to agree on three landuse scenarios to be tested as part of any business case development for a public transport scheme.

4.5.3 Landuse Assumptions

In order to assess passenger demand for Luas Broombridge, three specific landuse scenarios were investigated in line with the guidance discussed and agreed with the DoT as set out above to take into account the recent economic conditions.

- These are as follows:
- No growth scenario: 2006 population and employment;
- Future Year (2026) Moderate Growth Scenario ; and
- Future Year (2030) NTA's Strategy Landuse 2030 landuse forecasts1 (Higher Growth Scenario).

The no growth scenario uses 2006 population and employment levels as inputs as this is currently the most up-to-date and comprehensive census data available and is the data that the NTA transport model is calibrated against. Currently, not all of the detailed 2011 Census data is available. When available this detailed data will be used to recalibrate the NTA transport model to a new base year (2011). The 2030 scenario uses population and employment forecasts defined in the NTA's Strategy Landuse 2030 landuse forecasts[1].

The methodology associated with the moderate growth 2026 scenario is detailed further in section 4.5.4 below.

The forecasting methodology adopted by RPA is conservative so as to ensure confidence in RPA's patronage and revenue estimates for scheme appraisal because a primary source of risk and uncertainty in the preparation of business cases is an overly optimistic view of national and regional population growth assumptions.

In preparing the UDBC RPA had already revised its model assumptions in light of the global recession, which has seen the Irish economy contract significantly over the period 2008-2012. It is assumed that the employment and population growth previously forecast for 2016 in the Greater Dublin Area will not now transpire until 2030 and are at a lower quantum in line with the Central Statistics Office (CSO) M0F1 Traditional forecast. The "Moderate Growth" (which is used for the Base Case test for Luas Broombridge) scenario uses population and employment growth projections for 2026 which are based on NTA's assumptions and distribution at an electoral division/zonal level. However, this growth is not allowed to exceed the CSO's M0F1 forecasts, which are defined at a county level. The M0F1 projection assumes zero net migration to Ireland over the period to 2026 and assumes a return to a more traditional pattern of internal migration, such as that experienced up to the

[1] Strategy Landuse assumes a consolidation of landuse development around heavy rail/metro corridors.

mid-1990s. The precise basis for these population and employment forecasts was agreed between the DoT, Goodbody Economic Consultants and RPA during the audit of the business case for Luas Broombridge in December 2009.

In summary this Moderate growth scenario assumes that growth in population and employment slows from the exceptionally high levels experienced in years past. In particular, it is assumed that net migration into Ireland ends and is replaced by a situation where there is zero net migration into Ireland. The CSO forecasts which underpin the forecasts for future population and employment growth are the best available data.

4.5.4 Moderate Growth Methodology

Following on from a review of the OBC in 2009, it was recommended that a landuse sensitivity test be conducted with population and employment figures based on the CSO M0F1 forecasts. Further to this recommendation the moderate growth scenario has been used as the basis of our Base Case scenario. This section outlines how this ‘Moderate’ growth landuse scenario has been developed for the NTA model.

According to the CSO M0F1 projection, the Dublin Region’s population is projected to increase by approximately 13.5% between 2006 and 2026. Additionally, the GDA’s population is projected to increase by approximately 20.9%.

These projected changes have been incorporated into the NTA landuse forecasts in the following way.

The 2006 population for the Dublin Region (i.e. the area administered by Dublin City Council (DCC), Fingal County Council (FCC), South Dublin County Council (SDCC) and Dun Laoghaire Rathdown County Council (DLRCC)) is 1,186,855. A 13.5% increase to this area’s population is equal to an absolute increase of 160,225.

The CSO M0F1 forecasts do not distinguish between the Dublin Region’s constituent counties. As a result, a further step has been taken to apportion this absolute increase into each of the area’s counties based on the population growth forecast between 2006 and 2030 (NTA Strategy Landuse). The figures given in Table 4-4 below are derived from the forecasted increase in population between 2006 and 2030.

Table 4-4 2006 to 2030 Strategy Landuse

	2006 Population	2030 Population Strategy Landuse	Absolute Increase	% of Total Absolute Increase
DCC	505,873	682,244	176,371	41.82%
SDCC	243,843	328,065	84,222	19.97%
FCC	239,998	347,130	107,132	25.40%
DLRCC	197,141	251,152	54,011	12.81%
Total	1,186,855	1,608,591	421,736	100.0%

Using the percentages given in the table above, the absolute population increase of 160,225 can be apportioned into each county. Table 4-5 below gives the resulting population growth in each county, based on these proportions

Table 4-5 2006 to Moderate Growth

	2006 Pop	2026 Growth	2026 Pop	Growth Factor
DCC	505,873	67,007	572,880	1.132
SDCC	243,843	31,998	275,841	1.131
FCC	239,998	40,701	280,699	1.170
DLRCC	197,141	20,520	217,661	1.104
Total	1,186,855	160,225	1,347,080	1.135

The growth factors presented in Table 4-5 above are then applied to the 2006 matrices for each of the four counties. In addition, a growth factor of 20.9% was applied to all remaining zones in the model, outside of these four counties.

4.5.5 Infrastructure Assumptions

To assess the effect of Luas Broombridge three specific infrastructure scenarios were also investigated. These are as follows:

- Current Infrastructure;
- Current Infrastructure plus Metro North and DART Underground; and
- Proposed draft NTA Transport Strategy public transport network.

For the Current Infrastructure scenarios, it is assumed that the current public transport network will be maintained and no additional public transport infrastructure will be present in the future year scenario. For example, Metro North and Dart Underground are not included in these scenarios. The Proposed draft NTA Transport Strategy Infrastructure scenario includes the future infrastructure planned for the region.

4.5.6 Base Case and Sensitivity Tests

Based on the above landuse and infrastructure assumptions the following scenarios and combinations have been proposed to take into consideration the comments and recommendations of the audit of the Outline Business Case (OBC) that was carried out by Aecom and Goodbodys and the timelines and order of priorities for public transport investment. These were undertaken using the NTA transport model. They were carried out on both the AM and Off peak model.

- Base Case
    - Current Infrastructure (Do Minimum);
    - Add Luas Broombridge (Do something); and
    - Moderate Growth Landuse.

- Landuse Sensitivity Tests

The transport network in the Base case was tested with the following sensitivities:

- No Growth (2006 Calibrated Population and Employment with 2011 Transport Network); and
- Higher Growth (NTA 2030 Strategy Landuse).

- Infrastructure Sensitivity Tests

  The following infrastructure sensitivities were tested for both the Moderate Growth and Higher Growth scenarios:

- Infrastructure Sensitivity Test 1
  - Current Infrastructure plus Metro North and DART Underground (Do Minimum); and
  - Add Luas Broombridge (Do something).

  This test illustrates the complementary nature of Luas Broombridge with both Metro North and DART Underground.

- Infrastructure Sensitivity Test 2
  - Current Infrastructure plus NTA Draft Strategy Public Transport Network (Do Minimum); and
  - Add Luas Broombridge (Do something).

  This test illustrates that Luas Broombridge is a key component in the long term public transport strategy for Dublin.

4.5.7 Service Patterns

For the purposes of forecast demand analysis and the economic and financial appraisal that follow for Luas Broombridge, service patterns have been identified and have been modelled for the scenarios above.

The associated service patterns for both the Base case and sensitivity tests are outlined below.

In the Base Case and landuse sensitivities tests on the Base Case, the main difference in proposed service patterns is the quantum of trams per hour operating on Luas Broombridge infrastructure.

In the Moderate Growth and Higher Growth landuse sensitivity tests the service pattern operating on Luas Broombridge infrastructure is 20 trams per hour. 10 of the trams terminate at Broombridge whilst the other 10 utilise the city centre loop on Parnell Street.

In the No Growth scenario there are 17 trams per hour operating on Luas Broombridge infrastructure due to less demand. Seven of these trams terminate at Broombridge whilst 10 utilise the city centre loop on Parnell Street. Table 4-6 illustrates this.

Table 4-6 Service Pattern Base Case

Base Case - Current Infrastructure		**TPH**
Landuse	**Red Line**	
No Growth	Saggart to Connolly	5
	Connolly to Saggart	5
	Tallaght to Point	10
	Point to Tallaght	10
	Saggart to Belgard	5
	Belgard to Saggart	5
	Green Line	
	Bride's Glen to Broombridge	7
	Broombridge to Bride's Glen	7
	Sandyford to Parnell St. Loop	10
	Red Line	
Moderate & Higher Growth	Saggart to Connolly	5
	Connolly to Saggart	5
	Tallaght to Point	10
	Point to Tallaght	10
	Saggart to Belgard	5
	Belgard to Saggart	5
	Green Line	
	Bride's Glen to Broombridge	10
	Broombridge to Bride's Glen	10
	Sandyford to Parnell St. Loop	10

In the Infrastructure Sensitivity Test 1 which includes both Metro North and DART Underground in the Do Minimum scenario in addition to Current Infrastructure, the service pattern is the same as the Base Case Moderate and Higher Growth landuse tests with 20 trams per hour operating on Luas Broombridge. Ten of the trams terminate at Broombridge whilst the other 10 utilise the city centre loop on Parnell Street. Table 4-7 illustrates this.

Table 4-7 Service Pattern Infrastructure Sensitivity Test 1

Current Infrastructure + MN + DU		TPH
Landuse	**Red Line**	
Moderate & Higher Growth	Saggart to Connolly	5
	Connolly to Saggart	5
	Tallaght to Point	10
	Point to Tallaght	10
	Saggart to Belgard	5
	Belgard to Saggart	5
	Green Line	
	Bride's Glen to Broombridge	10
	Broombridge to Bride's Glen	10
	Sandyford to Parnell St. Loop	10

In the Infrastructure Sensitivity Test 2 which includes the NTA Draft Strategy Public Transport Network in the Do Minimum scenario the service pattern operating on Luas Broombridge is significantly different due to the inclusion of Metro South and Luas Bray line. In this scenario 15 trams per hour operate to and from Bray and Broombridge. Table 4-8 illustrates this.

Table 4-8 Service Pattern Infrastructure Sensitivity Test 2

NTA 2030 Strategy		TPH
Landuse	**Red Line**	
	Saggart to Connolly	5
	Connolly to Saggart	5
	Tallaght to Point	10
	Point to Tallaght	10
	Saggart to Belgard	5
	Belgard to Saggart	5
	Green Line	
	Bray to Broombridge	15
	Broombridge to Bray	15
	Line F	
	Newcastle Rd. to Poolbeg	15
Moderate & Higher Growth	Poolbeg to Newcastle Rd.	15
	Metro North/South	
	Belinstown to Fassaroe	15
	Fassaroe to Belinstown	15
	Metro West	
	Tallaght to SSG	10
	SSG to Tallaght	10
	Tallaght to Belinstown	7
	Belinstown to Tallaght	7
	Metro Tallaght	
	Tallaght to SSG via Kimmage	15
	SSG to Tallaght via Kimmage	15

4.6 Results

This section of the UDBC outlines the results of the forecast demand analysis that was undertaken.

4.6.1 Results Summary

Tables 4-9 and 4-10 present an overview of the results of the demand analysis. These results include both the Annual Luas Demand together with a summary of the Luas Green Line Boardings and Lineflows.

Table 4-9 Summary of Annual Luas Demand

Test	Landuse	Annual Luas Demand (Millions)		
		Do Min	Do Something	Change from Do Min
Base Case	No Growth	27.8	35.0	7.2
	Moderate Growth	34.7	45.2	10.5
	High Growth	43.8	56.4	12.5
Infrastructure Sensitivity Test 1	Moderate Growth	36.7	45.0	8.3
	High Growth	44.1	54.0	10.0
Infrastructure Sensitivity Test 2	Moderate Growth	38.8	48.4	9.5
	High Growth	46.6	57.8	11.2

Table 4-10 Summary of Lineflows and Boardings

Test	Landuse	Green Line Boradings		Green Line Maximum Lineflow AM (8-9)			Green Line Maximum Lineflow OP (2-3)		
		AM (8-9)	OP (2-3)	Lineflow	Stop	Direction	Lineflow	Stop	Direction
Base Case	No Growth	8,762	4,087	3,927	Ranelagh	Northbound	1,603	Ranelagh	Northbound
	Moderate	12,534	5,405	5,267	Ranelagh	Northbound	1,921	Ranelagh	Northbound
	High Growth	17,456	5,645	8,215	Ranelagh	Northbound	2,052	Ranelagh	Northbound
Infrastructure Sensitivity Test 1	Moderate Growth	13,177	5,599	5,289	Ranelagh	Northbound	1,943	Ranelagh	Northbound
	High Growth	14,873	5,777	8,133	Ranelagh	Northbound	2,047	Ranelagh	Northbound
Infrastructure Sensitivity Test 2	Moderate Growth	7,063	3,712	1,985	Ranelagh	Northbound	1,174	Stillorgan	Northbound
	High Growth	11,317	3,862	3,649	Ranelagh	Northbound	1,210	Stillorgan	Northbound

The results of the demand analysis demonstrate that there is strong demand and need for Luas Broombridge under all the different scenarios tested. Part of this demand will come from other public transport modes where passengers have transferred to Luas due to the implementation of Luas Broombridge.

A proportion of the new boardings on the Luas system come from the highway network. This will have a positive effect in terms of traffic decongestion in the city centre during the peak periods.

The results also show a decrease in boardings made on the bus network when Luas Broombridge is introduced. This can be attributed to bus users transferring to Luas as some bus routes run parallel to the proposed scheme which will have a competitive journey time and a more frequent and reliable service.

The results show a small decrease as a proportion in boardings made on the heavy rail network when Luas Broombridge is introduced. This is because some of the existing heavy rail users at Broombridge now transfer to Luas at the Broombridge stop because of the increased permeability of the city centre offered by Luas Broombridge.

The detailed breakdown of results of the demand analysis are now outlined in the sections that follow. This includes forecast annual demand and passenger Lineflows. Lineflows are presented for the AM peak hour (8am-9am).

4.6.2 Base Case

The demand forecasts for the Base Case scenario described above are presented in Table 4-11. The demand forecasts indicate that the introduction of Luas Broombridge will add 10.5 million passenger boardings per annum to the Luas Network.

The introduction of Luas Broombridge also has a positive impact on both the distance travelled on Luas and also the time spent travelling on Luas. The forecasts suggest an additional 65.5 million passenger kilometres on board Luas and an additional 242.6 million minutes spent on board Luas.

Table 4-11 Model Results Base Case

	Do Minimum			**Do Something**			**Change from Do Min**		
Luas	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)
millions	34.7	229.2	616.4	45.2	294.6	859.0	10.5	65.5	242.6

Passenger forecasting suggests that a portion of the new boardings on Luas Broombridge will come from the highway which in turn will have a positive effect in terms of traffic decongestion in the city centre.

Highway demand is forecast to decrease during the AM peak period (7-10) with the introduction of Luas Broombridge. Table 4-12 details the annualised peak period highway demand before and after the introduction of Luas Broombridge.

Table 4-12 Annualised Change in Peak Period Highway Demand – Base Case

Annual Peak Period Highway Demand (Person Trips)	**Do Min**	**Do Something**	**Change from Do Min**
Millions	367.4	367.0	-0.4

These results show that, during the peak period, approximately 400,000 fewer trips by car will be made per year after the introduction of Luas Broombridge.

Table 4-13 details the annualised peak period Luas boardings before and after the introduction of Luas Broombridge.

Table 4-13 Annualised Change in Peak Period Luas Demand – Base Case

Annual Peak Period Luas Demand	Do Min	Do Something	Change from Do Min
Millions	15.7	20.8	5.1

With the introduction of Luas Broombridge therefore, the forecast decrease in highway demand is approximately equal to 8% of the increase in Luas boardings during the AM peak period.

Part of the passenger boardings on Luas Broombridge come from other public transport modes.

The results reveal a very slight decrease in boardings made on the heavy rail network when Luas Broombridge is introduced due to some existing rail users transferring to Luas because of the increased permeability of the city centre offered through Luas Broombridge.

A decrease in boardings on the bus network can be attributed to bus users transferring over to Luas as some bus routes run parallel to Luas Broombridge and these bus routes will not be as frequent and reliable as Luas. A well-integrated public transport network would ensure that such bus services would be rearranged following the introduction of Luas Broombridge. This would result in a less adverse impact on bus patronage or even an increase in bus patronage if routes were designed to facilitate integrated trips on bus and Luas.

Broader transport planning considerations such as complementary bus services should be included in order to reflect an integrated public transport network as envisaged by the National Transport Authority. It is not fully appropriate to carry out this type of analysis based on a public transport network that has competing modes but one in which the modes effectively complement and integrate with each other to maximise the passenger carrying capacity and the availability of a public transport network.

The AM peak hour passenger load from Brides Glen to Broombridge for the Base Case is shown in Figure 4-3.

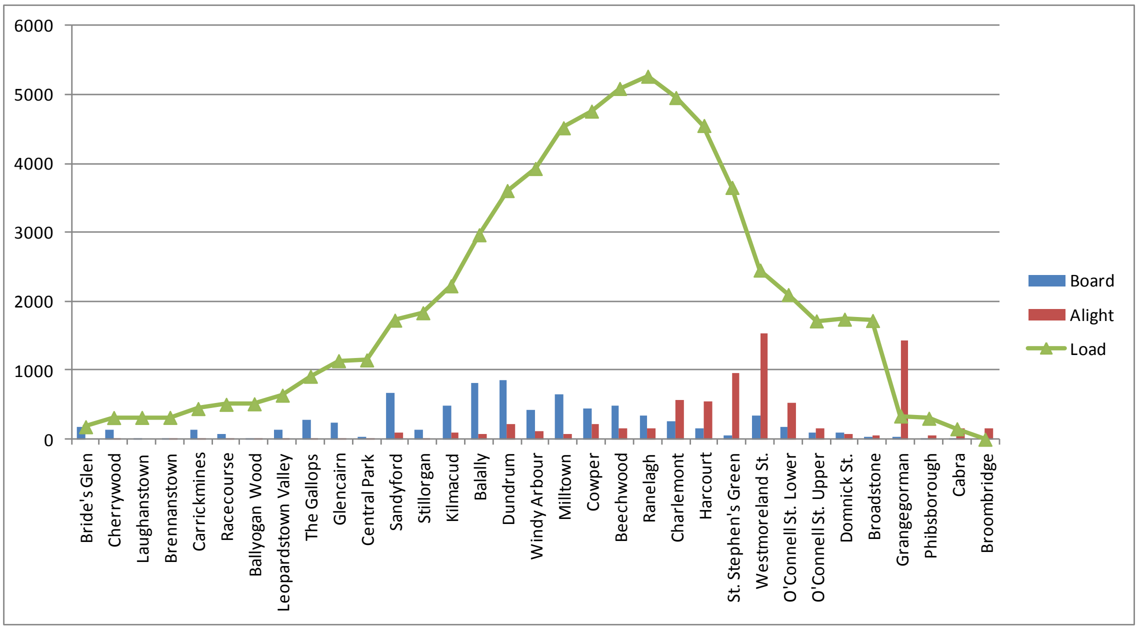

Figure 4-3 Total AM Peak Brides Glen to Broombridge Load

Figure 4-3 shows that the Base Case peak lineflow from Bride's Glen to Broombridge is approximately 5,270 passengers at Ranelagh stop. This peak lineflow figure is a combined total of the service pattern including Brides Glen to Broombridge and Sandyford to Parnell St. Loop. This peak lineflow demand can be accommodated by 20 trams per hour (tph) based on the theoretical maximum capacity of 310 persons per tram. Based on a planning capacity of 250 persons per tram the demand would slightly exceed the maximum capacity. This demand can be provided for by operating shorter headways or extending the lengths of the vehicles or a combination of both. The city centre stops and stops serving the Grangegorman Campus are key destinations. Westmoreland Street stop is forecast to be the busiest stop. This shows that with the introduction of Luas Broombridge passengers are travelling further into the city centre.

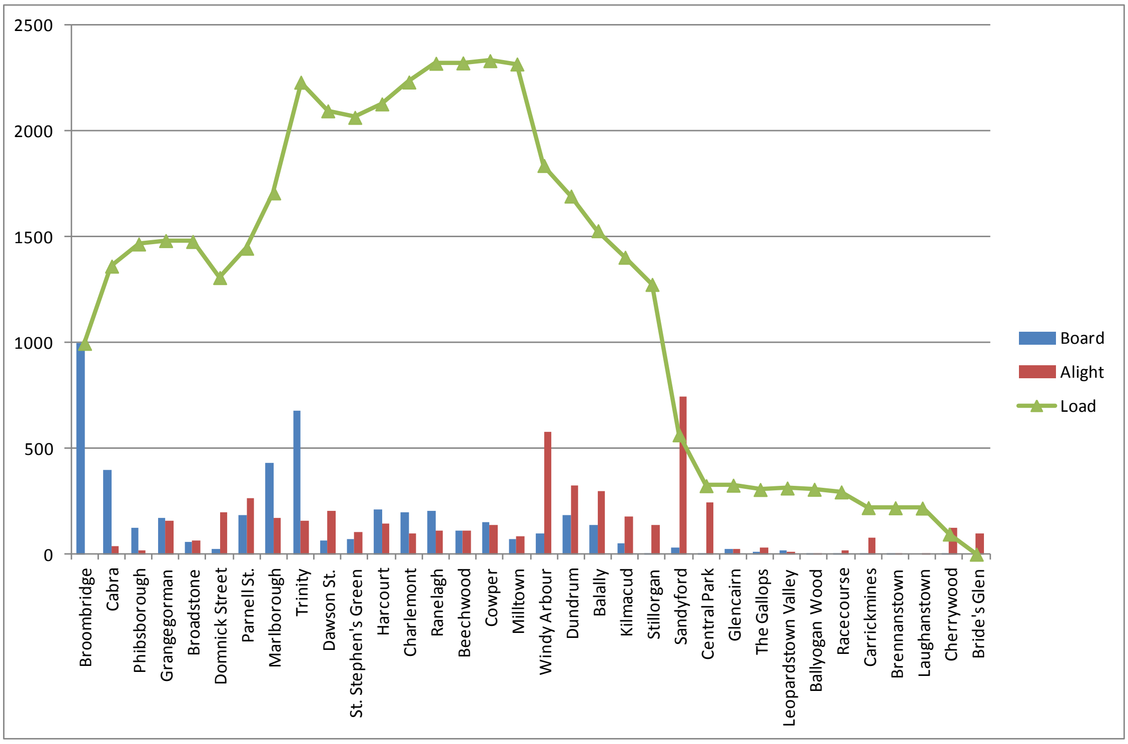

Figure 4-4 Total AM Peak Broombridge to Brides Glen Load

The AM peak hour passenger load from Broombridge to Brides Glen for the Base Case is shown in Figure 4-4.

Figure 4-4 shows that the demand is lower in the Broombridge to Brides Glen direction for the Base Case with a peak lineflow of approximately 2,330 passengers at Cowper stop. The stops at Broombridge, Cabra and the city centre stops at Marlborough Street (the Red Line interchange stop) and Trinity are some of the key generators of trips and Balally and Sandyford are some of the key destinations.

4.6.3 Landuse Sensitivity Tests

4.6.3.1 No Growth Scenario

The demand forecasts for the No Growth landuse sensitivity test described above is presented in Table 4-14. The demand forecasts indicate that the introduction of Luas Broombridge will add 7.2 million passenger boardings to the Luas Network.

The introduction of Luas Broombridge also has a positive impact on both the distance travelled on Luas and also the time spent travelling on Luas. The forecasts suggest an additional 49.9 million passenger kilometres on board Luas and an additional 178.6 million minutes spent on board Luas.

Table 4-14 Model Results No Growth Landuse Sensitivity Test

	Do Minimum			**Do Something**			**Change from Do Min**		
Luas	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)
millions	27.8	182.5	490.3	35	232.4	668.9	7.2	49.9	178.6

The AM peak hour passenger load from Brides Glen to Broombridge for the No Growth Landuse Sensitivity Test is shown in Figure 4-5. As per the current situation on the existing Green line Brennanstown and Racecourse stops are not opened in the 2006 landuse scenarios.

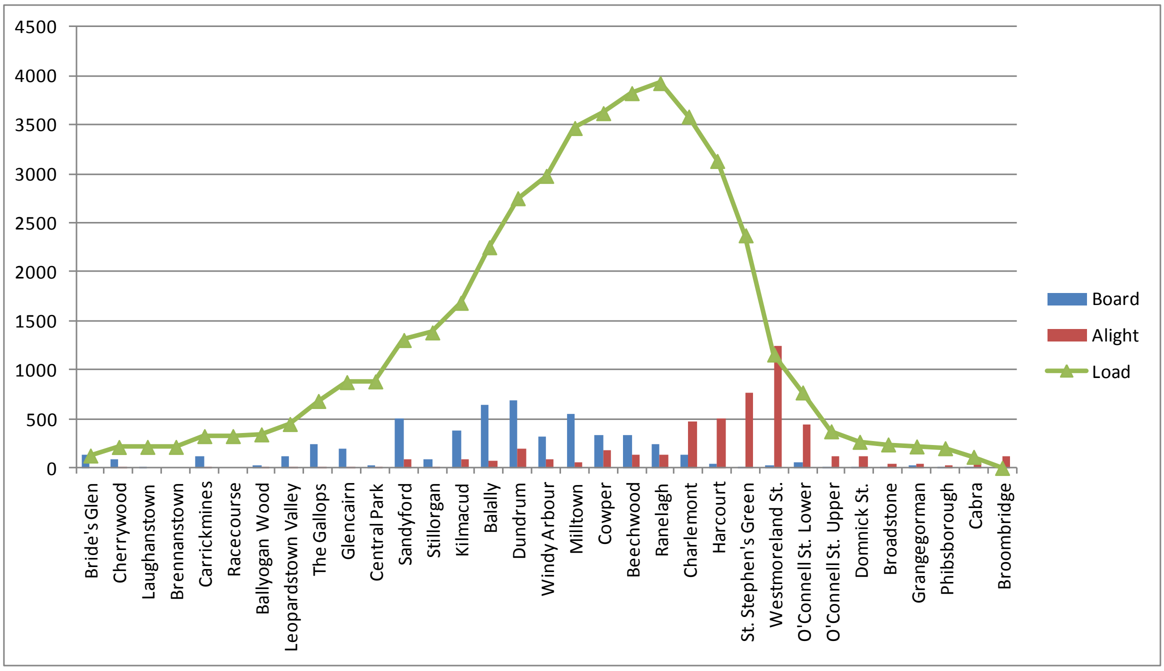

Figure 4-5 Total AM Peak Brides Glen to Broombridge Load No Growth Landuse Sensitivity Test

Figure 4-5 shows that the No Growth Landuse Sensitivity Test peak lineflow in the Bride's Glen to Broombridge is approximately 3,930 passengers at Ranelagh stop. As expected the peak lineflow is less in this scenario and the 17 tph service pattern meets the demand on this section. The new DIT campus at Grangegorman is not included in this scenario. The forecasts suggest that passengers are travelling further into the city centre with the introduction of Luas Broombridge.

The AM peak hour passenger load from Broombridge to Brides Glen for the No Growth Landuse Sensitivity Test is shown in Figure 4-6.

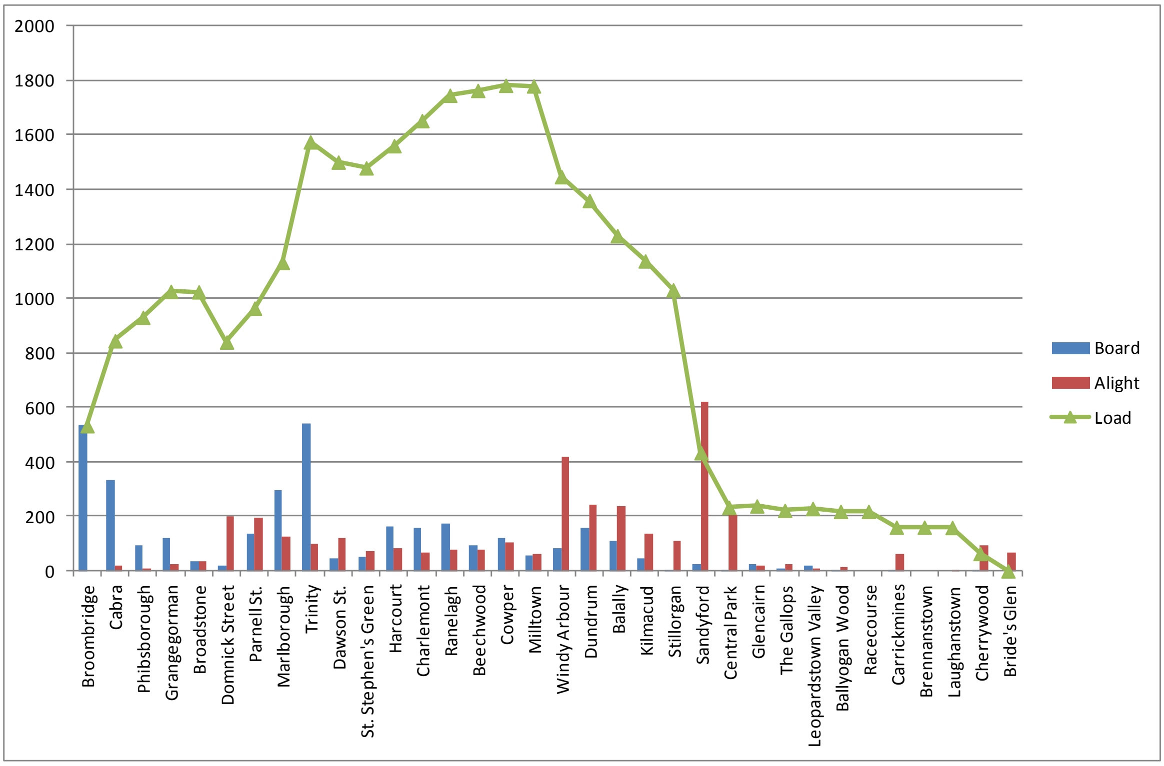

Figure 4-6 Total AM Peak Broombridge to Brides Glen Load No Growth Landuse Sensitivity Test

Figure 4-6 shows that the demand is lower in the Broombridge to Brides Glen direction for the No Growth Landuse Sensitivity Test with a peak lineflow of approximately 1,780 passengers at Cowper stop. As with the Base Case the stops at Broombridge, Cabra and the city centre are some of the key generators of trips and Balally and Sandyford are some of the key destinations.

4.6.3.2 Higher Growth Scenario

The demand forecasts for the Higher Growth Landuse Sensitivity test described above is presented in Table 4-15. The demand forecasts indicate that the introduction of Luas Broombridge will add 12.5 million passenger boardings to the Luas Network. As expected this is higher than the Base Case due to the higher population and employment figures.

The introduction of Luas Broombridge also has a positive impact on both the distance travelled on Luas and also the time spent travelling on Luas. The forecasts suggest an additional 78.4 million passenger kilometres on board Luas and an additional 285.4 million minutes spent on board Luas.

Table 4-15 Model Results Higher Growth Landuse Sensitivity Test

	Do Minimum			**Do Something**			**Change from Do Min**		
Luas	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)
millions	43.8	293.9	804.3	56.4	372.4	1089.7	12.5	78.4	285.4

The AM peak hour passenger load from Brides Glen to Broombridge for the Higher Growth Landuse Sensitivity Test is shown in Figure 4-7.

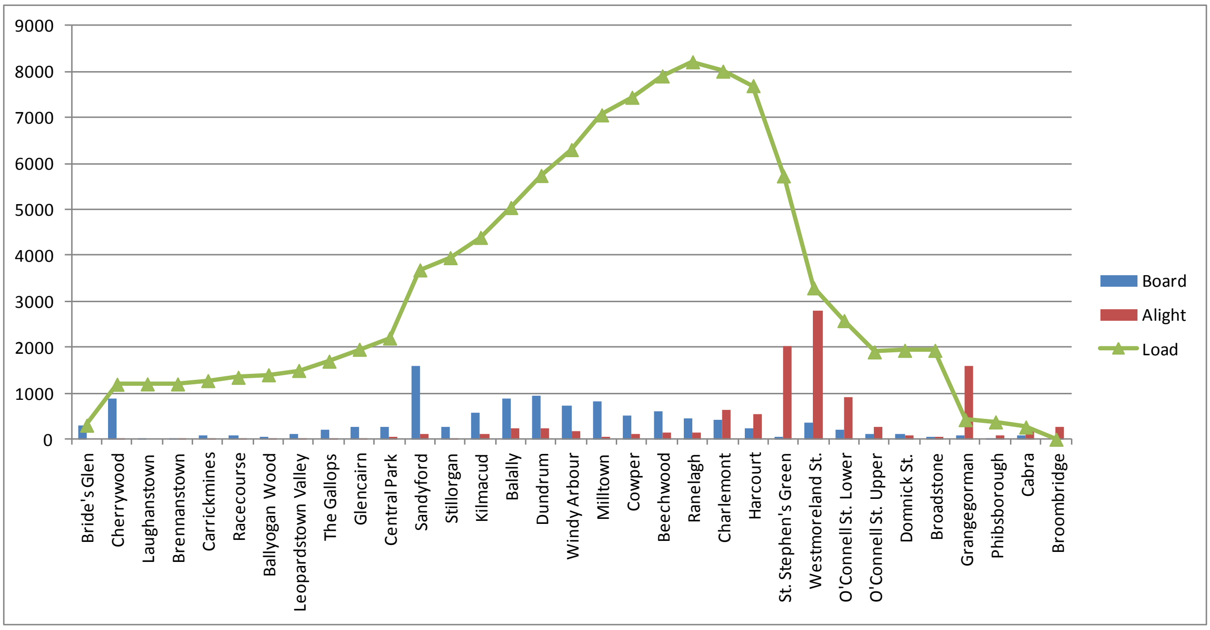

Figure 4-7 Total AM Peak Brides Glen to Broombridge Higher Growth Landuse Sensitivity Test

Figure 4-7 shows that the Higher Growth Landuse Sensitivity Test peak lineflow in the Bride's Glen to Broombridge is approximately 8,200 passengers at Ranelagh stop. As expected the peak lineflow is significantly more in this scenario due to the increased population and employment projections in this scenario above the Base Case. The demand is greater than the capacity that can be provided by Luas and justifies the need to have a more complete public transport network above the current infrastructure in place to cater for a more integrated landuse and transport strategy. As with the other scenarios the forecasts suggest that passengers are travelling further into the city centre with the introduction of Luas Broombridge.

The AM peak hour passenger load from Broombridge to Brides Glen for the Higher Growth Landuse Sensitivity Test is shown in Figure 4-8.

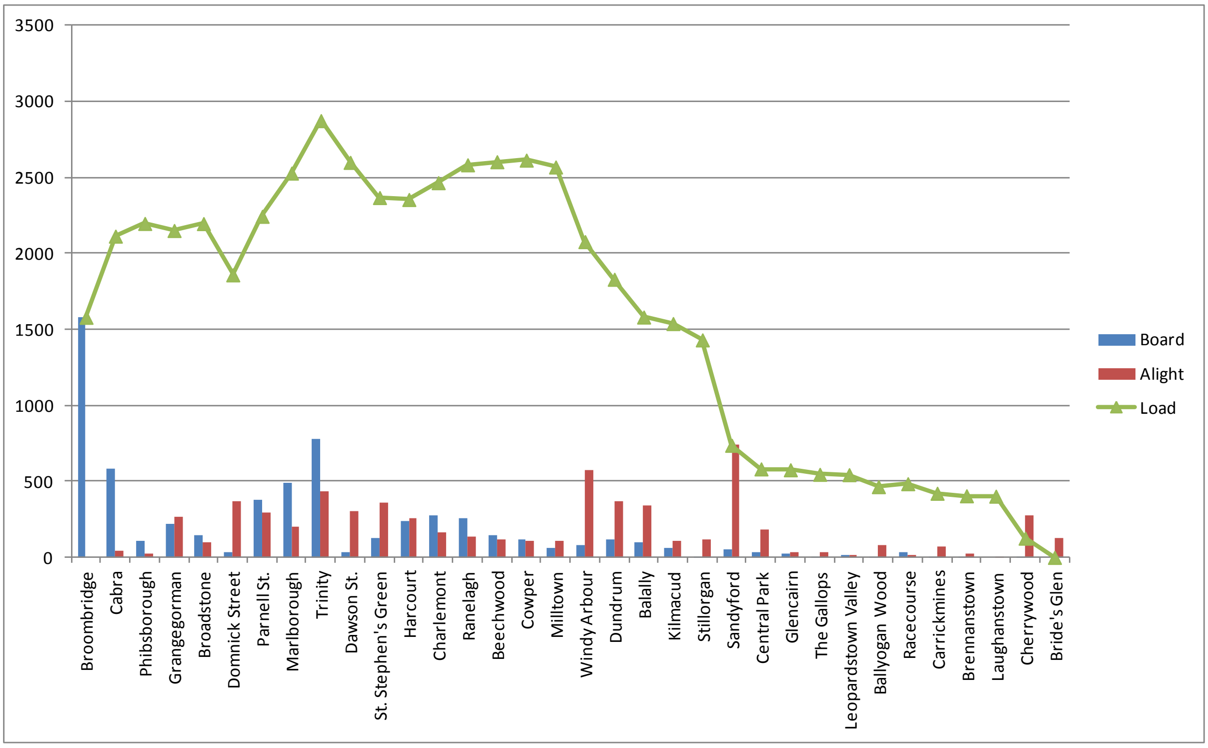

Figure 4-8 Total AM Peak Broombridge to Brides Glen Load Higher Growth Landuse Sensitivity Test

Figure 4-8 shows that the demand is higher in the Broombridge to Brides Glen direction for the Higher Growth Landuse Sensitivity Test over the Base Case but significantly less than the opposite direction with a peak lineflow of approximately 2,870 passengers at Trinity stop. As with the Base Case the stops at Broombridge, Cabra and the city centre are some of the key generators of trips and Balally and Sandyford are some of the key destinations.

4.6.4 Infrastructure Sensitivity Tests

4.6.4.1 Infrastructure Sensitivity Test 1 - Moderate Growth

The demand forecasts for the Infrastructure Sensitivity Test 1 - Moderate Growth described above is presented in Table 4-16. The demand forecasts indicate that the introduction of Luas Broombridge will add 8.3 million passenger boardings to the Luas Network. Due to the inclusion of both DART Underground and Metro North in this scenario, as expected this is less than the Base Case of 10.5 million passenger boardings.

The introduction of Luas Broombridge also has a positive impact on both the distance travelled on Luas and also the time spent travelling on Luas. The forecasts suggest an additional 48.2 million passenger kilometres on board Luas and an additional 181.2 million minutes spent on board Luas.

Table 4-16 Model Results Infrastructure Sensitivity Test 1 - Moderate Growth

	Do Minimum			**Do Something**			**Change from Do Min**		
Luas	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)	Boardings	Distance	Time

millions	36.7	234.8	616.7	45.0	283.0	798.0	8.3	48.2	181.3
Metro									
millions	14.9	136.0	194.4	14.2	133.7	190.5	-0.7	-2.3	-3.9

Table 4-16 also shows that the introduction of Luas Broombridge results in a very slight decrease in boardings made on Metro North. This decrease reflects the fact that some journeys that would have been previously undertaken in the absence of Luas Broombridge by means of a combined Luas and Metro journey would now be replaced by a direct journey on Luas.

Similar to the Base Case the forecasts show a small decrease as a proportion in boardings made on the heavy rail network when Luas Broombridge is introduced. This is because some of the existing heavy rail users at Broombridge now transfer to Luas at the Broombridge stop because of the increased permeability of the city centre offered through Luas Broombridge.

Luas Broombridge will interface with the proposed DART Underground project at St. Stephen's Green where an interchange will be provided with both DART Underground and Metro North. Viewed in a broader context, the light rail network created by Luas Broombridge will provide interchange options with the suburban/intercity rail network as enhanced by DART Underground, at Broombridge, Connolly, Spencer Dock and Heuston as well as St. Stephen's Green. Therefore DART Underground, Metro North and Luas Broombridge should be viewed as being very much complementary rather than competing for the same market.

The AM peak hour passenger load from Brides Glen to Broombridge for the Infrastructure Sensitivity Test 1 - Moderate Growth is shown in Figure 4-9.

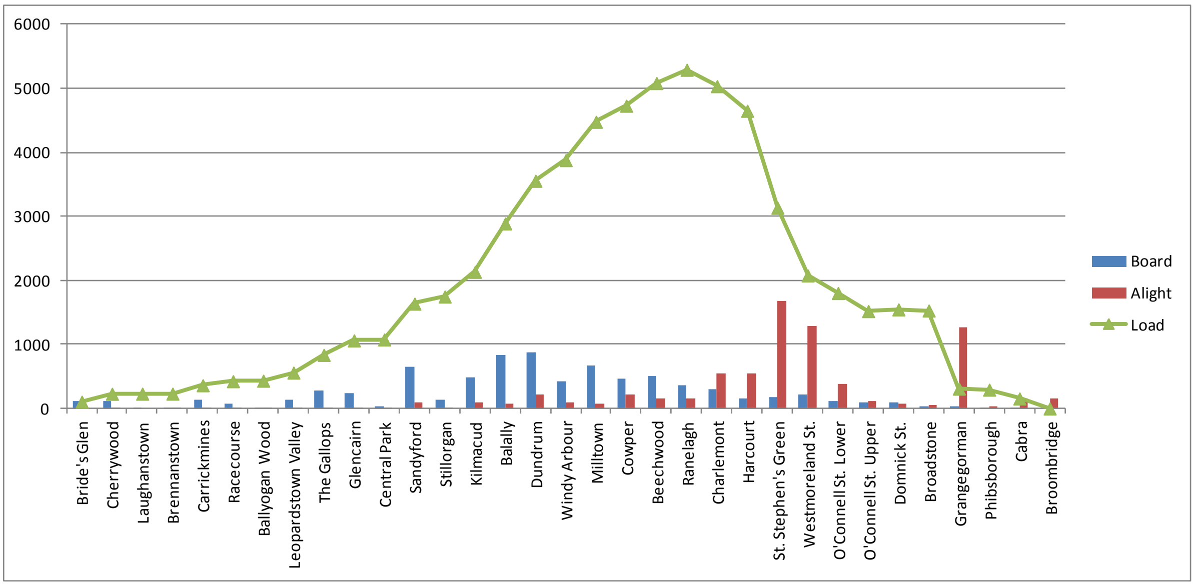

Figure 4-9 Total AM Peak Brides Glen to Broombridge Load Infrastructure Sensitivity Test 1 - Moderate Growth

Figure 4-9 shows that the Infrastructure Sensitivity Test 1 - Moderate Growth peak lineflow in the Bride's Glen to Broombridge is approximately 5,290 passengers at

Ranelagh stop. This peak lineflow is very slightly more in this scenario due to the increased public transport infrastructure above the Base Case.

The main difference between this Infrastructure Sensitivity Test and the Base Case is that there is an increase in alighters at St. Stephens Green due to the interchange opportunities provided by the inclusion of both Metro North and DART Underground.

The AM peak hour passenger load from Broombridge to Brides Glen for the Infrastructure Sensitivity Test 1 - Moderate Growth is shown in Figure 4-10.

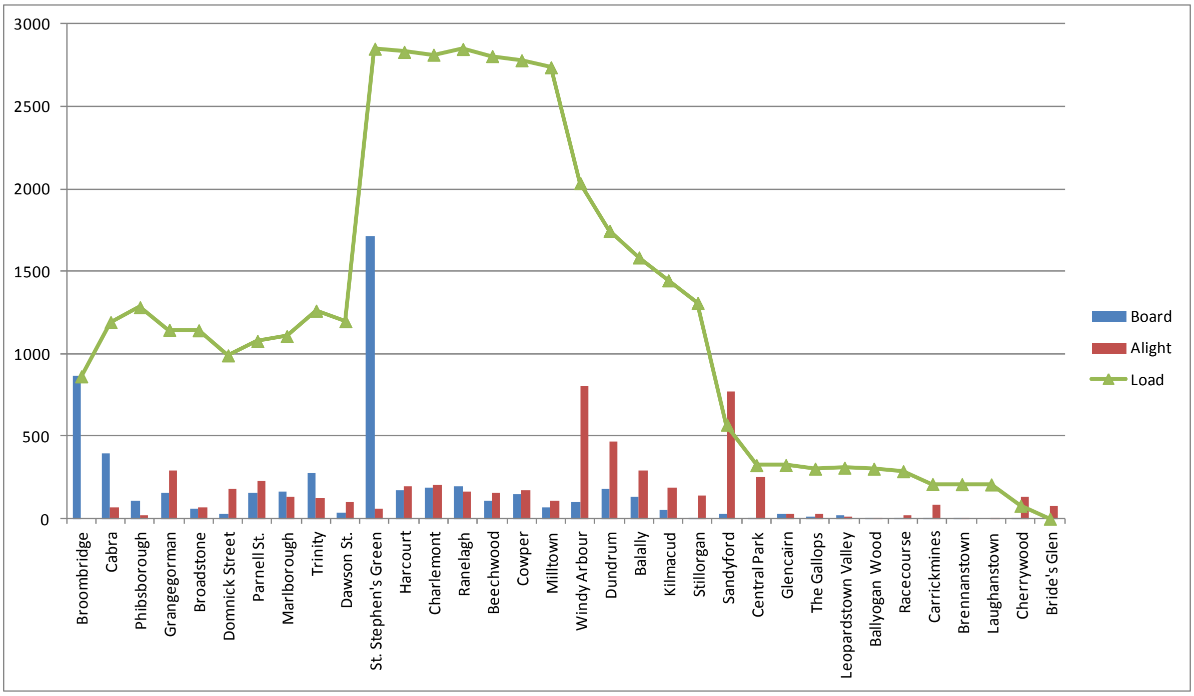

Figure 4-10 Total AM Peak Broombridge to Brides Glen Load Infrastructure Sensitivity Test 1 - Moderate Growth

Figure 4-10 shows that the Infrastructure Sensitivity Test 1 - Moderate Growth peak lineflow in the Broombridge to Brides Glen is approximately 2,850 passengers at St. Stephens Green stop. This differs from the Base Case which had the main trip generators at Broombridge and Cabra. St. Stephen's Green Stop is now a key generator of trips southbound on the Luas Green line because of the enhanced interchange opportunities offered with both Metro North and DART Underground.

4.6.4.2 Infrastructure Sensitivity Test 1 – Higher Growth

The demand forecasts for the Infrastructure Sensitivity Test 1 – Higher Growth scenario described above is presented in Table 4-17 Model Results Infrastructure Sensitivity Test 1 – Higher Growth. The demand forecasts indicate that the introduction of Luas Broombridge will add 10.0 million passenger boardings to the Luas Network. Due to the increase in population and employment projections in this scenario the passenger boardings are higher than the Moderate Growth test.

The introduction of Luas Broombridge also has a positive impact on both the distance travelled on Luas and also the time spent travelling on Luas. The forecasts suggest an additional 57.3 million passenger kilometres on board Luas and an additional 210.7 million minutes spent on board Luas.

Table 4-17 Model Results Infrastructure Sensitivity Test 1 – Higher Growth

	Do Minimum			Do Something			Change from Do Min		
Luas	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)
millions	44.1	292.3	772.7	54.0	349.6	983.4	10.0	57.3	210.7
Metro									
millions	21.3	196.2	281.0	20.1	192.0	274.3	-1.2	-4.2	-6.7

Table 4-17 also shows that the introduction of Luas Broombridge in this scenario results in a very slight decrease in boardings made on Metro North as per the Moderate Growth test. Whilst the actual number is slightly higher it is in similar proportion to the Moderate Growth test as there are more passenger boardings in the Do Minimum scenario on Metro North.

Similar to the Moderate Growth test the forecasts show a small decrease as a proportion in boardings made on the heavy rail network when Luas Broombridge is introduced.

The AM peak hour passenger load from Brides Glen to Broombridge for the Infrastructure Sensitivity Test 1 - Growth is shown in Figure 4-11.

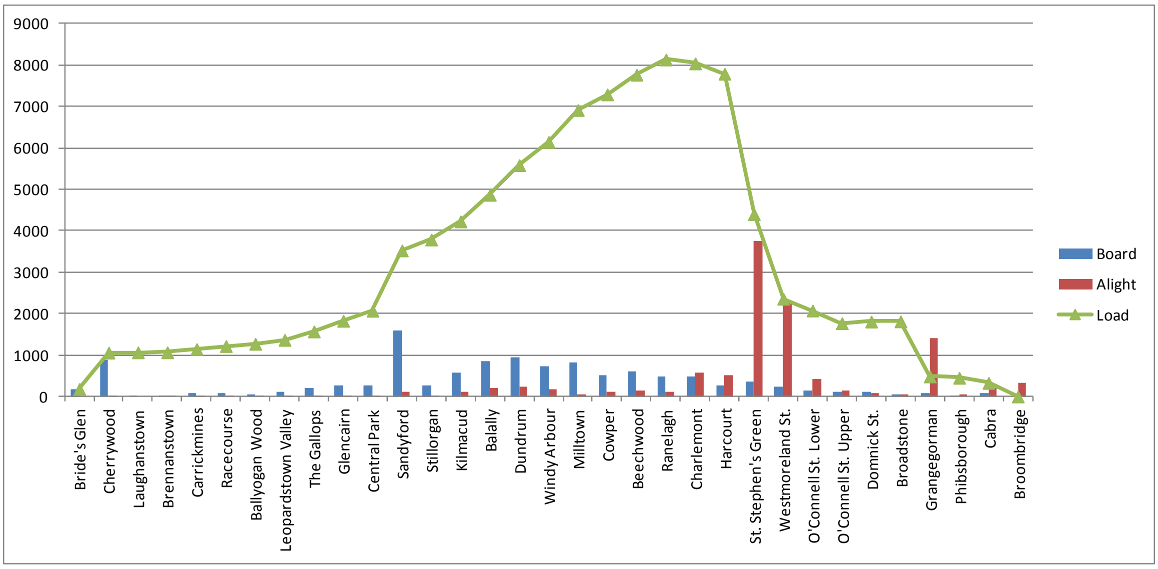

Figure 4-11 AM Peak Brides Glen to Broombridge Load Infrastructure Sensitivity Test 1 Higher Growth

Figure 4-11 shows that the Infrastructure Sensitivity Test 1 – Higher Growth peak lineflow in the Bride's Glen to Broombridge is approximately 8,130 passengers at Ranelagh stop. As expected the peak lineflow is significantly more in this scenario due to the increased population and employment projections in this scenario above the Base Case. The demand is greater than the capacity that can be provided by Luas and justifies the need to have a more complete public transport network above the current infrastructure in place to cater for a more integrated landuse and transport strategy.

The main difference between the Infrastructure Sensitivity Test 1 – Higher Growth and the Base Case is the increase in alighters at St. Stephens Green due to the interchange provided by the inclusion of both Metro North and DART Underground.

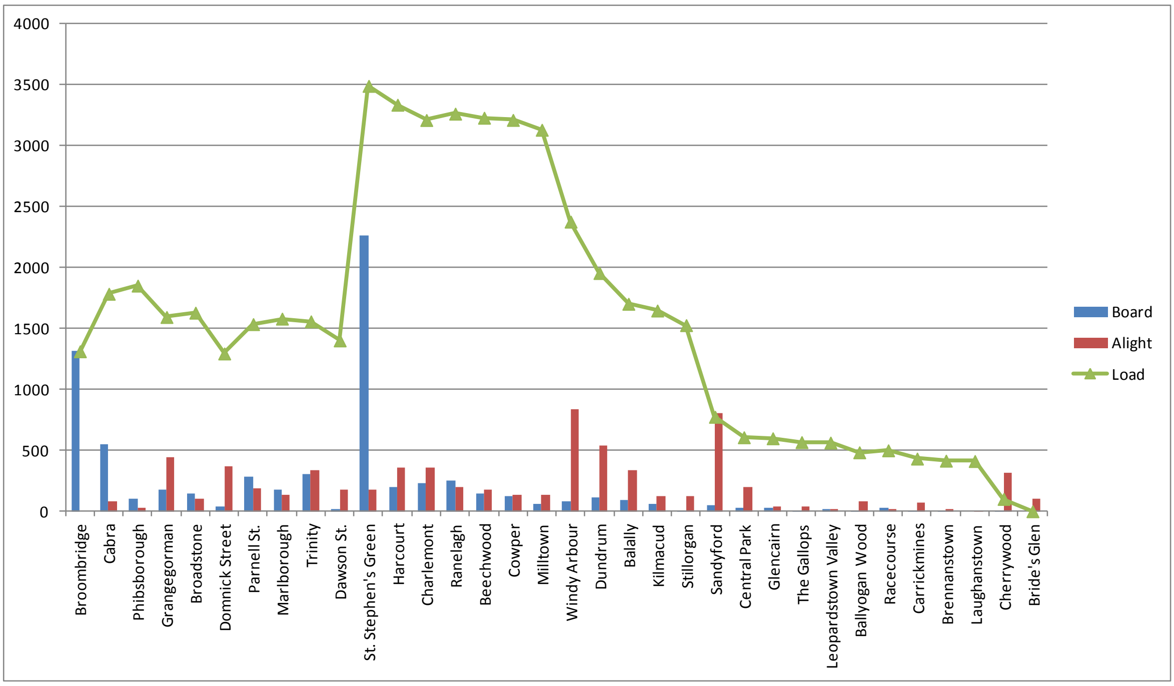

Figure 4-12 AM Peak Broombridge to Brides Glen Load Infrastructure Sensitivity Test 1 – Higher Growth

The AM peak hour passenger load from Broombridge to Brides Glen for the Infrastructure Sensitivity Test 1 – Higher Growth is shown in Figure 4-12.

Figure 4-12 shows that the Infrastructure Sensitivity Test 1 – Higher Growth peak lineflow in the Broombridge to Brides Glen is approximately 3,490 passengers at St. Stephens Green stop. Again, this differs from the Base Case which had the main trip generators at Broombridge and Cabra. St. Stephen's Green Stop is now a key generator of trips southbound on the Luas Green line because of the enhanced interchange opportunities offered with both Metro North and DART Underground.

4.6.4.3 Infrastructure Sensitivity Test 2 – Moderate Growth

The demand forecasts for the Infrastructure Sensitivity Test 2 - Moderate Growth described above is presented in Table 4-18. The demand forecasts indicate that the introduction of Luas Broombridge will add 9.5 million passenger boardings to the Luas Network. Due to the inclusion of more public transport provision in the Do Minimum scenario the change in Luas Demand is higher in this scenario than the Infrastructure Sensitivity Test 1. In the Do Minimum scenario due to the provision of Metro South there is very little demand on the existing Luas Green line. The inclusion of Luas Broombridge in the Do something scenario increases the demand on the Green line significantly over the Do Minimum scenario.

The introduction of Luas Broombridge also has a positive impact on both the distance travelled on Luas and also the time spent travelling on Luas. The forecasts suggest an additional 51.8 million passenger kilometres on board Luas and an additional 171.2 million minutes spent on board Luas.

Table 4-18 Model Results Infrastructure Sensitivity Test 2 - Moderate Growth

	Do Minimum			Do Something			Change from Do Min		
Luas	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)
millions	38.8	277.5	740.4	48.4	329.3	911.6	9.5	51.8	171.2

The AM peak hour passenger load from Bray to Broombridge for the Infrastructure Sensitivity Test 2 - Moderate Growth is shown in Figure 4-13.

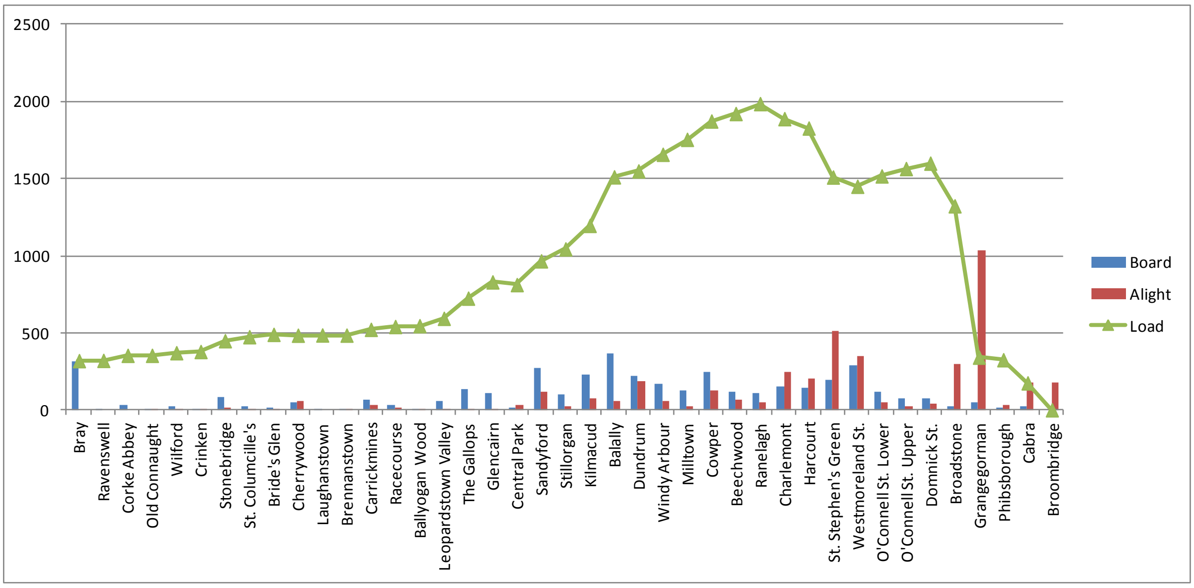

Figure 4-13 Total AM Peak Bray to Broombridge Load Infrastructure Sensitivity Test 2 - Moderate Growth

Figure 4-13 shows that the Infrastructure Sensitivity Test 2 - Moderate Growth peak lineflow between Bray and Broombridge is approximately 1,990 passengers at Ranelagh stop. This peak lineflow is significantly less in this scenario compared to the other scenarios due to the reduction of Luas Green line services as per the defined service pattern and the inclusion of Metro South in this scenario. However it is a significant increase over the Do Minimum boardings. St. Stephen's Green stop is a key destination due to the provision of both Metro North and DART Underground in this scenario.

The AM peak hour passenger load from Broombridge to Bray for the Infrastructure Sensitivity Test 2 - Moderate Growth is shown in Figure 4-14.

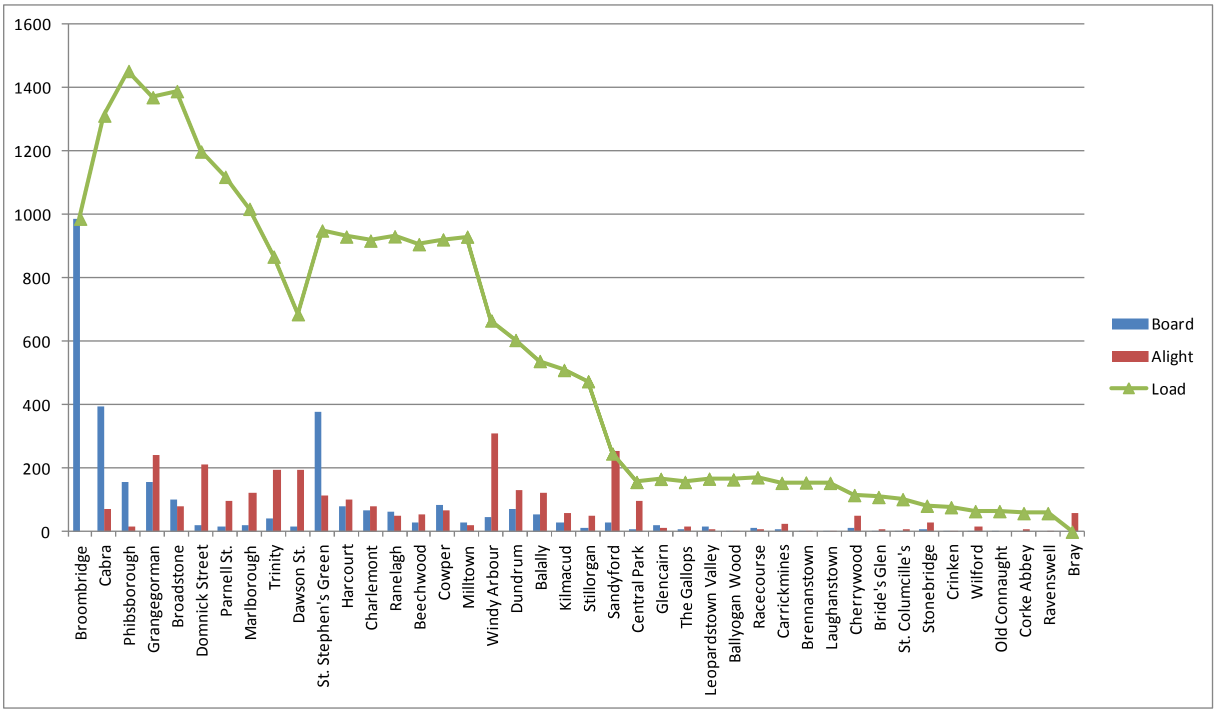

Figure 4-14 Total AM Peak Broombridge to Bray Load Infrastructure Sensitivity Test 2 - Moderate Growth

Figure 4-14 shows that the Infrastructure Sensitivity Test 2 - Moderate Growth peak lineflow in the Broombridge to Bray is approximately 1,450 passengers at Phibsborough stop. This peak lineflow is significantly less in this scenario due to the reduction of Luas Green line services as per the defined service pattern and the inclusion of Metro South in this scenario.

4.6.4.4 Infrastructure Sensitivity Test 2 – Higher Growth

The demand forecasts for the Infrastructure Sensitivity Test 2 NTA Strategy Landuse Landuse Growth described above is presented in Table 4-19. The demand forecasts indicate that the introduction of Luas Broombridge will add 11.2 million passenger boardings to the Luas Network. As expected, due to the increase in population and employment projections in this scenario the annual passenger boardings are higher than the moderate growth test.

The introduction of Luas Broombridge also has a positive impact on both the distance travelled on Luas and also the time spent travelling on Luas. The forecasts suggest an additional 60.6 million passenger kilometres on board Luas and an additional 198.5 million minutes spent on board Luas.

Table 4-19 Model Results Infrastructure Sensitivity Test 2 – Higher Growth

	Do Minimum			**Do Something**			**Change from Do Min**		
Luas	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)	Boardings	Distance (km)	Time (min)
Millions	46.6	332.7	898.0	57.8	393.4	1096.5	11.2	60.6	198.5

The AM peak hour passenger load from Bray to Broombridge for the Infrastructure Sensitivity Test 2 – Higher Growth is shown in Figure 4-15.

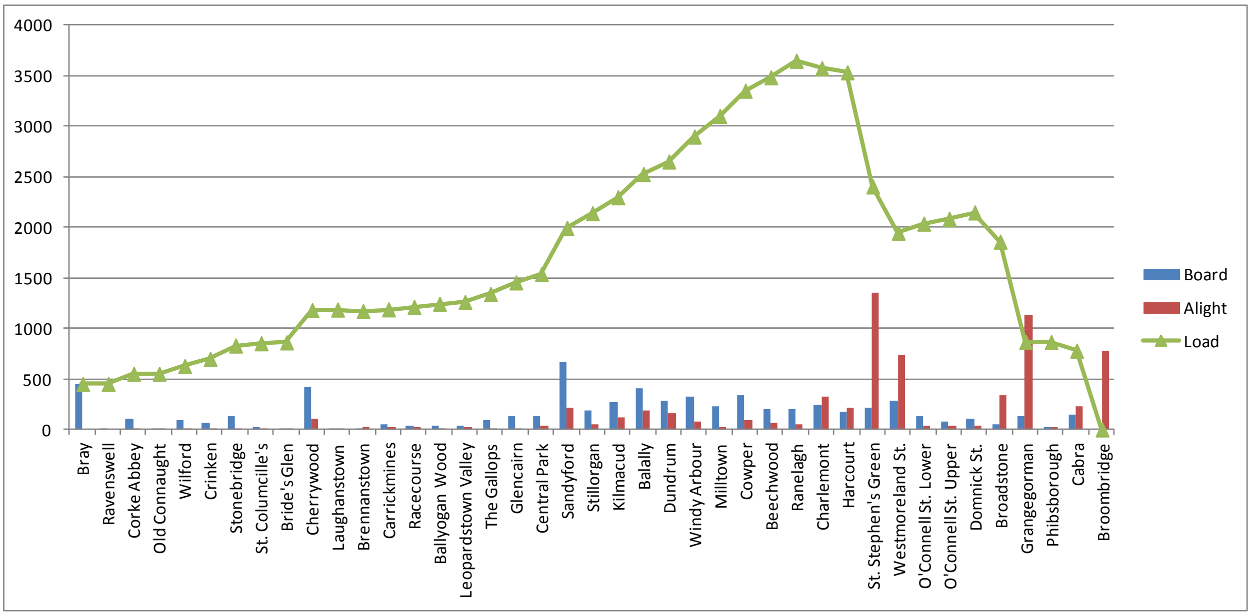

Figure 4-15 Total AM Peak Bray to Broombridge Load Infrastructure Sensitivity Test 2 – Higher Growth

Figure 4-15 shows that the Infrastructure Sensitivity Test 2 - Higher Growth peak lineflow between Bray and Broombridge is approximately 3,650 passengers at Ranelagh stop. This peak lineflow is significantly less in this scenario compared to the other Higher Growth tests due to the reduction of Luas Green line services as per the defined service pattern and the inclusion of Metro South in this scenario. As with the equivalent Moderate Growth test it is a significant increase over the Do Minimum boardings.

St. Stephen's Green stop is a key destination due to the provision of both Metro North and DART Underground in this scenario.

The AM peak hour passenger load from Broombridge to Bray for the Infrastructure Sensitivity Test 2 – Higher Growth is shown in Figure 4-16.

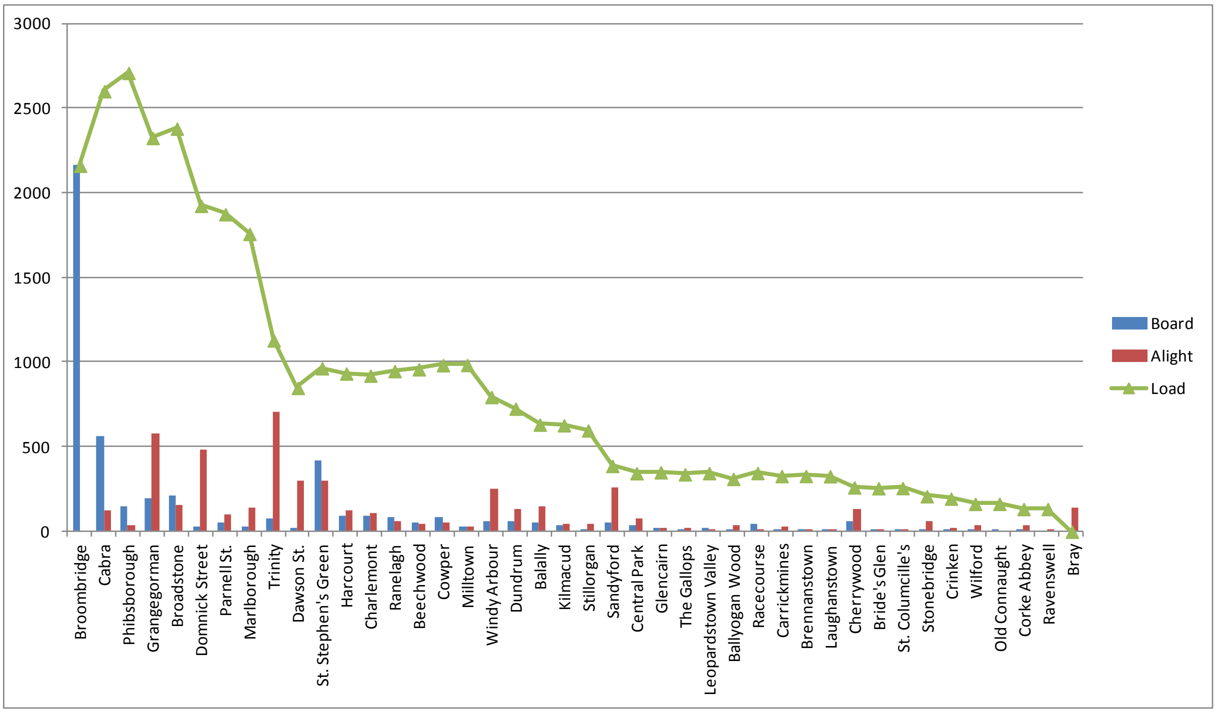

Figure 4-16 Total AM Peak Broombridge to Bray Load Infrastructure Sensitivity Test 2 – Higher Growth

Figure 4-16 shows that the Infrastructure Sensitivity Test 2 – Higher Growth peak lineflow between Broombridge and Bray is approximately 2,700 passengers at Phibsborough stop. This peak lineflow is significantly less in this scenario due to the reduction of Luas Green line services as per the defined service pattern and the inclusion of Metro South in this scenario.

4.7 Conclusions

The implementation of Luas Broombridge generates benefits for passengers who are travelling further into the city centre through its greater penetration of the city centre and also presents further opportunities for travel afforded by completion of the light rail network.

In the absence of Luas Broombridge it will be more difficult to encourage the modal shift to public transport and delay the prioritisation of public transport over private car.

The results of the forecast demand analysis demonstrate that there is strong demand and need for Luas Broombridge. Its introduction will produce additional boardings to the Luas network in all scenarios.

The demand forecasts indicate that the introduction of Luas Broombridge will add 10.5 million passenger boardings to the Luas Network in the Base Case.

These results show that, during the peak period, approximately 400,000 fewer trips by car will be made per year after the introduction of Luas Broombridge.

The Landuse Sensitivity tests show that even in the No Growth test Luas Broombridge will add an additional 7.2 million passenger boardings to the Luas network. The Higher Growth test forecasts an additional 12.5 million passenger boardings to the Luas network.

The Infrastructure Sensitivity tests carried out demonstrate how well the addition of Luas Broombridge integrates into a wider public transport network. Luas Broombridge will interface with the proposed DART Underground and Metro North schemes at St. Stephen's Green where an interchange will be provided. Viewed in a broader context, the light rail network created by Luas Broombridge will provide interchange options with the suburban/intercity rail network as enhanced by DART Underground, at Broombridge, Connolly, Spencer Dock and Heuston as well as St. Stephen's Green. Therefore DART Underground, Metro North and Luas Broombridge should be viewed as being very much complementary rather than competing for the same market.

The additional demand on the Luas network is forecast to range between 8.3 million and 11.2 million additional passenger boardings depending on the provision of infrastructure and landuse growth.

When Luas Broombridge is introduced it is expected with this more complete public transport network there will be a decrease in the number of interchanges required to complete a journey. Where previously there were two or more boardings required to complete many journeys, there will now be a requirement for only one boarding.

5 CAPITAL COSTING

5.1 Chapter Summary

- The capital cost estimate presented in this UDBC reflects the current pre-tender stage of project definitions, design and development;
- Wherever possible the estimates were prepared using historical cost information available from completed Luas projects and existing Luas operations and equipment contracts reflecting the anticipated demand, capacity and works required for Luas Broombridge; and
- The total capital cost of Luas Broombridge is estimated to be €368 million (including direct and indirect capital costs but excluding VAT). This figure is nominal and therefore includes the cost of escalation.

5.2 Methodology

5.2.1 Overview

The capital cost estimate prepared for the purposes of this Updated Detailed Business Case reflects the current pre-tender stage of project definition, development and design information available for Luas Broombridge.

The capital cost estimate is based on the project scope as defined in Chapter 3 - *Project Definition* and takes account of the Railway Order conditions imposed by An Bord Pleanála.

In the preparation of the capital cost estimate the following factors have been considered:

- International market conditions;
- Irish growth and labour rates;
- Industry norms and requirements; and
- Historical cost data, cost information from completed Luas projects and existing Luas operations and equipment contracts.

5.2.2 Quality control and peer review

The capital cost estimate was prepared by RPA's internal estimating department. A series of estimate peer reviews have been conducted by senior management and documented to ensure consistency of estimating approach & methodology, accuracy of the rates used and to identify any omissions or other inputs required in the compilation of the capital cost estimate

5.2.3 Estimating Approach

A systematic approach was employed in preparing the estimate. The key steps of this approach included:

- Understand the scope of the project and associated works;
- Identify the main 'drivers' in terms of time, cost and quality;
- Settle inconsistencies and identify opportunities for standardisation;
- Understand practical issues through site visits;
- Understand multi-stakeholder and third party interface issues;

- Input other third party costs;
- Reasonable consideration of relevant external factors such as access, working hours, adjacent developments/works;
- Obtain drawing/sketches, programme and standards;
- Clarify outstanding queries/exclusions;
- Identify scope activities, method statements, interface schedules and quantities together with the architects and engineers;
- Produce and populate “Cost Breakdown Structure” by applying benchmarked and peer reviewed costs for similar work;
- Estimate the cost impact of non standard construction proposals;
- Estimate impact of procurement strategy;
- Identify, assess and factor into the estimate the impact of key exclusions, assumptions, opportunities and risks; and
- Assess confidence (risk/tolerance).

5.2.4 Basis of Capital Cost Estimate

The capital cost estimate presented in Table 5-1 is based on the current project definition as set out in Chapter 3 - Project *Definition*. The unit costs have been derived from historical cost information including recently completed RPA projects such as Luas Citywest, Luas Docklands and Luas Cherrywood. Land and property acquisition costs have been prepared separately by Chartered Property Surveyors.

In general, cost information from previous projects/contracts has not been inflated to arrive at Q3 2012 prices (reflective of the current stagnation in the economic environment and the construction sector in particular) except in instances where there was a specific contractual provision for inflation adjustments to prices.

The general assumptions and parameters relating to the capital cost estimate are summarised below:

- Estimates of the capital costs have been prepared at Q3 2012 prices and escalated where necessary to reflect the timing of activities as described in the construction and implementation programme;
- The estimates consider the cost impact of the form of procurement chosen for any particular work package e.g. in the case of the Main Infrastructure, planning and reference design by the Employer followed by issuance of a Design & Build tender following EU Procurement Directives (see Chapter 9 Procurement Strategy);
- The construction cost estimate has been incorporated into the financial model with appropriate uplifts for risk/contingency and escalation;
- The estimate is based on the Railway Order route alignment, tram stop locations, structures, depot size and location;
- The project schedule referenced is “Luas Broombridge – Design, Procurement & Construction Programme” in Appendix 3;
- The risk allowance is based on the 80th percentile value of a quantitative cost risk assessment for the entire project; and

- RPA will maintain a chargeable VAT status during the implementation of the projects and thus be in a position to reclaim all VAT charged in project expenditures.
- The current estimating tolerance is approximately +/- 15-25% based on the level of design information and the knowledge of costs for projects of a similar nature. As the project evolves it is expected that the level of design development will reduce the estimating tolerance at Final Business Case (FBC) / TC3 stage to +/- 10-20%. If the design is sufficiently developed at FBC stage then it is expected that the level of uncertainty will reflect an estimating tolerance at the lower end of this range. A contingency sum is included in the total capital cost to cover this estimating tolerance and other unforeseeable events.

As the project develops it is anticipated that the estimates will be refined to reflect the evolving design through a series of estimate reviews and risk, value engineering and value management workshops. The estimate includes allowances for the following costs:

- The design of Luas Broombridge infrastructure;
- The construction of Luas Broombridge infrastructure;
- Design, manufacture, shipping to site and installation of all equipment;
- Relocation of existing equipment and services;
- Testing, commissioning and trial running;
- Reasonable stage and temporary works;
- Rolling stock;
- Property and land acquisition (CIÉ land acquisition costs assumed nil);
- Risk and contingency;
- Fees;
- Project management; and
- Escalation.

5.3 Results

5.3.1 Total Direct Capital Costs

The direct capital cost estimate for the project is €218.38m (excl. VAT) and is presented in Table 5-1 and is based on the current project design as discussed earlier in this document.

Table 5-1 Direct Capital Cost Estimates (Q3 2012 €millions)

Cost Categories	Cost (€millions)
Enabling Works, and Land/Property Acquisition	52.33
Structures, Civil and Track work, Mechanical and Electrical and Ticketing Infrastructure, Depot, Rolling Stock	166.05
Total Direct Capital Cost (Excluding VAT)	**218.38**

5.3.1.1 Enabling Works, Statutory Utility Diversions and Miscellaneous works

These works consist mainly of utility diversions and basement or cellar stabilisation works which must be carried out as part of the project.

Utility diversions refer to civil works associated with diverting utilities away from the swept path of the line. The rates used to price the direct works utility diversions are reflective of the location of the services being diverted (i.e. city centre and suburban). Utility schedules were utilised when pricing the direct works utility diversions. The costs include for the utility companies' direct costs associated with utility diversions.

Works to remove or protect existing statues and monuments and arboriculture works also form part of the enabling works.

5.3.1.2 Structures, Civil and Track work, Mechanical and Electrical and Ticketing Infrastructure and Depot

The allowances for structures include significant works associated with access to Broadstone. Structures also include works to existing bridges affected by the route alignment, works to existing structures and access requirements in the cutting.

Civil and track works includes the supply and installation of track works along the route together with the necessary crossovers and turnouts, spare parts and foundations for the overhead conductor system (OCS). The costs also include the construction of 53m long tram stops and supply/installation of tram stop furniture and construction of substation structures. This section also includes ancillary works such as bulk earthworks, boundary works, landscaping, road and footpath works, public lighting and modifications to street furniture. Miscellaneous works such as art provision, power connections to sub-stations and tram stops by the ESB have also been included.

The scope of mechanical and electrical works includes the provision of the OCS system including poles and overhead line equipment (OHLE), power supply including substation fit-out, communications and SCADA systems.

Ticketing costs relate to the purchase, installation and commissioning of ticket vending machines (TVM) and smartcard validators. The estimate is based on outturn costs extracted from recent Luas line extensions.

The estimate includes for the proposed light maintenance depot facility at Broombridge. The scope includes the depot buildings (including mechanical and electrical installations), external works including car parking, wash tank and depot equipment.

5.3.1.3 Rolling Stock

Allowance for 10 tram vehicles has been included in the estimate. Costs per vehicle have been extrapolated from recent contracts for the supply of vehicles on recent Luas extensions. The costs also include spares, special tools and training.

5.3.1.4 Land and Property Acquisition

The assessment of land and property acquisition costs has been undertaken by an external property consultant. It is assumed that all property will be procured under the Compulsory Purchase Order code. Land and property take areas have been identified and priced. The potential costs associated with CIÉ lands are excluded from the estimate as it is assumed that these lands will be made available free of charge.

5.3.2 Total Direct plus Indirect Capital Costs

The total capital cost (nominal and exclusive of VAT) amounts to €368.08m as shown in Table 5-2.

Table 5-2 Capital Cost Estimates [Total Project Direct and Indirect Capital Costs] including risk/contingency, client costs, start up costs and escalation (excluding VAT) (Q3 2012 € millions)

Cost Item	Cost €m
Total Direct Capital Cost	**218.38**
Risk/Contingency	61.45
Client Costs	54.02
Start Up Costs	2.38
Total Capital Costs (Q3 2012 prices)	**336.23**
Escalation	31.85
Total Capital Costs (Escalated, Excl VAT)	**368.08**

The total capital cost represents the direct capital cost set out in plus the additional estimated indirect capital costs as presented in. The indirect costs include the following:

5.3.2.1 Risk/Contingency (€61.45m)

A detailed Quantitative Cost Risk Assessment (QCRA) has been undertaken for all aspects of the Advance Enabling Works on a contract by contract basis. This has involved a rigorous process of risk identification, with simulation and a probability and cost impact assessment for each key risk. Based on this work risk allowances at 80% percentile value of the QCRA results have been included in the capital cost estimate along with a contingency allowance for estimating tolerance and unidentified risks.

5.3.2.2 Client Costs (€54.02m)

Allowances have been included in the estimate for an appropriate level of client cost associated with the various stages of the project lifecycle i.e. Project Definition, RO Preparation, Statutory Approval, Design and Procurement, Implementation and Start-Up. The costs reflect a strategy of in-house design which is consistent with the overall procurement strategy. The estimate allows for the necessary input to define, approve, design, procure and manage the project from route selection to commencement of operations. Client costs also include insurance, public relations, project management and legal costs during project implementation.

5.3.2.3 Start Up Costs (€2.38m)

These costs include the operator's start up costs, the vehicle maintainer's costs, the infrastructure maintainer's costs and costs associated with the maintenance of ticketing equipment and public relations costs up to the commencement of operations. RPA's client costs associated with supporting the start-up are also included. The estimate for start up costs is based on our experience with the current operations contract.

5.3.2.4 Escalation (€31.85m)

Allowances for escalation have been included to recognise the impact of inflation on construction and other costs that will be incurred during the project implementation period. The programme for project implementation foresees the enabling works commencing in 2013.

Reflecting the current economic climate, a realistic assessment of the rates of inflation has been assumed as follows: 0% for the remainder of 2012, 3% for 2013 through to the end of 2016 and 5% for 2017 to 2018. An inflation adjustment has only been applied to those costs that are expected to be impacted.

5.3.3 Annual Capital Cost to Government (€ millions nominal)

RPA has estimated the future spend profile based on the Design. Procurement and Construction programmes for Luas Broombridge and an expected rate of closure for compulsory purchase orders for property in line with the experience of previous Luas projects. This is shown in Table 5-3.

Table 5-3 Annual Capital Cost to Government (€ millions nominal)

	2006-2012	2013	2014	2015	2016	2017	2018
Annual Capital Expenditure (€m)	17.63	21.35	40.68	82.05	99.43	85.66	21.29

5.4 Conclusions

Capital costs are consistent with the design and project definition at this stage of the project. Wherever possible the estimates were prepared using cost information available from completed Luas projects and existing Luas operations and equipment contracts and reflect the anticipated demand, capacity and works required for Luas Broombridge.

The capital cost of Luas Broombridge is estimated by RPA to be €368.08 million (in nominal terms and excluding VAT).

6 RISK

6.1 Chapter Summary

- RPA adopts a systematic and structured approach to managing risk on the Luas Broombridge project;
- Project risks are grouped into five main categories: technical, commercial, third party, project management, and residual risks; and
- The risk management process and mitigation actions are outlined.

6.2 Methodology

RPA is adopting a systematic and structured approach to managing risk on the Luas Broombridge project in accordance with guidelines and best practice. This approach includes the identification and appraisal of risks, sensitivity and scenario risk analysis, and the development and implementation of appropriate risk management strategies. The risk management methodology is set out in detail in a Project Risk Management Plan.

Project specific risks are identified by the project team through lessons learned reviews, risk workshops and through regular risk reviews by RPA's Risk Management Team. Identified risks, along with their estimated likelihood and potential impact are recorded on a Project Risk Register.

The cost and time impacts of each individual risk is estimated and this information is used to carry out a formal appraisal of the potential overall cost and time impacts using Quantitative Risk Analysis (QRA). This appraisal helps RPA to predict the likely out-turn cost and time impacts of identified risks and it also provides a prioritised list of the most significant risks to implementing the project on time, within budget and to the required quality and performance standards.

The Project Risk Management Plan and Risk Register are the key management tools that are used by the project team to manage risk.

It should be noted that this process does not cover health and safety risks. There is a separate dedicated health and safety team to manage health and safety risks in parallel with the project risk management process described in this chapter. Design risk assessments are carried out at each design phase to ensure that the formal risk management methodology is applied. A senior Health and Safety Manager has been appointed to oversee this element of the project.

6.3 Risk Identification

Luas Broombridge Project risks are grouped into five main categories:

- Technical
- Commercial
- Third parties
- Project management
- Operational and maintenance risks

A summary of the main identified risks under each of these headings is given below.

6.3.1 Technical Risks

- Design coordination & approvals – unanticipated design changes or delays in required statutory approvals;
- Scope of utility diversions – diversions of underground utilities have been and will continue to be a significant source of design and scope uncertainty on Luas projects due to the difficulty of ascertaining the exact nature, condition and quantity of utility services in advance of wide-scale street excavation;
- Connaught / St Fassaugh Road bridge – it is intended to refurbish this bridge but due to its poor condition it ultimately may require replacement giving rise to demolition, integration and coordination risks and extra costs;
- Operating systems interfaces – the interfaces between the existing systems and the works of the infrastructure contractor are complex. Risks identified under this category include disruption to the Central Control Room, service interruption, and system compatibility risks;
- Ground conditions – RPA has identified specific areas of uncertainty in the area of Broadstone (a bus depot) and close to the Maxol service station on Constitution Hill, where the risk of contaminated land is high; and
- Scope of Enabling Works – There are a significant number of cellars along the Luas Broombridge corridor, many of them associated with protected structures. The full extent of acquisition, filling or protection is difficult to predict accurately given the likely presence of cellars which have been blocked off over the years and which remain unknown to the present owners.

6.3.2 Commercial Risks

- Market appetite – the international contracting market may be unwilling to bid for projects that use unfamiliar forms of contract such as GCCC, which transfers a majority of risk to the contractor;
- Property acquisition – uncertainty relating to unknown, uncharted or damaged basements, owner access restrictions, adverse possession, temporary land take requirements, arbitration costs, etc;
- Contractual risks – uncertainty due to, for example, inflated prices, client costs, road charges, risk of insolvency, unfulfilled contractor commitments, compliance with conditions of contract, claims, uncertainty of escalation allowance, programme related cost impacts;
- Procurement process – risk of challenges, errors, omissions, delays, and client costs relating to the choice of contract forms, method of measurement and payment mechanisms;
- Insurance risks – costs of coverage to indemnify against future loss, damage, or liability;
- Estimating uncertainty - the current estimating tolerance is based on the level of design information and the knowledge of costs for projects of a similar nature; and
- Programme uncertainty - extra costs arising from a protracted implementation programme due to limited funding availability.

6.3.3 Risks relating to third parties

- Approvals – the process of seeking approvals and consents from statutory bodies can lead to project delays;
- Traffic Management – risks due to the requirement to maintain access for servicing of premises, pedestrians and for public transport across the construction corridor;
- Railway Safety Commission – unforeseen design changes or requirements;
- Grangegorman Development Agency, Bus Éireann and Dublin Bus – uncertainty relating to the design, status and timing of the Grangegorman Development adjacent to Broadstone Bus depot;
- Irish Rail – coordination and integration risk relating to interfaces at Broombridge and at the crossing of the Phoenix Park railway line;
- Waterways Ireland – difficulty in achieving agreement on construction methodologies or working in the vicinity of the Royal Canal;
- Maxol Service Station acquisition – uncertainty regarding the timing of the property transaction;
- Betterment gains – commercial opportunities not fully realised , such as payment for enhancements to utilities plant owned by Statutory Authorities; and
- Other (e.g., third party development impacts, public relations risks, environmental impacts, legal risks etc).

6.3.4 Project Management risks

- Approvals process risks;
- Programme delays;
- Quality – failure of contractors to construct to the required specifications and standards; inadequacies in contractors' documentation; control failures; non-compliances; etc;
- Safety – Operator delay in completing Safety Case leading to delay to testing and trial running; uncertainty relating to new works assessment; co-ordination risks between project supervisors design process (PSDP) and construction stage (PSCS);
- Interface issues – coordinating, integrating and managing the requirements of a variety of stakeholders; and
- Construction – access restrictions; late handovers, shared access risks; contractor performance / default; working hours restrictions etc.

6.3.5 Operational and maintenance risks

- Operator risks – additional cost for implementing new operating requirements, service interruption during construction, business continuity, latent defects;
- Lifecycle risks (including residual contractual risks) - over the life of the project the risk that equipment may need replacing earlier than expected, or may be more expensive to replace; and
- Operations and maintenance - risks that operating costs may be greater than estimated or operating performance may be below employer requirements.

6.3.6 Risk Appraisal

The risk allowance included in the Luas Broombridge Capital Cost Estimate is based on a Quantitative Cost Risk Analysis (QCRA). Data and experience gained on other Luas projects were used to assess the adequacy of project risk estimates. Capital costs include a quantified risk allowance for all identified risks; a contingency allowance for unknown risks; and an allowance for estimating uncertainty.

6.4 Risk Management

The Project Risk Management plan describes the general principles for identifying and managing risk and the roles, responsibilities, and reporting requirements to be adhered to by the project team.

Typical mitigation actions for each of the five main risk categories are summarised below.

6.4.1 Technical Risks

- Design Risk: Implement a rigorous change management procedure; design risk assessments; design freeze; ensure that timescales for approvals are realistic; include adequate float and contingency; transfer design risk appropriately; carry out formal value engineering; undertake regular design risk reviews; specify minimum design and approvals periods;
- Unforeseen elements: Advance non-invasive radar mapping of underground services assists in providing a fuller understanding of their extent. However, at implementation stage it is generally the case that the difficulties of working in a confined street space combined with the density of services results in further works that cannot be foreseen at this early stage of project development;
- Cellars – undertake surveys of cellars along the corridor and map historic records of cellars onto alignment plans;
- Ground conditions – undertake trial pits and boreholes along the alignment corridor and test soil samples for contaminants;
- Environmental Risks: Implement RPA's Environmental Management System (EMS); draft robust environmental requirements; implement and carry out regular audits; insure against damage, loss, and liabilities; and
- Stakeholders: Implement the project Stakeholder Management Plan; maintain close and ongoing liaison with stakeholders, ensure early communication to secure timely agreements with approvals agencies; clarify and formally agree design levels and standards.

6.4.2 Commercial Risks

- Agree inflation figures with NTA review with tenderers before award of contract; tie to euro;
- Ensure that bidders have sufficient financial capacity; performance bonds / parent company guarantees, retention bonds;
- Professional Indemnity provisions: Peer review of designs; adequate design levels; ensure contractors have collateral warranty with RPA and insurance to underwrite same;

- Closely monitor contractor performance;
- Enforce standard procurement and contract management procedures;
- Early communication of variation orders;
- Contractor risks: appoint competent contractors; agree deliverables lists; ensure that all commitments are clearly defined;
- Pre-qualify contractors;
- Include contingency plans in contracts e.g. early access provisions;
- Obtain up-to-date valuations of property requirements; procure property consultant; and
- Value management and engineering to achieve better value for money from the investment.

6.4.3 Risks relating to third parties

- Agree construction methodology / establish process with Statutory Authorities by sign off using Joint Utilities Group process for sequencing and durations;
- Understand business requirements prior to commencing works; maintain close communication throughout the duration of the works; keep within EIS tolerance / limits; maintain detailed photographic records;
- Include "Insurance & Insurance claims Management Requirements" in contracts; Insurance spot checks on site; early discussion with brokers;
- Manage relationships with third parties - implement the project Stakeholder Management Plan;
- Ensure CPO land requirements are adequate;
- Negotiate early agreements with land owners;
- Negotiate early agreements on betterment credits with utility owners; and
- Ensure compliance with current regulations.

6.4.4 Project Management risks

- Robust programme evaluation; incentivise completion in a timely manner using conditions of contract;
- Investigate alternative methods of construction;
- Implement Project Execution Plan;
- Manage interfaces;
- Apply formal Risk and Value Management procedure;
- Use NTA stage-gate reviews to verify progress on plan; and
- Use Earned Value analysis to indicate cost and schedule performance.

6.4.5 Operational and maintenance risks

- Early agreement of roles and responsibilities with operator;
- Consider contractual agreement between operator and contractor;
- Carry out whole life cost evaluations of tenders.

6.5 Risk Reviews & Reporting

Risks will continue to be identified, evaluated and managed by RPA using regular risk review meetings and workshops in accordance with the Project Risk Management plan. The purpose of these reviews is to assess and validate progress on mitigation actions and identify any new or increasing risk trends. Critical risks will be escalated to the Project Steering Group for early resolution.

RPA uses standard project dashboards and trend reports to alert management to areas of increasing risk and to record progress on mitigating actions. These reports also include a list of the top risks that are most likely to affect both the project end date and the out-turn cost so that management can make informed decisions to mitigate the likelihood of delays and cost over-runs and to justify draw-down of contingency funds if required.

6.6 Contract Risk Allocation

The recommended procurement strategy for Luas Broombridge is summarised in Chapter 9. The risk factors that were considered by RPA in developing this strategy include:

- Risk appetite of the private sector for unfamiliar forms of contract and level of risk that is transferred to the contractor; and
- Optimum balance and transfer of design, interface, commercial, and construction risks.

6.7 Conclusions

RPA implements a formal Project Risk Management Plan that incorporates ongoing risk identification, analysis, risk management, and risk review activities as part of an overall corporate Risk Management Plan.

This process has been applied to identify and quantify the key project risks that are most likely to affect Luas Broombridge Project objectives.

Throughout the project lifecycle RPA will continue to monitor risk and will undertake the necessary mitigation as appropriate.

7 ECONOMIC APPRAISAL

7.1 Chapter Summary

- An economic appraisal was conducted on Luas Broombridge where the changes to user and non-user time benefits, operating cost impacts, and fares as a result of the implementation of Luas Broombridge were calculated;
- The economic appraisal has been conducted according to the Department of Transport, Tourism and Sport (DTTAS) economic appraisal guidance;
- The results from the Base Case demonstrate there is a strong economic case for the scheme, with a BCR of 2.28:1 showing the benefits of Luas Broombridge are more than double the costs;
- The majority of the benefits arise from reductions in journey times, for public transport users travelling to work or on non-business trips; there are also significant environmental benefits as a result of car transfer during the peak periods;
- A series of sensitivity tests indicate that the value-for-money case for the scheme is not eroded by changing the economic parameters used in the appraisal.
- A Shadow Price of Public Funds (SPPF) sensitivity test based on an application of 150% to the capital costs and the renewals costs of the project was carried out. This reduces the BCR in the central case from 2.28:1 to 1.54:1;
- Traditional transport CBA fails to include some important economic benefits. These benefits typically derive from the presence of imperfect competition and economies of scale in production, and have become known as Wider impacts (WIs);
- When a conservative assumption of an uplift to the conventionally measured benefits of 20% due to WIs is applied the base case including the SPPF sensitivity, the BCR increases from 1.54:1 to 1.83:1;
- Increasing the test discount rate from 4% to 6% reduces the BCR in the base case from 2.28:1 to 1.6:1;
- Using a 20 year appraisal period instead of a 30 year appraisal period reduces the BCR in the base case from 2.28:1 to 1.76:1.
- The Landuse Sensitivity scenarios display BCRs of between 0.95:1 and 8.72:1;
- The Infrastructure Sensitivity Test which includes both Metro North and DART Underground in the public transport network displays a strong economic case of 2.2:1 demonstrating further the strong economic case for the scheme.

7.2 Introduction

The National Transport Authority's (NTA) multimodal transport model has been applied to develop forecasts of patronage and costs for highway and public transport modes, for a base year of 2006 and a future year of 2030. The outputs developed from the transport model in turn provide the inputs for the calculation of the benefits of Luas Broombridge. The TUBA[2] programme has been used to calculate the user and non-user benefits of the scheme. TUBA is the standard transport appraisal software that has been used for many years to convert transport demand model outputs into economic appraisal.

TUBA calculates changes to user and non-user time benefits, operating cost impacts, and fares as a result of the implementation of Luas Broombridge. These impacts are monetised, discounted and summarised within TUBA and compared with the full discounted costs of the scheme over a thirty year appraisal period to give an indication of the economic worth of the project. The economic appraisal has been conducted according to the Department of Transport, Tourism and Sport (DTTAS)'s economic appraisal guidance, as set out in Guidelines on a Common Appraisal Framework for Transport Projects and Programmes[3], (CAF). The parameters used in the economic appraisal are included in Appendix 2. The monetisation of environmental impacts uses emission factors and values prepared for the CAF[4] which are based on the 2009 Department of Finance circular[5] on arrangements for the accounting of CO2 emissions in capital investment projects. Accident impacts are estimated and monetised using the parameters specified for this purpose in the CAF, which are included in Appendix 2.

The forecasts of additional Luas patronage and revenue are outlined in Chapter 4 – Transport Planning. The transport and modelling assumptions which have a bearing on the economic outcome of the project are summarised below in Table 7-1.

In keeping with the RPA approach to project appraisal, only projects that are committed or highly likely to proceed are included in the assumptions for the project. Generally a scheme that performs well under such conservative assumptions is likely to do at least as well in reality.

The CAF requires that an assessment of the disbenefits arising during the construction phase be carried out. RPA has been advised by the NTA that the necessary revisions to Dublin Bus operations will be put in place to ensure that no additional net cost will be incurred by Dublin Bus during the construction of Luas Broombridge. The NTA is satisfied that Dublin Bus will reorganise its services to eliminate net impacts on operating costs and revenue as a result of the construction of Luas Broombridge, and that the necessary traffic management measures will be put in place to aid this process. These traffic management measures will be implemented at the earliest stage feasible in order to provide an optimum operating environment during the construction phase.

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[2] Transport User Benefit Appraisal – see here for further information.

[3] *Guidelines on a Common Appraisal Framework for Transport Projects and Programmes*[3], June 2009. Available here: http://www.transport.ie/upload/general/11801-DOT_COMMON_APPRAISAL_FRAMEWORK1-0.PDF

[4] *Treatment of Transport Emissions in the Common Appraisal Framework, Draft,* September 2009, Goodbody Economic Consultants

[5] Department of Finance Circular S431/65/07

Table 7-1 Transport and Modelling Assumptions

Input	Do minimum	Do Something
Luas Tallaght to Connolly (Red Line)	Yes	Yes
Luas St Stephen's Green to Sandyford (Green Line)	Yes	Yes
Luas Connolly to The Point (Line C1)	Yes	Yes
Luas Sandyford to Bride's Glen (Line B1)	Yes	Yes
Luas Belgard to Saggart (Line A1)	Yes	Yes
Luas Bride's Glen to Bray/Fassaroe (Line B2)	No	No
Luas Stephen's Green to Broombridge (Luas Broombridge)	**No**	**Yes**
Luas City-centre to Lucan (Line F)	No	No
Metro North	No	No
Metro West	No	No
DART Underground	No	No
Dublin Port Tunnel	Yes	Yes
Outer Ring Road	Yes	Yes
Luas P&R	Yes	Yes
DTO Quality Bus Network	Yes	Yes
Integrated Ticketing	Yes	Yes

7.3 Economic Appraisal

RPA carried out an economic appraisal of Luas Broombridge based on the results of the modelled scenarios carried out during the forecast demand analysis and the estimates of capital and operating costs of the scheme. For the economic appraisal it has been assumed that:

- The scheme opens on 1st January 2018
- The evaluation period is 30 years
- The discount rate is 4%

The results from the modelled scenarios for 2006 and 2030 were used to give the patronage and benefit levels for the duration of the appraisal period (30 years), i.e. there was no growth in demand beyond 2030 assumed. This is a conservative assumption as in reality it is likely that general economic growth over the appraisal period will lead to an increase in demand for trips to and within the city centre, which is the market served by Luas Broombridge.

The capital, operating, maintenance and renewal costs of the project over the appraisal period have been calculated by RPA and are summarised below. These costs are expressed in 2002 prices and are in present value terms. The figures below exclude VAT. Provision for both risk and contingency is included in the costs.

- Total Capital Cost = €209.1m
- Total Operating and Maintenance and Renewals Costs = €72.1m

All parameters and the methodology applied are consistent with the Department of Transport guidelines on parameter values for use in the appraisal of transport projects. All costs and benefits in the evaluation have been discounted to 2002 prices for analysis purposes (financial and funding projections take account of escalation in values over time).

The 2006 and future year forecasts of additional patronage and revenue are outlined in Chapter 4. The transport assumptions and service patterns for all modelled scenarios carried out are also outlined in Chapter 4 Transport Planning.

7.4 Base Case

The results of the economic appraisal for the Base Case are presented in Table 7-2. In this table the public transport revenue impact is disaggregated between Luas/Metro and Rail/Bus.

All property costs are included in the economic appraisal at their market value as required by the Common Appraisal Framework. This includes €11.5m (M9 12 prices) for CIÉ property which RPA assumes will be transferred at zero cost.

The Base case scenario for the economic appraisal adopts the Moderate Growth landuse scenario, outlined in Chapter 4, and assumes the current infrastructure scenario. A residual value has been included as per the CAF, which amounts to €36m in present value terms.

These results, shown in Table 7-2, demonstrate there is a strong economic case for the scheme, with a BCR of 2.28:1, and a net present value of €296m in 2002 prices. The economic benefit (value for money) of the scheme is substantially greater than the costs. A positive net present value indicates the internal rate of return (IRR) of the project is above the test discount rate (4%). The actual IRR of the project in the Base Case Scenario is 8.1%. The BCR of 2.28:1 means that the benefits of the scheme are more than double the costs. This represents very good value for money for a scheme of this nature.

Table 7-2 Results of the Base Case Scenario

Analysis of Monetised Costs and Benefits Base Case	Present Value €000s (2002)
Consumer User Benefits	425,521
Business User Benefits	123,410
Private Sector Provider Impacts	- 55,759
Other Business Impacts	
Accident Benefits	358
Air Emissions Savings	34,090
Net present Value of Benefits (PVB)	527,620
Net present Value Costs (PVC)	231,457
Overall Impact	
Net present Value (NPV)	296,163
Benefit to Cost Ratio (BCR)	2.28
Appraisal Period	2018 to 2047

The majority of the benefits arise from reductions in journey times, including waiting times and walking times, for public transport users travelling to work or on non-business trips. There are also significant environmental benefits as a result of transfer from car to public transport during the peak periods.

There is a net reduction in revenue accruing to transport operators as a result of these scheme (shown as 'Private Sector Provider Impacts in Table 7-2) This is as a result of multi-modal (bus-tram or bus-bus) public transport journeys being replaced by single Luas journeys, as people make longer journeys on the extended Luas Green Line.

7.5 Scenario Testing

7.5.1 Overview

In order to test the robustness of the results of the economic appraisal the performance of Luas Broombridge has been examined under further scenarios to reflect the main risks to the economic performance of the scheme.

7.5.2 Economic Appraisal Parameters Sensitivity Tests

The Department of Public Expenditure and Reform (DPER) recently published a new Public Spending Code[6] code. The Public Spending Code was produced with the intention to introduce best practice in the appraisal, implementation and evaluation of projects and programmes across sectors including transport.

Following the review and consideration of the elements of the code RPA have identified a number of issues that are not suitable for Light Rail projects.

Current DTTAS cost-benefit appraisal guidance, as set out in the CAF, recommends a SPPF of 100%. This is on the basis that it would distort decision-making in a context in which some of the market-correcting benefits of transport projects were not monetised. In addition, the application of an SPPF requires the tracing of all Exchequer flows arising from the project, and not merely the inflation of capital costs by the SPPF. In particular, tax receipts and Exchequer outlays, both direct and indirect, would need to be established. With regard to indirect effects, the employment effect of projects would have to be assessed, so that tax flows to the Exchequer and social welfare payments avoided could be brought into the reckoning. Developer contributions and user charges would also need to be considered.

In previous research conducted for RPA by Goodbody Economic Consultants it was found that many countries apply a SPPF of 100%, and the highest rate applied (in Denmark, Sweden, Norway, and France) was 130%. On this basis it was concluded that a rate of 150% is too high in Ireland. The Public Spending Code recognises this where it states: "While there is as yet no change to the formally recommended parameter value for the shadow price of public funds, work has begun on revising the parameter value for the shadow cost of public funds. This should be completed by end 2012."

The new Public Spending Code recommends an SPPF of 150%. While this updated business case is being prepared using existing DTTAS parameters a sensitivity test has been conducted on the business case in light of the recommendation of the use of a SPPF of 150% in the VFM code.

Appraisal Timeframe

The code states that road and rail projects should be appraised over a 20 year timeframe. RPA do not agree with this. The code should refer to the standard capital appraisal rule that appraisal periods should reflect the useful economic life of the asset as a minimum, which for road and rail projects is longer than 20 years, often significantly longer. A 30 year appraisal period for road and rail projects is usually the minimum period, with a residual value used to capture the economic value of assets with longer economic life spans (e.g. tunnels). This is a standard approach adopted in EC, UK guidance etc.

7.5.3 Shadow Price of Public Funds (SPPF) Sensitivity Test

We have tested the impact of applying a SPPF of 150% to the capital costs and the renewals costs of the project. This sensitivity test has been conducted on the Base

[6] Available here: http://publicspendingcode.per.gov.ie/

Case scenario. Table 7-3 illustrates the impact of this sensitivity test on the Base Case.

7-3 SPFF Sensitivity Test

Analysis of Monetised Costs and Benefits **Base Case – Sensitivity with Shadow Price of Public Funds (150%)**	**Present Value €000s (2002)**
Consumer User Benefits	425,521
Business User Benefits	123,410
Private Sector Provider Impacts	-55,759
Other Business Impacts	
Accident Benefits	358
Air Emissions Savings	34,090
Net present Value of Benefits (PVB)	527,620
Net present Value Costs (PVC)	342,123
Overall Impact	
Net present Value (NPV)	185,497
Benefit to Cost Ratio (BCR)	1.54
Appraisal Period	2018 to 2047

Applying a SPPF of 150% to the capital costs and renewal costs reduces the BCR in the central case from 2.28:1 to 1.54:1, and reduces the net present value from €296m to €185m.

7.5.4 Wider Impacts

It has been known for some time that traditional transport CBA fails to include some important economic impacts of new or improved transport services. The UK programme of research on such impacts commenced with the Standing Advisory Committee for Trunk Road Assessment (SACTRA) in 1999. In recent years the UK DfT has developed a theoretical and methodological basis for measuring and valuing these effects.

These impacts typically derive from the presence of imperfect competition and economies of scale in production, and have become known as Wider Impacts (WIs). These benefits are:

- Agglomeration economies (increased productivity through agglomeration and the facilitation of jobs moving to more productive areas);
- Labour market effects (increased labour supply); and

- Increased output in imperfectly competitive markets (related to business travel).

Until comparatively recently there has been little agreement on the definition of these effects and the extent to which they are already captured in conventionally measured transport benefits. There is now broad agreement within the transport planning community on the existence of such effects, and the fact that they are additional to the traditionally measured benefits of transport.

Since 2005, the emerging methodology developed by the DfT has been used to quantify and value these effects. Formal guidance on the calculation of these effects was published by the DfT in 2009.

Evidence to date demonstrates that WIs can increase conventionally measured benefits by between 10%-40%, depending on the nature and location of the scheme. In addition experience shows that WIs are proportionately more important for schemes which:

- increase accessibility in urban areas;
- serve areas of high productivity and high employment density; and
- serve areas with high levels of employment in financial and business services sectors.

Relative to standard transport appraisal, which is a mature discipline with a common foundation practiced in numerous jurisdictions internationally, the incorporation of WIs into CBA is a relatively new departure for transport appraisal. In Ireland, the Common Appraisal Framework (CAF) does not require that wider impacts be quantified in the CBA and the guidance and detailed parameters required to estimate WIs rigorously do not yet exist in Ireland.

However, a sensitivity has been conducted which increments the conventional benefits of Luas Broombridge by 20%, as a conservative assessment of the magnitude of Wider Impacts which a scheme such as Luas Broombridge could be expected to have. This sensitivity has been applied to the base case in combination with the SPPF sensitivity test discussed above, in light of the fact that one of the arguments against the application of an SPPF for transport projects is that not all market-correcting effects of transport are monetised within conventional CBA. The summary appraisal results are presented in Table 7-4.

When a conservative assumption of an uplift to the conventionally-measured benefits of 20% due to Wider Impacts is applied the BCR increases from 1.54:1 (in the base case with a SPPF of 150% applied) to 1.83:1, and the net present value increases from €185m to €284m.

7-4 Wider Impacts Analysis

Analysis of Monetised Costs and Benefits Base Case – Sensitivity with SPPF (150%) and Wider Impacts	Present Value €000s (2002)
Consumer User Benefits	510,625
Business User Benefits	148,092
Private Sector Provider Impacts	- 66,911
Other Business Impacts	
Accident Benefits	358
Air Emissions Savings	34,090
Net present Value of Benefits (PVB)	626,254
Net present Value Costs (PVC)	342,123
Overall Impact	
Net present Value (NPV)	284,131
Benefit to Cost Ratio (BCR)	1.83
Appraisal Period	2018 to 2047

7.5.5 Discount Rate Sensitivity Tests

Currently the Department of Finance mandated test discount rate is 4%. However, the Public Spending Code recommends that appraisers test the robustness of CBA's against increased discount rates of varying magnitudes. Therefore we have conducted sensitivity tests on the base case using discount rates of 5% and 6%. The summary appraisal results for are presented in Table 7-5 below.

The use of a 5% discount rate rather than 4% reduces the base case BCR from 2.28:1 to 1.9:1, and reduces the base case NPV from €296m to €183m.

Even applying a higher discount rate of 6% the project demonstrates value-for-money, with a BCR 1.6:1 and an NPV of €107m.

Table 7-5 Base Case – Higher Discount Rates

Analysis of Monetised Costs and Benefits Base Case – Higher Discount Rates	**Present Value €000s (2002)**	**Present Value €000s (2002)**
	5% Discount Rate	**6% Discount Rate**
Consumer User Benefits	315,902	236,708
Business User Benefits	90,642	67,174
Private Sector Provider Impacts	- 44,413	- 35,592
Other Business Impacts		
Accident Benefits	266	199
Air Emissions Savings	25,308	18,963
Net present Value of Benefits (PVB)	387,705	287,453
Net present Value Costs (PVC)	204,341	179862
Overall Impact		
Net present Value (NPV)	183,364	107,591
Benefit to Cost Ratio (BCR)	1.9	1.6
Appraisal Period	2018 to 2047	2018 to 2047

7.5.4 Appraisal Period

We have conducted a sensitivity test on the base case using an appraisal period of 20 years rather than 30 years. The summary appraisal results for are presented in Table 7-6 below.

Table 7-6 Base Case – 20 Year Appraisal Period

Analysis of Monetised Costs and Benefits Base Case – 20 Year Appraisal Period	Present Value €000s (2002)
Consumer User Benefits	292,030
Business User Benefits	82,209
Private Sector Provider Impacts	- 46,196
Other Business Impacts	
Accident Benefits	246
Air Emissions Savings	23,395
Net present Value of Benefits (PVB)	351,684
Net present Value Costs (PVC)	199,805
Overall Impact	
Net present Value (NPV)	151,879
Benefit to Cost Ratio (BCR)	1.76
Appraisal Period	2018 to 2037

The project retains value-for-money even adopting a shorter appraisal period of 20 years. In this sensitivity test the BCR in the base case reduces to 1.76:1, and the NPV to €151.9m.

7.5.6 Landuse Sensitivity Tests

A series of scenarios were tested using the NTA multimodal transport model (2006 Base Year) based on a combination of different employment and population growth assumptions, and also different assumptions about possible future transport networks in Dublin.

Two additional demographic sensitivities were tested, along with the Base case outlined above:

- No Growth (2006 landuse);
- Future Year (2030) – Higher Growth (NTA's Strategy Landuse 2030 landuse forecasts7).

The No Growth scenario uses the 2006 population and employment levels from the Census as inputs as this is currently the most up-to-date census data available. The Higher Growth scenario use population and employment forecasts defined in the

[7] NTA Strategy Landuse assumes a consolidation of landuse development around heavy rail/metro corridors.

NTA's Strategy Landuse 2030 landuse forecasts. The Moderate Growth scenario is detailed in Chapter 4 above. Table 7-7 below presents the summary appraisal results for the No Growth Landuse sensitivity test scenario.

Table 7-7 No Growth Landuse Sensitivity Test

Analysis of Monetised Costs and Benefits 2006 Employment and Population Levels Scenario	**Present Value €000s (2002)**
Consumer User Benefits	239,754
Business User Benefits	45,867
Private Sector Provider Impacts	- 90,865
Other Business Impacts	
Accident Benefits	66
Air Emissions Savings	6,241
Net present Value of Benefits (PVB)	201,062
Net present Value Costs (PVC)	212,131
Overall Impact	
Net present Value (NPV)	-11,069
Benefit to Cost Ratio (BCR)	0.95
Appraisal Period	2018 to 2047

In this scenario, the BCR of the scheme is 0.95:1, with a net present value of -11.1m (2002 prices), indicating a negative value for money case for the scheme under these conditions. However, it should be noted that this scenario is wholly unrealistic and entails extremely conservative assumptions regarding population and employment growth in the Luas Broombridge catchment area. It assumes that the levels of population and employment that existed in 2006 will not only remain unchanged up to the opening year of 2017, but will continue at those levels during the 30 year appraisal period, with no growth in employment and population over a 40 year period.

In addition, a Higher Growth Scenario was tested (NTA Strategy Landuse). This scenario represents a more optimistic view of population and employment growth in the Greater Dublin Area up to 2030, and also assumes a consolidation of land-use and development around heavy rail/metro corridors in the future. This scenario is detailed in Chapter 4.

As shown in Table 7-8 in this scenario there is an extremely strong economic case for the scheme, with a BCR of 8.7:1 and a net present value of €1,947m (2002 prices).

Table 7-8 Higher Growth Landuse Sensitivity Test

Analysis of Monetised Costs and Benefits Employment and Population Levels - NTA Strategy Landuse	**Present Value €000s (2002)**
Consumer User Benefits	1,516,611
Business User Benefits	604,548
Private Sector Provider Impacts	-30,986
Other Business Impacts	
Accident Benefits	1,140
Air Emissions Savings	108,616
Net present Value of Benefits (PVB)	2,199,930
Net present Value Costs (PVC)	252,419
Overall Impact	
Net present Value (NPV)	1,947,511
Benefit to Cost Ratio (BCR)	8.72
Appraisal Period	2018 to 2047

7.5.7 Infrastructure Sensitivity Test 1

An Infrastructure Sensitivity test was also conducted to examine the economic performance of Luas Broombridge assuming a number of other public transport schemes were already in place prior to Luas Broombridge being implemented. In this scenario, the Do Minimum includes current infrastructure as well as Metro North and DART Underground. Table 7-9 below outlines the summary appraisal results from this scenario.

As shown in Table 7-9, the economic case for the scheme remains very strong in this scenario also, with a BCR of 2.2:1 and a net present value of €246m (2002 prices).

Table 7-9 Infrastructure Sensitivity Test

Analysis of Monetised Costs and Benefits Infrastructure Sensitivity Test	Present Value €000s (2002)
Consumer User Benefits	391,918
Business User Benefits	148,271
Private Sector Provider Impacts	- 13,302
Other Business Impacts	
Accident Benefits	142
Air Emissions Savings	13,460
Net present Value of Benefits (PVB)	540,489
Net present Value Costs (PVC)	245,672
Overall Impact	
Net present Value (NPV)	294,817
Benefit to Cost Ratio (BCR)	2.2
Appraisal Period	2018 to 2047

7.5.8 Economy and Jobs

RPA has conducted an analysis of the employment generation of Light Rail in Dublin based on the examination of the employment generated by the construction of both the original Luas Lines and subsequent extensions.

Luas Broombridge will generate much needed employment during the construction phase with the expectation that approximately 800 jobs per annum over the 4 year construction timeframe will be created. This will provide an immediate stimulus to the badly hit construction sector. Other sectors of the regional economy are likely to benefit such as those in the construction material supply industry (concrete; aggregate production; paving materials and reinforcement fabrication), plant hire, and those providing technical support services (Engineers; Architects; Quantity Surveyors). There will also be secondary spin off impacts due to the expenditure of wages in the local economy by the construction workforce.

Additionally there will be 60 permanent jobs created in the operation of the extended Luas system.

Over the longer term, Luas Broombridge will support economic recovery through enhancing the competitiveness and the functioning of Dublin city, which is the engine of economic growth in Ireland. Recent economic growth literature place high emphasis on the importance of cities as generators of economic growth, and forecast for this trend to continue. Luas Broombridge is designed to be an integral part of the future development of Dublin – it provides an integrated, high quality, modern public transport system, of the like that is increasingly expected by visitors and business people in European capitals.

7.6 Project Appraisal Balance Sheet

The Common Appraisal Framework (CAF) requires that a Project Appraisal Balance Sheet (PABS) be drawn up summarising the principle results of the project appraisal. The PABS reports the scoring of the project against the five criteria of Economy, Safety, Environment, Accessibility and Social Inclusion and Integration. A seven point scaling system is used. Table 7-10 reports the Project Appraisal Balance Sheet for Luas Broombridge.

Table 7-10 Luas Broombridge Project Appraisal Budget Sheet (PABS)

Criteria	**Luas Broombridge**		
	Qualitative Statement	**Quantitative Statement**	**Scaling Statement**
Economy			
Transport efficiency and effectiveness	Improves public transport generalised journey times through reduced need for interchange and quicker and more reliable journeys	BCR: 2.24:1 NPV: €296m PV	
Other economic impacts	Significant urban realm improvements; wider economic benefits likely to be generated through increased accessibility of city centre		Highly positive
Safety			
	Slight reduction in road traffic accidents as a result of mode switching	Reduction in accidents: €358,000 PV	Slight positive
Environment			
Air quality	Increased energy consumption by trams; reduced car emissions from modal shift.	Reduction in air emissions: €34m PV	Slight positive
Noise and vibration	Reduction in highway trips	During the peak period, approximately 400,000 fewer trips by car will be made per year after the introduction of Luas Broombridge.	Slight positive
Landscape & visual quality	Insertion of infrastructure will generally be positive with scheme seen as integral part of the city centre's transport system.	N/A	Slight positive

Biodiversity	Loss of a small area of Royal Canal pNHA dry meadow and grassy verge and scrub habitat; control of the invasive species Japanese knotweed (*Reynoutria japonica*)	Loss of approximately $90m^2$ of pNHA.	Slight negative
Cultural, archaeological and architectural heritage	There will be direct negative impacts on archaeological and architectural heritage, in particular on subsurface elements. However, providing mitigation measures outlined in EIS are implemented the scheme will enhance the amenity value and strengthen the potential for protecting the character of the area.	N/A	Slight negative
Land use, soils and geology	Providing mitigation measures outlined in EIS are implemented there will be no significant impacts on land use, soils and geology.	N/A	Neutral
Water resources	Providing mitigation measures outlined in EIS are implemented there will be no significant impacts on water resources.	N/A	Neutral
	Accessibility & Social Inclusion		
Vulnerable groups	The benefits of Luas enjoyed by existing vulnerable groups, and in particular those without access to a car, will be enhanced through higher frequencies		Highly positive
Deprived geographic areas	Serves RAPID area as well as deprived Marlborough St. area		Moderately positive
Integration			
Transport integration	Creates light rail network; creates interchange opportunities between Luas and heavy rail at Broombridge and Metro at O'Connell Street.		Highly positive
Land use integration	Fully compatible with RPGs, and Dublin City Development Plan. Fully		Highly positive

	supportive of policy of integrating land-use with transport planning; will facilitate Grangegorman DIT development	
Geographical integration	No impact	Neutral
Other Govt. policy integration	No impact on enhancing regional income. However, the NSS recognises the importance of Dublin to the overall Irish economy, and commits to protecting the international competitiveness of the Dublin region, which will be facilitated by fast, frequent and high-capacity public transport networks.	Slight positive

7.7 Conclusions

The results of the economic appraisal demonstrate there is a strong economic case for the scheme, with a BCR of 2.28:1, and a net present value of €296m in 2002 prices in the Base Case Scenario. The economic benefit (value for money) of the scheme is substantially greater than the costs. The BCR of 2.28:1 means that the benefits of the scheme are more than double the costs. This represents very good value for money for a scheme of this nature.

In order to test the robustness of the results of the economic appraisal the performance of Luas Broombridge has been examined under further scenarios to reflect the main risks to the economic performance of the scheme.

A series of sensitivity tests reflecting the economic appraisal parameters suggested in the current Public Spending Code were conducted. The application of a SPPF of 150% reduces the BCR from 2.28:1 to 1.54:1. This demonstrates further the robustness of the proposed scheme. Applying a SPPF of 150% in the Base Case does not remove the value-for-money of the scheme, as it retains a BCR of 1.54:1. In addition, when a conservative uplift of 20% for WIs above the conventional benefits is applied to the scenario with an SPPF of 150%, the value-for-money case of the scheme improves, with the BCR increasing from 1.54:1 to 1.83:1.

The impact of applying higher test discount rates (of 5% and 6%) was tested. The use of a higher discount rate does not erode the value-for-money of the scheme, with the application of a 6% discount rate reducing the base case BCR to 1.6:1 from 2.28:1.

A sensitivity test using a shorter appraisal period of 20 years was also conducted. In this test the scheme remains value-for-money but the base case BCR is reduced from 2.28:1 to 1.76:1.

Landuse sensitivity tests have been carried out based on a low or pessimistic No Growth scenario and a Higher Growth scenario. The No Growth scenario is extremely conservative and perhaps unrealistic in nature. In this scenario the BCR is 0.95:1.

Should the population and employment grow in line with the projections set out by the NTA Scenario the BCR shows an extremely strong BCR of 8.72:1.

The Infrastructure Sensitivity Test which includes both Metro North and DART Underground in the public transport network displays a strong economic case of 2.2:1.

8 PROJECT FINANCE AND CASH FLOWS

8.1 Chapter Summary

- The total funding requirement from the Exchequer for Luas Broombridge is estimated to be €368 million in nominal terms over the period 2006 to 2018. In net present value and cash terms this amounts to 100% of the capital costs of the project. It is expected that at 31 December 2012 €17.7m of this will have already been expended;
- It is not expected that developer contributions will be available for this project. There exists the possibility that a Section 49 Development Levy scheme could raise in the order of €5m to assist in minimising the Exchequer funding requirement. The current financing proposal does not rely on a S49 Supplementary Development Scheme as a source of funding. Nonetheless the possibilities will be fully explored;
- Projections on operations show that incremental patronage as a result of this project will generate sufficient revenues to cover incremental operating costs. Current indications are that this will be the position from the first year of operations. Therefore it is unlikely that an Exchequer subvention will be required; and
- Projections also show that operating surpluses should be sufficient to cover the renewal costs of the infrastructure over a 30 year operating timescale. Demand would be required to fall 46% below forecast over the lifetime of the project to eliminate the operating surplus and the amount required to fund life cycle asset renewals.

8.2 Background

The financing structure for Luas Broombridge is based on the availability of capital funding from the National Transport Agency of 100% of the nominal capital cost currently estimated at €368 m. It is assumed that the required funding will be available to match expenditures during the implementation period until financial completion of all contracts. This period is currently estimated as 2012 to 2018. The financing structure reflects the traditional nature of the project procurement strategy with a considerable amount of design being developed by RPA and included in the employers requirements in the both the enabling works and main infrastructure contracts. Having considered the constraints of the procurement strategy and the limited availability of funding from other sources RPA has concluded that funding through NTA capital grants would best meet the objectives of the Luas Broombridge project. Given the characteristics of the chosen procurement strategy and the current state of the financing market the use of PPP finance is not seen as “value adding” or appropriate and will not be considered further.

This chapter considers the cash-flows and likely cost to Exchequer over a 30 year operating period starting in 2017.

8.3 Financial Model Assumptions

A number of assumptions have been made in the financial model:

8.3.1 Project Timing

Commencement of construction (enabling works) is projected to occur in 2013 and Department of Transport approval to proceed with the project based on the Updated Detailed Business Case (UDBC) would be required for enabling and heritage works to commence in Q2, 2013. The main infrastructure contract is schedule to commence in November 2014 and the system is expected to commence revenue service in October 2017.

8.3.2 Inflation

The inflation rates assumed for public transport fares are related to forecast changes in the consumer price index and take account of issues such as the introduction of smartcards, more integrated journeys, the trend for increased take-up of period ticketing products and the effect of extensions to the Luas network over time.

Allowances made for escalation recognise the likely impact of tender price inflation on capital costs over the construction period. Inflation rates of 0% for 2012, 3% for 2013 through 2016 and 5% for 2017 to 2018 have been assumed. Exceptions to these rates of escalation were made where appropriate and with the benefit of particular knowledge.

8.3.3 Discount Rate

For the financial appraisal, nominal cash-flow have been discounted at a nominal rate of 6.65%. This is the rate currently advised by the Department of Public Expenditure and Reform for financial evaluation of projects[8].

8.3.4 VAT

All VAT is excluded from the model. The model reflects the VAT status of RPA, which treats the Agency as a chargeable body for VAT purposes. This status allows RPA to recover all VAT associated with the project expenditure as the Agency is engaged in the supply of infrastructure to Veolia which is an activity for which VAT must be charged.

8.3.5 Capital Costs

The capital costs used in the financial model are set out in Table 8-1 and reflect the capital costs discussed in Chapter 5 Capital Costing.

[8] http://per.gov.ie/project-discount-inflation-rates/

Table 8-1 Total capital cost (€ million, nominal amounts)

	2006-2012	2013	2014	2015	2016	2017	2018	Total
	€m	€m	€m	€m	€m	€m	€m	€m
Capital costs – Q3 2012 prices	17.7	20.9	38.7	75.6	89.1	75	19.2	**336.2**
Capital costs – nominal amounts in year of expenditure[9]	17.7	21.3	40.6	82.0	99.4	85.7	21.3	**368.0**
Discounted to 2012 @ 6.65%[10]	17.7	20.0	35.8	67.9	77.3	62.6	14.6	**295.8**

8.3.6 National Transport Authority (NTA) grants

It has been assumed that sufficient grants will be available from the National Transport authority (NTA) to fund the capital costs as they are discharged by RPA. The level of exchequer funding required is estimated at €368.0m, VAT excluded. During the project grant funding will be sought from NTA to discharge VAT inclusive liabilities. It will be necessary to retain working capital to fund these VAT amounts until they are recovered from the Revenue Commissioners.

8.3.7 Section 49 Development Levies

There exists the possibility that the grant funding required could be reduced over time by an amount conservatively estimated at €5.0m were a Section 49 Development Levy scheme to be introduced by Dublin City Council and sufficient development took place within the catchment area of the levy scheme. Due to the nature of current development adjacent to the alignment, it being predominantly brown-field, there is limited scope for significant planning gain within the catchment of the Broombridge route. This consequently limits the scope for Section 49 levies or developer contributions. RPA intends pursuing the introduction of a supplementary development scheme with NTA and the Local Authorities.

The forecast levy yield assumes that planning permissions can be levied in respect of a number of contribution schemes. Approximately 80% of the possible levy scheme area has overlap with other proposed projects. This may have an impact if it is deemed inequitable to impose more than one supplementary contribution scheme levy on the same development.

[9] Inflation of 0% for Q4, 2012 rising to 5% in 2018 has been applied in reaching the escalated capital cost of €368.0m

[10] The estimated capital cost of the project is €336.2 million in Quarter 3 2012 prices. On average the discount rate used exceeds the inflation rate which is why the discounted capital cost of €295.8 million is less than the project cost of €336.23m in 2012 prices.

8.3.8 Direct Contributions from Developers

It is not anticipated that there will be significant opportunities for direct contributions from developers for this project.

8.3.9 Transfer of land interests

Negotiations are being held with CIÉ and the Department of Transport for the transfer of lands (from Broadstone north to Broombridge) at nil consideration. NTA has indicated that arrangements can be put in place to protect the project's funding requirements from any unexpected compensation payments made associated with any property purchased from CIE.

8.4 Funding of Capital Expenditure

The nominal cash-flows are shown in Table 8-2. The total nominal cost of the project is estimated at €368.0 million. Exchequer funding of €368.0 million is required over the period 2012 to 2018. The discounted cash flows are shown in Table 8-3.

Table 8-2 Sources and Uses of Funds – Projected Cash-flows - Year of Expenditure

Nominal Cash-flows € millions	**2006 -2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
Capital Cost	17.7	21.3	40.6	82.0	99.4	85.7	21.3	**368.0**
TOTAL	17.7	21.3	40.6	82.0	99.4	85.7	21.3	**368.0**
NTA Capital Grants (non-repayable)	17.7	21.3	40.6	82.0	99.4	85.7	21.3	**368.0**
TOTAL	17.7	21.3	40.6	82.0	99.4	85.7	21.3	**368.0**
NTA Capital Grants %	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 8-3 Sources and Uses of Funds – Discounted Cash-flows € million

Cash-flows discounted @ 6.65%	**2006 -2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
Capital Cost	17.7	20.0	35.8	67.9	77.3	62.6	14.6	295.8
Less; NTA Capital Grants (non-repayable)	17.7	20.0	35.8	67.9	77.3	62.6	14.6	295.8
Net Funds flow	0	0	0	0	0	0	0	0
NTA Capital Grants %	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

8.5 Operating Cash-flows

8.5.1 Operating, maintenance and Life cycle asset renewal costs

Operating and maintenance costs (including life cycle asset renewals) are important components of the overall cost and financing requirement of the project. The life cycle and renewal costs that fall within the 30 year operating period commencing in 2018 have been included in the financial model. The costs set out in Table 8-4 below are exclusive of VAT and represent the estimated amounts that will be paid in the year in which those costs occur.

Table 8-4 Operating, maintenance and life cycle asset renewal costs (€ millions, Nominal)

	Years 1 to 5	**Years 6 to 10**	**Years 11 to 15**	**Years 16 to 20**	**Years 21 to 25**	**Years 26 to 30**	**TOTAL**
	€m	€m	€m	€m	€m	€m	€m
Operating and maintenance cost	42	46	51	56	62	69	326
Life cycle asset renewals	3	6	15	11	24	18	77

8.5.2 Fare and advertising revenue

Demand forecasts for Luas Broombridge are based on the base case output from NTA's multimodal Transport Model. Forecast revenue from passenger fares is assumed to be equal to forecast demand multiplied by the average yield. Average yield per boarding has been estimated using the actual average yield per boarding on Luas in 2012 of €1.58. This yield has been forecast to increase at 2% compound per annum to incorporate the combined impact of changes in fares, preferences for ticket products, average length of journeys etc. Table 8-5 sets out the passenger fare and advertising revenues forecast for a 30 year period commencing in 2018. The revenues are stated exclusive of VAT and are in nominal amounts.

Table 8-5 Projected revenue from fares and advertising (€ millions, Nominal)

	Years 1 to 5	**Years 6 to 10**	**Years 11 to 15**	**Years 16 to 20**	**Years 21 to 25**	**Years 26 to 30**	**TOTAL**
	€m	€m	€m	€m	€m	€m	€m
Fare revenue	76	99	118	131	145	159	728
Advertising revenue	1	1	1	2	2	2	9

Table 8-6 sets out the net present value of the Luas Broombridge operating cash-flows over a 30 year operating period. A discount rate of 6.65% has been used.

Table 8-6 Operating cash-flows (Present values, discounted to 2012)

Cash-flow	**€ millions**
Total operating revenue including advertising	205
Total operating costs	-95
Total operating surplus	**110**
Less; Life cycle asset renewals costs	-17
Operating surplus after funding life cycle asset renewal costs	**93**

Table 8-6 demonstrates that Luas Broombridge has an operating surplus in present value terms of €110m. The forecast operating surpluses over a 30 year timescale would fund the forecast life cycle asset renewal costs over the same period leaving a net surplus of €93m.

8.6 Risks and Sensitivity Analysis

Chapter 6 Risk sets out the key risks facing the project. Projected revenue, and in turn the forecasts for an operating surplus (or deficit) depends on the accuracy of RPA's demand forecasting, and although this has been proven robust on the Luas Green and Red Lines there remains a degree of risk in this area. In order to examine this sensitivity RPA modelled the impact of reductions in overall patronage over the life of the project, highlighting the reduction required to reduce the operating surplus to nil. The results are set out in Table 8-7 and all numbers are discounted using a 6.65% discount rate. It was assumed that operating and lifecycle costs remain unchanged. It would require a 46% reduction in the forecast patronage before the net operating surplus after renewals costs would be reduced to nil.

Table 8-7 Sensitivity of operating cash-flows (after deducting life cycle asset renewal costs) to reduction in patronage revenues (all figures stated in present value, discounted to 2012 using a 4% discount rate)

Cash-flow - € millions	**Base Case**	**10% Reduction (Patronage)**	**20% Reduction (Patronage)**	**46% Reduction (Patronage**
	€m	€m	€m	€m
Total operating revenue	205	185	165	112
Total operating costs	-95	-95	-95	-95
Life cycle asset renewals costs	-17	-17	-17	-17
Net operating surplus/deficit (after life cycle asset renewal costs**)**	**93**	**73**	**53**	**0**

The sensitivity shows that the net operating surplus (after charging life cycle asset renewals) in the base case reduces to €73m over the life of the project if patronage falls 10% below forecast. A reduction in the order of 20% reduces the net operating surplus to €53m and a reduction of 46% brings the net operating surplus to nil. If the last scenario were to occur there would be cash shortfalls in some years which might require short term funding arrangements to be put in place. However even if the worst of these sensitivities were experienced it is unlikely that Exchequer funding in the form of an operating subvention would be required. Some funding of the life cycle asset renewals cost might be required on a temporary basis.

8.7 Conclusions

The results of the financial modelling of project cash-flows and available funding for Luas Broombridge indicate a total capital cost of €368 million (nominal) with 100% of this being funded by the Exchequer through the National Transport Agency. The projects costs remain within the available expenditure ceilings and timing constraints for funding at all times during implementation. On that basis the project can be considered as being “affordable”.

There is a possibility that a Section 49 Development Levy scheme, if introduced by Dublin City Council, could generate in the order of €5m which could be used to assist the funding of the scheme or the repayment of NTA advances of Exchequer funds.

The results also show that Luas Broombridge has an operating surplus in present value terms of €110m when measured over a 30 year time frame. After the deduction of costs of life cycle asset renewals this surplus is reduced to €93m. Based on these forecasts and their sensitivity to reductions in patronage revenues it is extremely unlikely that Exchequer funding in the form of an operating subvention would be required during the expected useful operating life of the project.

9 PROCUREMENT STRATEGY

9.1 Chapter Summary

- The procurement strategy for Luas Broombridge must accommodate the project constraints and stakeholder requirements; build on lessons learned during the construction of the Luas Red and Green Lines and extensions to date; and facilitate the achievement of RPA's objectives.
- The procurement strategy must accommodate sufficient flexibility to ensure that the design and construction of the systems for future Luas projects can be achieved without undue constraints on those projects.
- RPA has carried out a PPP Procurement Assessment in accordance with the Capital Appraisal Guidelines and this project was deemed unsuitable for procurement as a PPP.
- The option that best suits RPA's requirements is initial client design for heritage, basement modifications and utility diversion works (with target cost for utilities) followed by a design build package for the main infrastructure works. Rolling stock can be procured through exercising an option under the procurement initiated in 2005 for the supply of light rail vehicles for the developing Luas system.

9.2 Introduction

RPA considered a range of procurement approaches available for the implementation of the Luas Broombridge project.

The approach adopted to determine the best procurement strategy was as follows:

- The constraints, stakeholder requirements and lessons learned from the previous Luas projects were considered, in particular the more recent Luas extensions to Cherrywood, to Docklands and to City West;
- Objectives were set for the procurement process;
- A range of different options for the procurement process was developed; and
- The advantages and disadvantages of each option in terms of the objectives were evaluated, drawing on internal and international experience where applicable.

9.3 PPP Assessment

In accordance with the Department of Public Expenditure and Reform's (DPER) guidance on Public Private Partnerships (PPP), "Assessment of Projects for Procurement as Public Private Partnership", RPA has carried out an assessment of the suitability of the Luas Broombridge project for a PPP form of procurement. This assessment concluded that Luas Broombridge was not a suitable project for PPP, on a number of grounds.

Luas Broombridge is an addition to an existing system that is currently being operated and maintained by a separate party. It would be impossible to have a separate operator operating on Luas Broombridge to that operating on the rest of the Luas network as services run continuously through on an end to end basis. It is also impossible to have a separate rolling stock maintenance arrangements for Luas Broombridge as again, trams are not dedicated to sections but operate over the entire network. While in theory it would be possible to have a separate maintenance arrangement for the Luas Broombridge infrastructure, this would offer the state extremely poor value for money as many of the fixed costs (management, equipment, depot facilities etc.) would be duplicated. This would result in the maintenance cost for Luas Broombridge being disproportionately high when compared to the rest of the network. For these reasons, there would be no significant service or operational requirements for a PPP contractor.

Luas Broombridge cannot be a separate system for revenue generation purposes. There is thus no potential for the Luas Broombridge project to generate income for a PPP Company.

There is a significant difficulty in transferring construction risk to the contractor given the significant interfaces with the city streets and with other stakeholders including the roads authority, statutory undertakers and city centre traders. As the overall Luas system is operated and maintained by other parties, there is no scope for transfer of operational or availability risk.

For these reasons, Luas Broombridge was not a suitable project for PPP.

9.4 Project constraints, stakeholder requirements and lessons learned

9.4.1 Project constraints and stakeholder requirements

A number of constraints face the project, some of which are more relevant than others to the procurement strategy:

9.4.1.1 Traffic Management Requirements

A coherent and well managed traffic management plan is vital to the minimisation of disruption during the construction phase and to the overall success of the project. The Luas Broombridge procurement strategy must be sufficiently flexible to ensure that changes in the scope of the enabling works and/or in the timing of adjacent developments and/or other transport plans and transport operator constraints can be accommodated without undue impact on traffic flows in city centre areas.

Luas Broombridge is traversing a largely built up environment with congested traffic challenges which leave little scope for deviation. Pedestrian and vehicular access to premises must be maintained such that the economic well-being of the city centre is ensured throughout the works phase. DCC’s Directions for Roadworks Control require that RPA rather than their contractors make all applications for traffic management permits. In order to ensure that RPA can perform this function without delaying site operations, the procurement strategy for the scheme must consider the fact that RPA will need to remain closely engaged with the sequencing and programming of the contractor’s works throughout the construction stage.

9.4.1.2 Utility Designs & Diversion Works

A further constraint facing the project is in respect of the extent and the complexity of utility diversions and the external interfaces with local authorities and utility providers, during both design and construction stages. The strategy must consider the appropriate allocation of the risks involved in managing these interfaces especially in relation to finalising detailed designs, programming of works, sequencing of works and controlling costs.

9.4.1.3 Interface with 3rd Parties and External Stakeholders

As with any project of this nature and scale there are a number of external interfaces that may impact on project delivery. Responsibility for managing the day-to-day requirements of Dublin City Council (DCC), existing businesses and local residents will need to be considered when finalising the procurement strategy. This is particularly the case when it comes to responding to changing demands and requirements of these third parties at design, construction and hand-over stages. Management of interfaces with other key stakeholders such as CIE and their constituent companies will also be a crucial requirement for a successful delivery of the Luas Broombridge project. This is especially relevant in the Broadstone area where the bus activities at the Bus Éireann depot and also the Phibsborough Bus garage of Dublin Bus will require careful consideration during the planning and execution of the works.

9.4.1.4 RPA Internal Resources

The procurement strategy must be cognisant of the demands that may be placed on RPA internal resources

9.4.1.5 Impacts on Businesses

There have been strong representations from business groups in the city centre focussing on the necessity to complete the project works in the shortest possible timeframe and with the minimum of disruption. The procurement strategy will need to consider how best to accommodate these requirements.

9.4.2 Luas Lessons Learned

There are a number of key lessons arising from the construction of previous Luas projects:

- The statutory processes were managed well and should continue to be managed by RPA;
- The RPA relationship and the working arrangements built up with the utility companies through the Joint Utilities Group (JUG) worked well, and this approach should be maintained in so far as is practicable;
- The procurement of the works in several work packages has allowed RPA sufficient flexibility to develop designs for later packages while enabling works are proceeding on site;
- Design changes will inevitably arise throughout the course of the works and this can lead to delays and disruption to works on site. Due to the number and complexity of external interfaces on the recent Luas Docklands project it was decided that RPA would retain responsibility for managing these design

interfaces. In doing so RPA was able to reduce disruption to businesses, achieve greater programme certainty and minimise 'legacy' issues with third parties, including Dublin City Council (DCC). It is noted that this approach came with a significant premium associated with the contract management and design resources necessary to fulfil this task, and led to the submission of a large number of design-related claims by the contractor; and

- Standards of finish may have varied across previous projects. Where RPA has retained closer control over detailed design this has resulted in a higher quality finish. The Luas Broombridge procurement strategy must ensure the same high level of quality control is maintained. This is especially relevant in the core city centre where protected structures and architectural heritage features are to the fore.

These lessons together with the constraints outlined above inform the options analysis.

9.5 Objectives

The objectives for the procurement process are to achieve:

- High quality of finished product;
- Value for money;
- Timely and efficient completion of works;
- Flexibility;
- Process risk minimisation;
- Technical compatibility with the Luas network; and
- Systems integration with other future Luas projects

9.5.1 Quality

The procurement strategy needs to allow RPA to have a significant degree of control over the quality of the works to be carried out. Luas schemes have developed a reputation for high standards of build quality and it should be the aim of the procurement strategy to maintain those standards.

This scheme passes through a sensitive, historic and dynamic city centre environment and the designs developed for the works need to take account of these factors. Also, for a large part, the environment within which the scheme is to be built is in the charge of the local authority, DCC. Therefore, almost all of the design works will, at the very least, require some input from DCC, and in certain cases will require their explicit approval prior to construction.

It is accepted that in order to achieve a high quality of finish, numerous minor design changes will be necessary throughout the implementation period and that these changes may need the agreement of external parties, e.g. DCC and property owners. The procurement strategy must strike a balance between facilitating design changes which may be required to maintain RPA's high standards of quality without exposing RPA to an unacceptable level of commercial claims from contractors.

9.5.2 Value for Money

The procurement strategy also needs to ensure that RPA achieves value for money and Luas Broombridge is developed and built for the best price. In this regard, the following factors need to be considered in developing the strategy:

- Use of lessons learned from previous RPA projects;
- Use of lessons learned from other international light rail projects;
- Private sector innovation;
- Competitive tension;
- Good project management and planning;
- Whole life approach to design; and
- Optimum risk balance and transfer.

Most of these factors are about reducing the costs of the project, or improving its quality. Costs should be lower if the process is cognisant of the lessons learned from the previous Luas projects.

Given the size of the Luas Broombridge project, the extent of technical constraints due to the built-up, historic nature of the environment, the quantum of existing utilities and the requirement to integrate with the existing system, it is considered that the opportunity for private sector innovation is minimal. Whereas alternatives may exist to the design of structural or electrical elements within the light rail infrastructure, their whole-life costs could be higher when maintenance and durability are taken into account.

Experience also shows that maintaining competitive tension between bidders until close to contract award will reduce costs. In particular, processes which involve protracted negotiations with a single preferred bidder are likely to result in higher costs or a worsened risk allocation. Good management and planning of the project are also vitally important to adding value.

Ensuring reasonable costs to the public sector over the life of the project is also an integral part of obtaining value for money. In this respect the public sector should be looking for the optimal allocation of risks and, where appropriate, should use the competitive tendering process to transfer as much of the design and construction risk as possible to the private sector, thereby reducing RPA's commercial exposure.

The GCCC suite of public works contracts will be utilised in the various works contract packages as appropriate to ensure optimum allocation of risk and that value for money is obtained. Additionally a target cost form of contract will be adopted for the utility diversions contract given the high degree of risk associated with underground utilities.

9.5.3 Works Programme

It is important that the procurement strategy takes account of the requirement to construct the scheme with as little disruption as practicable to local businesses and residents along the alignment.

In developing the procurement strategy RPA needs to consider what level of control it requires over its contractors' programming and sequencing of the works and whether including incentives for completion of the scheme, or parts of the scheme, are appropriate.

9.5.4 Flexibility to accommodate technical requirements, future connections & regulatory change

Luas Broombridge is just one phase in the creation of a light rail network for Dublin. Future phases, which will impact on Luas Broombridge, include possible extensions to Lucan (Line F) and northwest from Broombridge via Finglas to join up with Metro West. These links are unlikely to be developed in the short to medium term and are not included in the Government's current transport plans, but the selected procurement strategy must allow for any future extension to be procured using a competitive process, and with minimum interference and cost to the existing operations / infrastructure.

The contracts to deliver Luas Broombridge must be sufficiently flexible to accommodate any potential future regulatory changes at minimum cost.

Experience of building the original Luas Lines and extensions has demonstrated the significant time, cost and quality risks associated with the agreement of detailed designs with external stakeholders. The procurement strategy must allow for the possibility of significant numbers of design issues arising during construction. Similarly, the ability for the project and its management to agree numerous specific technical solutions with DCC and other third parties must be considered as a requirement, particularly in the city centre section of the project.

9.5.5 Process risk minimisation

Process risk relates to the risks around stakeholder and market buy-in and the procurement process itself. There is a risk that the procurement process will fail or be delayed if, for instance, a losing bidder should challenge the procurement outcome as being unfair. Minimising or at least containing that process risk may be achieved by using procurement processes and forms of construction contract which are familiar to the market.

Given the current climate within the construction industry market, appetite would exist for most forms of procurement approach.

These factors should be included in assessing the suitability of any procurement strategy.

9.6 Procurement Options

The procurement options available for Luas Broombridge are varied. Before short-listing options for consideration, a number of assumptions have been made.

9.6.1 Assumptions

9.6.1.1 Railway Order and Land Acquisition

In common with all RPA projects to date the responsibility for securing the Railway Order and acquiring property rests with RPA.

9.6.1.2 Operations and Maintenance

The existing Luas operating contract will expire in 2014. A new competition for a system wide operator will include Luas Broombridge. Having two operators on the Luas network would result in significant technical difficulties and inefficiencies.

The existing Luas Infrastructure Maintenance Contract (IMC) and Vehicle Maintenance Contract (VMC) will also be renewed to include Luas Broombridge. While it may be possible to have a new maintenance contract for Luas Broombridge, as demonstrated successfully by Docklands Light Rail, to comply with procurement legislation and to realise economies of scale, it is more likely that competitions for operators and maintainers will be run for the entire network rather than in parts.

9.6.1.3 Rolling Stock

A call for Competition Notice was placed in the Official Journal of the European Union (OJEU) in December 2005 stating that RPA required “up to 50 light rail vehicles”. Following a pre-qualification process and issuance of documentation to potential suppliers, the successful contractor was awarded a contract in March 2007 for the supply of 18 trams (to satisfy the trams demand of the projects B1, CE2 and C1). An additional 8 trams were added to the contract for the Luas extension to Citywest. Thus, to-date orders have been placed for a total 26 trams.

RPA has reviewed the terms of this contract in order to specifically assess the legal position regarding procurement of trams for Luas Broombridge. It has been established that the current contract with Alstom permits RPA to enter negotiations on the supply of trams for Luas Broombridge without having to re-advertise or re-tender.

It is noted that exercising this option and entering into negotiations with a single supplier has the potential to expose RPA to considerable commercial risk in the absence of competitive tension. Thus it is intended that where practicable the project programme allow sufficient time for this package to go out to open tender should these negotiations fail to attain predetermined value-for-money criteria.

9.6.1.4 Systems Integration

In 2007 the B1_400 contract was awarded for the design, construction and commissioning of the infrastructure, power supply and control systems for Luas Line B1 (Cherrywood). As an option under this contract, RPA secured the right to award the systems elements for approximately 30 km of additional light rail lines to the B1_400 Systems contractor, Efacec. This included a priced option for BXD which was disaggregated in the pricing document at that time into Line BX and Line D. The right to exercise this option will expire in 2017.

Similar to RPA’s position with the procurement of rolling stock, it is noted that exercising this option and negotiating a price for the systems works with a single contractor has the potential to expose RPA to considerable commercial risk. Accordingly it is envisaged that the project programme will allow sufficient time for this package to go out to open tender should these negotiations fail to attain predetermined value-for-money criteria. What must be considered in any procurement for the systems work is the desirability for a common system control for the entire Luas network.

9.6.2 Procurement Options

Since the submission of the Outline Business Case for the scheme RPA has continued to consider the most appropriate procurement options for Luas Broombridge. Through work-shops and meetings RPA has examined further procurement options - Table 9-1 lists the options which were considered viable drawing on experience from other projects, particularly the Cherrywood and Docklands extensions.

Table 9-9-1 Shortlisted procurement options (excluding rolling stock)

Option	**Brief Description**
A	Turnkey Design and Build contract let to a single consortium including all enabling works, infrastructure and rolling stock.
B	Initial Client Design contract for enabling works including heritage works, basement modifications and utility diversions; Design and Build contract(s) for light rail infrastructure works (including key structures) and E&M systems.
C	Client Design contract(s) for basements, utility diversions and light rail infrastructure works (including key structures); Design and Build contract(s) for E&M, signalling, and systems integration.
D	Early Contractor involvement for enabling and light rail infrastructure works, using previous Luas projects to benchmark the cost plan. Design and Build contract(s) for E&M, signalling, and systems integration.

9.7 Evaluation of procurement options

9.7.1 Option A

Turnkey Design and Build contract let to a single consortium including all enabling works, infrastructure and rolling stock.

Option A is arguably the least attractive of all the options. Appetite within the utility companies and the local authority to engage with a contractor in the planning and design of utility diversions and infrastructure designs will remain low impacting on project timing. It is also likely the private sector will view this as a high risk and cost it accordingly. Option A also takes away control over the design process from RPA and transfers all responsibility for managing design interfaces to the private sector irrespective of the consequences. Given the complex nature of the utilities and the sensitive, historic nature of the existing streetscape, this would be unacceptable.

Option A effectively transfers all responsibility to the contractor while failing to provide sufficient protection to RPA in relation to time / cost overrun and quality of finish. In contrast to other options, it fails to adequately meet most of the objectives.

9.7.2 Option B

Initial Client Design contract(s) for enabling works including heritage works, basement modifications and utility diversions; Design and Build contract(s) for light rail infrastructure works (including key structures) and E&M systems.

Option B appears to provide a good balance of risk apportionment between RPA and the private sector. Risk transfer is lower than for Option A but the model recognises some of the key constraints facing the project. By retaining the advance contract packages and in particular the utility diversion works, within RPA's design control a number of key interface risks are mitigated. Option B also provides RPA with the opportunity to improve a tried and tested model and benefit from the lessons learned on previous Luas projects. A similar model has been tried before albeit in a suburban environment (Luas Line B1 to Cherrywood) and RPA would have a range of skills currently available in-house to manage the project using this option.

Market appetite for this procurement model is proven and, as such, it meets the objective of minimising process risk.

Option B offers good flexibility, especially at the enabling works stage. In respect of the light rail infrastructure works the procurement of a design / build contractor to manage external interfaces would seek to transfer the risks of dealing with third party issues that might arise during detailed design or construction stage to the contractor, and this in theory would reduce RPA's commercial exposure to design-related claims from the contractor. However, these commercial risks need to be balanced against the programme and quality risks of transferring full responsibility for managing all third party relationships and developing final designs for the scheme to a contractor, especially given the complexity and sensitivity of the environment within which Luas Broombridge is to be built.

In a city-centre environment it has been RPA's experience that numerous specific design solutions will need to be agreed with DCC and adjacent property owners that do not conform with, or are not covered by, standard technical specifications. Were this to arise under a design/build contract, it is highly probable that delays will occur in the agreement of design solutions which are acceptable to both the contractor and the third party, leading to increased pressure on the project programme. Option B provides RPA with a greater degree of flexibility in respect of programming the works and achieving a high-quality finished product than Option A.

Options B, C & D separate the enabling works packages from the main infrastructure works. Option B could allow for earlier procurement of the infrastructure contract as there is less design work for RPA prior to going to tender. However this must be balanced against the need to provide a greater degree of specification in a reference design for the city centre than might otherwise be the case in a suburban environment. Further programme savings could materialise were the contractor to prepare detailed designs in line with their construction programme, thereby allowing the works to commence in advance of the completion of the full 'for construction' design.

With Option B, the risks associated with the quality of the D&B systems design and systems integration could be mitigated by appointing the systems contractor (Efacec) used for Luas Lines A1, B1 & C1. This would be possible by exercising the option available under the B1_400C contract but, while Efacec has a proven track record in delivering high quality systems designs and installations for RPA, it is important to note that (a) this option expires in August 2017 and, (b) there would be commercial risks associated with requesting a price for the works from only one contractor. For Options B, C & D, RPA would need to ensure that there is a level of competitive tension introduced into the procurement of the systems contractor. One method of achieving this would be to set value for money parameters for the negotiations with Efacec and, where practicable, allow sufficient time within the project programme to go out to tender for the works.

On balance Option B does offer RPA the opportunity to transfer significant design risks to the contractor while maintaining some flexibility to closely manage the project. The constraints relating to utility design and construction could be managed successfully using this model. Also, by utilising the E&M contractors who successfully designed and installed the systems on Luas Lines B1 and C1 for this project RPA, would minimise any commissioning risks associated with this element of the works, especially systems integration.

Under this option RPA would seek to transfer the external design interface risks associated with the light rail infrastructure package to a design/build contractor. While this is an attractive approach to achieving the procurement objective of optimising risk balance and transfer, it has been RPA's experience on previous Luas projects that transferring full responsibility for managing third party interfaces to the contractor and resolving design on-site issues with DCC can lead to a reduction in RPA's control over programming and sequencing of the works, as well as issues with the quality of the finished product. However, if RPA can minimise these external design risks prior to contract award, the likelihood of design-related issues causing delays on site could be reduced while still achieving the desired risk transfer.

In conclusion, Option B performs better than Option A in relation to programme / design flexibility and quality of finish and, if the risks associated with external design interfaces are managed, this option would also provide RPA with a better risk profile than Options C & D under these criteria.

9.7.3 **Option C**

Client Design contract(s) for basements, utility diversions and light rail infrastructure works (including key structures); Design and Build contract(s) for E&M, signalling, and systems integration.

Option C is similar to Option B with the only difference being that the light rail infrastructure works would be client-designed rather than contractor-designed. The following deals with that particular aspect of this option.

This option involves low risk transfer which would increase RPA's commercial exposure in respect of dealing with design issues during the construction stage. However, as mentioned above in the Option B evaluation, transferring full responsibility for managing all third party relationships and developing final designs for the scheme to a contractor removes RPA's influence on programming and sequencing of the works and reduces RPA's input into decisions on quality issues. RPA will inevitably need to be involved in detailed design issues – this assessment is based on RPA's previous experience with city centre Luas works – and Option C is the best option for accommodating these requirements.

Under Option C the key structures at Broadstone and over the Phoenix Park Tunnel (PPT) railway line would also be client-designed. The main issue to consider with the bridge over the PPT railway line is gaining the consent of the Railway Safety Commission (RSC) for the construction of the structure. Iarnród Éireann is responsible for liaising with the RSC to arrange for the granting of this consent, and these consents can have conditions attached. As a client design contract, RPA would be able to incorporate any RSC conditions into the final designs and/or contract conditions, but it would also mean that RPA could not transfer certain risks to the contractor, such as unforeseen ground conditions.

At Broadstone the main issue is the interface with CIE and its subsidiary companies Bus Éireann and Dublin Bus. Access to the bus garages needs to be maintained throughout all phases of the works. As for the PPT structure under a client design contract, RPA would be able to incorporate any CIE bus company conditions into the final designs and/or contract conditions, but it would also mean that RPA could not transfer certain risks to the contractor, such as unforeseen ground conditions.

This option provides a lesser degree of scope for innovation in the design than all of the other options. However, given that (a) one of the procurement objectives for Luas Broombridge is that its designs must integrate with existing Luas Infrastructure and other future Luas projects, and (b) the built-up city centre environment within which Luas Broombridge is to be constructed, the scope for innovation is minimal.

Early commencement of some enabling works may facilitate speedier delivery and there is likely to be a strong indigenous market for a traditional contracting approach. Therefore Option C performs well against this criterion.

Option C would require a greater level of internal resources than Option B across a range of disciplines within RPA throughout the design and construction phases of the project. This could be effectively managed through a mix of existing internal resources as well as engaging external project management support services to assist in this process as demands dictate.

Option C provides RPA with the flexibility to manage this high-profile project. However, it is the also option with the lowest risk transfer.

9.7.4 **Option D**

Early Contractor Involvement (ECI) for enabling works and light rail infrastructure works using previous Luas projects to benchmark the cost plan. Design and Build contract(s) for E&M, signalling, and systems integration.

Option D would be a radical departure from any procurement model previously used by RPA. Hence, Option D scores poorly in terms of minimising process risk.

A benchmark now exists from Luas Red and Green Lines for agreeing a target cost or guaranteed maximum price with a preferred contractor. Under this model contractor innovation will theoretically be high as the reimbursement mechanism under the contract encourages up front idea sharing, opportunities also exist for early contractor input into E&M design. However given the current advanced status of the design for the Luas Broombridge project, opportunities to realise cost savings from contractor innovations are considerably reduced.

Under this model, risks are apportioned to those best placed to manage them. While certain risks are apportioned at contract award stage, some risks are assigned during the contract period in a non-competitive environment, which could expose RPA to significant commercial risks as the project timescales become critical. Furthermore, for reasons previously explained under Option B and C above, it is likely that RPA will need to be involved in managing critical external design interface risks.

Option D provides RPA with a good level of control and a high degree of flexibility while retaining the benefit of private sector project management efficiencies. However, given the constraints on construction programming which will be imposed by external factors such as DCC's traffic management requirements and the interfaces with existing utility companies, there will be few opportunities to derive any significant benefit in this area.

Considerable monitoring is required on procurements of this nature and RPA would have to recruit additional resources to manage this effectively.

9.8 Conclusions

RPA has carried out a test concluding that a PPP-type procurement for Luas Broombridge is not suitable.

RPA then proceeded to assess four different procurement options, A to D.

Option A, the turnkey design and build approach, fails to adequately meet the majority of the procurement objectives and is not considered a suitable procurement option for Luas Broombridge.

Option B has been used successfully in the past by RPA (on Line B1) with client design of enabling works and contractor design and build for the main infrastructure and systems elements. However it is noted that Line B1 was constructed in a suburban setting, rather than a city centre environment where significantly greater and more complex interface issues exist. Option B is an attractive option as the procurement of a design and build contract for the light rail infrastructure works transfers the external design interface risks to the contractor. Given that Luas Broombridge is, to a large extent, a city-centre project, there are significant risks associated with transferring such a degree of control over detailed design, programming / sequencing of the works and third party liaison to a design/build contractor which would have the potential to give rise to serious programme and quality concerns for RPA. In order to overcome the quality and programme risks associated with the design/build approach, RPA would need to develop reference designs to a sufficient level of detail to ensure the requisite standard of quality for the works is achieved. It is also noted that the development of detailed reference designs should also shorten the contractor's design period.

Option C is similar to Option B except that RPA would retain responsibility for the design of the light rail infrastructure and structures. This option is based on the procurement strategy successfully implemented for Line C1. It was noted that by retaining responsibility for the detailed design of all of the works, with the exception of the systems package, this option sees RPA retaining more risk than any of the other options. While this could expose RPA to cost and time claims from contractors it provides the advantage of retaining a greater degree of control over the quality of the finished product and also provides a great deal of flexibility in managing the detailed design issues with local authority and third party interfaces that will inevitably arise. Option C is also the option which requires the largest resource input from RPA for both the design and construction phases, but this has been managed effectively in the past through the use of a mix of internal resources and external project management support services procured specifically for the scheme.

The Early Contractor Involvement (ECI) approach, as detailed in Option D, would perform well in terms of optimising risk transfer. Under this approach the earlier the contractor is procured the greater the commercial benefits that can be realised. However, given the advanced status of the Luas Broombridge design it is unlikely that significant cost savings could be made by procuring the packages using ECI. Furthermore, this approach has not been used previously by RPA for procuring works and therefore there are increased process risks associated with Option D.

Having assessed all of the above options, it is considered that Option B is the most attractive procurement option and best meets the objectives for the procurement of Luas Broombridge. This represents a change in procurement approach to that which was included In the Outline Business case wherein it was concluded that the light rail infrastructure works should be procured using a client design form of contract. This change came about through a process of internal risk reviews, further project definition and consultation with external stakeholders, DCC and CIE in particular. RPA will develop very detailed reference designs which will be reviewed by DCC / CIE for approval in advance of contract award. While it is acknowledged that there may be additional design costs associated with this approach the benefits of transferring design risk to a contractor for the construction stage are seen to out-weigh these costs.

Thus it is considered that Option B represents the optimum procurement strategy for Luas Broombridge.

10 PROGRAMME AND WAY FORWARD

10.1 Chapter Summary

- This chapter looks at the activities following submission of the Updated Detailed Business Case;
- Timely approval of the Updated Detailed Business Case and timely implementation of the activities described are essential for the project to remain on target for completion at the end of 2017. The nature and extent of the 1916 centenary celebrations will be key constraints on the delivery of the project programme;
- The design and procurement process and the finalisation of the funding arrangements are core activities to be progressed prior to construction commencement in 2013;
- A Railway Order application was subm

  granted a Railway Order for the project on 2 August 2012;
- An effective and integrated communications plan will be implemented by RPA which will aim to build confidence in RPA's ability to deliver the project while managing the potential negative effects of the works.

10.2 Activities

The key RPA tasks following granting of Railway Order and approval of the detailed Business Case update are as follows:

10.2.1 Procurement

RPA will commence the procurement process for the enabling works, utility works, and the civil & track works following a call for competition in the Official Journal of the European Union (OJEU Notice). An OJEU Notice has already been issued for the Heritage works and for the Utility Diversion works contracts. This will be followed by pre-qualification of suitable bidders and a formal tender process. Contracts for heritage works, the re-lining of sewers, filling of cellars, and utility diversions are all scheduled to be awarded by mid-2013 allowing construction to commence on a phased basis at that time.

10.2.2 Design

There is little in the way of substantive change or amendment required to the scope of the proposed scheme as a consequence of the Railway Order granted on 2 August 2012 and the conditions attached thereto. The principal amendment has arisen from the decision of the Bord to condition the removal of the northbound stop platform on Dawson Street.

Prior to issuing any tender documents the detailed design will be completed for the scope of works identified for each contract. This design work will also help RPA to identify the interface requirements with other developments and with the relevant authorities in advance of construction. Substantial elements of the city centre detailed design will be carried out in-house. Further details are to be found in Chapter 9 of this updated Detailed Business Case.

10.2.3 Construction

The sequence of construction of Luas Broombridge will largely be dictated by the need to minimise impacts on traffic flow and access to the city during the construction period with an emphasis on public transport priority and servicing needs of commercial premises. The works will require to be undertaken in such a manner that will avoid conflicting with the occurrence of 1916 centenary commemoration events in O'Connell Street and its environs. Further definition will be applied to this sequencing once the events, their timing and durations become known and contractors appointed to the works develop the detailed traffic management plans.

10.2.4 Funding

The funding arrangements required to implement the project will be agreed with NTA prior to the commencement of construction. These will require ongoing review to take account of tender experience and overall progress with the construction contracts.

10.2.5 Communications

An effective and integrated communications plan will be implemented by RPA which will aim to build confidence in the delivery of the project, reduce the potential negative effect of the works and underscore the benefits of Luas Broombridge. The strategy will build upon RPA's extensive communications efforts made to-date and will cover the period of construction from enabling works to commissioning.

The key messages of the communications plan will focus on RPA delivering a new transport option for Dublin and keeping the city centre open for business during the period of construction.

10.3 Programme

The key programme dates are set out in Table10-1 below. The dates set out in the this table are dependent on a number of factors including:

- Timely approval of this Updated Detailed Business Case (UDBC); and
- Provision of necessary funding in line with the implementation programme.

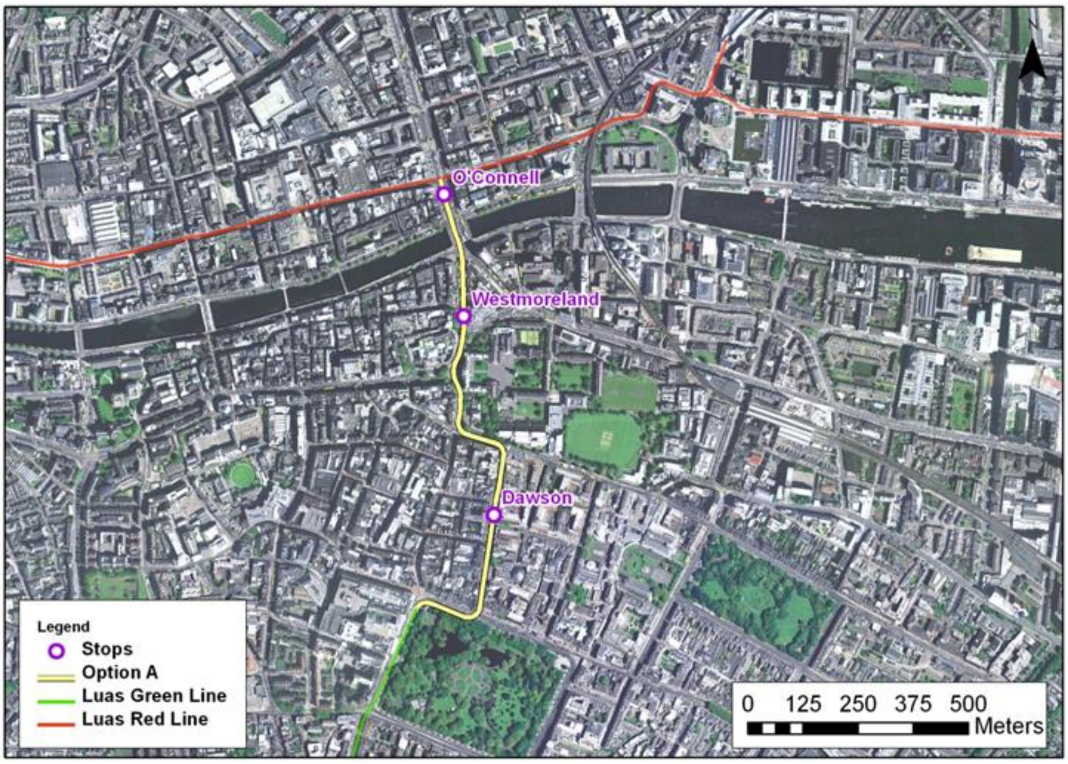
Table 10-1 Key Dates for Luas Broombridge Programme

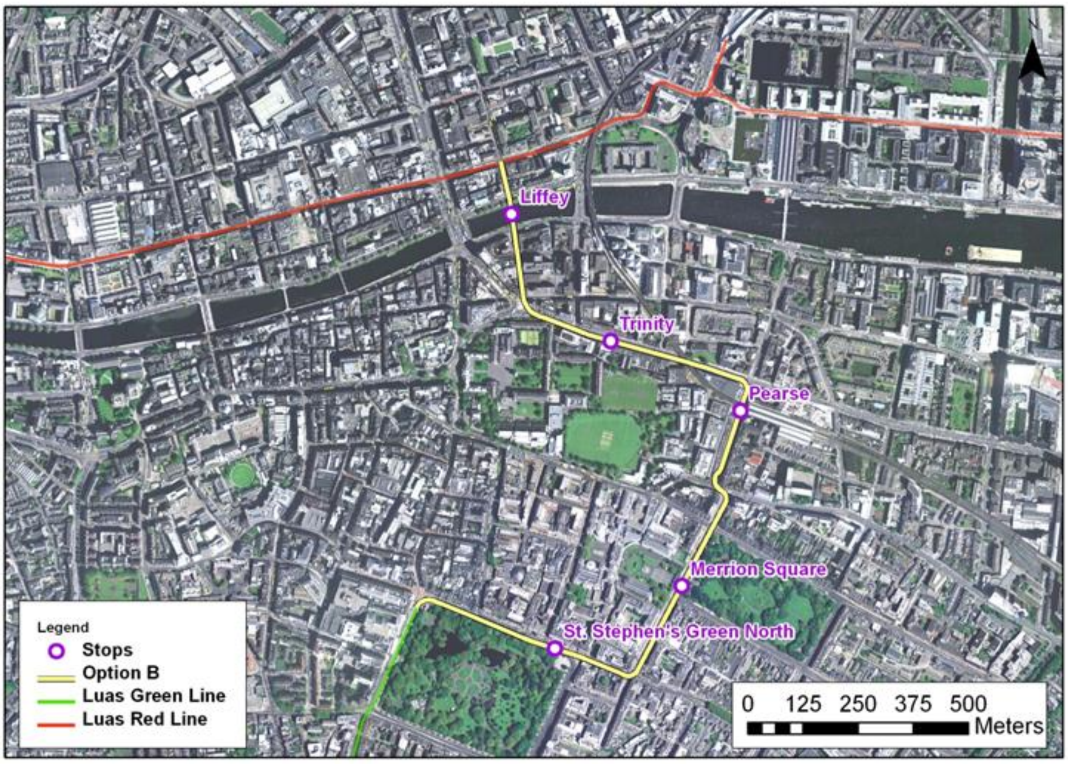
	Start	Finish	2012	2013	2014	2015	2016	2017
NTA Approve Detailed Business Case	Oct-12	Nov-12						
Sewer Re-Lining - Award		Apr-13						
Sewer Re-Lining - Construction	Apr-13	Sep-14						
Heritage Works- Award		May-13						
Heritage Works - Implementation	May-13	Feb-17						
Cellars - Award		May-13						
Cellars - Construction	May-13	Apr-14						
Utility Diversions - Award		Jun-13						
Utility Diversions - Construction	Jul-13	Oct-15						
Main Infrastructure - Award		Nov-14						
Main Infrastructure - Construction	Jan-15	Dec-16						
Power & Systems - Award		Apr-16						
Power & Systems - Installation	Apr-16	Mar-17						
Trial Running	Jun-17	Oct-17						

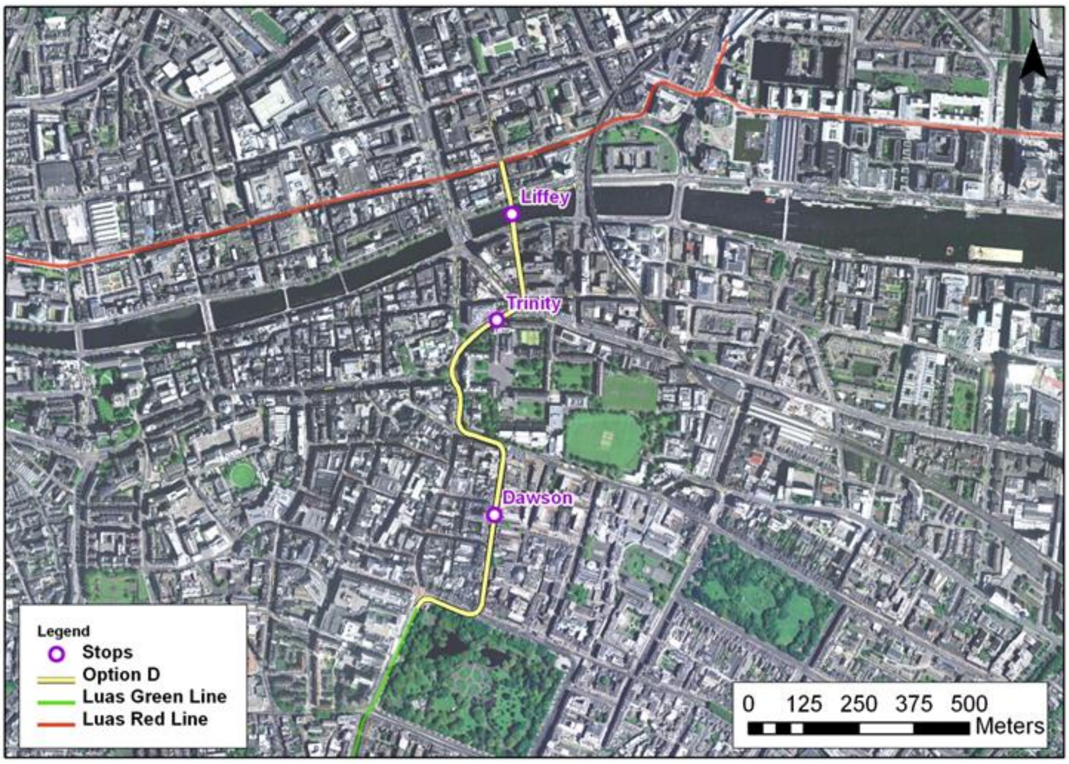
APPENDICES

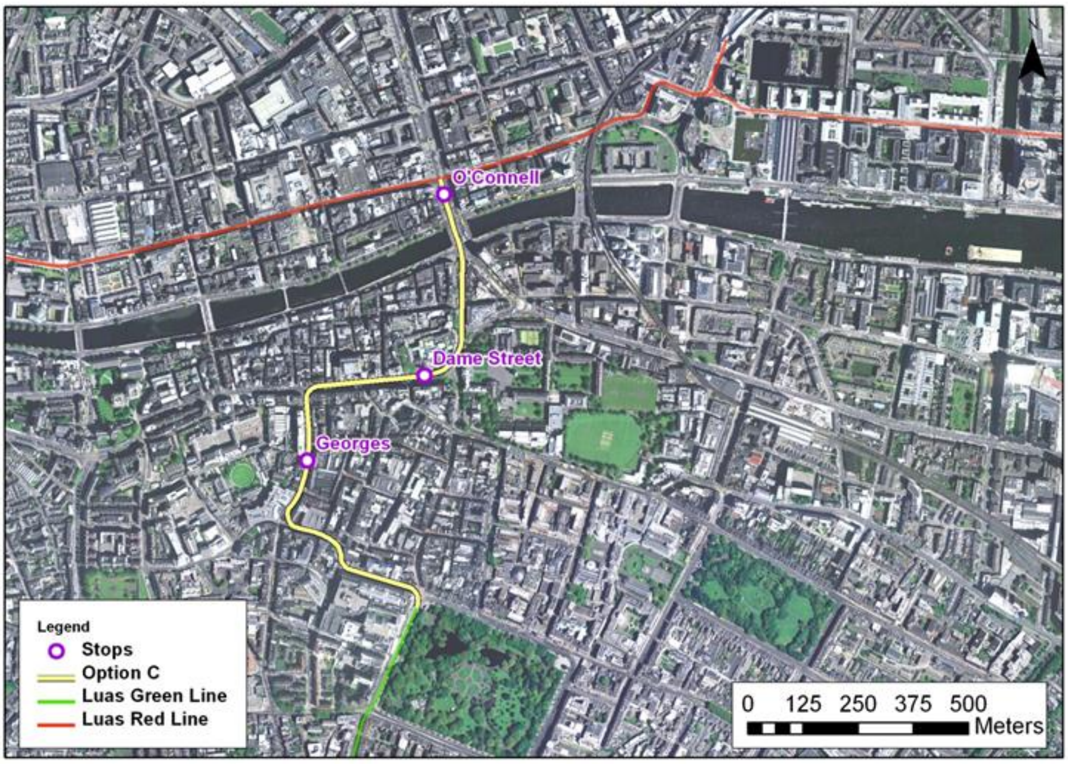
Appendix 1

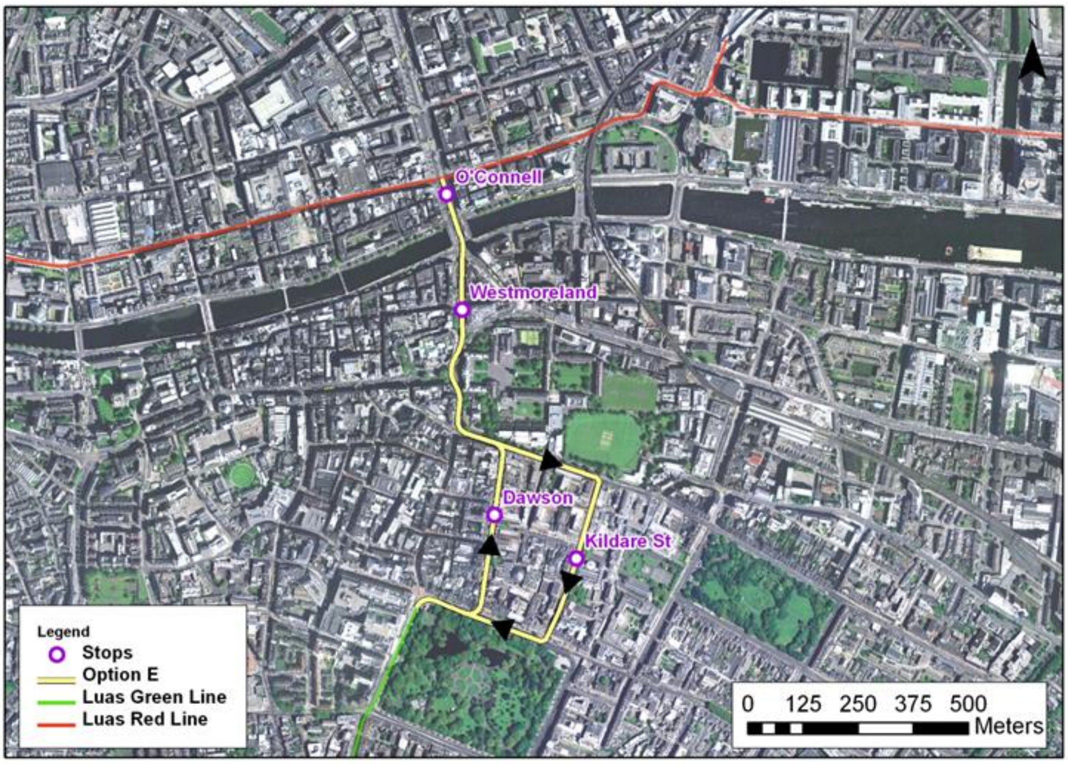
St. Stephen's Green to Red Line Route Options

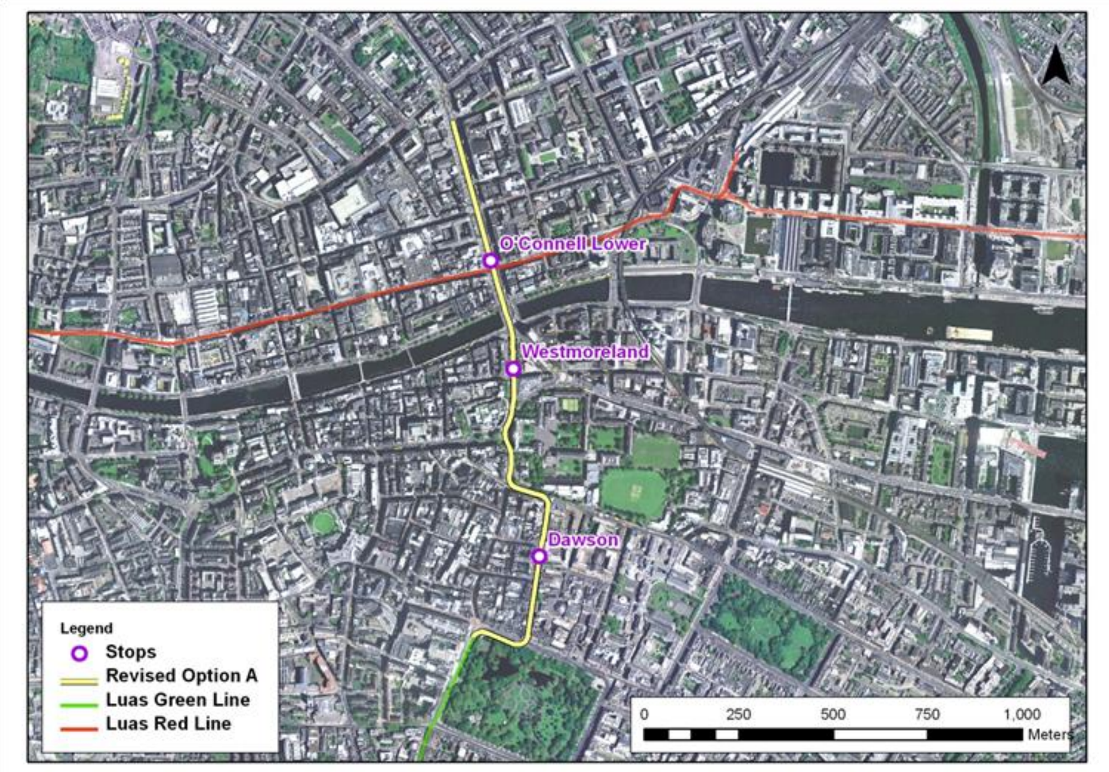


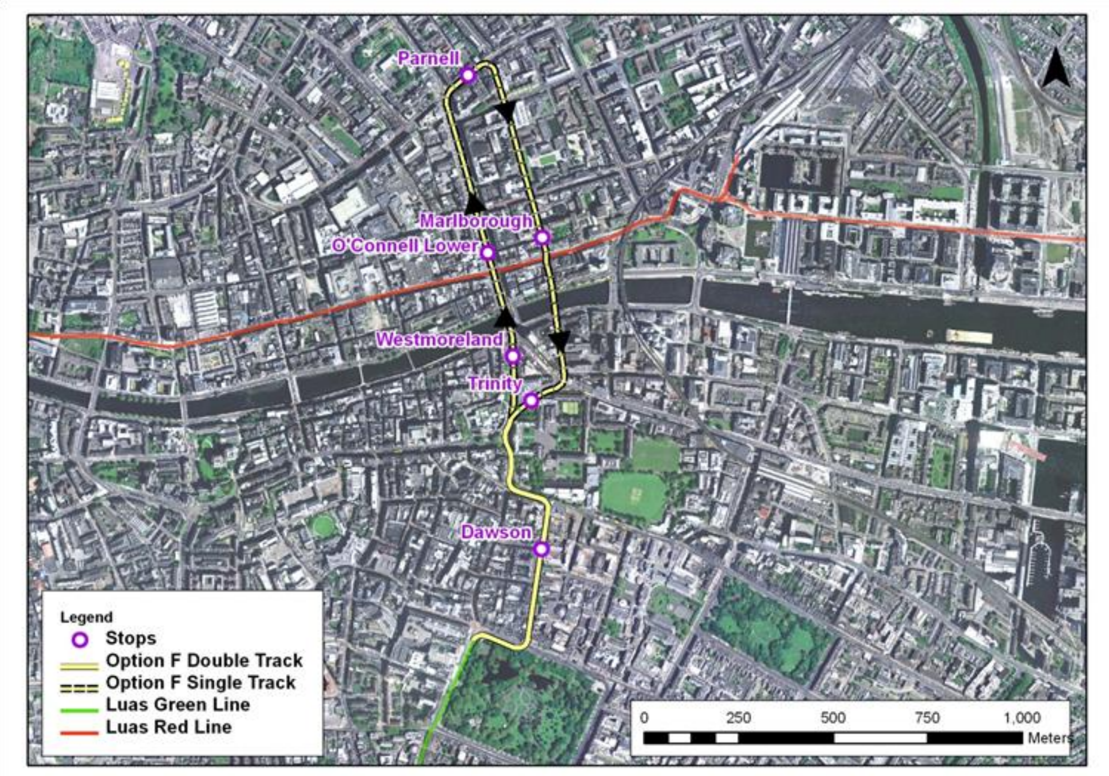



Liffey
Trinity
Dawson
Legend
Stops
Option D
Luas Green Line
Luas Red Line
0 125 250 375 500
Meters


O'Connell
Dame Street
Georges
Legend
Stops
Option C
Luas Green Line
Luas Red Line
0 125 250 375 500
Meters

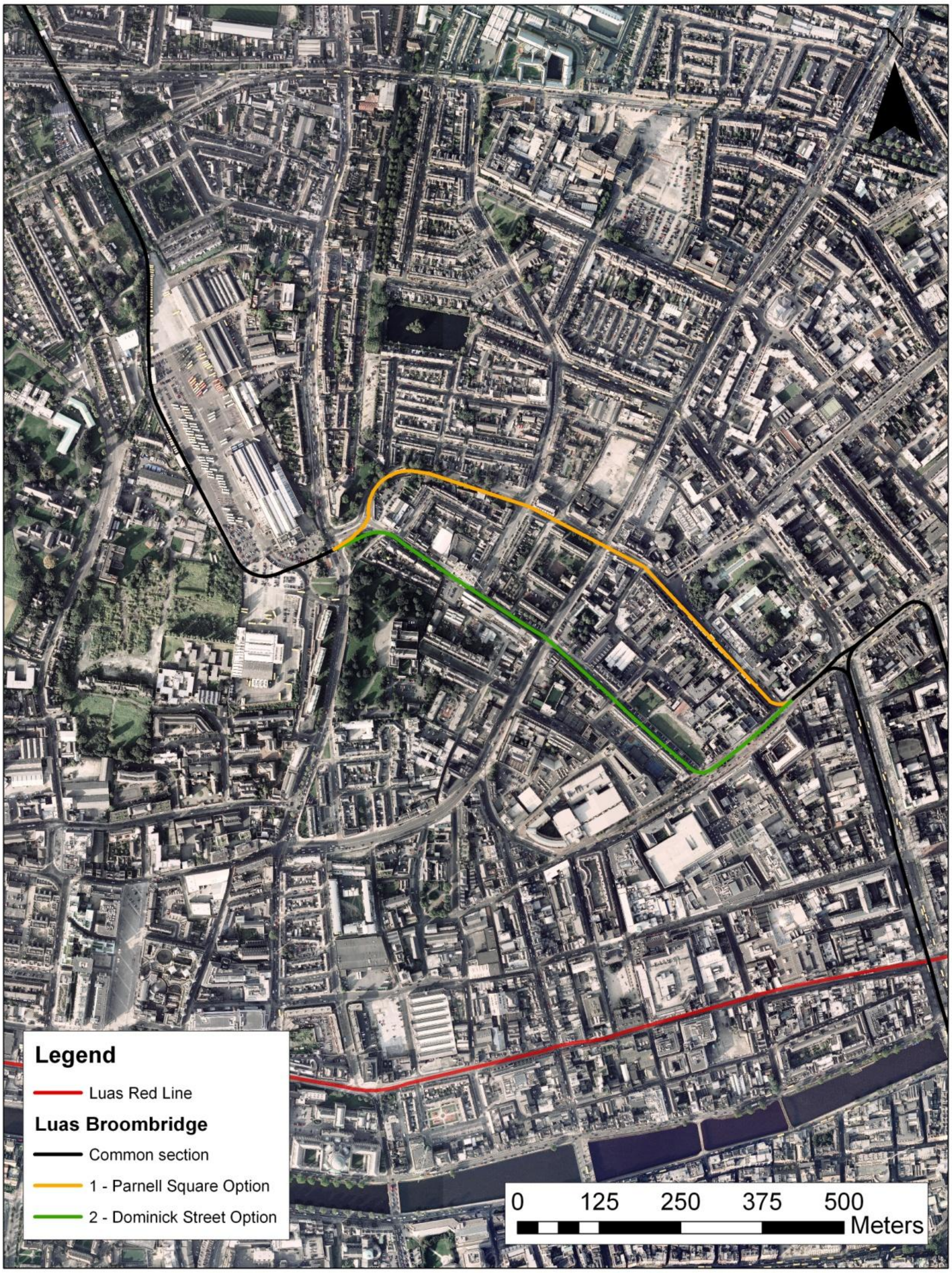

O'Connell
Westmoreland
Dawson
Kildare St
Legend
Stops
Option E
Luas Green Line
Luas Red Line
0 125 250 375 500
Meters





Revised Option A and Option F

City Centre / Red Line to Broadstone Route Options



PRIMARY CRITERIA	Measure	Dominick Street / Cathal Brugha Street	Parnell Square West / Cathal Brugha Street	Dominick Street / Parnell Street	Parnell Square West / Parnell Street	Comments on Assessment
Economy - Costs/Funding	Capital Costs	3	3	3	3	The route options are similar in lengths and hence this measure is ignored for the purposes of evaluating options.
	Expected Patronage	3	3	3	3	Demand modelling reveals no difference in results across the options. A neutral score is assigend for all options.
	O&M costs	3	3	3	3	Similar to other costs, the O&M costs for all the options would be the same due to the same number of vehicles required, similar demand, similar track geometry and similar run times.
	Journey Time	3	3	3	3	Journey time differences are in the order of seconds between the different routes therefore no difference in scores.
	Developer Funding Opportunities	2	2	2	2	There are no funding opportunities via development levies along the on-street sections.
	Average Score	2.8	2.8	2.8	2.8	
Environment	Ecology	3	3	3	3	Similar across all options
	Water Quality	3	3	3	3	Similar across all options
	Soils and Geology	3	3	3	3	Similar across all options
	Landscape and Visual	5	5	5	5	All options present opportunities for streetscape improvement in similar terms
	Archaelogy	2	1	2	1	Dominic St was preferable to the Parnell Square West options as this Parnell Square West route impacts on two Recorded Monuments
	Architectural Heritage	2	1	2	1	Parnell Square West Options were also considered less preferable from an architectural heritage perspective as this route impacts on a greater number of protected structures including their coal holes and cellars
	Air Quality	3	3	3	3	The number of car trips reduced would be simialr across the options from the model results.
	Traffic Impacts	2	2	2	2	All routes similar in repsect of interactions with road junctions
	Average Score	2.875	2.625	2.875	2.625	
Accessibility & Social Inclusion	Employment Catchments	5	5	5	5	Very High in the City Centre, there fore mark of 5 given for each. No difference between each route option due to analysis based on zones
	Residential Catchments	3	3	3	3	Score of 3 given as the catchemnt is true medium density areas given for each.
	Access to transport system for vunerable groups	3	3	3	3	No difference between each route option due to analysis based on zones
	Deprived Geographic areas	3	3	3	3	Both the Dominick Street and Parnell Square West options run through the same RAPID Area.
	Average Score	3.5	3.5	3.5	3.5	
Integration	Integration with overall network Bus	3	3	4	4	Those options with a routing via Parnell Square West will score higher as a stop on Parnell Street would offer significant advantages due to close proximity of interchange with buses on Parnell Square East.
	Rail	4	4	4	4	As all options will provide interchange with Maynooth Railway line services at Broombridge,

PRIMARY CRITERIA	Measure	Dominick Street / Cathal Brugha Street	Parnell Square West / Cathal Brugha Street	Dominick Street / Parnell Street	Parnell Square West / Parnell Street	Comments on Assessment
						they will all score the same
	Metro	2	2	4	4	Those options that route via Parnell Street would benefit from better interchange with future Metro North stop on Parnell Square East arising out of a Line D stop location on Parnell Street. Other options do not provide good interchange with Metro North.
	Shopping Centres	5	5	4	4	Route options on Dominick Street and Parnell Square West that also use Cathal Brugha Street serve both Carlton and ILAC better than a route option via Parnell Street
	Hospital	3	4	3	4	Route options that use Parnell Square West better serve the Rotunda Hospital than those that do no.
	Others	2	4	2	4	Route options on Parnell Square West better serve the Museums and other places of interest on Parnell Square North (Museums, Garden of Remembrance), Parnell Square West (Comhaltas Ceoltoiri etc) and on Granby Row (Wax Museum).
	Operations	2	2	4	4	Options that route via O'Connell Street and Cathal Brugha Street require more in the way of curved track. Two additional 25m radii are required as against a single 25m radius on the turn from Parnell Street to Marlborough Street.
	Transport and Land Use Policies	4	4	4	4	Simialr across all options, no discernible difference.
	Impact on Buses	4	2	2	2	A route option via Dominick Street / Cathal Brugha Street does not require any change or loss of bus lanes or stops.
	Government Policy	5	5	5	5	All options comply with Government Policy as Line D is included within Transport 21
	Other (non-transport, non-land use) Government policy	4	4	4	4	All options will result contirbuite to the development of a more sustainable city centre environment.
	Average Score	3.5	3.6	3.6	3.9	
Constructability/Engineering	Construction Safety	3	2	4	3	Construction of route options that entail O'Connell Street / Cathal Brugha Street (buses, vehicles, pedestrians) and Parnell Square West (buses, vehicles, pedestrians) will entail greater interaction with road vehicles and pedestrians than other route otpions.
	Impact on highway network	3	2	3	2	In the case of Dominick Street / Cathal Brugha Street, this will include Parnell Street and O'Connell Street. Dominick Street is not considered a strategic route. For Dominick Street / Parnell Street, this will include Parnell Street east and west. Dominck Street and Marlborough Street are not considered strategic routes. For Parnell Sq. West and Cathal Brugha Street there are three strategic routes - Parnell Square West, Parnell Street and O'Connell Street For Parnell Sq. West / parnell Street, stratgeic routes affected woudl be Parnell Sq. West, Parnell Street east and Parnell Street west

PRIMARY CRITERIA	Measure	Dominick Street / Cathal Brugha Street	Parnell Square West / Cathal Brugha Street	Dominick Street / Parnell Street	Parnell Square West / Parnell Street	Comments on Assessment
	Utilities interface	4	2	4	2	Route options that utilise Dominick Street have much less in the way of impacts on utilities than options centreing on Parnell Square West. Cathal Brugha Street and Parnell Street are similar in respect of impacts on utilities.
	Geotechnical	3	3	3	3	similar across all options
	Maintainability	3	3	5	5	Increased curvature on track associated with Cathal Brugha Street options.
	Average Score	2.6	2	3.16	2.5	
Other	Commercial Impact (Office/Retail)	3	3	3	3	No discernible differences between the options. Options on Dominick Street potential to offer advantages to redevelopment proposals.
	Parking / Traffic Management	2	1	2	1	Options via Parnell Square West would impact adversely on road capacity and kerbside facilities on that strategic route.
	Public Consultation Support	4	4	4	4	Based on submissions to the consultation process, there was public supported for all route options
	Objections	2	4	2	4	Based on consultation process, there was objections to the Dominick Street option from residents on Dominick Street
	DCC Support	2	2	4	2	DCC support for Dominick Street and Parnell Street routing.
	Average Score	2.6	2.8	3	2.8	
Safety	Number of road traffic junctions	4	4	4	4	Similar across all options.
	Average Score	4	4	4	4	
Totals		21.94	21.33	**22.94**	22.13	
Averaged Totals	**Scoring**	3.13	3.05	**3.28**	3.16	

MCA of City Centre / Red Line to Broadstone Route Options

Appendix 2

CBA Parameters	
Discount Rate	4.00%
Appraisal Period	30
Price Base	2002
Evaluation Base	2002
Opening Year	2018
Economic Growth	
	Real GNP Growth % pa
2000 to 2002	6.23%
2002 to 2010	2.70%
2011 to 2015	2.37%
2016+	2.29%
Value of Time Market Price (€ per person per hour)	
Work or Business Values of Time	€26.50
Non Work values of time	
Commuting Time	€8.10
Non Commuting Time	€7.30
Car Occupancy	
2006	
Am Peak	1.2
Inter Peak	1.4

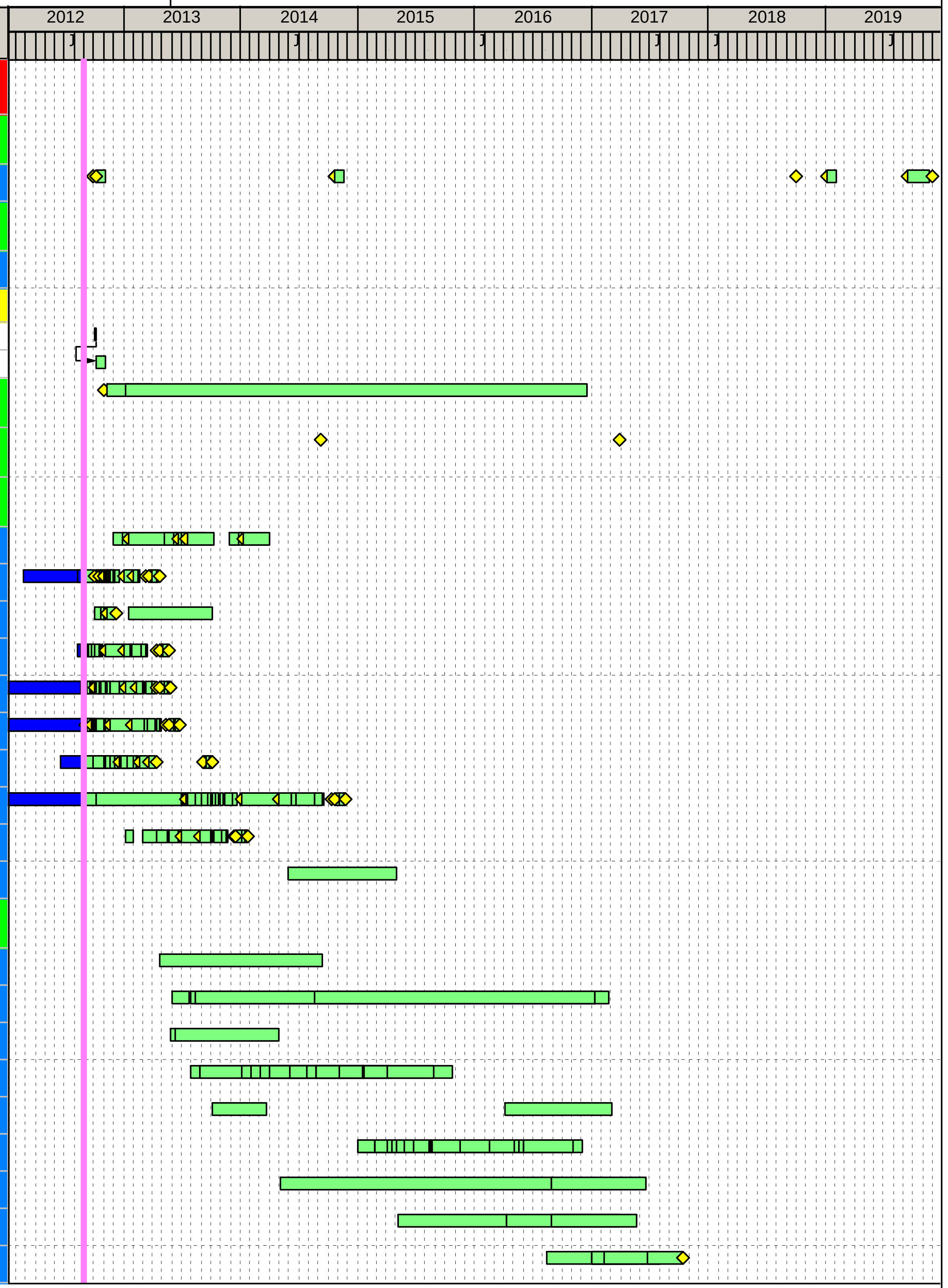
2030	
Am Peak	1.2
Inter Peak	1.4
Accident Costs	
Accident Rate (per m veh km)	0.054
Average cost per accident (2002)	€ 179,343
Vehicle Operating Costs	
Fuel Consumption Parameters	
Resource cost of fuel	€ 0.33
Duty	€ 0.39
VAT	€ 0.15
L = a + bv + cv^2	
a	0.1587516
b	-0.0026590
c	0.0000181
Non Fuel Costs	
C=a1 +(b1/V)	
a1 work	6.18
b1work	31.58
a1 non work	6.18
b1non work	31.58
Operational Build Up	
Years from opening	

2018	100%
2019	100%
2020	100%
2021	100%
2022	100%
2023	100%
Demand Build Up	
Years from opening	
2018	80%
2019	85%
2020	90%
2021	100%
2022	100%
2023	100%
Annualisation	
Public Transport	
Peak Hour 1 Peak Hour 2 Peak Hour 3	 476
Off Peak	2850
Air Quality (Urban) € (2002) per vehicle km	
Values taken from Treatment of Transport Emissions in the CAF – September, 2009	

10-1 CBA Parameters

Appendix 3

Activity ID	Activity Name	Original Duration	Start	Finish
Line BXD - St. Stephen's Green - Broombridge		2249	04-Apr-11 A	29-Nov-19
The NTA Gate Process		1783	28-Sep-12	29-Nov-19
NTA Gate Process		1783	28-Sep-12	29-Nov-19
Detailed Business Case		21	05-Oct-12	06-Nov-12
Detailed Business Case		21	05-Oct-12	06-Nov-12
Approval of Detailed Business Case		21	05-Oct-12	06-Nov-12
BXDFBC0025	Submit Detailed Business Case to NTA	1	05-Oct-12*	08-Oct-12
BXDFBC0030	NTA review and approve Detailed Business Case	20	08-Oct-12	06-Nov-12
Property Procurement		1066	01-Nov-12	16-Dec-16
Railway Safety Commission Approvals		659	11-Sep-14	30-Mar-17
Design, Documentation and Procurement		1059	04-Apr-11 A	05-May-15
Ministerial Consent for Heritage Works		346	30-Nov-12	04-Apr-14
BXD_104 Sewer Re-Lining		300	24-Feb-12 A	23-Apr-13
BXD_170 Condition Survey		262	01-Oct-12	03-Oct-13
BXD_102 Heritage Works		205	09-Aug-12 A	24-May-13
BXD_100 BXD Investigation & Treatment of Cellars		450	05-Sep-11 A	29-May-13
BXD _101 Utility Diversions Documentation and Procurement		579	04-Apr-11 A	25-Jun-13
BXD_410 Stop Furniture Supply		335	20-Jun-12 A	04-Oct-13
BXD_400 Main Infrastructure Civil & Track Works		906	01-Jun-11 A	27-Nov-14
BXD_500 Rolling Stock Procurement, Manufacture, Delivery		271	07-Jan-13	23-Jan-14
BXD_450 Systems & Power		240	30-May-14	05-May-15
Construction Implementation		1159	23-Apr-13	12-Oct-17
BXD_104 Sewer Re-Lining		360	23-Apr-13	11-Sep-14
BXD_102 Heritage Works		927	31-May-13	24-Feb-17
BXD_100 BXD Investigation & Treatment of Cellars		238	29-May-13	30-Apr-14
BXD_101 Utility Diversions		578	30-Jul-13	23-Oct-15
BXD_410 Stop Furniture Supply		883	04-Oct-13	06-Mar-17
BXD_400 Main Infrastructure Civil & Track Works		496	02-Jan-15	01-Dec-16
BXD_500 Rolling Stock Procurement, Manufacture, Delivery		812	05-May-14	21-Jun-17
BXD_450 Systems & Power		532	06-May-15	23-May-17
Testing & Commissioning and Trial Running		290	16-Aug-16	12-Oct-17



LUAS Broombridge

Summary Design,Procurement & Construction

Programme

Version No. BXD _001_91

Date	Revision	Checked	Approved
31-Aug-12	Version No. BXD PG_001_91	JVC	