

## **Docklands Bus / Luas Comparison Study**

### **Final Report**



**May 2006**

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It should be noted that the costs presented in this report are not those prepared by the Railway Procurement Agency for the Business Case of Luas Line C1 but have been developed by Jacobs Consultancy in discussion with the RPA and other data available for the study. The costs for Luas Line C1 are likely to change as the scheme is further developed, though the RPA consider that such change will not be significant in the context of this study.



## EXECUTIVE SUMMARY

### Background

The Dublin Transport Strategy outlined in the Dublin Transportation Office (DTO) document 'A Platform for Change'<sup>1</sup> recommended extending the current Luas Red Line from Connolly to The Point in the Docklands redevelopment area. The Railway Procurement Agency has developed the scheme, termed Luas Line C1, which proposes to extend the Luas route along Mayor Street Lower and Mayor Street Upper with a new bridge over Spencer Dock and additional stops at George's Dock, Mayor Square, Spencer Dock and The Point.

The Dublin Transportation Office commissioned Jacobs Consultancy to undertake the Dublin Docklands Bus / Luas comparison study in January 2006 to inform and support the decision making process. The study brief was to investigate the potential for a bus alternative to Luas Line C1 between Connolly and The Point and to compare this with the Luas Line C1 scheme.

### Study Methodology

The Study progressed through a series of discrete stages:

- Study area definition;
- Review of the background in terms of land use and transport network changes, target markets, and operating issues;
- Definition of an appraisal framework for the comparison of options based on a review of the background policy documents;
- Review of bus technology options;
- Definition of bus route options;
- Scoring of bus options against the appraisal framework and shortlisting the best bus options;
- Technical assessment of the best bus options examining operating and engineering issues and costs;
- Demand and revenue forecasting using the DTO multi-modal transport model; and
- Scoring the best bus options and Luas Line C1 against the appraisal framework.

### Study Area and Issues

The study area was defined as the core north docklands redevelopment area bounded by Amiens Street, North Wall Quay, East Wall Road and Sheriff Street. Whilst the area west of Guild Street is already well developed the area between Spencer Dock and The Point has yet to be redeveloped. The Dublin Docklands Development Authority (DDDA) has developed a master plan<sup>2</sup> and planning schemes<sup>3</sup> for the area, which incorporate forecasts of substantial growth in the population and employment of the area by 2016. This development is to be focused on a public transport artery along Mayor Street where it will be of a higher density with a landmark 100m tower to the north of The Point close to the proposed terminus of Luas Line C1.

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<sup>1</sup> A Platform for Change, Dublin Transportation Office, November 2001

<sup>2</sup> DDDA Dublin Docklands Area Masterplan 2003

<sup>3</sup> DDDA Docklands North Lotts Planning Scheme, July 2002, DDDA Docklands North Lotts Amending Planning Scheme, January 2006

The Point is a significant existing trip attractor within the study area and is to be expanded from a capacity of 8,500 seats to 14,500 seats. The proposed Luas Line C1 is an important element of the transport strategy for The Point<sup>4</sup> – providing for the rapid dispersal of over half of the visitors to the venue. The ability of the bus option to perform this function is a key issue.

The DDDA advised that the strong market for growth in Docklands means that, rather than public transport being required to encourage development, the key issue is the contribution to reducing the potential 'transport deficit' resulting from the intensive development with restrictive parking supply policies which form part of the sustainable development strategy. It is important to understand to what extent the options assist in achieving the stated public transport mode share target of 85% of all motorised trips in the morning peak hour by 2016.<sup>5</sup>

The development plan for north Docklands also includes the proposed development of the National Conference Centre at Spencer Dock. Transport schemes underway or proposed in the area include the Dublin Port Tunnel with associated widening of East Wall Road and Macken Street Bridge to the west of Spencer Dock, both likely to be in place before the Luas Line C1. Irish Rail propose to construct a new station at Spencer Dock to the north of Sheriff Street, to provide for terminating Maynooth corridor rail services. As part of the Government's 10 year transport investment plan *Transport 21*, they are also proposing the Interconnector project which will link train services from Heuston to Docklands and the northern DART corridor via a tunnel, and a series of underground stations, including one in Docklands to the south of North Wall Quay.

The redevelopment of the area coupled with the transport network changes is expected to lead to significant traffic levels on North Wall Quay, East Wall Road, Sheriff Street and Amiens Street and significant levels of access traffic on Mayor Street and the various north-south roads crossing it. Public transport passengers expect reliable journeys and particularly dislike interchanging between services. The public transport network in north Docklands needs to connect with the network in the City Centre to maximise its attractiveness for trips to and from the area

### Defined Appraisal Framework

An appraisal framework was developed from a review of the National, Regional and Local Objectives defined within the relevant planning documents; The National Spatial Strategy 2002, The Department of Transport Statement of Strategy 2005 – 2007, the Dublin Regional Planning Guidelines 2003, the Dublin Transportation Office Transport Strategy "A Platform for Change" 2001, the Dublin City Development Plan 2005 – 2011, and Dublin Docklands Development Authority Master Plan 2003 and Docklands North Lotts Planning Scheme 2002.

For each objective, sub-criteria were defined to enable the contribution of each option to be assessed using quantitative data where possible. The framework objectives and sub-criteria were defined as:

- **Safety;**
- **Economy;**
- Sub-criteria: Value for Money (defined as demand (scored as Connectivity, Journey Time and Vehicle Quality<sup>6</sup>) Operating Cost and Capital Cost) and Economic Regeneration.

<sup>4</sup> North Lotts Planning Scheme Draft Amendment No 1 – EIS supplied by DDDA.

<sup>5</sup> Dublin Transportation Office, A Platform for Change, November 2001.

<sup>6</sup> In the later comparison of shortlisted bus and Luas Options demand was informed by the model results.

- **Integration;**
- Sub-criteria: Interchanges and Spatial Strategy.
- **Accessibility;**
- Sub-criteria: Social Inclusion and City Core access for Docklands Residents (to Retail and Employment by direction) and for Docklands Employees (direct connections from outside Docklands and Indirect Connections to the North, South and West).
- **Environment;**
- Sub- criteria: Noise, Local Air Quality, Greenhouse Gases, Landscape, Townscape, Heritage, Biodiversity, Water Environment, Physical Fitness and Journey Ambience.
- **Mode Shift;**
- **Efficiency;**
- Sub-criteria: Reliability, Public Transport Capacity and Impact on the Highway Network.
- **Affordability;**
- **Deliverability;**
- Sub-criteria: Public Acceptability, Technical Practicality and Disruption.
- **Regeneration:** defined as: Penetration, Stimulation and City Living; and
- **Attractiveness:** of the public transport option.

Regeneration appears twice in the framework, firstly the value of economic regeneration within the Economy Objective but also as a separate local planning objective to highlight the importance of transport in this context within the study area.

The same appraisal framework was applied at two stages in the study, firstly for comparing and shortlisting the bus options and secondly in the comparison of shortlisted options with Luas Line C1. The contribution of each option to the objectives was scored using a 7-point scale, substantial positive, significant positive, slight positive, neutral impact, slight negative, significant negative and substantial negative impacts.

### Defined Bus technology and Route Options

To enable a robust comparison with the Luas C1 scheme, bus options would need to be of a high quality. This would primarily relate to the vehicle design, propulsion and guidance system. It was assumed that a modern tram-like bus with single articulation would be most appropriate (with more than 1 type available). It would not be practical to use physical guidance technology, such as raised kerbs in the Docklands operating environment due to the severance impacts on traffic and pedestrians. There might be some marginal benefit to passengers of minimising the separation between stop platform and vehicle through the use of modern guidance technology such as optical guidance or wire guidance, though at a significant additional vehicle and / or infrastructure cost. It would be most practical if the buses were of a high quality and capacity, diesel powered and not guided.

Site visits were undertaken to identify operating constraints and seven main bus route options were defined to meet the targeted objectives. Four short shuttle bus options between Connolly and the Point were defined, with differences related to avoiding the need for a new bridge over Spencer Dock (north and south) and the terminus at The Point. Three longer service options were defined to provide enhanced accessibility and improved interchange with buses and trains. They were extensions to Heuston Station, to East Point Business Park and to St Stephens Green.

## Shorlisting Bus Options

The appraisal framework was used to highlight the difference between the bus options in contributing to the agreed objectives. Two options were selected for further development:

- The best shuttle bus option (Option 1), operating along the Mayor Street alignment and with loops around Connolly and The Point at each end to turn the vehicle; and
- The best longer bus service option (Option 6), effectively an extension of the current Dublin Bus service 90 between Heuston and Connolly, utilising the Mayor Street alignment and extending from the Point to East Wall and East Point Business Park.

## Technical Assessment of Bus Options

Technical assessment of the operations issues and operating costs as well as infrastructure requirements and capital costs of the two bus options was undertaken. The operations assessment included the ability of the bus options to serve the needs of The Point in distributing passengers away from the site after large events. This was deemed a significant issue for bus, especially for the shuttle bus option (Option 1), which would have a small fleet.

The demand for the two best bus options (Option 1 and Option 6) was estimated through the use of the DTO transport model. It is to be expected that passengers would appreciate the quality of the vehicles as higher than an ordinary bus but lower than for Luas, due to the difference in vehicle size and capacity, propulsion, guidance and physical presence and related ride quality. Each bus option was coded in the model as though it were a Luas with the same quality assumptions. As a sensitivity test at the other extreme, journey times were coded to reflect the current bus mode penalty within the model. Demand forecasts were expanded and economic evaluations undertaken using factors and assumptions in line with the RPA's Luas Line C1 business case assumptions.

## Comparison of Bus Options with Luas Line C1

The bus options are compared with Luas Line C1<sup>7</sup> in Table 1 – highlighting key technical issues. An important difference is the forecast ridership in north Docklands, which is significantly lower for the bus options. This is because Luas Line C1 benefits passengers by reducing the need to interchange at Connolly and providing a direct route to north Docklands.

The bus and Luas route options were compared through the application of the defined appraisal framework. A key element of this relates to the economic value for money assessment which is summarised in Table 2. We were not able to estimate accurate network-wide user, new user and non-user time savings resulting from the options using the model. Instead, elements of the economic evaluation pertaining to the study area were examined and the evaluation tested assuming a 3 minute user time saving for all options and appropriate ranges for transfer from car. The Present Value (PV) figures in Table 2 are 2002 prices and discounted to a 2002 base year.

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<sup>7</sup> Drawing on information in the EISDublin Light Rail, Line C1 Connolly to the Point Depot, published by the RPA.



**Table 1 Bus vs Luas Comparison: Technical Information**

Factor	Bus Option 1 (Shuttle)	Bus Option 6 (extended)	Luas Line C1
Round Trip Time	17.5 minutes	81 minutes	14 minutes
Fleet Size	6 (4 in service)	20 (18 in service)	1 additional vehicle in service
Capacity at 5 min freq	1440 passengers per direction	1440 passengers per direction	3,720 passengers per direction (practical capacity)
Ability to serve Point events	11 Supplementary buses required	Requirement to lower the frequency on extended network.	With existing fleet.
Annual Operating costs	€1.4m	€3m (over service 90 costs)	€1.2m additional costs
Capital Costs	€18.8m (2006 prices)	€36m (2006 prices)	€56.2m (2002 prices)
Annual Demand	1.29m – 2.20m	4.50m – 5.86m (over service 90)	6.354m – additional passengers (and over 11m passengers per annum travelling within Docklands)
Peak vehicle load <sup>8</sup>	37 - 61	87 - 113	233

**Table 2 Bus vs Luas Comparison: Financial and Economic Assessment**

	Bus Option 1 €m	Bus Option 6 €m	Luas Line C1 €m
PV Capital Costs	15.7	34.8	45.8
PV Operating Costs	17.9	37.5	14.7
PV Total Costs	33.6	72.3	60.5
PV Revenues	20.9 – 35.6	72.6 – 94.7	102.7
PV Net Revenue	2.96 – 17.7	35.1 – 57.2	88.0
Net revenue/ Capital Costs	0.19 – 1.13	1.01 – 1.64	1.92
Total Costs / Passenger per annum	€15 - €26	€12 - €26	€10
Economic Evaluation test Benefit Cost Ratio	0.49 – 0.89	0.87 – 1.01	2.35

In terms of the evaluation against the objectives it was concluded that the appraisal scores for Luas were more favourable than for the shuttle bus route (Option 1) on the criteria of economy, integration, accessibility, mode shift, efficiency, regeneration and attractiveness. The Luas and shuttle bus option scored the same for the safety, environment, and affordability objectives. The appraisal scores for the deliverability objective are similar, however, Luas was allocated a greater positive and greater adverse score. There was no objective in which the shuttle bus option scored favourably over the Luas option, therefore the Luas option is considered better than the shuttle bus route (Option 1).

In addition the Luas scored more favourably on the safety, economy, efficiency and attractiveness objectives than the extended bus route (Option 6). Luas and the extended bus option achieved the same appraisal score for the integration, environment, mode shift, affordability and regeneration objectives. Their appraisal scores for the deliverability objective were similar, however, Luas was allocated a greater positive and greater adverse score. The extended bus option scored favourably over Luas only on the accessibility objective – though this is related to serving the East Wall and East Point Business Park rather than improving accessibility for the residents and employees in the study area.

<sup>8</sup> Range between 'as bus' and 'as Luas' quality assumptions

The decision as to which option is preferable depends on the weightings associated with the appraisal objectives, however, the Luas option is clearly more effective at meeting the wider objectives of the study area of north Docklands than the bus options. In transport decision making a significant weight is placed on the value for money element of the economy objective, the higher ridership and relatively low additional operating costs of extending Luas suggests better value for money compared to the bus options.

## **Conclusions**

Whilst quality bus routes could be introduced to serve north Docklands between Connolly and The Point instead of extending the Luas, they would not attract as much patronage as Luas, even if the vehicles were viewed as being as attractive as Luas services. This is because the bus options involve greater need to interchange with rail and Luas routes in the City Centre.

The bus routes are significantly less effective in serving the transport needs of North Docklands, particularly in reducing car use and providing a quality public transport option for accessing North Lotts and The Point.

Whilst an effective bus option was identified that ran beyond the immediate study area to secure increased demand it remained less effective between Connolly and The Point. The option tests suggest that areas to the north and east of Sheriff Street require improved public transport access as part of the developing transport strategy for the area as a whole.

The Luas extension option provides a significantly greater contribution to the identified local objectives for North Docklands, especially the key objective of providing a sustainable transport solution for the development of North Docklands (the North Lotts and Point Village areas) and securing the greatest contribution to the regional transport modal share objectives.

Whilst Luas is a more costly option and would involve a greater construction impact, its greater contribution to the regional objectives and requirements of the sustainable development of the North Lotts and Point Village areas suggests that the scheme should be implemented over a lower cost and less effective bus based option.

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# 1 INTRODUCTION

## 1.1 Background

In the last fifteen years the economy of Dublin City has grown particularly strongly, by 79% between 1991 and 1999<sup>9</sup>, which has brought a substantial increase in employment and population. As a result, car ownership and car use has grown dramatically leading to increasing highway congestion and lengthening journey times, especially in peak periods. The Dublin Transportation Office (DTO) developed a transport strategy, 'A Platform for Change', for the period 2000 to 2016 based on investment in public transport and demand management. The strategy identified a number of improvements to the suburban rail network, the introduction of new 'metro' and Luas (light rail) routes and services, improved bus routes and new and improved public transport interchanges.

The first two Luas Lines in the City, the Red Line from Connolly to Tallaght via Abbey Street and Heuston and the Green Line from St Stephens Green to Sandyford, were opened in September and June 2004, respectively. They are operated with modern high capacity light rail vehicles at a relatively high frequency. 70% of the vehicle length is low floor. The system provides on and off vehicle real-time passenger information and off-vehicle ticket purchase and the services are well used. In 2005 the Luas routes carried 22.2 million passengers, 1.5 million ahead of forecast and made an operating profit.

The Dublin Docklands Development Authority (DDDA) was established to secure the redevelopment of the run-down former docks areas to north and south of the River Liffey and to the East of the City Centre. To the north of the river the initial phase of redevelopment around George's Dock and as far eastwards as Guild Street is largely completed and incorporates the International Financial Services Centre (IFSC) and other financial sector employers and modern housing. This area lies within walking distance of Connolly Station and the City Centre, however, the further redevelopment of the north Docklands to The Point requires improved public transport to meet the future travel demands.

The Platform for Change document recommended extending the Red Line from Connolly to Docklands. The Railway Procurement Agency (RPA) developed this extension, termed Luas Line C1 in more detail. The Luas extension is proposed to run between Connolly and The Point via Mayor Street Lower and Mayor Street Upper and including a new bridge over Spencer Dock. Luas forms a keystone of the transport strategy for Docklands embodied in the Docklands Masterplanning documents which guide the redevelopment process. Other transport infrastructure improvements are proposed to serve the north Docklands area, including rail and quality bus corridors, and have received support through the Government's 'Transport 21' statement, which identifies the Luas extension for completion is 2008.

Consultation regarding the scheme has been undertaken and included examination of alternative Luas alignments. The RPA have published the Line C1 proposals in the Environmental Impact Statement and are seeking a Railway Order for powers to construct and operate the extension.

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<sup>9</sup> A Platform for Change, Dublin Transportation Office, November 2001.

Some local businesses have expressed concerns regarding the potential disruption during the construction of the Luas Extension and have proposed alternative bus options.

## **1.2 Study Requirements**

This study is required to investigate the potential for a bus alternative to the Luas Line C1 scheme between Connolly and The Point and to compare this with the Luas Option.

The study was required to undertake an objective appraisal of the issues including review of the study area, planning and development issues, review of the technology options and route options, selection of a best bus option and comparison with the Luas Line C1 scheme.

As this study may be required to present evidence to the public inquiry for the Luas Line C1 Railway Order key requirements for the study are:

- To be independent and objective;
- For issues to be well researched;
- For all potential options to be identified and assessed; and
- For evidence to be presented clearly and concisely.

To meet these requirements a comparison of technology options in Docklands is undertaken against the wider national and regional objectives that the transport strategy is seeking to deliver.

## **1.3 Study Area and Scope**

The core study area, shown in Figure 1, was defined as the North Docklands area between Connolly and East Wall Road and between North Wall Quay and Sheriff Street. However, service extensions to meet traffic objectives beyond this area are also considered.

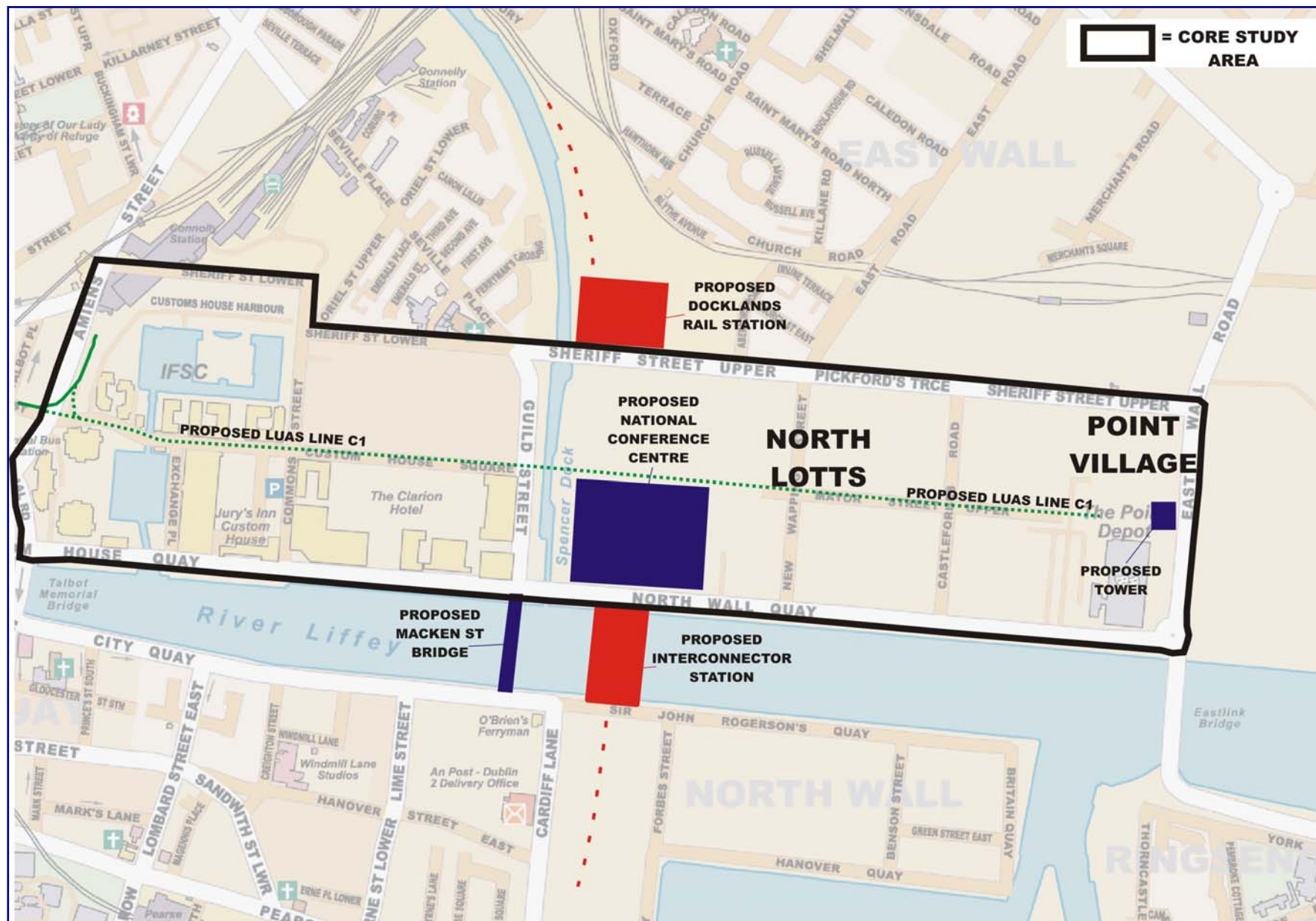
## **1.4 Report Structure**

This introduction is followed by an outline of the background to the study in section 2. Section 3 describes the development of the appraisal framework for use in the comparing bus options and the comparison between bus and Luas Line C1. Section 4 outlines the bus technology options and section 5 specifies the bus route options. Section 6 appraises the bus route options and specifies the preferred options. Sections 7 and 8 provide the technical assessment of the bus options leading to the estimated costs and the demand forecasts and economics for the bus option. Section 9 presents the comparative evaluation of the bus and Luas options and section 10 presents the study and conclusions.

The defined appraisal framework and completed appraisal framework are presented in the Appendices.



Figure 1 Study Area and Key Issues





## 2 BACKGROUND ISSUES

### 2.1 Dublin Docklands

#### 2.1.1 Development Issues

The area of Docklands between the current developments around Custom House Dock and the IFSC and the Point is identified as an extension of the City Centre in the Docklands Masterplan and North Lotts Area Planning Scheme. There has been high growth in private car trips in recent years associated with the economic development of Dublin. The Transport Strategy (Platform for Change) and Dublin Docklands Area Masterplan 2003 identify the need to achieve a high public transport mode share target for trips into the City Centre (85% of motorised traffic in the AM peak hour). This will relieve traffic congestion and ensure further economic growth of the region.

The DDDA development plans<sup>10</sup> include an integrated public transport plan based on the extension of Luas to the Point, integrating with Rail and Bus services at Connolly, and the east of Spencer Dock and between bus services at The Point. The strategy envisaged a light rail only service along Mayor Street and Bus Corridors on the parallel corridors to the north and south.

Development within north Docklands is expected to be a mix of employment, housing, retail and other associated land-uses to create an urban 'village'. The development heights are limited to between 7 and 12 stories with some local variation allowed. A higher density of development is being planned for along the alignment of the Luas C1 route, specifically higher developments, up to 14 stories, will be allowed closer to the Luas stops along the proposed Mayor Street alignment and a 100m high tower at the east end of the route is proposed alongside the Point.

The EIS for the Luas Extension identified that the population in the study area will increase from 2,000 in 2002 to 12,000 people in 2016 and employment will grow from 20,000 to 29,000 over the same period.

The DDDA considers that the market for development in the Docklands is strong and current constraints are influenced by the lack of appropriate waste water capacity which will be resolved in 2007. Therefore, rather than the Luas promoting development in Docklands it is anticipated that without Luas there will be a 'Transport Deficit' due to the generated demand for travel coupled with parking restrictions.

The recent decision to locate the National Conference Centre at Spencer Dock in north Docklands will result in another major trip generator along the corridor. The scheme involves a 37,817sqm, 2,000 seater auditorium and smaller venues and a 218 bed hotel totalling 16,382sqm. With a parking space cap of 240 spaces the DDDA envisage that there will be a heavy reliance on public transport.

The Point is a major concert venue of regional, if not national importance, and generates a significant demand for travel, mainly in the evenings. Currently access is mainly by car and there are some traffic problems created by events. In the future, as intensification of development occurs in the area to the west of The Point there will be parking restrictions introduced and more competition for parking.

<sup>10</sup> DDDA Dublin Docklands Area Masterplan 2003, DDDA Docklands North Lotts Planning Scheme, July 2002, DDDA Docklands North Lotts Amending Planning Scheme, January 2006

A 700 space underground car park is planned at The Point, to serve the concert venue and other employment and retail developments proposed in the vicinity. Consideration is being given to expanding the capacity of The Point from a capacity of 8,500 seats to 14,500 seats.

Luas is expected to provide a key role in terms of securing acceptable dispersal from the Point. The North Lotts Planning scheme<sup>11</sup> envisages Luas accommodating 79% of public transport trips (52% of all trips) and a frequency sufficient to carry 5,000 people per hour to the City Centre (assuming 12,000 seats at The Point). It is expected that visitors will also make use of the Park and Ride facilities offered on the Luas line, such as at Red Cow.

Key issues for the study are therefore to what extent the best bus option will meet the development objectives for the extension of Docklands; specifically:

- Contribution to resolving the anticipated **'transport deficit'** in the study area, particularly before other transport infrastructure and services are introduced;
- Contribution to providing the desired **connectivity** within the study area;
- Contribution to meeting the desired **public transport mode share** (85%)<sup>12</sup> of this extension of the City Centre; and
- Contribution to meeting the **specific transport needs of The Point** in terms of distribution of people within a short time period after events.

In addition the Luas scheme will cater for trips to and from the National Conference Centre at Spencer Dock and for distributing trips arriving at the proposed Docklands terminal rail station.

### 2.1.2 Transport Network Development

The transport strategy for the north Docklands area comprises the Luas Line C1 extension by 2008 and a number of other transport schemes highlighted in Table 3.

In the medium term the Docklands station would improve direct rail access from the western commuter rail corridor, and help to resolve platform capacity problems at Connolly Station. A key role for the Luas extension or bus alternative in relation to the Docklands Station scheme will be to provide a link back into the City Centre for those people not ending their journey in Docklands.

In the long term the Interconnector project will improve access from the northern (Drogheda) and southwestern (Kildare) rail corridors and will provide improved connections to the City Centre south of the river. A key issue for the evaluation is the level of **integration** it provides between public transport modes.

<sup>11</sup> North Lotts Planning Scheme Draft Amendment No 1 – EIS supplied by DDDA.

<sup>12</sup> A Platform for Change, Dublin Transportation Office, November 2001.

**Table 3 Key Dublin and Docklands Transport Projects**

Scheme	Description	Anticipated Completion Date
<b>Direct Docklands Impact</b>		
Port Tunnel	The tunnel will connect the Port to the motorway network to the north and will necessitate new traffic arrangements being implemented for North Wall Quay and other roads in the Docklands vicinity.	2006
Macken Street Bridge	A new bridge that is planned to cross the Liffey at the eastern end of the IFSC footprint, able to accommodate vehicular and tram traffic.	2007
Luas Line C1 Extension	Between Connolly and The Point	2008
Spencer Docklands Terminal	Irish Rail proposes to construct a surface terminal station north of Sheriff Street, adjacent to the Canal, for mainline rail passenger services on the western (Maynooth / Dunboyne) rail corridor.	2009
Docklands Interconnector Project	Irish Rail project that will see a tunnel built between Heuston Station and East Wall junction, including new underground stations at St Stephen's Green, Pearse and Docklands. Docklands surface terminal station may remain open for diesel hauled services or for trains to the proposed conference centre.	2015
Bus	The DDDA's master plan and the DTO's strategy both have proposals for QBC routes operating in an orbital pattern.	-
<b>Other Key Transport Projects</b>		
Luas Extensions	From the Government's Transport 21 strategy; City Centre link between Tallaght and Sandyford lines From Tallaght to Citywest From Sandyford to Cherrywood From City Centre to Liffey Junction From City Centre to Lucan From Cherrywood to Bray	2008 2008 2010 2012 2013 2015
Metro	From the Government's Transport 21 strategy; Metro West from Tallaght to Clondalkin Metro West phase 2 from Clondalkin to Lucan Metro North from City Centre to Swords Metro West phase 3 from Lucan to Blanchardstown Metro West phase 4 from Blanchardstown to Ballymun	2010 2011 2012 2012 2014

Source: [www.Transport.ie](http://www.Transport.ie) Transport 21 – key dates

### 2.1.3 Bus Network Issues

Dublin Bus in partnership with the local highway authorities has been developing Quality Bus Corridors on the radial routes around Dublin. These involve significant bus priority to improve bus journey time and reliability. Nine current corridors exist from the City Centre to Blanchardstown, Finglas, Lucan, Malahide, North Clondalkin, Rathfarnham, Stillorgan, Swords and Tallaght.



The Dublin Bus Network Review<sup>13</sup> report was published in February 2006 and recommended investment in additional buses to meet the needs of new developments around the greater Dublin area and to meet capacity requirements. The report also assessed different network options and assessed depot requirements. Specific recommendations were:

- 283 additional buses required between 2006 and 2008;
- 144 further additional buses required between 2009 and 2011;
- New depots in Clondalkin, Tallaght, Blanchardstown and the south of the city;
- Development of a core higher frequency bus network within the M50 and with significant bus priorities;
- Express bus services from outer suburban locations;
- Far side City Centre termini – to increase accessibility in the City Centre;
- Development of orbital routes; and
- Development of the existing QBC's and five further QBC's to Blackrock, Howth, Ballymun, South Condalkin and Tallaght (Greenhills).

Specific suggestions in and around the study area are:

- Bus Lanes from Eden Quay to the proposed Macken Street Bridge along the north quays to ease access to Docklands North and South;
- Contra-flow bus lane from Macken St to George's Quay and existing bus lanes on George's Quay and Burgh Quay extended to stop lines; and
- Various other traffic management measures in the City Centre to deter general traffic on key bus corridors.

The report also mentions the development of off-street bus interchanges. A proposal at Strand Street near the Abbey Street Luas stop is well advanced and may result in an 8 stand bus station below a hotel development. A similar initiative is being developed at land east of Connolly Station and north of Sheriff Street Lower where a bus terminus below a multi-storey development would be used by buses currently terminating in the City Centre improving access to the western part of the study area. The scheme is at a relatively early development stage and timetable to implementation is not known.

Within the Bus Network Review report neither the radial high quality network nor the orbital bus network diagrams show services in the north Docklands study area, though the report suggests short term bus network development in the corridors where major Transport 21 schemes are recommended including extension of bus services to Docklands. The creation of Macken Street Bridge with further infrastructure development in South Docklands will enable improved bus penetration and create the opportunity to develop orbital services through the study area.

Dublin bus identified the potential for development and extension of three specific routes to serve north Docklands service 25 from Lucan, service 66 from Clondalkin and service 77 from Tallaght which are all existing Quality Bus Corridors. A QBC in north Docklands was last examined approximately five years ago. The proposed route was along Mayor Street to Guild Street and along Sherrif Street to East Wall where it continued to the Ferry Port. Bus lanes were proposed on Sherrif Street between East Wall Road and Guild Street.

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<sup>13</sup> Dublin Bus Network Review report, Dublin Bus, February 2006

The North Quay alternative route for the QBC was rejected due to traffic problems, lack of width at certain points and remoteness from the identified markets. This scheme would need to be reviewed and revisited with the latest development proposals and anticipated traffic changes as a result of the forthcoming opening of Dublin Port Tunnel. Dublin Bus identified the North Docklands area's current traffic congestion problems as adding significant costs in terms of vehicles required to run existing services and poor reliability.

#### 2.1.4 Target Markets

Public transport needs to meet the needs of people accessing and moving through the north Docklands area. There are a number of specific target markets which can be identified:

- Travel between residential and employment (and retail and other activity locations) within Docklands;
- Docklands residents travel to retail and other activities outside Docklands – primarily in Dublin City Centre;
- Docklands residents travel to employment locations outside Docklands; and
- Access to Docklands employment from outside the study area.

Census 2002 Journey to Work data was provided by the DTO for the Greater Dublin area for the trips to and from North Docklands, between Amiens Street, North Wall Quay, East Wall Road and Sheriff Street Upper and Lower. The Information is summarised in Tables 4 and 5.

Table 4 shows that over three quarters of Docklands residents work in Dublin City, with slightly more working to the south of the Liffey. Further analysis showed that the Dublin City destinations were widely spread, rather than concentrated in the core of the City Centre, especially to the north.

**Table 4 Destinations of Journey to Work Trips from Docklands<sup>14</sup>**

Area / County	%
Dublin City North	37%
Dublin City South	41%
Fingal	5%
South Dublin	5%
D'laoire / Rath	10%
Meath	0%
Kildare	0%
Wicklow	1%
External	1%

Table 5 shows that only 2% of people working in north Docklands are residents of north Docklands and that there is a wider geographic spread of origins of workers. There is an equal spread between the north and south city, with a total of 43% coming from Dublin City, and a further 40% coming from the adjacent Counties of Fingal, South Dublin and Dunlaoire / Rathdown.

<sup>14</sup> Sample = 762 of estimated resident population of 2,130 (2002 Census) = 36%.

**Table 5 Origins of Journey to Work Trips to Docklands by County<sup>15</sup>**

Area / County	%
Internal North Docklands	2%
Dublin City North	23%
Dublin City South	20%
Fingal	13%
South Dublin	10%
D'laoire / Rath	17%
Meath	3%
Kildare	6%
Wicklow	3%
External	2%

A sector analysis of the data was undertaken dividing the residents between corridors well served by Dart services which currently provide relatively good public transport access to that part of Docklands which is already developed, and other sectors radiating from the City. In addition the City Centre within the canals was split north and south of the River Liffey. The defined sectors are shown in Appendix A. Table 6 shows the results which reveal that around a third of people working in north Docklands originate in the corridors served by Dart, significantly more than other larger sectors of the City and therefore suggesting that origins are influenced by the current level of accessibility provided by the public transport network.

**Table 6 Origins of Journey to Work Trips to Docklands by Sector**

Sector	%
Dart north	14%
Dart South	15%
Dublin Centre North	6%
Dublin Centre South	5%
North Sector	11%
North West Sector	9%
West Sector	7%
South West Sector	9%
South Sector	16%
Not Coded	8%

Access to the Dart services will be improved through interchange at Connolly in all options. The Luas Line C1 extension to the Red Line will improve access to Docklands from the southwest and part of the west sectors. The Transport 21 public transport improvements will improve access to north Docklands from the northwest and west sectors through the Docklands Terminal Station scheme and further improve access from the West and 'centre south' sectors through the Interconnector scheme. The other Luas and Metro network extensions will further improve access from the southwest, south, north and west sectors.

The target markets for improved public transport to Docklands that the options might also serve, probably through interchange, were therefore defined as the north / northwest, the west and the south / southwest of the City.

<sup>15</sup> Sample = 10,376 of estimated jobs in north Docklands of 13,419 (2002 Census) = 77%.



### **2.1.5 Traffic Issues**

The most significant issue in relation to the highway network in the area is the imminent opening and subsequent management of the Port Tunnel. This scheme provides new highway capacity for port traffic to reduce freight flows on the Quayside roads through the centre of the City. This will be aided through appropriate traffic management measures in the City Centre. However, the road also provides new capacity from the north to the north Docklands area and via North Wall Quay to the City Centre.

A peak period toll of 12 euros is currently planned to prevent general traffic reducing the benefits to freight. However, the reduction in HGV traffic on North Wall Quay could benefit public transport if the capacity released is not taken up by other road traffic.

Another significant scheme relates to the proposed Macken Street Bridge which requires a Traffic Management Cell within the study area to prevent rat-running. This will involve considerable restrictions to traffic movements on the Mayor Street axis and place greater reliance on Sheriff Street and North Wall Quay to distribute traffic around the area.

The Luas Line C1 EIS<sup>16</sup> includes forecast traffic flows on key roads in 2016 which reveals that the heaviest used traffic routes will be the strategic highway network bounding the study area; Amiens Street and Custom House Quay with over 2,000 vehicles per hour (2-way AM peak) whereas Mayor Street will be relatively lightly trafficked (around 300 vehicles per hour).

The site visit undertaken to plan the bus routes in the study also noted that East Wall road is a heavily trafficked street and is being widened as part of the Port Tunnel scheme. Second order traffic routes in terms of general traffic flows will be Sheriff Street Upper / Seville Place to the north of the study area and Guild Street and Commons Street running north-south through the study area. All other roads will be used by access traffic only.

These issues need to be taken into account in planning for reliable public transport services and in planning for the level of segregation of buses and trams from general traffic.

## **2.2 Luas Line C1 Extension Issues**

### **2.2.1 Network and Construction Issues**

The Luas Line C1 extension is proposed to run from Connolly Station to a new terminus to the West of The Point via Mayor Street Lower, and Mayor Street Upper including a new bridge over Spencer Dock which will link Mayor Street Lower and Upper for pedestrians and cyclists and provide access to the National Conference Centre (see Figure 1). Intermediate stops are proposed at Spencer Dock, Mayor Square (between Guild Street and Commons Street) and George's Dock (between Commons Street and Amiens Street).

Alternative alignments for Luas Line C1 at the western end were examined in the EIS and involved two-way and / or 1-way running using Commons Street and Sheriff Street Lower.

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<sup>16</sup> Dublin Light Rail Line C1 Connolly to The Point Depot, Environmental Impact Statement, Railway Procurement Agency

The chosen alignment of the Luas extension shares roadspace with general traffic on Mayor Street Lower between Amiens Street and Commons Street, and Mayor Street Upper between the Spencer Dock Stop and The Point Terminus. The route will be segregated from other traffic on Mayor Street Lower between Commons Street and Spencer Dock Stop. That section of the highway network is forecast to have between 600 and 1,000 vehicles per hour (2-way) in the peak hours with traffic accessing developments including the National Conference Centre and significant volumes of turning traffic at the junctions of Commons Street and Guild Street.

The International Financial Services Centre steering committee, which represents around 50% of businesses in the area, has objected to the planned route of Luas via Mayor Street. Their fear is that the construction of Line C1 along the main thoroughfare of Docklands will cause traffic disruption, disrupt utilities and communication services and cause lasting damage to the businesses in the area. Harcourt Street is cited as an area that has suffered in a similar fashion.

The IFSC steering committee proposed an alternative alignment via North Wall Quay to the south of Mayor Street Lower, which was also examined and rejected by the RPA in the development of the EIS for the extension. The IFSC suggest the use of buses using QBC arrangements instead of extending the Luas network.

## **2.2.2 Operating Assumptions**

The Luas operating assumptions are documented in the EIS and summarised as:

- 5 minute peak service intervals (Mondays to Fridays 0700 – 1000 and 1600 – 1900);
- 7.5 minutes interpeak service intervals (Mondays to Fridays 1000 – 1600 plus 1900 – 2230 and Saturdays 0930 – 1900);
- 10 minute off peak service intervals (Mondays to Fridays 0530 – 0700, Saturdays 0630 – 0930 and 1900 – 0030 and Sundays, Public Holidays 0800 - 0000); and
- 15 minute late evening service intervals (Mondays to Fridays 2230 – 0030).

It is understood that the Luas Line C1 will have a one-way journey time of 7 minutes including 2 minutes of layover time allowed at Connolly Station for trams that reverse there. The proposed delta junction arrangement allows Connolly to be bypassed in accessing Docklands dependent on demand patterns. The service will be an extension of the Red Line and will therefore be stabled at the existing depot at Red Cow.

The vehicles used will be 40m long double-articulated trams with 70% low-floor (350mm high above the rolling surface) and 20% of the tram length is door width to enable speedy boarding and alighting to minimise stop dwell times.

The 40m vehicles have a seating capacity of 80 and crush capacity of 356 passengers (at 6 persons / sqm) leading to a maximum peak capacity of 4,272 passengers per hour per direction assuming a 5 minute headway. However, Luas resource planning uses a practical capacity of 87% of crush loads (assuming 5 persons / sqm), around 3,720 passengers per hour per direction. The provision of capacity of 5,000 pph away from The Point will involve the use of a third siding at The Point and the strategic positioning of vehicles, enabled by the use of vehicles that would otherwise be removed from ordinary service in the off peak.

All Luas stops have ticket machines and smartcard validators. Pre-paid weekly, monthly and annual season tickets and a smartcard are also available. All stops have real-time passenger information displays listing the time to the next 3 arrivals and vehicles have internal next stop displays and announcements.



## 3 DEVELOPMENT OF APPRAISAL FRAMEWORK

### 3.1 Introduction

The appraisal of the bus route options to determine the best bus option to compare with the Luas needs to be undertaken against the wider regional economic, social and transport objectives, coupled with the key issues raised in earlier sections of the report. This section reviews the stated National and Regional objectives relevant for the study and formulates the appraisal framework.

### 3.2 National Objectives

The *National Spatial Strategy, 2002* states that to support balanced regional development, the Greater Dublin Area's transport networks must:

- Build on Ireland's radial transport system of main roads and rail lines connecting Dublin to other regions, by developing an improved mesh or network of roads and public transport services;
- Ensure, through building up the capacity and effectiveness of Ireland's public transport networks, that increases in energy demand and emissions of CO<sub>2</sub> arising from the demand for movement are minimised;
- Allow internal transport networks to enhance international access to all parts of the country, by facilitating effective interchange possibilities between the national transport network and international airports and seaports; and
- Address congestion in major urban areas by increasing the use of public transport and alternate modes of transport such as cycling and walking.

In the *Statement of Strategy 2005–2007*, the Department of Transport mission statement states that the department “*will underpin Ireland's economic growth and competitiveness and contribute to social development through the efficient and effective delivery of a sustainable, appropriately regulated, safe and integrated transport system*”. The department set out five high level goals:

**Integration** - To ensure an integrated approach to the development and delivery of transport policy by providing a coherent policy framework covering all modes of transport and underpinning the development of an integrated transport system and by the integration of transport policies with other Government policies, particularly balanced regional development, social inclusion and sustainable development.

**Investment** - To improve accessibility, expand capacity, increase utilisation and enhance quality of the transport system by delivering a prioritised transport investment programme.

**Safety** - To ensure that transport infrastructure and services are provided, managed and used in a manner that protects people from death and injury.

**Competition, Regulation and Reform** - To enhance the efficiency and effectiveness of the delivery of transport services through competition, economic regulation and structural reform of State Agencies

**Delivery** - To ensure that the Department is organised, resourced and developed to deliver quality services to our external and internal customers.

The Department's strategic objectives in relation to public transport are to:

- Provide a well functioning, integrated public transport system, which enhances competitiveness, sustains economic progress, promotes balanced regional development and contributes to social cohesion;
- Provide a defined standard of public transport, at reasonable cost to the customer and the taxpayer; and
- Ensure the timely and cost effective delivery of the accelerated investment in the infrastructure and facilities necessary to ensure improved public transport provision.

The *National Development Plan 2000 - 2006* has four basic strategic objectives:

- To continue sustainable national economic and employment growth;
- To strengthen and improve Ireland's international competitiveness;
- To foster balanced regional development; and
- To promote social inclusion.

### 3.3 Regional Objectives

The Dublin Regional Authority and Mid-East Regional Authority set out guidelines in the *Regional Planning Guidelines Review, 2003* which stated five major transport objectives:

- Managing the demand for travel in city and towns;
- Delivery of planned services described in DTO Platform for Change;
- Catering for slow modes (walking and cycling);
- Public transport provision in rural areas; and
- Merging national transport with local transport.

In 2001, the Dublin Transportation Office (DTO) published "*A Platform for Change*" which sets out an integrated transportation strategy for the Greater Dublin Area for 2000 to 2016. The primary aim of the strategy is to reduce the amount of travel by creating a more compact city and create conditions which improve public transport.

The strategy has two key interdependent elements:

**Demand Management** - To reduce the growth in travel while maintaining economic progress, measures have to be put in place to encourage a transfer of trips, especially at peak periods, from the private car to sustainable modes of transport (such as public transport, cycling and walking).

**Infrastructure and Service Improvements -**

The strategy envisages an extensive, high quality, fully accessible integrated network hence the need for some strategic road construction and traffic management and a substantial expansion of the public transport network. Being an integrated strategy, it will only be effective if these two elements are implemented together in a coherent way.

Two additional quantitative objectives were set out which were:

- To reduce the level of congestion on the road network to 1991 levels, when the average speed in the morning peak hour was 22Kph; and
- To provide adequate capacity for all journeys to work and education, that make up the vast majority of trips in the morning peak hour.

One of the benefits foreseen by the strategy is public transport accommodating 63% of the total motorised trips in AM peak hour in the Greater Dublin Area and 85% of those motorised trips with city centre destinations.

### 3.4 Local Objectives

The *Dublin City Development Plan 2005-2011* set out high level objectives of:

- Providing efficient access to the city core; and
- Maintaining the city core as the primary economic, cultural and social heart of the metropolitan area.

Other transport related objectives included:

- Encourage modal shift towards public transport by increasing network capacity;
- Improving cross city accessibility through provision of Quality Bus Networks (QBN);
- Improving equity through additional provision for the mobility impaired;
- Improving efficiency through provision of QBN coupled with traffic management techniques such as bus priorities and introduction of integrated ticketing;
- Improving the environment by encouraging cycling and walking; and
- Integration of different transport modes.

The *DDDA Master plan 2003* movement strategy sets out objectives taking into account the DTO's strategy as follows:

- To promote the use of public transport;
- To prioritise the early provision of an integrated public transportation system;
- To reduce the adverse environmental impact of traffic;
- To ensure that public transport modes are inter-linked; and
- To promote cycling and walking.

It recognises a need to facilitate interchange between bus, rail and Luas at Station Square, the Point Village and Connolly Station.

The *Docklands North Lotts Planning Scheme 2002* identifies a movement strategy that aims to:

- Maximise public transport accessibility, quality and capacity;
- Create a high quality pedestrian and cycling environment; and
- Minimise car traffic.

The scheme also envisages a land use mix of 40% commercial and 60% residential.

### **3.5 Definition of Evaluation Framework**

A framework was developed for the evaluation process to enable a thorough evaluation of all bus route options and the appraisal of the best bus option(s) against the Luas Line C1 extension. The appraisal needed to encompass the output / outcome objectives from the Regional and National objectives and take account of the key study issues identified in the earlier sections. The aim is to determine the option that best achieves the balance between the ability to achieve the objectives while delivering an optimal value for money within the affordability constraints.

#### **3.5.1 Objectives**

Within the overall framework of the National and Regional Transport Objectives, eleven objectives, defined in the appraisal criteria, were chosen to formulate the overall depth of the evaluation framework as outlined below:

- Safety;
- Economy;
- Integration;
- Accessibility;
- Environment;
- Mode Shift;
- Efficiency;
- Affordability;
- Deliverability;
- Regeneration; and
- Attractiveness.

Where an important sub-objective has been identified it is important to reflect that within the evaluation criteria rather than duplicating objectives.

#### **3.5.2 Evaluation Criteria**

The framework evaluation requires an appraisal of each option with due consideration of the key output objectives. The framework is designed to be used as a preliminary framework to shortlist the best bus option and to provide the later, more detailed comparative assessment of the bus vs Luas option. The framework is intended to be transparent – showing both positive and adverse impacts, logical and acceptable in terms of cross comparison between options and provide a documented and auditable justification for any recommended option.



**(a) Safety**

The Government encourages a switch to use of public transport hence improving safety and security through investment in Public Transport.

**(b) Economy**

An objective of transport investment is to enhance the economy while reflecting good value for money.

The capital and operating costs need to be compared against the demand, and resultant revenues and benefits of the investment to determine the value for money of the option. The demand will be influenced by the connectivity and journey time of a specific route combined with the quality of the option.

This objective also includes the ability of the option to foster economic regeneration, in the Docklands this is interpreted as contributing to reducing the transport deficit that would otherwise occur without transport investment.

**(c) Integration**

The appraisal against integration relates to:

- Integration between modes, through the level of interchange improvement opportunities created; and
- Integration between policies including land use, which should relate to the Spatial Strategies including those contained in the City and Docklands masterplans.

**(d) Accessibility**

The accessibility appraisal focuses on provision of efficient access to the city core. In order to encourage city living, accessibility has to be enhanced. The appraisal has to give due consideration to the docklands residents and employees' ability to achieve direct / efficient connectivity both within the city core and the greater Dublin, recognising:

- Most retail activity takes places outside the Docklands in the City Centre primarily to the north of the Liffey; and
- Employment opportunities exist both within and outside the Docklands with the rest of the City Centre being particularly important, including government offices and the education sector.

In addition improving social inclusion through improved accessibility by public transport is subjectively assessed taking account of the needs of the communities in the older parts of Docklands.

**(e) Environment**

Enhancing and preserving the environment is a key sustainability objective with sub-objectives relating to noise, local air quality, greenhouse gases, landscape, townscape, heritage, biodiversity, water environment, physical fitness and journey ambience (which are drawn from the current UK Appraisal Guidance).

The various bus route options with their particular bus types where applicable are assessed against the various impacts they are likely to cause, direct or indirectly. The impact on the physical environment, air quality and noise however take precedence.

#### **(f) Mode Shift**

Achieving a major switch to use of public transport is an important objective for the transportation authority. The DTO set a 2016 target of public transport accommodating for 63% of the total market for motorised travel in the Greater Dublin Area in the AM peak hour, and 85% of those trips with city centre destinations. Options are appraised in terms of their ability to contribute to this outcome through the scale of demand generated and attractiveness to car users.

#### **(g) Efficiency**

The efficiency objective was sub-divided into three sub-objectives:

- The reliability of the public transport option, through the level of interaction with other road traffic;
- The increase in public transport capacity provided to assist in coping with the high demand for travel within the region; and
- The impact of the option on the operation of the highway network, such as though the additional vehicles operating, the location in terms of the background traffic demands and additional turning movements at junctions.

#### **(h) Affordability**

The various route options are appraised against their costs (capital and operating) and Dublin's ability to meet them.

#### **(i) Deliverability**

Key aspects affecting the delivery of transport infrastructure improvements were defined as:

- **public acceptability** of the route/ technology option including the delivery of the stated transport strategy;
- **Technical practicality** of the scheme in terms of the technology availability and route specific problems; and
- **Disruption** to everyday business including during the construction phase.

#### **(j) Regeneration**

Whilst the value of economic regeneration is included within the Economy Objective it is an important planning objective – the physical regeneration of Docklands. It is therefore highlighted as an additional regional objective in the framework to assess the contribution of transport to influencing the development in the study area. The service provided should aim to:

- Penetrate the docklands;
- Stimulate development;
- Encourage city living;

- Encourage employment in Docklands; and
- Facilitate other DDDA / City Council development objectives.

It should be noted that there is some double-counting in relation to this objective and the Economy and Integration objectives.

**(k) Attractiveness**

The assessment considers the physical characteristics of the different types of buses and the tram and the extent to which it makes public transport attractive.

The defined appraisal framework is included in Appendix B. The framework is designed for completion at the level of the objectives sub-criteria and these details are then summarised to the main objectives level for overall cross comparison of options. Where necessary the detailed comparison of options may be called upon where the summary appraisal does not provide sufficient detail.



## 4 BUS TECHNOLOGY OPTIONS

### 4.1 Introduction

This section examines the technology options available for the development of the Bus Option. It was decided at the outset that a quality Bus Rapid Transit service should be assumed for all bus options, to enable a valid comparison of an optimum “Luas type” bus option with the Luas Line C1 scheme.

The main attributes of a quality Rapid Transit service are identified, followed by a review of the various bus technology options available that might provide some of these attributes, and their costs.

### 4.2 Bus Technology Options

#### 4.2.1 Introduction

It is considered that a bus option that provides the quality of service that secures the objectives of the development plan for Docklands should have the following key attributes defined for Rapid Transit:

- Fast journey time;
- Reliable service;
- High quality waiting environment (shelters, passenger information systems);
- Quick boarding and alighting (off-vehicle ticketing and multiple doors);
- Ease of interchange between services and between modes;
- High-quality vehicles;
- Good ride quality – with advantages provided through kerb or other guidance technology;
- High accessibility – such as providing raised kerbs stops and low-floor vehicles;
- High frequencies;
- Attractive services - from early morning to early evening;
- Integrated ticketing – (at least between tram and Docklands Bus) - minimising interchange penalties; and
- High profile / visible system.

#### 4.2.2 Vehicles Types and Costs

There are many different types of buses, varying with the level of passenger capacity, price, fuel type, vehicle guidance, double / single ended and additional features such as number of doors, air conditioning etc.

Another factor that can vary the quality of the service provided, without changing the vehicle greatly, is the degree of segregation provided for the vehicle. Segregation can be achieved either by providing modest provisions such as bus lanes through to complete segregation, such as with the use of kerb-guided buses in Essen, Adelaide and Leeds.

Table 7 shows the range of bus options available, from standard vehicles to the more sophisticated 'tram like' vehicles. This list is by no means exhaustive and also certain additional features of such vehicles (e.g. air conditioning) are excluded.<sup>17</sup>

**Table 7 Bus types and characteristics**

Vehicle Type	Example	Description	Passenger Capacity	Approximate vehicle cost (thousands)
Standard single-deck bus	Excel (Optare)	NA	45-63	€160 - 195
Standard double-deck bus	Spectra (Optare)	NA	78 (not including standing)	€205 – 235
Standard single-deck articulated bus	Citaro G (Mercedes Benz)	18 metre diesel powered vehicle with 3 doors	148	€290
Visible tyres with vehicle guidance	Phileas	Electronically guided. 18 metres. Entirely flat low floor. Hybrid powered.	120	The infrastructure cost of embedding magnetic markers can constitute a significant portion of the costs. A 15 km system in Eindhoven with 10 vehicles cost €115 million.
	Phileas	Electronically guided. 24 metres. Entirely flat low floor. Hybrid powered.	180	
Non-visible tyres with vehicle guidance	CiViS (Irisbus)	Optically guided (but also capable of normal operation), with 4 swing-out doors and completely flat floor. Hybrid powered	104	€585
	TVR (Bombardier)	Slot guided, double articulated with 3 doors and diesel powered	143	€1,170
Non-visible tyres without vehicle guidance	Cristalis (Irisbus)	Non-guided version of the CiViS, 12 metres and 11.2 metre turning circle. 3 doors. Hybrid powered.	96 (in Lyon)	€510
	Cristalis (Irisbus)	Non-guided version of the CiViS, 18 metres and 11.5 metre turning circle. 4 doors and Hybrid powered.	140 (in Lyon)	€730
	f t r (Wright Bus)	Diesel powered with 2 doors	100-120	€460

Source: Irisbus website ([www.irisbus.com/cgi-bin/irisbus.dll/Irisbus/index.jsp](http://www.irisbus.com/cgi-bin/irisbus.dll/Irisbus/index.jsp)), 'Study of High Quality Buses in Leeds' (available at [www.dft.gov.uk/stellent/groups/dft\\_control/documents/homepage/dft\\_home\\_page.hcsp](http://www.dft.gov.uk/stellent/groups/dft_control/documents/homepage/dft_home_page.hcsp)), 'Bus Rapid Transit' ([www.connectedcities.net/magazines/NT\\_2005\\_fall\\_cc.html](http://www.connectedcities.net/magazines/NT_2005_fall_cc.html)), 'Bus Rapid Transit News Lane Vol 2 No. 3' (available at [www.calstart.org/programs/btr/archives/btrnewslaneVOL2NO3.pdf](http://www.calstart.org/programs/btr/archives/btrnewslaneVOL2NO3.pdf)).

Standard single and double deck buses (similar to those currently in operation in Dublin) are by far the cheapest vehicles available. However, they do not offer the same capacity, comfort or visual impact as other vehicles. Standard single articulated buses can have the highest capacities (e.g. the Citaro G). These tend to maximise the number of seats available and capacity is traded off with comfort.

<sup>17</sup> All figure converted to Euros to the nearest €5k (using and exchange rate of 1.4617 € to the £ taken from [www.economist.com](http://www.economist.com) 30.01.06)

The price difference between the Citaro G and the Excel (between €95,000 and €130,000) can be used to estimate the price difference between a standard single deck bus and a, longer, articulated bus, whereas the price difference between the Cristalis articulated and double articulated vehicles (€220,000) reflects the price of the longer more sophisticated 'tram like' vehicles. The price difference between the Cristalis and CiViS (around €75,000) reflects the cost of optical guidance, whereas the cost of kerb guidance and electronic guidance depends on the guided route length.

It is considered that for a bus option with significant passenger capacity to perform a high quality role equivalent to the proposed Luas extension, ideally an articulated vehicle such as the ftr, Citralis or Civis should be used with the need for guidance dependent on the scheme requirements.

### **4.2.3 Vehicle Guidance**

Vehicle guidance allows the vehicle to operate a smoother ride by limiting the amount of horizontal displacement and can also guide the vehicle accurately to dock at the stop platform to within a few centimetres. Guiding buses can also be used to minimise horizontal displacement where there is limited space, such as at bridges and tunnels. Examples of different types of bus guidance are given below.

#### **(a) Kerb guidance**

Kerb guidance is the oldest form of guided bus technology involving physical measures the kerb guideway and alterations to the bus. The kerb guideway has two tracks separated by the width of a bus axle and with upstanding kerbs. Small guide-wheels are attached to the front axle of the bus and protrude from the vehicle and steer the vehicle in the guideway. It has the advantage of being fully segregated, thereby giving the bus an advantage over car traffic but is the most expensive option, though making alterations to the bus in order for it to be compatible to the kerb guidance is relatively cheap. Therefore such a technology will incur a small fixed cost with significant variable costs.

Kerb guidance involves laying a concrete track which may involve relocating underground equipment and significant construction impact. The raised kerbs create a barrier to movement over the guideway and it is therefore of limited use in an urban environment except within the centre of a dual-carriageway.

#### **(b) Slot Guidance**

A second physical guidance technology was developed but less widely applied involving slot, or single rail, guidance. A metal rail is embedded in the road and guide-wheels protrude from the bottom of the vehicle to locate the rail from both sides. Slot guidance, therefore, gives the appearance of a tram with one rail rather than two. The relative advantage of slot guidance is that if the vehicle is powered electrically the rail can be used for the return current, rather than having two overhead wires.

Slot guidance requires significant infrastructure costs to secure the rail, involving significant construction impact including the relocation of underground equipment. An example of a vehicle with slot guidance is the Bombardier GLT.

### **(c) Optical Guidance**

Optical guidance involves a camera in the front of the vehicle reading markings painted on the road. A computer determines the position of the vehicle on the road and adjusts the steering. However, this system may not function efficiently in adverse weather conditions such as snow when the markings are obscured. The vehicle itself (CiviS) will be more expensive but the road markings are relatively cheap to maintain and there is no construction impact.

The guidance system has the potential to cause uneven wear and rutting of the road surface, because of the fixed position of the wheel tracks. This will mean higher road maintenance costs or the use of a more rigid road surface than asphalt (e.g. concrete). However, as laying concrete would mean relocating underground equipment and construction disruption, regular resurfacing would be more practical. This option would therefore incur a high fixed cost related to the vehicles and significant variable cost.

### **(d) Wire Guidance**

Wire guided systems use buried cables and on bus equipment to guide buses either throughout their routes or for narrow sections and to 'dock' at stops. The detection equipment on the vehicle determines the position of the vehicle in relation to the cable and adjusts the steering accordingly. Wire guided technology has been used in the Channel Tunnel service tunnel and also in warehouses to guide fork lift vehicles.

This option would involve burying cables in the road surface, therefore bearing some engineering work. However, the construction disruption is minimal and underground equipment would not need to be relocated as relaying the cable after roadworks would be a relatively small cost.

The guidance system has the potential to cause uneven wear and rutting of the road surface, because of the fixed position of the wheel tracks. Regular road maintenance, including relaying the buried cable, would be more costly and the use of a more rigid road surface than asphalt (e.g. concrete) would need to be considered. However, laying concrete would mean relocating underground equipment and construction disruption.

This option would have either a very high initial cost and lower longer term costs or lower initial costs and significant long term costs.

### **(e) Electrical guidance**

Electrically guided vehicles are equipped with an electronic guidance system and follow a route via magnetic markers embedded in the road surface spaced a certain distance apart. Like other forms of vehicle guidance, there could be an issue with wheel track rutting, leading to increased maintenance cost and rebedding of magnetic markers, or use of a more rigid road surface such as concrete. An example of an electrically guided vehicle is the Phileas.



#### **4.2.4 Other Technology Issues**

##### **(a) Vehicle Appearance**

Several new bus systems employ a cover over the wheels to conceal the tyres as much as possible in an attempt to give a 'tram like' appearance. However, on inspection of models which incorporate this characteristic, such as the f t r, it was observed that the lower part of the tyres is still visible and we believe that the impact on passenger perception will be limited.

##### **(b) Articulated Vehicles**

Increasing the roof height to create the feeling of space inside the vehicle to emulate trams involved using single deck vehicle and using articulated, two-section, longer buses. The front of the vehicle steers while, in the case of the f t r, the engine is located in the rear section. The employment of two shorter sections compared to a standard bus has the advantage of reducing the turning circle required and enabling the articulated vehicles to operate in urban environments. Articulated vehicles may be essential in the context of the study area, which involves many corners that were not initially designed for long vehicles.

Examples of the single articulated vehicles are the Citaro G, and a double articulated vehicle is the Phileas. There are relatively few examples of double-articulated vehicles in operation. In addition to Germany, Switzerland and Holland double-articulated buses have recently been introduced in Gothenburg, Sweden. In Sweden the 25m long vehicles operate on a guided busway and required a change in the rules governing bus types. This change in rules governing vehicle types would probably be required in Ireland and the UK and there could be practical problems operating longer vehicles safely in city centre streets, un-guided, which would also need to be addressed.

##### **(c) Motive Power**

The Luas is electrically powered through an overhead wire and pantograph on top of the vehicle that picks up the current and returns it through the rails. This results in no vehicle emissions at the point of use, which is of benefit in an urban area. Buses are usually diesel powered with the latest versions needing to meet the EU standards controlling emissions.

Buses can be powered by electricity with the use of an overhead pick-up system (trolley poles) and, usually, two overhead wires are required for incoming and return currents. This significantly increases the infrastructure requirement and initial cost of systems. It also removes the flexibility of bus operation.

Buses can be powered a range of other liquid and gas fuels, such as Liquefied Natural Gas (LNG) which are widely used in Argentina and New Zealand, they require the use of a national infrastructure adapted to deal with transporting gas and / or specifically developed refuelling stations, and could therefore be impractical in Dublin.

Hybrid vehicles use both diesel and battery to power the vehicle. Such a system would use diesel as a power supply for the vehicle in areas which are not regarded as pollution black spots (or locations where the bus is able to travel at speeds which will not emit an unacceptable level of pollution) as well as charging the battery which could then be used to power the vehicle in highly dense urban areas.

**(d) Double-ended vehicles**

Double-ended vehicles such as the Luas allow the vehicle to be driven from both ends, which minimises the infrastructure requirements at the termini. Such a feature can be useful if there is inadequate road space to turn round. Buses are usually single ended and require a turning facility, and usually a layover point at the termini. Although some double-ended buses have been manufactured, and have an estimated price tag of €1.46 million, they have not been applied widely and we are therefore uncertain of their practicalities.

## 5 BUS ROUTE OPTIONS

### 5.1 Existing Bus Network

Like many European cities, Dublin has a largely radial highway network and Dublin Bus operates an extensive network of bus routes on a broadly high frequency radial pattern and with little cross-city operation. Buses run to a number of termini spread across the City Centre. A number of quality bus corridors (QBCs) have been developed with dedicated bus lanes, which improve the speed and reliability of buses on the congested highway network. Buses run at different times depending on the route, usually from around 6:00am until close to midnight. A NiteLink service also operates at weekends throughout the early hours.

### 5.2 North Docklands Routes

There are three main routes serving the north docklands and IFSC, shown in Figure 2:

- **Route 53:** This runs from Eden Quay to North Strand Road then on to Church Road and finally East Wall Road and back. The average frequency for the morning peak is three buses per hour from East Wall Road to Eden Quay. It should be noted that there is no service from Eden Quay to East Wall Road during the morning peak. There is an average of two buses per hour throughout the remainder of the day. The travel time for each trip is approximately 30 minutes;
- **Route 53A:** The first trip runs from Eden Quay to The Point via North Wall Quay and on to Alexandra Road. The average frequency of the morning peak is two buses per hour, after which there is only one more service for the remainder of the day. The return trip has a frequency of two buses per day during the off peak period. There is no service on Sunday; and
- **Route 90:** This runs between Heuston Station and Connolly Station every 15 minutes throughout the day, with an interruption in the middle of the afternoon and a low frequency in the evenings. The buses run eastbound along Sarsfield Quay, Arran Quay, Inns Quay, Ormond Quay and Bachelors Walk parallel to Luas Line B and run westbound along Georges Quay, Aston Quay, Merchants Quay, Ushers Quay and Victoria Quay on the south side of the river. The bus runs around a loop to serve the IFSC and Connolly station via Custom House Quay, Commons Street, Sheriff Street Lower and Amiens Street.

Based on the timetables operated there is likely to be more demand on the 53 route than on the 53A, observations also suggested little off peak demand on the 90 route.

### 5.3 Connecting Routes

There are three key routes providing interchange possibilities to Routes 53 and 53A:

- **Route 90:** described above and providing access to Heuston Station and bus termini along the river;
- **Airlink 747:** Running from Dublin Airport, this service goes to O'Connell Street and the Central Bus Station opposite the IFSC and back. The travel time is approximately 35 minutes with an average frequency of four buses per hour; and

- **Airlink 748:** This runs from Dublin Airport to the Central Bus Station and on to Heuston Station and back. The travel time is approximately 45minutes with an average frequency of two buses per hour.

Eden Quay is the closest bus terminus point to the north Docklands and services connect the docklands to the city core. There are a number of bus services on this quay which also access the Greater Dublin area, particularly the south and southwest and northeast of the City, as detailed in Appendix C.

The Dockland Masterplan expresses an aspiration to extend buses currently terminating at Eden Quay into north Docklands. It is assumed this relates particularly the services from the south and southwest of the City.

## **5.4 Bus Route Option Definition**

This section defines the possible bus route options and their key issues. The bus options were defined to focus on the core objective of improving access between Connolly and The Point through north Docklands. Site visits were carried out on January 18<sup>th</sup> and 19<sup>th</sup> 2006, which highlighted potential issues and influenced option development.

Mayor Street Lower and Mayor Street Upper are routes that are central in the North Docklands Village and therefore public transport stops provided on this central route provide greatest accessibility to and from north Docklands. It has been designated as a public transport priority corridor rather than a general traffic route. A route along North Wall Quay would provide less accessibility to possible users because its primary catchment would be that immediately to the north of North Wall Quay. A route to the north of the study area along Sheriff Street Lower, Seville Place and Mariners Port may also provide less accessibility as a result of the highest density development being located to the South. However, as a route on Mayor Street will definitely require a bridge over Spencer Dock, we have included routes which avoid this section as possible options.

A short distance shuttling service may not be the best option as it forces interchange and is therefore not attractive to passengers making longer distance journeys. A longer route would hold the advantage of creating greater origin destination possibilities, but would limit the opportunities for using specific high-quality vehicles and could introduce additional unreliability to the service provision. For this reason, we have developed options for both short-distance shuttle services and for services that run beyond the termini to provide improved connection to other public transport services in the City Centre and to connect with other locations in north Docklands.

### **5.4.1 General Networking Issues**

A series of site visits of the North Docklands area took place as part of this Study. On the site visits particular attention was paid to the needs of the bus option to terminate at The Point and at Connolly and the practicality of operating between these locations. Specifically, attention was paid to whether a long wheel base bus or articulated vehicle would be able to negotiate corners within the study area, through a general assessment of the road geometry at junctions. Junctions that were identified as being potential problems at this stage were:

- The left turn into Amiens Street from Seville Place;
- The junction of Seville Place with Oriel Street;
- The turn from Sheriff Street Lower into Oriel Street Upper; and

- The junction of North Wall Quay with Guild Street. Due to the combination of the road geometry and the drawbridge which significantly limits a vehicle's ability in using the available road space to negotiate the corner.

Junctions that were identified as possible problems but unlikely to be as severe were the junctions of:

- Sheriff Street Upper with New Wapping Street;
- Mayor Street Upper with New Wapping Street;
- North Wall Quay with New Wapping Street;
- Sheriff Street Upper with Casteleforbes Road;
- Mayor Street Upper with Casteleforbes Road; and
- North Wall Quay with Casteleforbes Road.

As this area is to be redeveloped it is possible that some or all of these problems may be resolvable in the future.

Other observations made on the site visit which would influence route planning and the detailed development of the scheme were:

- No through road between Sheriff Street Lower and Sheriff Street Upper and the junction with Seville Place and Guild Street.
- A pole supporting the Luas overhead wires situated at the junction at Amiens Street with Mayor Street Lower may inhibit the ability to amend the road layout at the junction.
- Narrow road width on Mayor Street Lower (approx. 6m), between the Harbourmaster Place and the drawbridge.
- The taxi rank and bus/coach stops on Amiens Street, outside Connolly Station, restrict the potential for constructing a suitable bus stop with shelter.
- There is a potential for further regeneration and development to the east of Connolly Station, north of Sheriff Street Lower.
- The existing bridge over Spencer Dock on Sheriff Street Upper vibrates when being traversed by vehicles of all sizes. This may need to be reconstructed and could therefore significantly add to infrastructure costs.
- The area around The Point is proposed for significant development which will result in there being no space for long articulated vehicles to turn round. Therefore turning the service round will require using roads designated for general traffic to be used for turning the bus service. This will increase journey times and would affect reliability. A double ended vehicle could overcome this problem.
- There is no space for long articulated vehicles to turn round at the junction at Amiens Street with Mayor Street Lower. Harbour Master Place was investigated for its suitability as a turning area for buses or for a relocated taxi rank but the space available was deemed insufficient.
- There might be resistance to the provision of bus stops on North Wall Quay due to the impact on the scenery of the river front.

Planning for the route options assumed that the following proposed infrastructure will be implemented if required:

- New bridge over the Spencer Dock, linking Mayor Street Lower and Mayor Street Upper;
- New road west of The Point, linking North Wall Quay and Sheriff Street Upper; and
- Two new north-south roads between Spencer Dock and New Wapping Street.

#### **5.4.2 Route Options**

The defined bus route options are shown in Figures 3 - 9 and summarised below.

##### **(a) Route 1 – Mayor Street**

Figure 3 shows that route option 1 starts from Amiens Street outside Connolly Station, the bus would travel south and turn into Mayor Street Lower then eastwards along Mayor Street Lower, along the new proposed bridge over Spencer Dock. The bus would continue along Mayor Street Upper until reaching The Point. To turn the bus around the bus would complete a loop by turning right at the proposed new road (linking North Wall Quay and Sheriff Street Upper), then eastwards along North Wall Quay, northbound on East Wall Road, westwards along Sheriff Street Upper and south down the proposed new road until reaching Mayor Street Upper again. The bus would then return along Mayor Street Lower until the junction with Commons Street where it would turn right into Commons Street (northbound) and then westwards along Sheriff Street Lower and south down Amiens Street to stop outside Connolly Station.

Factors that may affect the practicality of this option are:

- The tram pole at the junction at Amiens Street with Mayor Street Lower;
- Relocating the taxi rank to north of the bus stop outside Connolly Station; and
- Construction of the proposed new road between Castleforbes Road and The Point.

The bus service would require a layover point, in the form of a layby off the main highway in the vicinity of The Point, to regulate the timetable. The proposed route would not necessitate the buses being guided, though guidance at stops would minimise the gap for boarding passengers.

##### **(b) Route 2 – Mayor Street sub-option**

This option (shown in Figure 4) is the same as Route Option 1 without the loop around The Point, assuming the bus service uses double-ended vehicles. At the east end of Mayor Street Upper the vehicle would reverse with a layout similar to the proposed Luas terminus. Adequate terminal space could not be found in Harbour Master Place (or near the junction at Amiens Street with Mayor Street Lower), therefore, like Route 1, the vehicle would operate around a loop around Connolly Station and finish its journey at Amiens Street.

Factors that may affect the practicality of this option are the same as for route 1.

### **(c) Route 3 – North Wall Quay**

Figure 5 shows that, as for route option 1 this route would commence at Amiens Street, outside Connolly Station and operate around a loop around The Point. The route would travel via Commons Street, North Wall Quay and a new road between North Wall Quay and Mayor Street Upper to avoid the need for a new bridge over Spencer Dock. Commons Street was selected over the parallel Guild Street due to the tight turn from Guild Street and physical constraint imposed by the bridge at the Spencer Dock entrance.

This route would be significantly longer than Route 1, adding at least 2 minutes to the journey (possibly longer in the westerly direction as a result of 2 right turns onto and off North Wall Quay). It is anticipated that this would require an additional vehicle to provide the service. It could stop at the same stops as route 1 and could provide an additional stop on North Wall Quay.

Other factors that may affect the practicality of this option are:

- The tram pole at the junction at Amiens Street with Mayor Street Lower;
- Relocating the taxi rank to north of the bus stop outside Connolly Station;
- Construction of the proposed new road at The Point; and
- Possible construction of bus stops along the river front.

The proposed route would not necessitate the buses being guided, though guidance at stops would minimise the gap for boarding passengers.

### **(d) Route 4 – Sheriff Street**

Figure 6 shows that this route would follow the same route as route 1 except for using Guild Street, Sheriff Street Upper and the proposed new road at Spencer Dock between Mayor Street Lower and Mayor Street Upper to avoid the need for a bridge over Spencer Dock. This route would contain many of the problems associated with Route 3. The extra loop will also lead to the same disbenefits (because Sheriff Street Upper is also a general traffic road), and the route along Sheriff Street Upper will be less accessible (like North Wall Quay) than the central corridor. Additionally, this route may need renovation of the Lift Bridge over Spencer Dock which would outweigh the benefits of not providing a new bridge over the dock at Mayor Street.

Other factors that may affect the practicality of this option are:

- The tram pole at the junction at Amiens Street with Mayor Street Lower;
- Relocating the taxi rank to north of the bus stop outside Connolly Station;
- Construction of the proposed new road at The Point; and
- Possible renovation of the Lift Bridge on Mariners Port.

The proposed route would not necessitate the buses being guided, though guidance at stops would minimise the gap for boarding passengers.



## **(e) Route 5 – Heuston Extension**

This route incorporates the existing Route 90 bus service, which travels westwards along the south side of the River Liffey to Heuston Station, and returns eastwards along the north side of the river, and would follow the same path as bus route option 1 between The Point and Connolly Station, as shown in Figure 7. Two options have been identified at this stage as it is questionable whether the service could operate two-way under the railway bridge at Sheriff Street Lower, affecting the eastbound routing.

### **North Side (sub-option)**

Ideally the buses would travel to Beresford Place / Memorial Rd and turn left into Amiens Street to stop on the opposite side of the road at Connolly Station, carrying on north and turning right into Sheriff Street Lower. The bus will continue by turning right into Commons Street and left into Mayor Street Lower to rejoin the route of option 1 to The Point.

A specific problem of this route is that buses will travel in both directions along Sheriff Street Lower under the railway bridge where the width of the road would be an issue. Here guided vehicles could be given consideration, or a traffic management solution considered. Other factors that may affect the practicality of this option are:

- The tram pole at the junction at Amiens Street with Mayor Street Lower;
- Relocating the taxi rank to north of the bus stop outside Connolly Station; and
- Construction of the proposed new road at The Point.

### **South Side (sub-option)**

If the bus cannot turn right from Amiens Street to Sheriff Street it would have to operate eastbound on a loop using Eden Quay, Custom House Quay, Commons Street, Sheriff Street Lower and Amiens Street to Connolly Station. It would then continue south on Amiens Street and left into Mayor Street Lower and continue to The Point as for bus route option 1. A shorter route accessing Mayor Street Lower from Beresford Place / Memorial Rd was ruled out due to the conflict with trams travelling two-way through the junction between Store Street and Connolly Station.

The problem with this option is that it involves traversing two loops around Connolly Station this would;

- Significantly add to the journey time;
- Be frustrating for passengers travelling eastbound; and
- May lead to passenger confusion at the Connolly Station stop where eastbound and westbound buses stopping at the station will be travelling in the same direction past the station.

The other factors that may affect the practicality of this option are the same as that of the North Side sub-option. The proposed route would not necessitate the buses being guided, though guidance at stops would minimise the gap for boarding passengers.



**(f) Route 6 - East Point Business Park Extension**

Figure 8 shows that this option would further extend the route 5 option to serve additional locations in north Docklands requested by the DDDA, specifically East Wall residential area and East Point Business Park. After travelling east to The Point and turning along North Wall Quay and into East Wall Road the bus would continue along East Wall and Alfie Byrne Road and operate around a loop in East Point Business Park. The bus would travel back to the junction of East Wall Road with Sheriff Street Upper, where it would rejoin the Route 1 route, serving The Point again before returning to Connolly.

This option will have the added advantage over Route 5 of being able to serve the Business Park and further increasing the origin-destination possibilities. However, it may not be attract enough patronage in the off-peak period, therefore, a combination of Route 6 (peak period) and Route 5 (off-peak period) could be a more attractive alternative.

The north and south sub-options between Beresford Place and Connolly identified in route 5 apply to this route and the same factors listed in Route 5 affect the practicality of this option. We have not been able to examine the route beyond East Wall Road / Sheriff Street Upper junction to determine any other constraints to the scheme.

**(g) Route 7 - St Stephen Green Extension**

This option would link the Docklands area to Saint Stephens Green, suggested in documentation sent to the RPA by the IFSC Steering Committee. Figure 9 shows that the bus would start at the corner of Saint Stephens Green North and Dawson Street and travel north up Dawson Street and west along Nassau Street and Suffolk Street until reaching College Green. From College Green the bus would turns right and north up Westmoreland Street and over O'Connell Bridge and then follow the same path as that for bus route option 5 (including the north and south sub-options between Beresford Place and Connolly). In the reverse direction the bus would cross the Talbot Memorial Bridge and travel south along Moss Street and Shaw Street west along Pearse Street, College Street, east along Nassau Street, south along Kildare Street to the terminus at Stephens Green North.

Factors that may affect the practicality of this option are:

- The tram pole at the junction at Amiens Street with Mayor Street Lower;
- The narrow road under the railway on Sheriff Street Lower on the north side sub-option;
- Relocating the taxi rank to north of the bus stop outside Connolly Station;
- Construction of the proposed new road at The Point;
- Removal of speed ramps on Moss Street; and,
- Introduction of traffic signal control incorporating a right turn from Kildare Street to St Stephens Green North for buses only.

### 5.4.3 Other Options

Extending the Docklands bus service beyond the City Centre to other parts of the City might also be considered in more detail if any bus option was taken forward. This would require more detailed network examination to determine the practicality of the routes for articulated bus operation and the stopping requirements and effects on traffic and access. Any such investigation might start with the relatively high frequency services coming to Eden Quay from the south / southwest of the City listed earlier.

**Figure 2 Existing Bus Services in North Docklands**

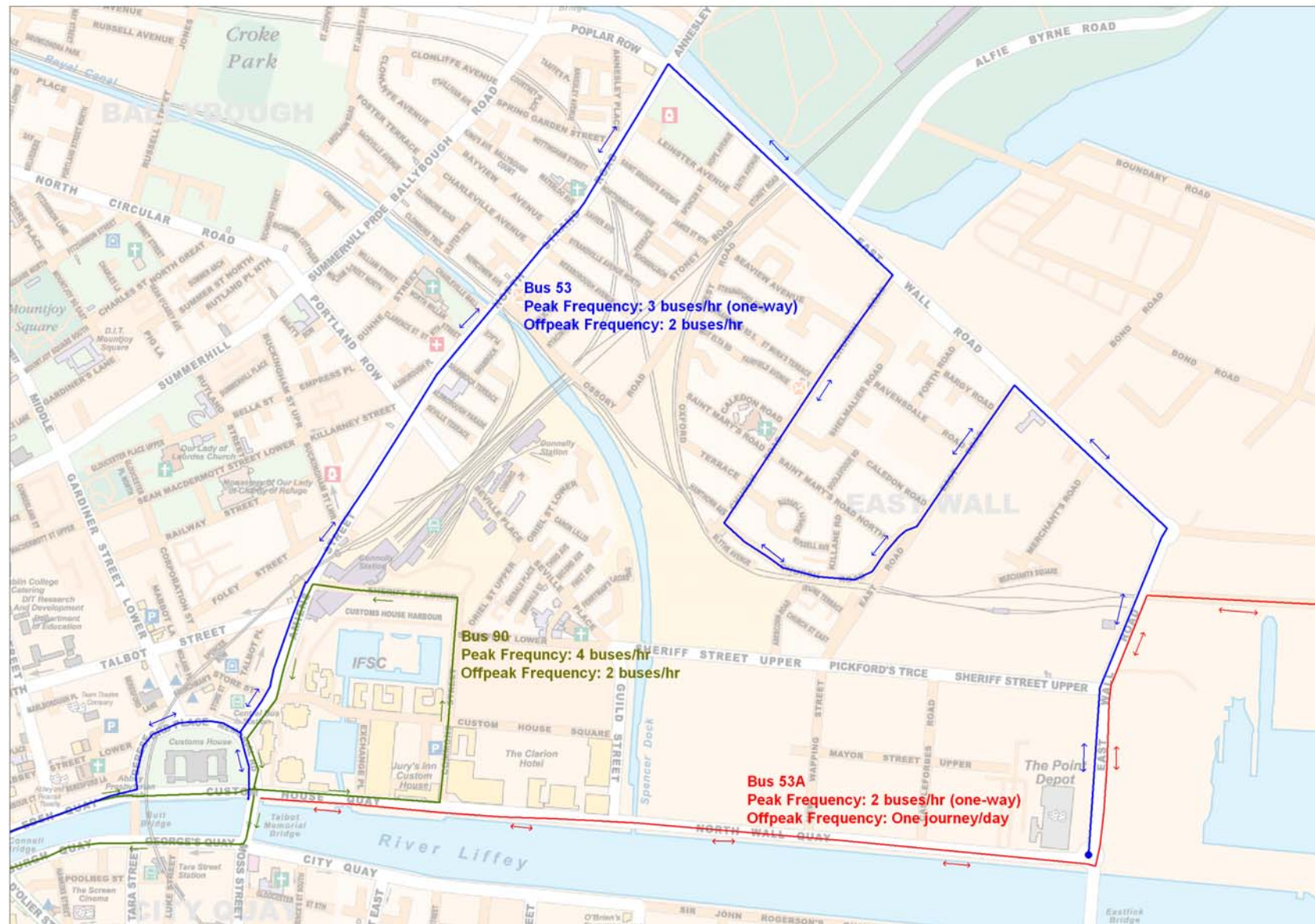






Figure 3 Bus Route Option 1

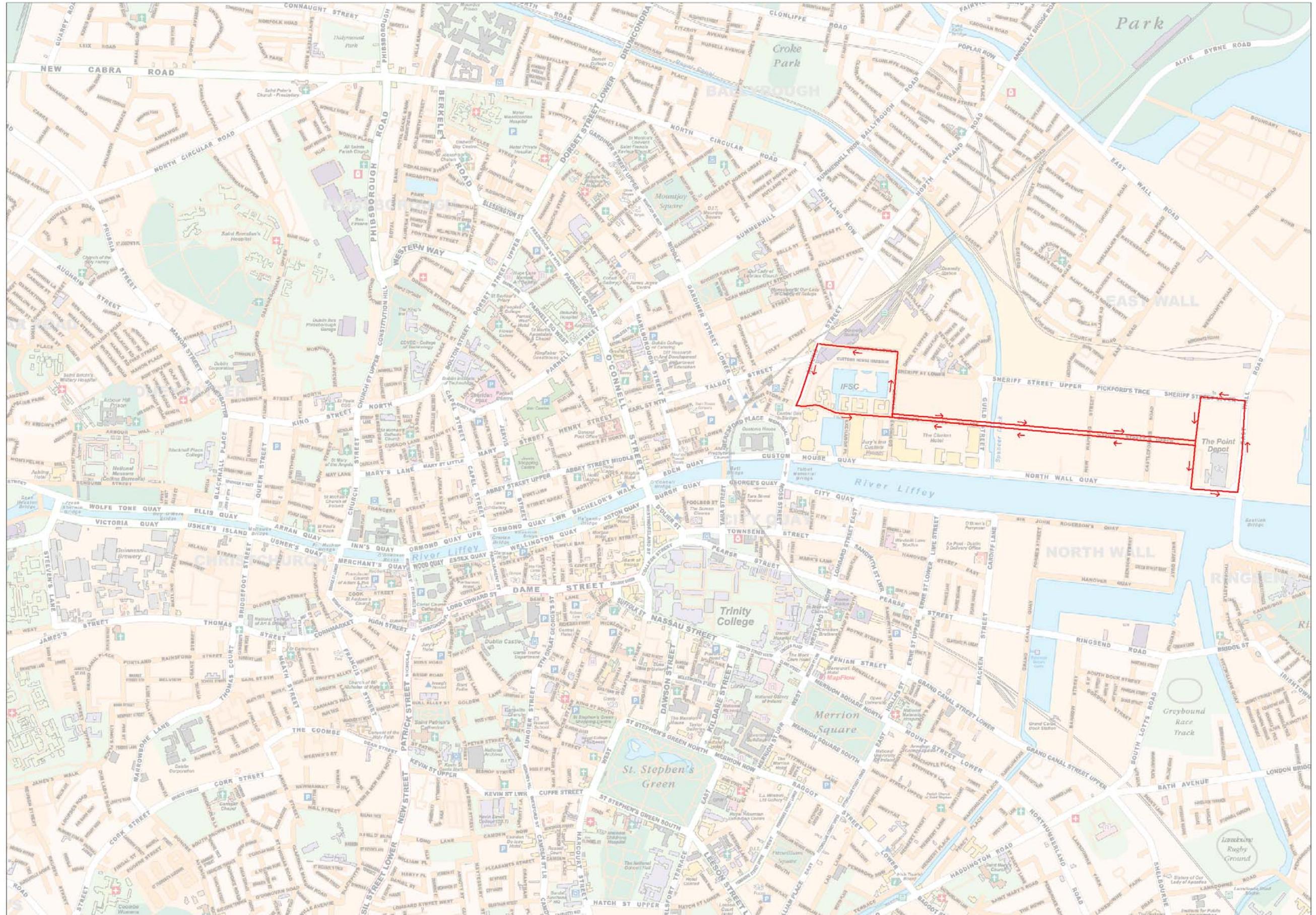








Figure 4 Bus Route Option 2

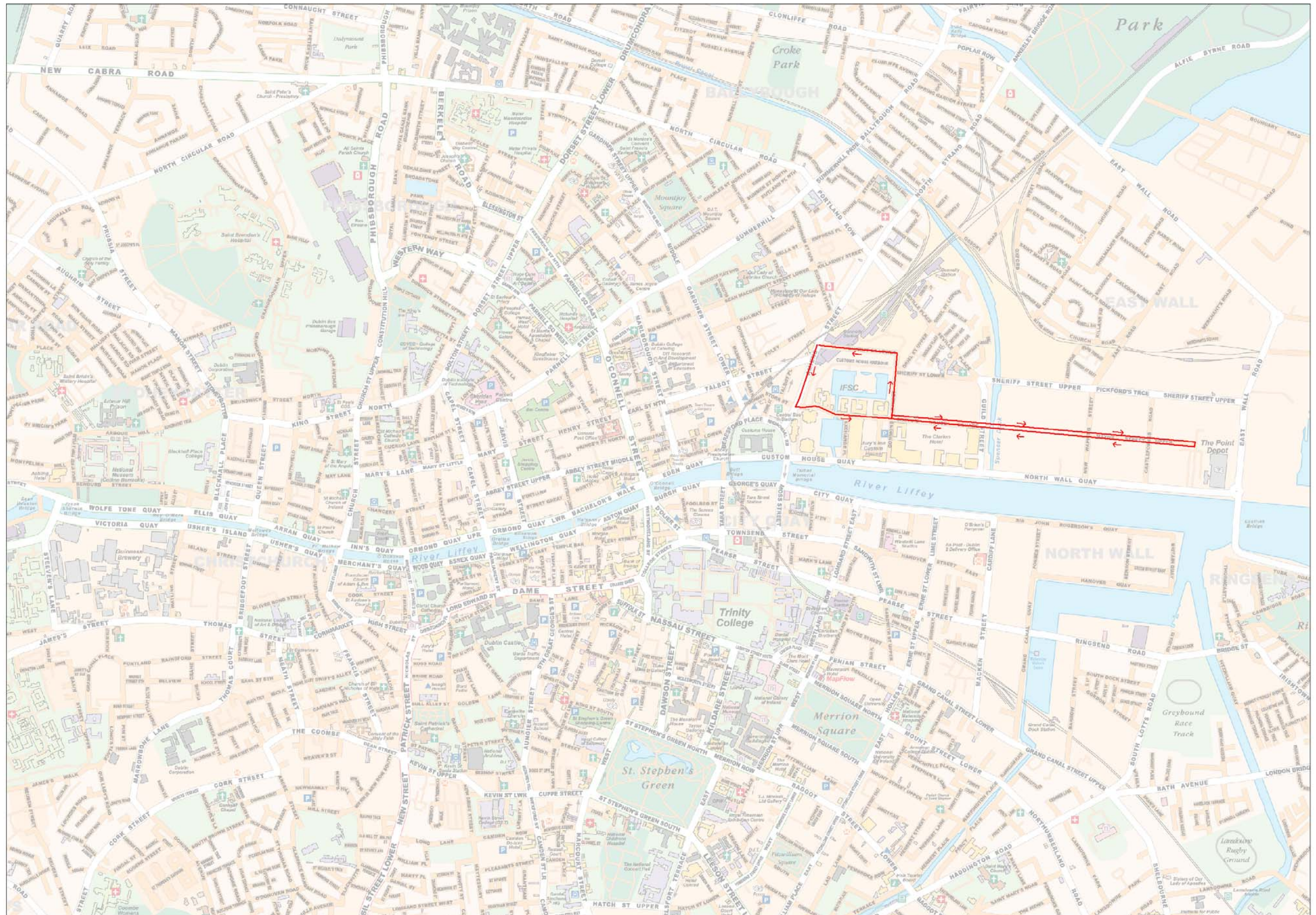








Figure 5 Bus Route Option 3

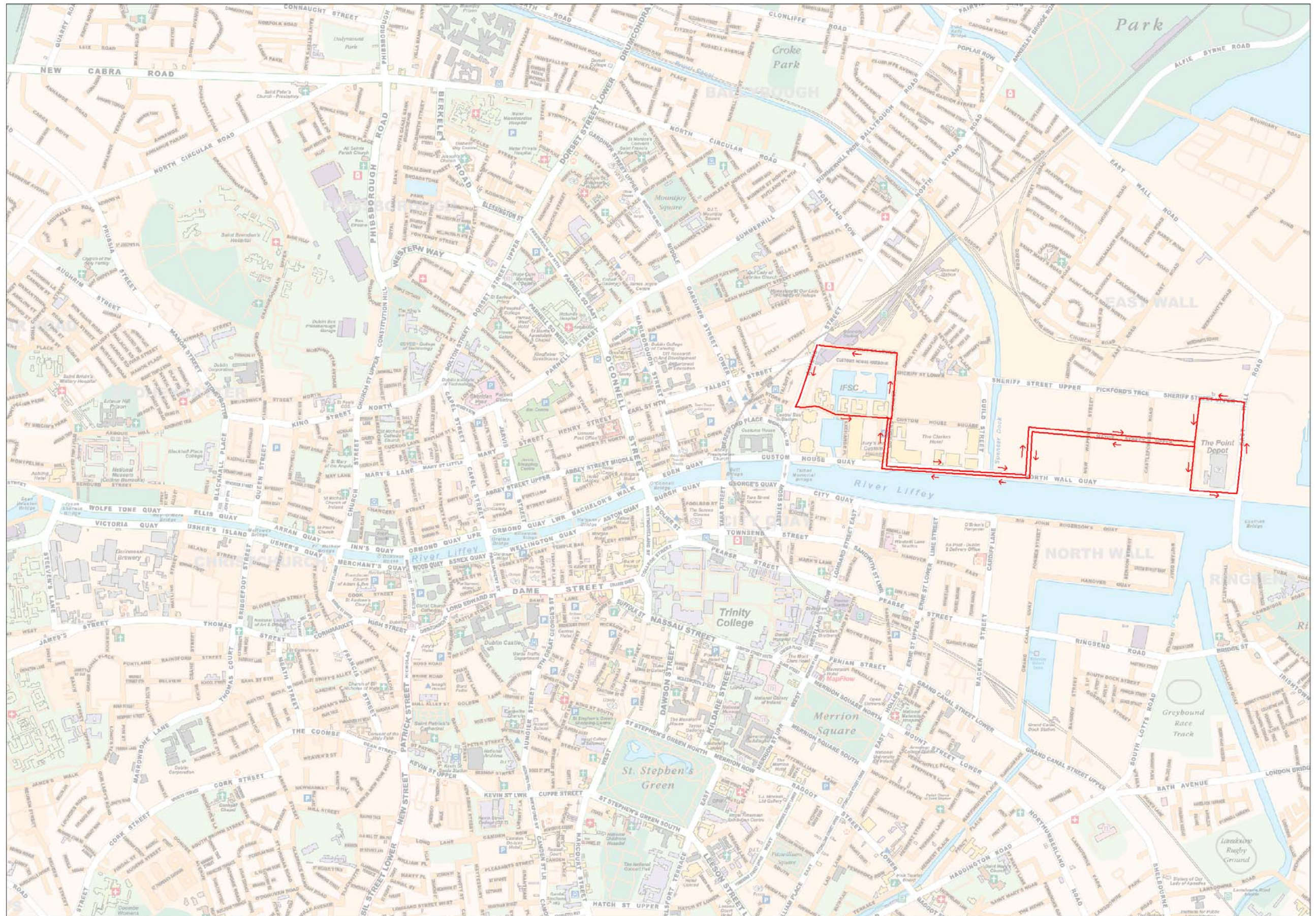








Figure 6 Bus Route Option 4

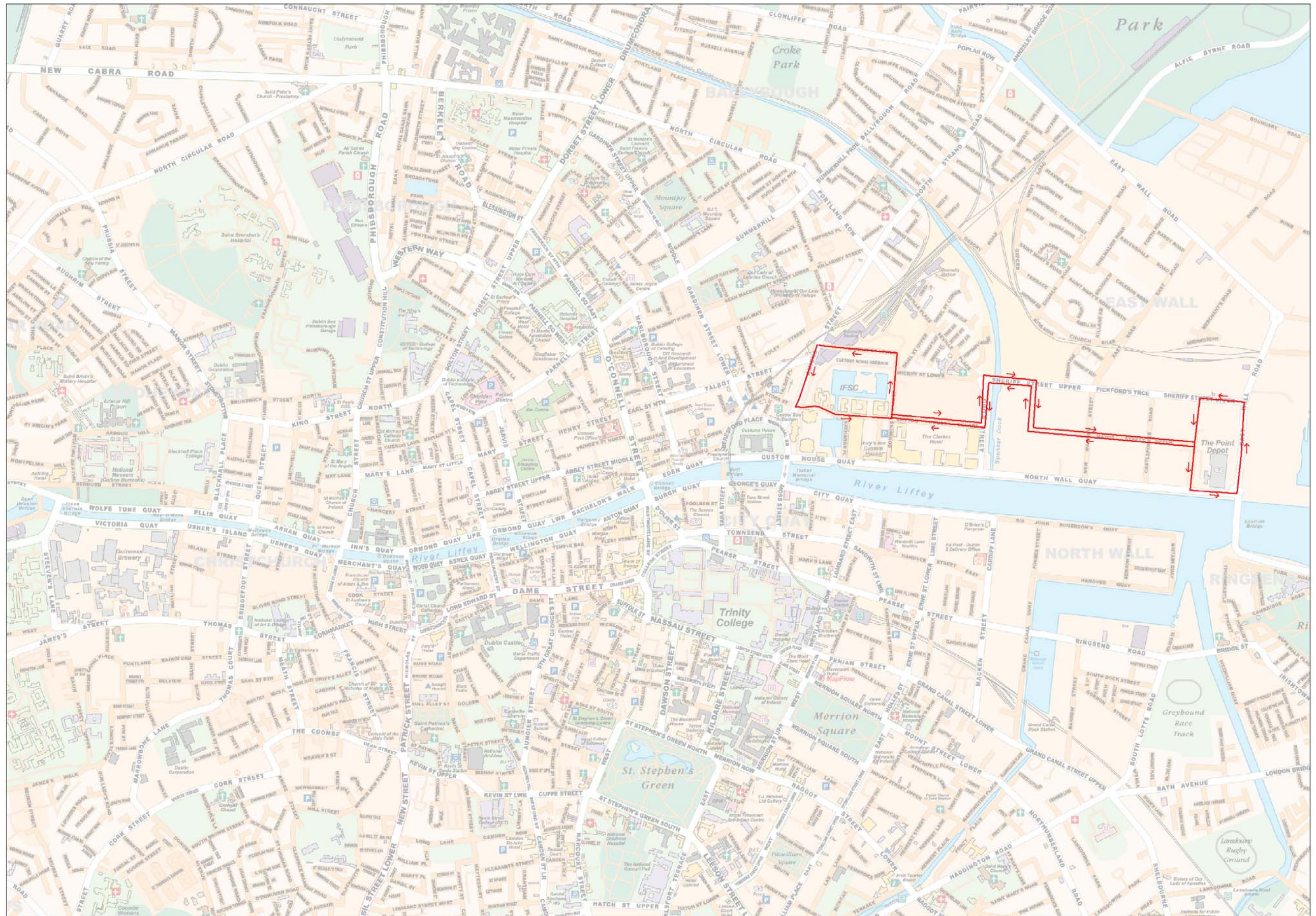








Figure 7 Bus Route Option 5

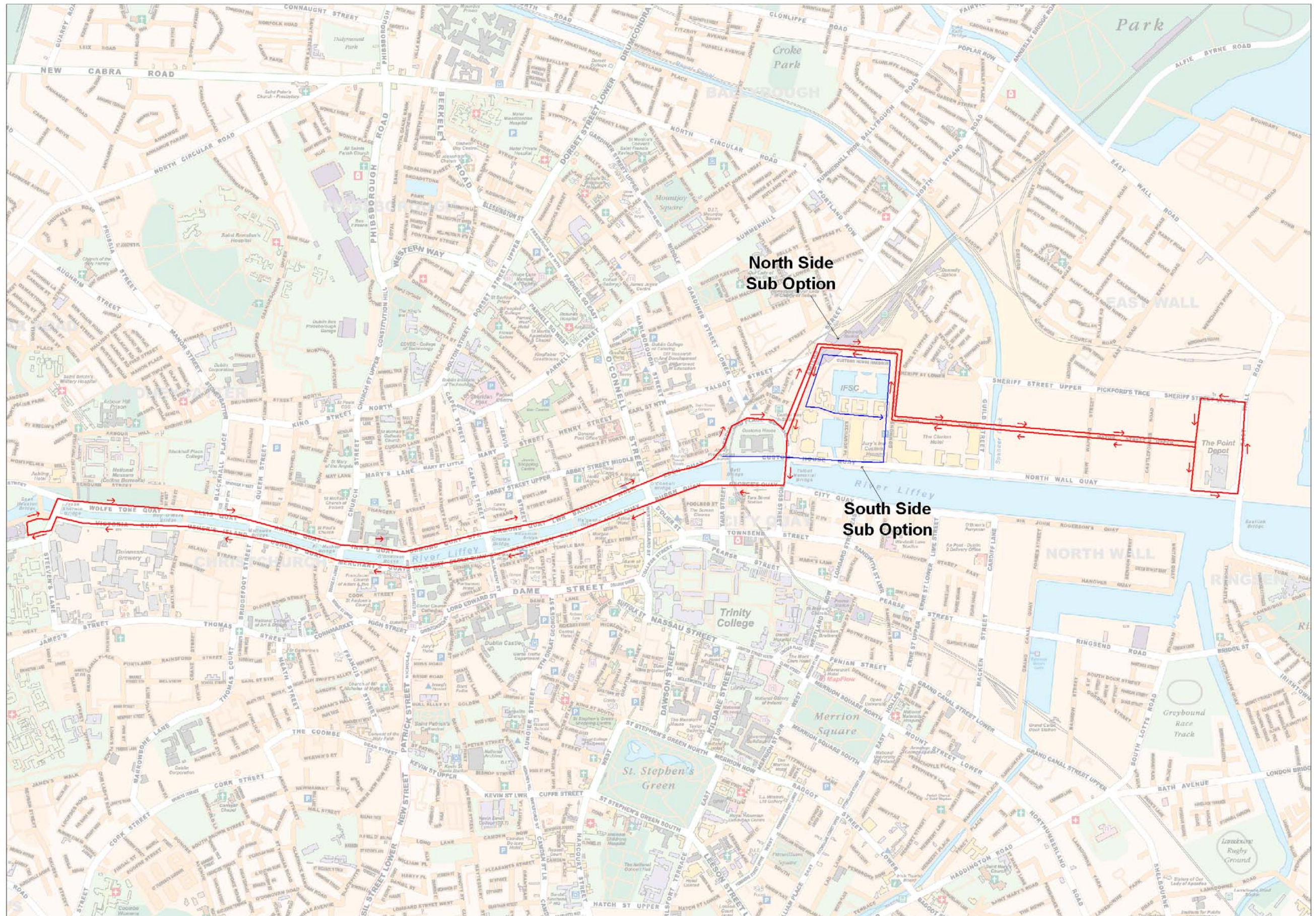








Figure 8 Bus Route Option 6

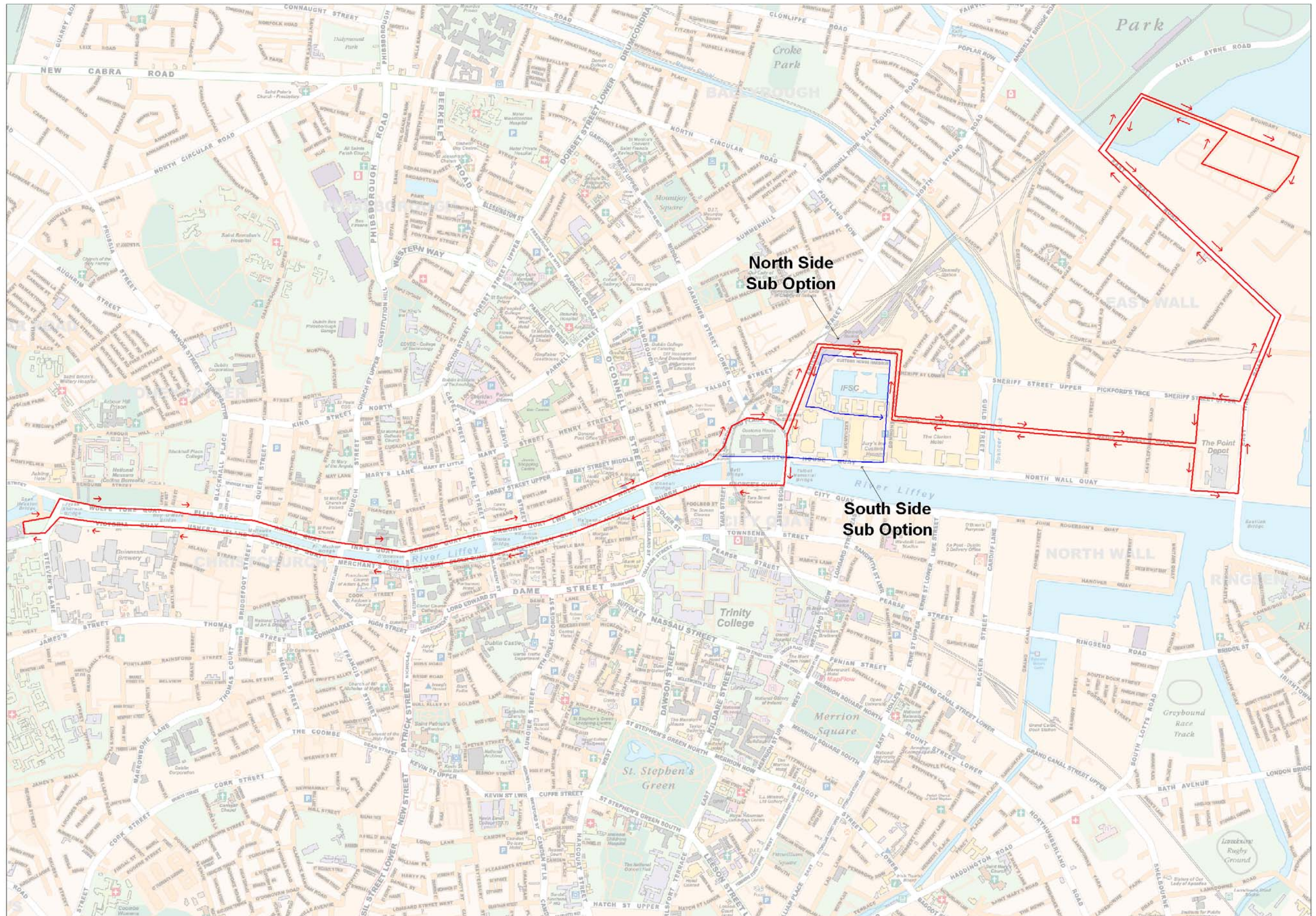
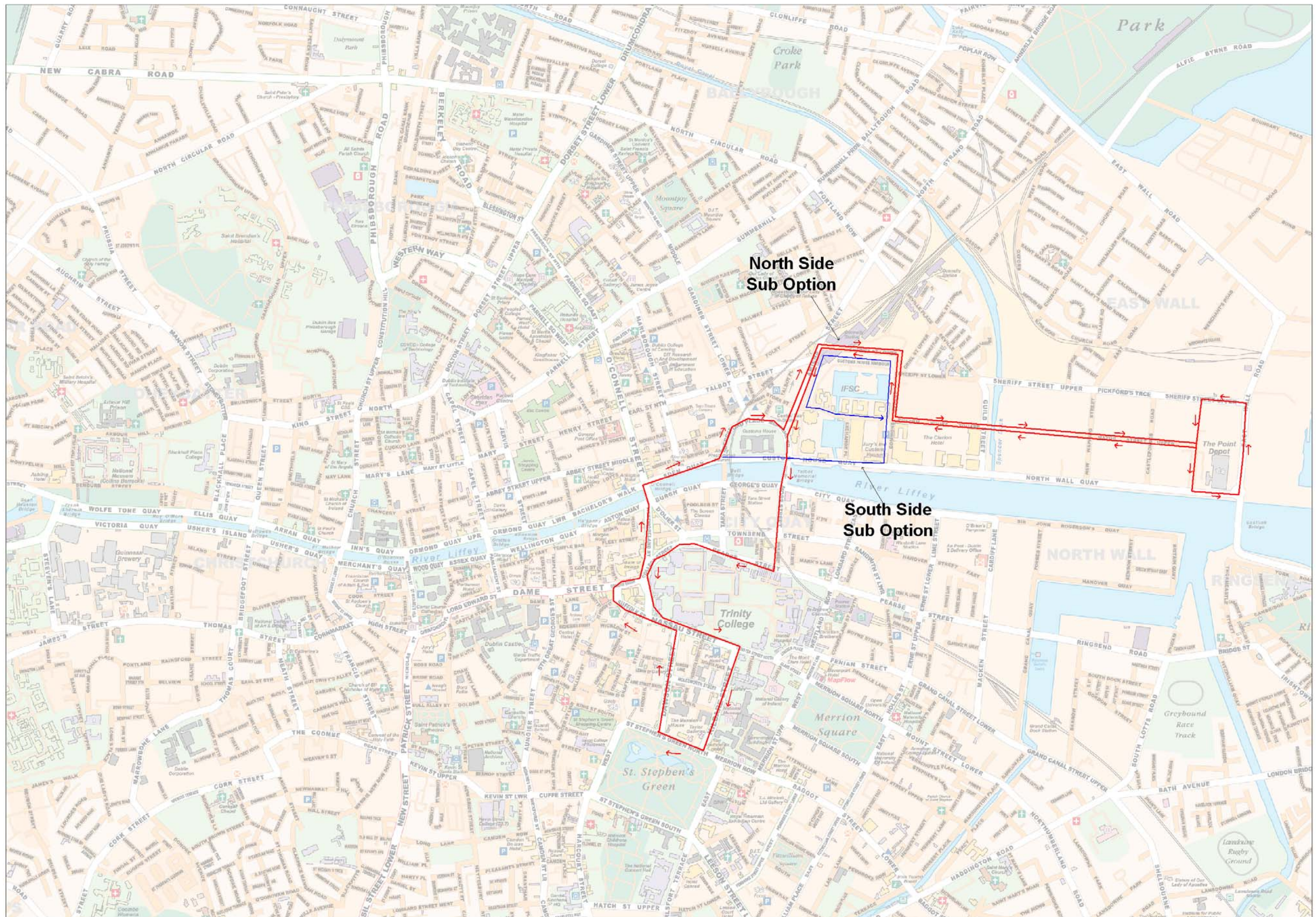








Figure 9 Bus Route Option 7







## 6 BUS ROUTE OPTION APPRAISAL AND SELECTION

### 6.1 Introduction

This section describes the appraisal of the bus route options using the defined framework and summarises the results and decision making in terms of the best bus option(s) to take forward to the comparative assessment against the Luas Line C1 scheme. The completed detailed appraisal framework is shown in Figure 10 and the summary appraisal at the level of the main objectives formed from aggregation of the more detailed framework is provided in Figure 11.

### 6.2 Appraisal results

#### 6.2.1 Safety

This objective did not include any sub level objectives and the 'scores' were based on a subjective assessment of the safety and security impacts of the options. All route options were allocated a 'slightly positive' score because all options are schemes that intend to stimulate greater public transport use and therefore reduce the amount of car use and associated highway accidents. A 'significant' or 'substantial' positive score could not be justified as none of the options specifically target safety as an objective, in the manner of other transport schemes, such as speed humps and pedestrian crossings.

Routes 3, 5 (north), 6 (north), 7 (north) were given an additional appraisal score of providing a 'slightly adverse' impact, because Route 3 requires the vehicle to negotiate more junctions (than Routes 1 and 2) and travel further along the busier North Wall Quay rather than Mayor Street Lower creating more traffic interaction. Routes 5 (north), 6 (north) and 7 (north) were given the additional 'slightly negative' appraisal score because they require vehicles to travel 2-way along Sheriff Street Lower and there is the concern that the narrow road could increase the risk of accidents, although detailed scheme design would aim to minimise these impacts.

#### 6.2.2 Economy

The economy objective incorporated the value for money and economic regeneration sub-objectives. Without detailed economic appraisal of the bus options at this stage the value for money assessment was based on the assessment of its sub-criteria demand / revenue represented by connectivity, journey time and vehicle quality and operating and capital costs.

All the route options were allocated at least a 'slightly positive' impact score because they provide an increase in public transport supply, which will increase connectivity, reduce journey times for both users and non-users and induce some form of economic regeneration. The vehicle quality of all options is likely to be high because novelty 'tram like' buses were assumed for all options.

Routes 1, 2, 5 (north), 5 (south), 6 (north), and 6 (south) were allocated a 'significantly positive' impact score because Routes 1 and 2 are likely to have lower journey times than the rest as they are essentially shuttle services throughout the complete length of Mayor Street<sup>18</sup> and also their connectivity is better than Routes 3 and 4 because the route along Mayor Street is more beneficial in terms of patronage potential (by serving the central north docklands catchment) than North Wall Quay and Sheriff Street Upper.

Routes 5 (south), 6 (north), and 6 (south) all provide high levels of connectivity because of the extended routes (with Routes 6, north and south, providing further connectivity to the East Point Business Park), and its particular advantage over Route 7 (north) and Route 7 (south) being that they will generate further economic regeneration through the enhanced connectivity through integration with rail and Luas including at Heuston Station and the greater number of city centre demand locations served.

Routes 3 and 4 would have higher capital and operating costs than routes 1 and 2 due to the additional distance involved in travelling south and north, respectively, to avoid the Mayor Street Bridge. The additional 3 minutes estimated would require an additional vehicle in operation.

Route 2 was given a 'substantially beneficial' score for vehicle quality because double ended vehicles are necessary which would be regarded as being the most 'tram-like', though this would also raise the capital costs. Routes 6 (north) and 6 (south) were given a 'substantial adverse' score for operating cost because the route is substantially longer, this would also result in greater capital costs.

### 6.2.3 Integration

The integration objective incorporates the interchange and spatial strategy sub-objectives. Interchange was cross compared through measuring direct and indirect<sup>19</sup> connections with rail stations and bus termini in the City Centre derived from the Dublin Bus map of city centre terminals. All the options were allocated at least a 'slightly positive' impact score for the integration objective, because they all provide further interchange connections to Connolly station, the Central Bus Station, the potential Spencer Dock station, which will also be near the Interconnector, and the planned bus interchange at The Point. All options also provide a public transport service which will inevitably be conducive to the spatial strategy objective by connecting with the existing public transport system.

Routes 7 (north) and 7 (south) were allocated a 'significantly positive' impact score because they provided interchange possibilities with bus links from Westmoreland Street, D'Olier Street, Hawkins Street, Burgh Street, Fleet Street, College Street, Townsend Street and Pearse Street. This adds a further 9 interchange possibilities and we therefore felt that it merited a higher score than Routes 1, 2, 3 and 4.

<sup>18</sup> The journey time of Route 1 is estimated to be around 20 minutes. This estimate was derived by assuming that the journey length is roughly 4.5 kilometres with the vehicle travelling at 15 kilometres per hour and the required layover period being 3 minutes. Route 2 is likely to be considerably shorter and the remaining routes being significantly longer.

<sup>19</sup> Interchange walking time of under 5 minutes was deemed as an 'interchange possibility' in this aspect.

Routes 5 (north), 5 (south), 6 (north), and 6 (south) were allocated a 'substantially positive' impact score because they provided interchange possibilities<sup>20</sup> with Custom House Quay, Eden Quay, Bachelors Walk, Middle Abbey Street, O'Connell Street Lower, Lower Abbey St, Georges Quay, Burgh Quay, Hawkins Street, D'Olier Street, Westmoreland Street, Aston Quay and Heuston Station. This adds another 13 interchange possibilities including Heuston Station which was regarded as being a particularly important interchange linking to a significant portion of the city to the west and south.

Additionally, these options are regarded as being particularly conducive to the spatial strategy of the city because it provides a direct route between the Docklands and Connolly Station, and Routes 6 (north) and 6 (south) link a peripheral Docklands area, East Point Business Park, to the core Docklands developments and existing public transport system.

#### **6.2.4 Accessibility**

Accessibility was assessed in terms of improvements for particular transport markets – taking account of direct connections and indirect connections taking account of the pattern of bus services providing access to other areas of Dublin through interchanges. All options were deemed to provide at least a 'slightly positive' impact because they all provide docklands residents some access<sup>21</sup> into Dublin's most prominent retail area (between Bachelors Walk and Parnell Street) as well as providing access to employment areas within the docklands and outside.

Routes 5 (north), 5 (south), 6 (north) and 6 (south) were allocated a 'significantly positive' score because they all provided direct connections to other areas of the city centre as well as providing a significant amount of indirect connections to the west and south of the city.

Routes 6 (north) and 6 (south) were allocated a 'substantially positive' score because they provided most of the benefits of the other extended bus route services<sup>22</sup> as well as providing greater accessibility via a direct connection to employment in the East Point Business Park. These routes also offered greater social inclusion benefits to the north docklands residents into and out of the core Docklands area as well as providing access of non docklands residents to activities, including recreational i.e. The Point, within Docklands.

#### **6.2.5 Environment**

There was very little variation between the route appraisal scores for the environmental objective. For some criteria all routes were allocated at least a 'slightly adverse' impact score because:

- Buses in general contribute to noise, air pollution and green house gases;
- Public transport improvement will encourage some Docklands pedestrians and cyclists to take the less healthy option of riding a bus;
- All the routes require buses to travel in general traffic roads in which passengers are likely to derive disbenefits in terms of journey ambience;

<sup>20</sup> Ibid.

<sup>21</sup> Either directly or through an interchange.

<sup>22</sup> The 'extended bus routes' are the routes which the shuttle service (between Connolly Station and The Point) only forms part of its entire route. These are Routes 5 (north), 5 (south), 6 (north), 6 (south), 7 (north) and 7 (south).

- All routes require buses to travel along roads which include heritage buildings including Custom House Quay between North Wall Quay and Mayor Street); and
- All bus options involve the use of traditional road surfaces rather than introducing Cobbles and Granite surfaces which would detract from the aims of the DDDA civic design framework in the 2003 materplan in terms of materials. To secure a high ride quality the bus options would require the removal of some cobbled surfaces in the vicinity of the IFSC.

For other criteria all routes were allocated at least a 'slightly positive' score because:

- Public transport helps encourage a shift from car use therefore reducing air pollution and green house gas emissions;
- Public transport gives car users the opportunity to take the more healthy option of riding a bus to and from which they would walk; and
- Most routes require the vehicle to travel along the River Liffey, for at least some part of the journey, therefore providing passengers a 'pleasing' view contributing to better journey ambience.

Routes 6 (south) and 7 (south) were awarded a score of providing 'significantly positive' impact on the environment because they both require vehicles to travel along Custom House Quay and therefore gave the passengers an opportunity to enjoy the river view for a greater proportion of the journey. Route 6 (south) also gives the opportunity for passengers to enjoy other areas of the city such as Fairview Park, and Route 7 (south) offers a ride along Saint Stephens Green and along roads with a higher concentration of pleasant buildings situated on the south side of the river.

#### **6.2.6 Mode shift**

All route options were given at least a 'slightly positive' impact score in regards to increasing the city's public transport mode share target because they provided new public transport routes and greater interchange possibilities with an associated increase in public transport capacity.

The longer route options were given a significant positive score as they would be likely to attract more demand and offer more mode switch opportunities. There would be slight differences between the shuttle options due to some (3 and 4) having greater interaction with traffic which will make them less reliable.

#### **6.2.7 Efficiency**

All routes were awarded an appraisal score of providing a 'significantly positive' impact on the efficiency objective because they are likely to induce a shift from car to public transport use and therefore free road space which will in turn increase highway reliability. Although routes which required travelling along general traffic routes for a greater portion of its journey (e.g. Routes 3 and 4) were not deemed to be as beneficial in this respect than others (e.g. Routes 1 and 2). Additionally, all routes increased the public transport capacity because they all required the utilisation of extra vehicles. Routes 6 (north) and 6 (south) require more vehicles than the others in order to cover the extra distance required and maintain headway levels.

Routes 3, 5 (north), 5 (south), 6 (north), 7 (north) and 7 (south) were all allocated a 'slightly adverse' impact in regards to their impact on efficiency because they require significant travelling along general traffic roads and are therefore likely to fill scarce road space.

### **6.2.8 Affordability**

The bus options have relatively low infrastructure costs, mainly the Mayor Street Bridge, and the vehicles themselves are relatively affordable, therefore all options were deemed to be likely to provide a 'significantly positive' impact in terms of affordability. Route 2 would require double-ended vehicles which are more expensive and Routes 6 (north and south) will require more vehicles due to the extra length of the route, but such extra costs may be balanced out by the extra revenue that the schemes are also likely to generate.

### **6.2.9 Deliverability**

All options were deemed to provide at least a 'slightly adverse' impact on the ability to deliver the scheme because the public response is likely to be negative as the accepted Masterplan promises the Luas extension. Public acceptability of the bus options is likely to be high, depending on the technology chosen and resultant construction issues. Route 2 requires use of a vehicle that is regarded as the closest substitute to a tram. Also some options have less or no requirement for infrastructure alongside the river and would therefore provoke less concern amongst environmentalists.

Route 2 was deemed to provide a 'highly adverse' impact on the ability to deliver the scheme because double-ended vehicles are not largely available and are not 'tried and tested' technology, thus ranking poorly in terms of technical practicability. All other options were given a 'significantly positive' impact in terms of deliverability because they are easy to implement (hence the high appraisal scores for technical practicability<sup>23</sup>).

### **6.2.10 Regeneration**

All the options which introduced a shuttle service were given a 'significantly positive' score for their contribution to the city's regeneration because they provide considerable access in and out of the docklands area and therefore contributed significantly to city centre living. Whilst the options with the extended bus services would provide additional regeneration impetus outside the study area they were given the same 'significant positive' score for the impact within the study area.

### **6.2.11 Attractiveness**

All options were regarded as being at least 'slightly positive' in terms of their contribution in presenting public transport as an attractive mode of transport assuming the use of new 'tram like' vehicles which are likely to raise the profile of buses in general. Route 2 was awarded a 'significantly positive' score because a 'double-ended' vehicle would go further than traditional single-ended vehicles in terms of novelty value. It was decided that buses in general would not score as highly as trams because of their perceived lower status and for the fact that replacing the tram with a bus would break up the existing public transport system and would therefore result in public transport being less attractive as a mode of transport.

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<sup>23</sup> The northern routes of the extended networks were not regarded as being as technically practical as the other options (apart from Route 2) because of the possible 'pinch point' on Sheriff Street Lower. The possibility of this becoming an issue was the reason for downgrading its appraisal score.

## 6.3 Route selection

In selecting a route option for taking forward in the study, it was decided to initially select one option from the shuttle services and one option from the extended services.

### 6.3.1 Selected shuttle service

The consultants' concern that Route 2 would not be deliverable led to the rejection of that option as there would be concern over its practicality even if it scored the highest on all other objectives.

The appraisal framework shows that Routes 1, 3 and 4 scored the same on all objectives apart from the economy and mode shift objective, in which **Route 1 was judged to be the most beneficial and is therefore recommended for further assessment.**

### 6.3.2 Selected extended bus service

Selecting the preferred extended bus service was undertaken by comparison between the main options, Routes 5, 6 and 7, followed by consideration of the difference between the north and south route sub-options.

#### (a) Selecting between Routes 5, 6 and 7

Routes 5 and 6 attained the highest appraisal scores for the economy and integration objectives, and Route 6 was awarded the highest score for the accessibility and mode shift objectives. All options were judged to provide the same score on all other criteria. Therefore the appraisal framework shows that **Route 6 scores the same or highest for all options and is therefore recommended for further assessment.**

#### (b) Selecting between Routes 6 (north) and 6 (south)

The southern sub-option was deemed to be safer, mainly because of the pinch point on the northern route at Sheriff Street Lower. However, this problem could be resolved by installing vehicle responsive traffic signals or widening the road. Alternatively, it is possible that an optical guided vehicle may provide a solution. The south sub-option was deemed to provide more positive impacts on the environment mainly due to passengers being able to experience better journey ambience by travelling an extra distance along the river. However, the southern sub-options result in longer distances travelled and journey times, lowering passenger attractiveness and increasing costs. **It was therefore recommended that the routing decision of option 6 should follow more detailed assessment of the practicality of the northern variant in the next stage.**



Figure 10 Detailed Appraisal of Bus Route Options

					Bus Route Options									
Objectives	Sub-criteria				1	2	3	4	5(North)	5(South)	6(North)	6(South)	7(North)	7(South)
Safety					+	+	- +	+	- +	+	- +	+	- +	+
Economy	Value for money	Demand	Connectivity		++	++	+	+	++	++	+++	+++	++	++
			Journey Time		++	++	+	+	+	+	+	+	+	+
			Vehicle Quality		++	+++	++	++	++	++	++	++	++	++
		Operating Cost		-	-	--	--	--	--	---	---	--	--	
		Capital cost		-	--	-	-	-	-	--	--	-	-	
Economic Regeneration				+	+	+	+	++	++	++	++	+	+	
Integration	Interchanges				+	+	+	+	+++	+++	+++	+++	++	++
	Spatial Strategy				++	++	++	++	+++	+++	+++	+++	++	++
Accessibility	City Core	Docklands Residents	Retail	Out	++	++	++	++	+++	+++	+++	+++	++	++
			Employment	In	+++	+++	++	++	++	+++	+++	+++	+++	+++
				Out	+	+	+	+	++	++	+++	+++	++	++
		Docklands Employees	Direct Connections		0	0	0	0	++	++	++	++	++	++
			Indirect Connections	North	+	+	+	+	+	+	+	+	+	+
				South	+	+	+	+	++	++	++	++	++	++
		West		+	+	+	+	+++	+++	+++	+++	++	++	
		Social Inclusion				+	+	+	++	++	++	+++	+++	++
Environment	Noise				-	-	-	-	-	-	-- +	-- +	-	-
	Local Air Quality				- +	- +	-- +	-- +	- +	- +	- +	- +	- +	- +
	Green House Gases				- +	- +	-- +	-- +	- +	- +	- +	- +	- +	- +
	Landscape				0	0	0	0	0	-	0	-	0	-
	Townscape				-	-	-	-	-	-	-	-	-	-
	Heritage				-	-	-	-	-	-	-	-	-	-
	Biodiversity				0	0	0	0	0	0	0	0	0	0
	Water Environment				0	0	-	0	0	-	0	-	0	-
	Physical Fitness				- +	- +	- +	- +	- +	- +	- +	- +	- +	- +
Journey Ambience				- +	-	- + +	- +	-- +	- + +	-- + +	- + + +	-- + +	-- + + +	
Mode Shift	% Demand				+	+	+	+	++	++	++	++	++	++
Efficiency	Reliability				++	++	+	+	++	+	+	+	++	++
	PT Capacity				++	++	++	++	++	++	++	++	++	++
	Impact on Highway Network				- + +	++	- + + +	- + +	- + + +	- + + +	- + + +	- + +	- + + +	- + + +
Affordability					++	++	++	++	++	++	++	++	++	++
Deliverability	Public Acceptability				--	-	---	--	-	--	-	--	-	--
	Technical Practibility				+++	---	+++	+++	++	+++	+++	+++	++	+++
	Disruption				-	-	-	-	-	-	-	-	-	-
Regeneration	Penetration	Stimulation	City Living		++	++	++	++	++	++	++	++	++	++
Attractiveness	Public Transport				+	++	+	+	+	+	+	+	+	+
Preferred Route(s)														

Scale:

Scale

Positive Impact			No Impact	Negative Impact		
Substantial	Significant	Slight	Neutral	Slight	Significant	Substantial
+++	++	+	0	-	--	---

Figure 11 Summary Bus Route Option Evaluation Framework

Objectives	Bus Route Options									
	1	2	3	4	5 (North)	5 (South)	6 (North)	6 (South)	7 (North)	7 (South)
Safety	+	+	- +	+	- +	+	- +	+	- +	+
Economy	++	++	+	+	++	++	++	++	+	+
Integration	+	+	+	+	+++	+++	+++	+++	++	++
Accessibility	+	+	+	+	++	++	+++	+++	++	++
Environment	- +	- +	- +	- +	- +	- +	- +	- ++	- +	- ++
Mode Shift	++	++	+	+	++	++	++	++	++	++
Efficiency	++	++	- ++	++	- ++	- ++	- ++	++	- ++	- ++
Affordability	++	++	++	++	++	++	++	++	++	++
Deliverability	- +	- -	- +	- +	- +	- +	- +	- +	- +	- +
Regeneration	++	++	++	++	++	++	++	++	++	++
Attractiveness	+	++	+	+	+	+	+	+	+	+
Preferred Bus Routes										

Scale	Positive Impacts			No Impact 0	Negative Impacts		
	Substantial	Significant	Slight		Slight	Significant	Substantial
	+++	++	+		-	--	---

## 7 PREFERRED BUS OPTIONS TECHNICAL ASSESSMENT

### 7.1 Introduction

The technical practicality of the bus options were examined in more detail to determine the capital and operating costs for input to the economic evaluation.

### 7.2 Operations Issues

It is important to clearly understand the proposition of the bus option, as identified at the start of Section 4 of this report. It is envisaged to replicate the travel experience of the Luas where possible by creating a bus rapid transit (BRT) system, built around the travel experience of the vehicles. In addition it would be advantageous to fully integrate the BRT system with Luas from a passenger perspective, particularly in terms of ticketing and passenger information but also in terms of stop equipment and vehicle branding.

The BRT system is therefore assumed to have dedicated stops protected from the elements with high quality shelters and good lighting. Communications at the stop will consist of CCTV and help points that will link the passenger with a Control room. In addition real time Passenger Information Displays using Automatic Vehicle Location (AVL) technology will be deployed.

Each platform at each stop will have at least 1 ticket vending machine that will be of the same design as those currently in service on the Luas. The approach has been to assume that passengers will have pre-paid before boarding, so lowering boarding times. Enforcement will need to be via ticket inspectors as occurs on the Luas now.

Ideally the buses will be accorded Urban Traffic Control (UTC) priority at signals, so providing enhanced journey times and greater reliability.

#### 7.2.1 Run Times and Fleet Requirements

The running times of the bus options were estimated from the link lengths and an average speed including stop dwell times of 15kph within Docklands and 10kph in the City Centre (for route option 6), which allows for assumed bus priority measures in Docklands. It is assumed that the service frequency would be the same as for Luas - a 5 minute headway - producing the estimated fleet requirements shown in Table 8. In determining the fleet requirements we have assumed 10% more vehicles for both maintenance and reliability with a minimum of 2 (at least one on stand-by and allowance for heavy maintenance). The number of vehicles required to ensure a regular bus service would depend on the level of traffic congestion, which would need to be assessed in more detail and would tend to affect route 6 more than route 1 due to the greater length.

**Table 8 Bus Run Times and Fleet Requirements.**

Option	Round Trip Time	Round Trip Time including Layover	Vehicles in Service	Fleet Size
Route 1	17.5 mins	20 mins	4	6
Route 6 <sup>24</sup>	81 mins	90 mins	18	20

<sup>24</sup> Assuming replacement of bus service 90 between Heuston and Connolly.

### 7.2.2 Capacity

The capacity of the system is obviously dependent upon the vehicle chosen. We have assumed an ftr vehicle that has a capacity of around 120 passengers depending on the internal layout and Table 9 shows that the resultant capacity would be around 39% of the Luas. Dublin Bus already operate 20 articulated low-floor Volvo B7LA buses with a maximum capacity of 140+ and also 20 Volvo B9TL low floor tri-axle double deck buses with around the same capacity as the ftr.

The capacity requirements, based on the demand forecasts, are outlined in Section 8. The ftr vehicle would be able to cope with the forecast maximum flows and would be more eye-catching than the existing higher capacity buses operating in Dublin.

**Table 9 Modal capacity**

Vehicle type	Passenger capacity	Pphpd (5 min freq)
Luas 40m Tram	310	3720
ftr	120	1440

### 7.2.3 Serving the Point complex

To serve the transport needs of The Point the public transport system needs to provide a capacity of 5,000 passengers per hour in a single direction from The Point to Connolly to distribute people from evening events. This would require the following conditions from each mode.

**Table 10 Meeting the Special events at the Point**

Vehicle Type	Headway (mins:secs)	Notes
Luas 40m Tram	3:30	The RPA Luas team have built this frequency into the design of the system. There will be enough vehicles in the fleet to enable this frequency to be provided in the off peak.
Ftr (route 6 fleet size)	1:25	This would require 14 vehicles, although it may be able to be reduced should a special service be implemented, ie: non-stopping between the Point and Connolly station.  If route 6 were chosen as the favoured option overall, the special service would be able to operate as the fleet would be of a larger size. This would require the level of service on the whole route to be lowered to every 15 or 20 minutes, which might be appropriate at the times of The Point events. However, the BRT would be distributing people to Connolly for Luas and Rail rather than direct to Heuston and park and ride sites.
Ftr (route 1 fleet size) supplemented by standard double deck buses	1:10	If route 1 were chosen as the favoured option overall, the service would require support from other bus operators, as the fleet is not large enough. We estimate that an additional 11 double deck buses with a max capacity of 88 passengers would need to supplement 6 ftr vehicles.

Clearly the BRT options are not as effective in serving the needs of The Point as their capacity is lower. The short route – supplemented by ordinary buses might not be acceptable or even practical and consideration would have to be given as to the space required to be provided for the buses to stand at or near The Point.

#### 7.2.4 Management of the Operation

We have taken the position that the BRT should be controlled by an existing operator, so taking advantage of economies of scale. The most qualified candidates would be the operators of Luas or Dublin Bus. The advantages of each are the integration of systems versus the maintenance of the vehicle which has a relatively standard diesel bus engine, respectively. The DTO view of the philosophy of the system may influence the choice, however, should the Luas Operator be chosen other issues will arise, such as optimum location of depot and managerial control.

#### 7.2.5 Location of the Depot

Where the buses will be stabled requires further investigation. Route 1 requires 6 vehicles, whilst Route 6 requires 20. These must be securely parked, with bus washing and staff facilities.

#### 7.2.6 Maintenance

The question as to how maintenance would be carried out in the depot would need to be addressed. Obviously a fleet of 6 vehicles will mean inefficiencies in maintenance delivery, unless they were grouped with a similar fleet. 20 vehicles will probably enable the fleet to begin to be maintained efficiently.

### 7.3 Operating Costs

The costs of the bus route options have been estimates and compared to that of Luas C1 using the same operating cost model (these are very similar to the costs provided by the RPA). The results are shown in Table 11. The operating costs of the shuttle bus option (route 1) are 23% higher than the Luas Line C1. The operating costs for the longer route 6 option would be substantially higher at around €5m per annum, however the table shows the net additional operating costs over the existing service 90 which would be replaced, around €3m per annum and 55% higher than Luas Line C1.

**Table 11 Estimated Annual Operating Costs (2006 prices)**

Component	Luas C1 (€000's)	Bus route 1 (€000's)	Bus route 6 <sup>25</sup> (€000's)
Staff	668.0	812.0	1,581.0
Maintenance	136.2	165.2	382.3
Traction & utilities	111.2	152.9	382.9
Overhead (incl security)	81.4	86.2	175.2
Cleaning	40.5	97.5	231.5
Insurance	77.9	52.6	110.2
Contingency	72.8	83.0	169.8
<b>Total</b>	<b>1,188.0</b>	<b>1,449.4</b>	<b>3,032.8</b>

Assumptions that have been made are:

- **Staff**; rostered for a 40hr week. Average Luas salaries have been advised by the RPA, and bus driver salaries from Dublin Bus recruitment website. Includes employment costs such as pensions, etc. Managerial supervision of the bus services has also been accounted for;

<sup>25</sup> Based on additional route mileage over bus service 90.

- **Traction and utilities;** KW/h unit cost provided by RPA. Consumption from UK light rail databases; and
- **Maintenance;** Luas technician salaries provided by RPA, Bus Maintenance from UK's Commission for Integrated Transport, factored to the Dublin Market.

In terms of the assumptions for vehicle overhauls over the length of the evaluation it was assumed that additional capital costs would be incurred. For the Luas which uses vehicles with a 30 year life, system overhaul costs are assumed as 50% of the initial purchase cost of the vehicles after 15 years. Bus vehicles have a much shorter life and it is assumed that the fleet is renewed every 10 years and 50% of shelters and at stop equipment costs are included after 15 years. It is assumed that the road surfaces would be maintained by the highway authority.

## 7.4 Engineering Issues

The proposed routes of the bus options were outlined in section 5. The key engineering issues for the options were assessed, concentrating on the section between Connolly and the Point and assuming the road surfaces for Option 6 outside the docklands are suitable for the bus options as there are general traffic routes. The key infrastructure requirements and assumptions leading to the estimated capital costs are given below.

### 7.4.1 Junctions

In order to provide a high quality bus corridor the bus must have priority. To achieve this, traffic signals will be required at all major junctions along the route, specifically:

- Amiens Street / Sheriff Street;
- Commons Street / Mayor Street Lower;
- Mayor Street Lower / Guild Street;
- Mayor Street Upper / New Wapping Street;
- Mayor Street Upper / Castleforbes Road;
- New Road / North Wall Quay;
- East Wall Road / Sheriff Street Upper; and
- Sheriff Street Upper / New Road.

Both options also involve turning left at the roundabout at the junction of North Wall Quay and East Wall Road. It has been assumed that this junction which is used by existing buses and HGV's does not need to be altered, although there will be no priority for buses which would need to be examined in more detail if the bus scheme is taken forward.

It has been assumed that the approaches to all traffic signals would have anti-skid surfacing.

### 7.4.2 Route 6 – Sheriff Street Railway Bridge

For Route Option 6 two-way bus operations are required under the railway bridge at Sheriff Street. The road at this point is approximately 6.0 – 6.5m wide which may not be wide enough for a guided bus system. An alternative is to have a signalised entry onto Sheriff Street, therefore only permitting one-way traffic at any given time. The traffic turning right off Amiens Street would have to be given priority to prevent queuing on Amiens Street. There is sufficient width on Amiens Street for the turning facility and this arrangement has therefore been assumed, adding to the number of traffic signals required for this option.

### 7.4.3 Spencer Dock Bridge

Both options require the construction of a suitable road bridge over Spencer Dock. The Luas Line C1 scheme includes a bridge with facilities for road traffic accessing the National Conference Centre, pedestrians and the Luas. We have assumed the costs associated with the Luas Scheme for the Bus Options.

### 7.4.4 New Road Construction

The bus option will require a similar level of priority over other traffic between Connolly and The Point and we have assumed that the segregated alignments proposed for Luas would need to be constructed as new roads for the Bus Options. Specifically, the south side of Mayor Street between Commons Street and Guild Street and between Spencer Dock and New Wapping Street for both options.

### 7.4.5 Resurfacing

Several roads in North Docklands have a cobbled surface which would not be suitable for a high quality bus service in terms of ride quality. In addition some road surfaces are of a poor quality. We have therefore assumed that the following roads would be resurfaced in both options:

- **General resurfacing:** Mayor Street Upper; and
- **Replacing cobbles with blacktop:** Sheriff Street, Commons Street between Mayor Street and Sheriff Street, and Mayor Street Lower.

### 7.4.6 Platforms, Shelters and Equipment

We have assumed that the high quality bus options would be integrated with the Luas network and therefore provide a high level of stop infrastructure including;

- Kassel Kerb for bus 'docking';
- High quality passenger shelters;
- Real Time Information;
- Ticket Machines and validators; and
- CCTV.

Due to the different lengths of the bus options we have included 12 stops for Route Option 1 and 29 stops for Route Option 6. This assumes that Dublin Council would allow the creation of the high quality stops along the Quays either side of the Liffey.

### 7.4.7 Vehicles

We have assumed that the high quality bus options would require the use of modern articulated vehicles. The option of vehicle guidance can provide high quality running and bus stop 'docking', minimising the separation between stop platform and vehicle. However, physical (such as Kerb) guidance is not appropriate in the docklands environment due to the severance effect on traffic and pedestrians. The cheapest guidance systems are optical and electronic, but do not provide the visual impact of LRT and guiding the wheel leads to greater road surface wear and maintenance costs.





Use of a coloured road surface without guidance would replicate the visual impact of the other guidance technologies at minimum cost.

We have assumed the costs associated with the ftr vehicle without guidance technology.

#### 7.4.8 Depot Requirements

The Dublin economy has been growing in recent years there has been an increase in the size of the bus fleets in the city causing pressure on depot capacity. If the Docklands bus services were to be run by Dublin Bus (or another existing bus operator) the operator may need to provide additional depot capacity and may need to make some alterations, such as to accommodate the longer vehicles. If the buses were to be maintained by the existing Luas operator new depot facilities would be required.

Dublin Bus identified that they have spare capacity for around 40 vehicles<sup>26</sup> at their Harristown depot which would be suitable for the operation of docklands bus services. This currently accommodates the existing fleet of 20 articulated buses operating in the city. Dublin Bus could also temporarily use a depot at Broadstone with capacity for 150 buses which is earmarked for development. However, the Dublin Bus Network Review identified a requirement for additional vehicles to serve new development and growth and a consequent need for significant additional depot capacity. The document recommends new depots at Clondalkin, Tallaght, Blanchardstown and to the South of the City, none of which are close to Docklands. It has therefore been assumed that the scheme would require new depot capacity.

#### 7.4.9 Other Costs

There is currently a Taxi rank running along Sheriff Street and Amiens Street. Both ranks would have to be relocated.



Taxi rank along Amiens Street

Taxi rank along Sheriff Street



### 7.5 Capital Costs Bus Options

The capital costs are shown in Table 12 and have been estimated based on the following assumptions:

<sup>26</sup> Dublin Bus Network Review, Dublin Bus, February 2006



- Structures unit costs have been derived from cost information of the current Luas lines and inflated at 5% per annum to arrive at January 2006 prices. An estimated of 50% of the structures costs has been assumed for Spencer Dock Bridge as the Luas costs also include for the widening and strengthening of Georges Dock Bridge.
- The Construction of road costs, resurfacing costs and replacing cobbles with blacktop costs are based on Dublin City Council Costs for the Quality Bus Network.
- The following road widths have been used in the calculations:
  - Sheriff Street: - 7m (average)
  - Commons Street – 9m
  - Mayor Street Upper – 9m
  - Between Spencer Dock and New Wapping Street – 9m
  - Mayor Street Lower – 9m
- Platforms to be twice the length of the bus to provide capacity for operating flexibility in periods of high demand: ie 18.7m x 2 = 38m.
- Anti skid used for 30m prior to traffic lights.
- Cost of Traffic Signals obtained from Spons 1999 and inflated at 5% per annum to arrive at 2006 prices.
- Additional depot costs assumed as €65,000 per vehicle based on recent published new bus depot construction costs.
- Vehicle costs from advice from Wrightbus for the ftr vehicle (€460,000).

**Table 12 Estimated Capital Costs of Bus Options (Q1 2006 prices)**

Element	Route Option 1 Cost €k	Route Option 6 Cost €k
New Road Costs	104.9	104.9
Resurfacing Costs	255.2	255.2
Structures (Spencer Dock Bridge)	3,645.0	3,645.0
Stops, platforms, shelters and equipment	2,520.0	6,090.0
Communications (duct and wiring)	1,000.5	3,726.0
Traffic Signals, including anti-skid surface	741.6	847.5
Depot Costs	390.0	1,300.0
Vehicles	2,760.0	9,200.0
<b>Sub-Total</b>	<b>15,062.2</b>	<b>28,813.6</b>
Contingency @ 25%	3,765.5	7,203.4
<b>TOTAL</b>	<b>18,827.7</b>	<b>36,017.0</b>



## 8 PREFERRED BUS OPTIONS DEMAND AND REVENUES

### 8.1 Demand Forecasts

To estimate the passenger demand that would be generated by the bus options the DTO coded the bus routes into their 2016 Full Area Model using the bus journey link and speed assumptions (described in section 7.2.1) and assuming 5 minute headways. Demand forecasts for bus route option 6 were adjusted to remove the existing bus flows for service 90 which the route replaces.<sup>27</sup>

A key issue in the model is the assumed perceived quality of bus options compared to Luas and Rail services. Within the model an in-vehicle time factor of 1.37 is applied to bus services. This was calibrated in the development of the model to achieve the observed sub-modal split. The factor effectively slows buses down and represents the overall attractiveness of buses including vehicle quality, reliability, etc.

It was decided to test the sensitivity of the bus routes to this factor. To enable this to be tested, two sets of model runs were carried out: the first with the Docklands bus routes coded as bus services, and the second with the bus routes were coded into the public transport network model as Luas routes. In the second set of runs, relevant Luas link speeds were adjusted to represent the 'bus' variable, while other parameters in the model were not altered. A check was made that the boarding penalty was the same (calculated through the ratio of passengers to double doors on Luas and the ftr vehicle). It should be noted that the model contains mode-to-mode transfer penalties which are 2 minutes higher for transfers between rail / Luas and bus. By coding the bus routes as Luas routes the transfer penalty between the buses and rail / Luas routes is therefore low which needs to be taken into account in interpreting the results.

The demand forecasts were undertaken with the DTO 2016 land-use assumptions regarding the density of development in north Docklands. These assumptions are compatible with RPG forecasts for the region, but they are lower than the DDDA assumptions, particularly in relation to the level of redevelopment in the North Lotts and Point Village areas, and therefore represent a cautious forecast.

Table 13 shows the demand forecast range for the bus options and the net change in trips in the public transport matrix. The AM (average) peak hour model forecast is converted to annual demand using a factor to estimate an average off peak hour of 30% derived from RPA information for Luas Line C1. This factor reflects that demand for travel in north docklands is heavily peaked. The conversion to annual forecasts is based on the expansion factors used for Luas Line C1 supplied by the RPA.<sup>28</sup>

**Table 13 2016 Demand Forecasts: Bus Route Options**

	Route 1		Route 6	
	"as Luas"	"as Bus"	"as Luas"	"as Bus"
Am Peak Hour Boardings	1,009	592	2,685	2,060
Annual Boardings	2,201,739	1,291,803	5,858,939	4,495,126

Table 13 shows that the different in-vehicle time factors have a significant effect on forecast bus option flows – with Route 1 "as bus" boardings 41% lower than "as Luas" and Route 6 "as bus" boardings 23% lower than "as Luas".

<sup>27</sup> Service 90 AM peak hour boardings = 376, DTO 2016 base model.

<sup>28</sup> Am peak to annual peak factor = 1040 and off peak hour to annual off peak factor = 3807

In interpreting the demand data account needs to be taken of the attractiveness of different modes. This can be inferred from the proportion of users who have a car available for their journey but have chosen to use public transport.

Table 14 shows relative car availability data from recent bus, rail and Luas passenger surveys, revealing a significant difference between bus and rail modes and the Luas average being higher than the average for all rail lines but within the range. It is noted that recent investment in Quality Bus Corridors in Dublin has been able to increase the level of car available travellers using buses but there is a lack of sufficient before / after data available to draw specific conclusions regarding the potential for high quality bus routes to attract car traffic. General evidence from the UK suggests changes in the order of 10% additional trips from car users<sup>29</sup>.

**Table 14 Car Availability of Bus, Rail and Luas Passengers**

Mode <sup>30</sup>	Average Proportion of Car Available Passengers	Range
Bus	18%	12% - 33%
Rail	47%	29% - 85%
Luas	57%	56% - 58%

In both of the bus route options the buses will operate on ordinary highways, shared with other traffic and therefore susceptible to traffic delays. The shuttle option (route 1) has a higher proportion of the route segregated from ordinary traffic but there would be traffic interactions at the Connolly and The Point ends of the route. The longer bus route option (6) would be susceptible to significantly more traffic delays through interaction with traffic on both sides of the River Liffey and on East Wall Road accessing the Business Park.

Both routes would have at least some journey time variability and, even with the use of high quality vehicles passengers will perceive a difference between the buses and Luas / Rail vehicles – including the length and number of boarding points. Given the positive transfer penalty in the model described above it is reasonable to assume the low end of the demand forecast range for the analysis.

### 8.1.1 Effectiveness of Bus Options

Table 15 shows the maximum link flows for the bus route options – to highlight the effectiveness of the services in moving people within the study area. This shows that the buses (when coded as ‘bus’), with an assumed capacity of 120 passengers, would be between 30% and 50% utilised in the Route 1 option and over 75% utilised at the peak load point on the Route 6 option.

The maximum load point is closer to Connolly for Route option 1 and closer to The Point for route option 6 due to the significant demand for trips to / from East Point Business Park on Route 6. However, the section of Route 6 between Burgh Quay and Heuston Station is relatively lightly used in both directions. Thus, although the route provides for greater accessibility through enhanced interchange options the model forecasts low flows and low through movements based on the assumptions made. This may be because the route parallels the Luas Red Line.

<sup>29</sup> Centro (West Midlands) Line 33 Showcase Bus Route after survey.

<sup>30</sup> Sources, DTO bus and rail surveys November 2001, RPA Luas Passenger Surveys 2005.

**Table 15 Bus Route Options Link Flows and Capacity Utilisation**

	Route 1		Route 6	
	“as Luas”	“as Bus”	“as Luas”	“as Bus”
Maximum Link	Georges Dock – Custom House Square	Georges Dock – Custom House Square	Spencer Dock – Mayor Street Upper / Castleforbes Road	Spencer Dock – Mayor Street Upper / Castleforbes Road
Maximum Load	735	438	1350	1038
Maximum (Average) Load per vehicle	61	37	113	87

Table 16 shows the forecast boardings and alightings for the bus options.

**Table 16 Boarding and Alighting Flows: Bus Options (low forecasts)**

	Route 1		Route 6	
Stop	Boardings	Alightings	Boardings	Alightings
Connolly Station	194	0	930	0
Georges Dock	246	1	-	-
Commons Street North	-	-	53	0
Custom House Square	0	5	41	4
Spencer Dock	0	3	19	1
Mayor St / Castleforbes Rd	0	60	1	11
The Point / New Rd Sth	0	141	1	14
East Wall Rd Point Village	46	229	6	93
East Wall Rd Forth Rd	-	-	92	7
East Point Business Park	-	-	528	1012
East Wall Rd Forth Rd	-	-	6	11
The Point New Rd Nth	44	1	197	2
Mayor St / Castleforbes Rd	57	0	383	1
Spencer Dock	5	0	55	5
Custom House Square	0	3	2	14
Commons Street North	0	149	0	54
Connolly Station	-	-	26	376
Georges Quay	-	-	1	138
Burgh Quay	-	-	0	367
Aston Quay	-	-	0	135
Viking Boat	-	-	1	48
Merchants Quay	-	-	0	43
Ushers Quay	-	-	0	2
Victoria Quay	-	-	0	4
Heuston Station	-	-	1	0
Sarsfield Quay	-	-	1	0
Arran Quay	-	-	0	0
Inns Quay	-	-	13	0
Ormond Quay	-	-	43	0
Bachelers Quay	-	-	36	0
Connolly Station	-	-	-	92

The Route 1 shuttle option main flows are between Connolly and the Point, with few journeys to places in-between. Route 6 flows are influenced by the service to East Wall Road and East Point Business Park, with a few more journeys to intermediate locations as a result of the greater number of journey opportunities possible. However, the model forecasts a significant inbound flow between North Lotts and Connolly/ Georges Quay / Burgh Quay in this option which was not forecast in the higher forecast (as Luas option), as a result we advise caution over the interpretation of these figures without further detailed investigation of the forecasting model.

## 8.2 Revenue Forecasts and Financial Evaluation

The demand forecasts for the bus options were converted to revenues by application of an average fare factor of €1.10 per trip, supplied by the RPA from existing Luas fares income data (in 2002 prices). Table 17 shows the revenues and forecast operating surplus for the bus options. Note that the figures assume the demand for the new services rather than the net additional public transport network additional demand.

**Table 17 Financial Evaluation: Bus Route Options<sup>31</sup>**

	Route 1		Route 6	
	"As Bus"	"As Luas"	"As bus"	"As Luas"
Annual Demand (m)	1.292	2.202	4.495	5.859
Annual Revenue (€m)	1.421	2.422	4.945	6.445
Operating Costs (€m)	1.449	1.449	3.033	3.033
Operating Surplus (€m)	- 0.028	0.973	1.912	3.412
Percentage Surplus %	- 2%	67%	63%	112%

The economic implications of the bus options are considered in comparison to Luas Line C1 in the next section.

<sup>31</sup> Net additional over existing bus service 90



## 9 BUS / LUAS COMPARISON

### 9.1 Luas Line C1 Impacts

The Luas option was tested in the DTO model as an extension of the Luas Red Line to generate comparable data to the bus options. Table 18 shows the Luas Line C1 demands by station and average loads. Although Luas has fewer boarding and alighting points than the bus options, each stop is forecast to have more passengers boarding and alighting with a total of 5,606 passengers using stops in the Study Area within the AM peak hour. Those passengers boarding at Connolly and Mayor Street lower eastbound or alighting at Spencer Dock, Mayor Street Lower and Connolly westbound, (totalling 400) have both trip ends within the study area showing that the majority of trips have either their origin or destination beyond the docklands part of the City Centre.

The 2016 forecasting model estimates that Luas Line C1 generates 2,912 additional Luas trips in the AM peak hour. This is substantially more than for bus route 1, significantly more than bus route 6 'as bus' and slightly more than the forecast load for bus route 6 'as Luas'. A significant proportion of demand for bus route 6 is gained from the additional section of route beyond The Point, so Luas Line C1 is substantially more effective in increasing public transport use in the core of the study area, between Connolly Station and The Point.

The peak load is towards Connolly station and around 223 persons per vehicle, this is substantially greater than the loads carried on the bus options.

**Table 18 Luas Line C1 Boarding, Alighting and Load**

Stop	Board	Alight	Load	Average Load / Vehicle
Connolly Station	203	-		
Mayor Street Lower	4	351	2177	181
Spencer Dock	0	726	1452	121
Mayor Street Upper	0	55	1397	116
The Point	1558	1396	1558	130
Mayor Street Upper	729	0	2287	191
Spencer Dock	385	1	2671	223
Mayor Street Lower	9	46	2635	220
Connolly Station	-	152		
Sum	2888	2727		

As feeding the Luas Red Line is an important benefit of the Line C1 scheme the transport model forecasts for the Luas Red Line were examined to assess the impact of the bus options in comparison to the Luas through route. Table 19 shows that the shuttle bus option feeds the Luas Red Line, although the additional Luas trips are below a third of the additional trips generated by extending the Luas. This is related to the interchange required at Connolly.

**Table 19 Luas Red Line Impact, Bus Compared to Luas Line C1**

Option	Luas Red Line Am Peak Boardings	Difference
Luas Base	16,349	-
Bus Route 1 "as Bus"	16,775	426
Bus Route 1 "as Luas"	17,307	958
Bus Route 6 "as Bus"	16,408	58
Bus Route 6 "as Luas"	16,293	-57
Luas Line C1	19,262	2,912

The longer route 6 bus option has little overall impact on Luas Red Line flows. This is related to the fact that bus route 6 parallels the Luas Red Line between Heuston and Connolly as well as connecting with it at Connolly.

The Financial Evaluation of the Luas Line C1 extension is shown in Table 20. The figures shown are estimated demand, revenue and operating costs additional to the operations and demands currently on the Luas Red Line. The relatively low incremental operating costs, leading to a relatively high demand and revenue forecast suggests a large operating surplus, substantially greater than for the bus options.

**Table 20 Luas Line C1 Financial Evaluation**

	Luas Line C1 Financial Evaluation
Annual Additional Demand (m)	6.354
Annual Additional Revenue (€m)	6.990
Incremental additional Operating Costs (€m)	1.188
Operating Surplus (€m)	5.802
Percentage Surplus %	488%

## 9.2 Application of Appraisal Framework

To compare the Bus Options with Luas Line C1 against the identified regional objectives we have appraised the Luas scheme using the Appraisal Framework developed for the study.

We have used the same methodology and criteria that were used to shortlist the bus route options and the assumptions regarding the Luas scheme are those set out in the Environmental Impact Assessment (EIA).<sup>32</sup>

The results of the assessment are shown in Figures 12 and 13, which compare the Luas Line C1 with the shortlisted Bus Options. Key Observations are detailed below.

### 9.2.1 Safety

Although the Luas option would attract more people from cars and therefore lead to a greater contribution to the safety objective than any of the bus options, the scheme is scored as slightly positive as it does not specifically target safety as an objective.

<sup>32</sup> Dublin Light Rail, Environmental Impact Statement, Line C1 Connolly to The Point Depot.

### 9.2.2 Economy

There are two aspects of economy to consider – value for money through analysis of the economic evaluation and economic regeneration.

#### (a) Value for Money

It was not possible to undertake a detailed economic evaluation of the bus options within the available timescale and resources of the study as the forecast network time savings to users and non-users were affected by the levels of convergence of the assignment models. This meant that, whilst the models could be relied on to produce reasonable forecasts of service loads and boarding/alighting data, they could not be used to determine the relatively small time savings within a heavily congested network without significant further modelling work. However, the economic evaluation can be informed from the available data through consideration of the impacts of the different options in terms of user and non-user benefits and by cross comparing cost and benefit data.

Table 21 summarises the main user and non-user benefits and the scale of benefits derived from the model results and nature of the schemes. Luas Line C1 will produce higher time savings than the other options as this option reduces the need to interchange between the City Centre and Docklands and as the route serves a much wider area to the South West of the City where there is significant demand. Luas Line C1 would result in higher new user time savings as it is forecast to attract more people and they too will benefit from the reduced interchange at Connolly. The non-user time savings for Luas are also likely to be greater as the scheme has a greater impact on the modal split of the study area - Table 21 suggests that the Luas has around twice the impact on the modal split of the study area compared to the bus options.

**Table 21 Comparative User and Non-User Benefits Bus and Luas**

Benefit Group	Luas Line C1	Bus Route 1	Bus Route 6
Existing User Time Savings			
- within Study Area	Substantial	Significant	Significant
- between City Centre and Study Area	Substantial	Slight	Slight/Significant
- Other	Significant South West of City to Docklands	none	Significant East Point to Docklands and City Centre
New User Time Savings	Substantial	Slight	Significant
Non User Time and Cost Savings	Substantial	Slight	Significant

An economic assessment model was prepared to compare the main economic evaluation parameters and cross-compare the options. The economic evaluation was undertaken in line with RPA guidance on their evaluation of Luas Line C1. The evaluation brings together the capital (construction) and operating costs with the revenues and a test of the economic evaluation has been undertaken by making an assumption of the average journey time saving per passenger to derive user and non-user benefits. The evaluation was undertaken over a 30 year appraisal period from an assumed opening in 2009. All figures are converted to 2002 prices and all values discounted to a 2002 base year, consistent with the business case assessment of Luas Line C1. All modelling assumptions and economic evaluation factors are summarised in Appendix D.

Table 22 summarises the outputs of the economic assessment in terms of the financial effects (capital and operating costs and revenues). The data is shown as a range for the bus options based on the low and high forecasts produced by the transport models. The data presented are Present Values (PV) assessed over the life of the scheme using a discount rate of 4.01% (as advised by RPA). The high and low demand forecasts have been used to produce the range to the economic evaluation results.

The Luas Line C1 has significantly lower operating costs and significantly higher forecast demand and revenues leading to a significantly greater contribution of revenue to the capital costs and a lower total cost per passenger. Bus route option 6 performs better than option 1 showing that, though the longer route is more expensive than the shuttle, it produces significantly greater demand and revenue providing some contribution of revenues to the capital costs and lower cost / passenger figures. However, Luas Line C1 provides a greater revenue contribution towards capital costs and lower overall cost per passenger than the best bus option.

**Table 22 Economic Comparison of Luas and Bus Options**

	Luas Line C1	Bus Route 1	Bus Route 6 <sup>33</sup>
PV Capital Costs (€m)	45.8	15.7	34.8
PV Operating Costs (€m)	14.7	17.9	37.5
PV Total Costs (€m)	60.5	33.6	72.3
PV Revenues (€m)	102.7	20.9 – 35.6	72.6 – 94.7
PV Net Revenue (€m)	88.0	2.96 – 17.7	35.1 – 57.2
Net revenue / Capital Costs	1.92	0.19 – 1.13	1.01 – 1.64
Annual Passengers (net effect) (m)	6.354	1.291 – 2.202	4.495 – 5.859
Total Costs / Passenger (€)	10	15 - 26	12 - 16

The economic evaluation was further tested by making assumptions regarding the average time saving for users and non-user benefits. Even though it is anticipated that the Luas Line C1 will produce higher time savings than the bus options, the economic evaluations have been tested using the same time saving and benefit assumptions across all options. This will produce a relatively optimistic view of the value for money of the bus route options compared to Luas Line C1.

We have assumed a user time saving of an average of 3 minutes for all in-scope passengers in all options. In-scope passengers are defined as those using the new Luas or bus service in the Docklands area, which could be part of a through journey, where the passenger has boarded / alighted outside the Docklands area, or a passenger journey entirely within the Docklands area. Time savings assumptions were factored by applying values of time advised by the RPA.

Non user benefits were estimated based on an assumed 40% transfer from car for Luas, 30% transfer for the high-quality bus options, and 20% transfer for the low-quality bus options. The calculation assumes that a third of peak benefits apply for the off-peak period. A benefit rate for other traffic of €0.50 per new Luas / bus user was assumed. In addition to these benefits there would also be Vehicle operating cost savings resulting from the transferred car users. This additional value has not been calculated for this comparative exercise – implying that the economic benefits shown in the table below will all be lower than the true value.

<sup>33</sup> Net additional over existing bus service 90

The comparative economic evaluation results of this test are shown in Table 23, which shows that the Luas Line C1 extension has a significantly greater cost benefit ratio (BCR) than the bus options. It can be concluded that the Luas Line C1 extension therefore provides significantly better value for money than the bus options and is therefore more worthy of funding subject to any detailed business case for the scheme.

**Table 23 Comparative Economic Evaluation Results**

	Luas Line C1	Bus Route Option 1	Bus Route Option 6
PV Costs (€m)	60.5	33.6	72.3
PV Benefits (€m)	142.5	16.4 - 30.0	63.0 - 72.8
NPV <sup>34</sup> (€m)	82.0	-17.2 - -3.6	-9.3 - 0.5
BCR	2.35	0.49 – 0.89	0.87 – 1.01

These figures are produced for comparison of the relative value for money of the Luas and bus options only. The detailed business case of the Luas Line C1 extension scheme will be produced by the RPA and will include more detailed and thorough analysis of user and non-user benefits.

## **(b) Economic Regeneration**

The study area covers a significant part of the redevelopment area of North Docklands, where a significant amount of housing and employment development is proposed in a relatively high density mixed use development plan with restricted on-street and off-street parking. The current market for development in the area is strong and once existing development constraints are removed it is anticipated that the redevelopment would occur. The economic regeneration measure was therefore determined as the contribution to the potential transport deficit in the area – which could lead to problems with parking demand/supply and/or under-occupation of the developments.

The Luas Line C1 extension is forecast to attract more people than the bus options within the study area and will carry higher total flows. The Luas will therefore contribute more to the defined economic regeneration objective.

The Luas option was allocated an appraisal score of ‘substantially positive’ in terms of contributing to the economy objective. This is because Luas would provide better value for money based on the economic assessment as the Luas would contribute more towards economic regeneration within the study area (note the overlap with the Regeneration objective).

### **9.2.3 Integration**

The Luas option was allocated a score of ‘substantially positive’ for its likely contribution towards the integration objective because it provides more interchange opportunities than Route 6 as it extends further to park and ride interchange points as well as serving a significant number of bus and rail interchange points through the City Centre. It would perform significantly better than Bus Route 1.

### **9.2.4 Accessibility**

The Luas was awarded a score of ‘significantly positive’ for the accessibility objective because the route serves the key land uses within north Docklands, would have the shortest journey time and provides through journey opportunities to a larger number of

<sup>34</sup> Revenues excluded.



destinations, covering a similar area to that of Bus Route Option 6 within the City Centre, but also beyond Heuston.

### **9.2.5 Environment**

The Luas option was awarded both a 'slightly positive' and 'slightly adverse' appraisal score for the environmental objective. This is similar to the bus route options, however, the differences for the sub-objective score was such that:

- The Luas was not given an adverse score for local air quality because trams do not contribute towards local air pollution to the same extent buses; Luas was given a significant positive score for greenhouse gases as it will have a more significant impact on reducing car travel demand with associated benefits.
- The Luas was given a slight adverse score for noise generation by the vehicles in operation and a significantly positive score for the significant forecast impact on general traffic reduction. There would also be some short term adverse noise impacts during the construction phase which would be more significant for Luas.
- The Luas was given a score of 'slightly adverse' for townscape due to the impact of the overhead electric cables. The Luas was also awarded a 'slightly positive' score for the townscape sub objective because the Spencer Dock Bridge is anticipated to contribute to the attractiveness of the city due to its "landmark feature and with the use of modern high quality materials"<sup>35</sup>. Also, the Luas extension will involve landscaping and the use of high quality materials such as cobbles and granite paving. Luas would have more physical presence and contribute to the form of the proposed new public squares at Spencer Dock and The Point.
- The Luas was given a higher positive score for Physical Fitness than the bus options as it will create a higher level of public transport use (with associated walking from origin and to final destination) and transfer more people from using cars.
- The Luas would not contribute towards journey ambience in terms of passing through areas regarded as being very attractive, such as along the River Liffey. However, it is an attractive form of public transport and would not travel through very unattractive areas, such as busy general traffic routes.

### **9.2.6 Mode Shift**

The Luas was awarded a 'substantially positive' score for mode shift because it would attract the greatest amount of patronage. The relative impact of the options on the car mode share in the corridor was derived from the DTO models and is shown in Table 24.

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<sup>35</sup> Dublin Light Rail, Environmental Impact Statement, Line C1, Connolly to The Point Depot, RPA.

**Table 24 Docklands Modal Split Impact<sup>36</sup>**

Option	AM Peak Car Mode Share Origins	AM Peak Car Mode Share Destinations
Base	57%	43%
Bus Route 1 "as Bus"	54%	36%
Bus Route 1 "as Luas"	55%	38%
Bus Route 6 "as Bus"	54%	39%
Bus Route 6 "as Luas"	50%	38%
Luas Line C1	45%	36%

All options have a positive impact on reducing the car mode share of trips, especially from the Docklands zones. The impact of Luas Line C1 is significantly greater than the bus options, especially in terms of trips originating in the study area. The Luas option would provide a more significant contribution to the Platform for Change objectives of public transport accommodating 63% of the peak travel market in Dublin and 85% of trips with a City Centre destination.

### 9.2.7 Efficiency

The Luas is likely to improve the reliability of the transport system as it is forecast to attract the greatest number of car users to public transport therefore freeing up more road space than the bus options. This will also lead to the public transport system being more reliable itself. A higher proportion of the Luas Line C1 route is segregated from other road traffic compared with the bus options resulting in a significantly more reliable service in the Docklands. The proposed trams are larger than the proposed new 'tram like' buses and therefore contribute the most towards increasing the public transport capacity. Therefore, it was allocated an appraisal score of 'substantially positive' for the efficiency objective.

### 9.2.8 Affordability

The Luas option is more expensive to implement than any of the bus options (€65.05m at June 2005 prices). However, it is understood that a levy scheme has been agreed with the DDDA for the specific objective of Luas Line C1. The RPA estimates that when the new developments are occupied a substantial amount, possibly 50%, of the capital costs could be secured. The Luas Line C1 scheme is identified as a key scheme within the Department of Transport Transport 21 Strategy and as there is identified funding and a significantly positive economic case for the scheme the Luas option has been awarded a score of 'significantly positive' in terms of the affordability objective.

### 9.2.9 Deliverability

The public are likely to positively react to the Luas option (as opposed to the bus options) however, we are aware that some elements of the IFSC will respond unfavourably, therefore, the Luas was awarded a score of both 'substantially positive' and 'significantly adverse' for public acceptability. There appear to be no substantial problems constructing and operating the Luas option and it was thus given a 'substantially positive' score for technical practicality, however, the construction period is likely to be the longest and most severe with the Luas option and it was therefore allocated a 'significant adverse' score for the disruption sub objective. On balance the Luas scores for public acceptability, technical practicality and disruption were

<sup>36</sup> Average car split of trip productions and attractions for zones adjacent to the Luas / Bus Routes in North Docklands between Connolly and the Point.

aggregated to a score both 'substantial positive' and 'significant' negative for the deliverability objective.

### **9.2.10 Regeneration**

The Luas extension would contribute most towards the regeneration objective by supporting the longer term viability of new development, partly because it is likely to attract the greatest amount of patronage and provide the greatest journey time savings in the core North Docklands development area. Luas was therefore awarded an appraisal score of 'substantially positive' for the regeneration objective.

Whilst the bus route option 6 provided a significant benefit outside the study area (specifically East Wall and East Point Business park) the business park is not forecast to grow between 2002 and 2016 and the scheme produced lower impacts within the study area.

### **9.2.11 Attractiveness**

Trams are widely regarded as being more attractive than buses and therefore the Luas was allocated a score of 'substantially positive' for the attractiveness objective.

## **9.3 Bus vs Luas Comparison Framework Results**

Figure 12 shows the completed detailed evaluation framework results for the shortlisted bus options and Luas Line C1 and figure 13 shows the summary framework focused on the main objectives.

It can be seen that the appraisal scores for Luas were more favourable than for the shuttle bus route (Option 1) on the criteria of economy, integration, accessibility, mode shift, efficiency, regeneration and attractiveness. The Luas and shuttle bus option scored the same for the safety, environment, and affordability objectives. The appraisal scores for the deliverability objective are similar, however, Luas was allocated a greater positive and greater adverse score. There was no objective in which the shuttle bus option scored favourably over the Luas option, therefore the Luas option is considered better than the shuttle bus route (Option 1).

In addition the Luas scored more favourably on the safety, economy, efficiency and attractiveness objectives than the extended bus route (Option 6). Luas and the extended bus option achieved the same appraisal score for the integration, environment, mode shift, affordability and regeneration objectives. Their appraisal scores for the deliverability objective were similar, however, Luas was allocated a greater positive and greater adverse score. The extended bus option scored favourably over Luas only on the accessibility objective – though this is related to serving the East Wall and East Point Business Park rather than improving accessibility for the residents and employees in the study area.

The decision as to which option is preferable depends on the weightings associated with the appraisal objectives, however, the Luas option is clearly more effective at meeting the wider objectives of the study area of north Docklands than the bus options. In transport decision making a significant weight is placed on the value for money element of the economy objective, the higher ridership and relatively low additional operating costs of extending Luas suggests better value for money compared to the bus options.

**Figure 12 Detailed Comparative Framework Assessment Bus vs Luas**

					Bus Route Options		Luas Line	
Objectives	Sub-criteria				1	6(North)	C1	
Safety					+	- +	+	
Economy	Value for money	Demand	Connectivity		++	+++	++	
			Journey Time		++	+	+++	
			Vehicle Quality		++	++	+++	
		Operating Cost		-	---	-		
		Capital cost		-	--	---		
	Economic Regeneration				+	++	+++	
Integration	Interchanges				+	+++	+++	
	Spatial Strategy				++	+++	+++	
Accessibility	City Core	Docklands Residents	Retail	Out	++	+++	+++	
			Employment	In	+++	+++	+++	
				Out	+	+++	++	
		Docklands Employees	Direct Connections			0	++	++
			Indirect Connections	North	+	+	+	
				South	+	++	++	
				West	+	+++	+++	
		Social Inclusion				+	+++	++
	Environment	Noise				-	-- +	- ++
Local Air Quality				- +	- +	++		
Green House Gases				- +	- +	- ++		
Landscape				0	0	0		
Townscape				-	-	- +		
Heritage				-	-	-		
Biodiversity				0	0	0		
Water Environment				0	0	-		
Physical Fitness				- +	- +	- +		
Journey Ambience				- +	-- ++	0		
Mode Shift	% Demand				+	++	+++	
Efficiency	Reliability				++	+	+++	
	PT Capacity				++	++	+++	
	Impact on Highway Network				- ++	-- ++	+++	
Affordability					++	++	++	
Deliverability	Public Acceptability				--	-	-- +++	
	Technical Practibility				+++	+++	+++	
	Disruption				-	-	--	
Regeneration	Penetration	Stimulation	City Living		++	++	+++	
Attractiveness	Public Transport				+	+	+++	
Preferred Route(s)								

Scale	Positive Impact			No Impact	Negative Impact		
	Substantial	Significant	Slight		Slight	Significant	Substantial
	+++	++	+		0	-	---

**Figure 13 Summary Comparative Framework Assessment Bus vs Luas**

Objectives	Bus Route Options		Luas Line C1
	1	6	
Safety	+	- +	+
Economy	++	++	+++
Integration	+	+++	+++
Accessibility	+	+++	++
Environment	- +	- +	- + +
Mode Shift	++	++	+++
Efficiency	++	- + +	+++
Affordability	++	++	++
Deliverability	- +	- +	- - + + +
Regeneration	++	++	+++
Attractiveness	+	+	+++

Scale	+++	Substantial Positive Impact
	++	Significant Positive Impact
	+	Slight Positive Impact
	0	no impact
	-	Slight Negative Impact
	--	Significant Negative Impact
	---	Substantial Negative Impact



## 10 CONCLUSIONS

Whilst quality bus routes could be introduced to serve north Docklands between Connolly and The Point instead of extending the Luas, they would not attract as much patronage as Luas, even if the vehicles were viewed as being as attractive as Luas services. This is because the bus options involve greater need to interchange with rail and Luas routes in the City Centre.

The bus routes are significantly less effective in serving the transport needs of North Docklands, particularly in reducing car use and providing a quality public transport option for accessing North Lotts and The Point.

Whilst an effective bus option was identified that ran beyond the immediate study area to secure increased demand it remained less effective between Connolly and The Point. The option tests suggest that areas to the north and east of Sheriff Street require improved public transport access as part of the developing transport strategy for the area as a whole.

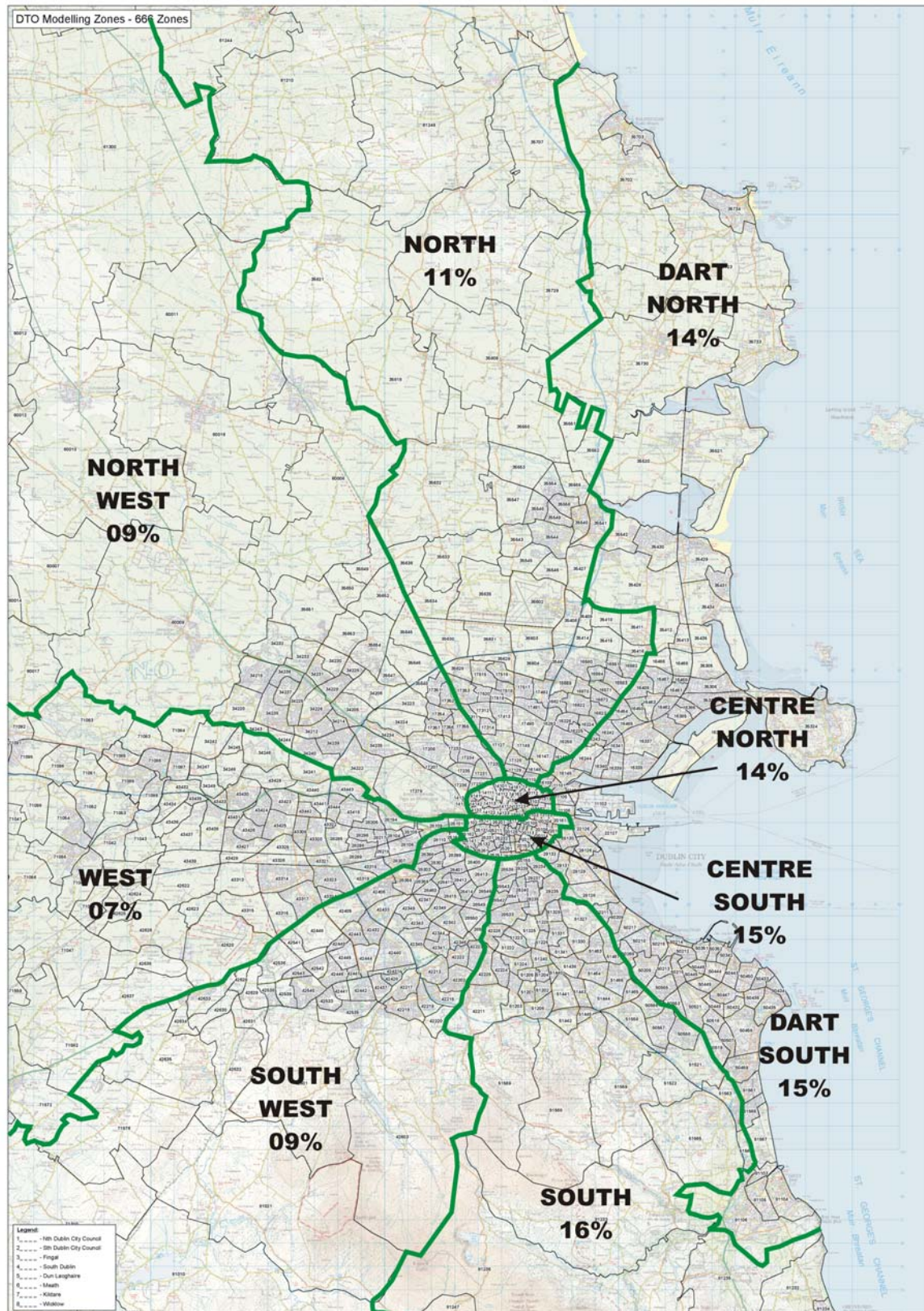
The Luas extension option provides a significantly greater contribution to the identified local objectives for North Docklands, especially the key objective of providing a sustainable transport solution for the development of North Docklands (The North Lotts and Point Village areas) and securing the greatest contribution to the regional transport modal share objectives.

Whilst Luas is a more costly option and would involve a greater construction impact, its greater contribution to the regional objectives and requirements of the sustainable development of the North Lotts and Point Village areas suggests that the scheme should be implemented over a lower cost and less effective bus based option.

It is recommended that further consideration is given to developing a public transport plan for serving North Docklands including the Luas Line C1 extension and incorporating an examination of an extended bus service from the West, running on to East Wall and East Point Business Park as well as examination of orbital (north-south cross river) bus services. The plan should take account of the traffic congestion relief to be gained from the opening of Dublin Port Tunnel (with the opportunity to secure improved bus journey times and/or reliability in the City Centre), the forthcoming implementation of Macken Street Bridge and the possible bus interchange at Connolly Station.



## APPENDIX A - ORIGIN SECTORS : DOCKLANDS EMPLOYEES



Source: Census 2002 Journey to Work survey.



## APPENDIX B - APPRAISAL FRAMEWORK

				Bus Route Options			
Objectives	Sub-criteria			1	2	3	4
Safety							
Economy	Value for money	Demand	Connectivity				
			Journey Time				
			Vehicle Quality				
		Operating Cost					
	Capital cost						
Economic Regeneration							
Integration	Interchanges						
	Spatial Strategy						
Accessibility	City Core	Docklands Residents	Retail	Out			
			Employment	In Out			
		Docklands Employees	Direct Connections				
			Indirect Connections	North			
				South			
				West			
	Social Inclusion						
Environment	Noise						
	Local Air Quality						
	Green House Gases						
	Landscape						
	Townscape						
	Heritage						
	Biodiversity						
	Water Environment						
	Physical Fitness						
	Journey Ambience						
Mode Shift	% Demand						
Efficiency	Reliability						
	PT Capacity						
	Impact on Highway Network						
Affordability							
Deliverability	Public Acceptability						
	Technical Practibility						
	Disruption						
Regeneration	Penetration	Stimulation	City Living				
Attractiveness	Public Transport						
Preferred Route(s)							





## APPENDIX C - EDEN QUAY BUS SERVICES

Route No.	Routes	Peak Frequency (buses/hour)		Travel Time (mins)	General Dublin Direction
		AM	PM		
49/A	Eden Quay	3	3	65	South
	Leonard's Corner				
	Templeogue Village				
	The Mill/Old Bawn				
	Tallaght (The Square)				
50	Eden Quay	2	2	60	South West
	Dolphin's Barn				
	Walkinstown Cross				
	Tallaght (The Square)				
	City West				
50X	Killinarden	1 bus/day from Killinarden	2 buses/day from Belfield	85	South West
	Tallaght (The Square)				
	Cuckoo's Nest				
	Dolphin's Barn				
	Fleet Street				
54A	Belfield	2	2	60	South
	Eden Quay				
	Harold's Cross Green				
	Spawell				
	Tallaght (The Square)				
56A	Eden Quay	4	3	60	South West
	Dolphin's Barn				
	Walkinstown Cross				
	Cookstown Cross				
	The Square				
65	Ballymore	1	1	80	South
	Cross Chapel				
	Tallaght (The Square)				
	Templeogue Village				
	Terenure				
	Swan Centre				
	Camden Street				
65B	Eden Quay	2	2	70	South West
	Camden Street				
	Swan Centre				
	Terenure				
	Templeogue Village				
	Tallaght (The Square)				
	City West				
77	Eden Quay	6	5	60	South
	Dolphin's Barn				
	Walkinstown Cross				
	Tallaght (The Square)				
	Jobstown				
77A	Eden Quay	5	4	60	South West
	Dolphin's Barn				
	Walkinstown Cross				
	Balrothery				
	The Square				
77X	Tallaght	2 buses/day	2 buses/day	90	South West
	Fleet Street				
	Dolphin's Barn				
	Cuckoo's Nest				
	Westbrook				
	Belfield				

Route No.	Routes	Peak Frequency (buses/hour)		Travel Time (mins)	General Dublin Direction
		AM	PM		
29/A	Eden Quay	4	4	50	North East
	Fairview				
	Killester				
	Raheny (St. Annes Est.)				
	Newgroove Cross				
20B	Eden Quay	4	4	51	North
	Malboro St. (Eden Q)				
	Fairview				
	Donnycarney Church				
	Beaumont				
31B	Eden Quay	1	1	60	North East
	Fairview				
	Killester				
	Raheny				
	Howth Summit				
32A	Eden Quay	1	1	60	North East
	Fairview				
	Raheny				
	Baldoyle				
	Malahide				
32B	Eden Quay	2	2	60	North East
	Fairview				
	Raheny				
	Baldoyle				
	Portmarnock				
27B	Eden Quay	4	4	60	North East
	Fairview				
	Donnycarney Church				
	Artane Roundabout				
	Castletimon				
	Harristown				

## APPENDIX D - MODELLING AND ECONOMICS ASSUMPTIONS

### Modelling Assumptions

The modelling of demand for the bus and Luas options for this study were undertaken by the Dublin Transportation Office Commercial Modelling Section using the model developed and applied for the assessment of Luas Line C highway impacts and documented in their report “Luas Line C Extension – Transportation Modelling, Validation and Methodology, February 2005”. The models comprise a public transport network trip assignment model and a highway network traffic assignment model and a mode choice model. The models have been calibrated for the AM peak hour and were adjusted to reflect the base 2006 network plus the following changes to represent the base 2016 situation:

- Macken Street Bridge plus associated banned turn movements;
- Dublin Port Tunnel;
- East Wall Road Widening;
- Three proposed north – south links between North Wall Quay and Sheriff Street; and
- Extensive traffic management along Mayor Street and throughout the study area.

The public transport services coded in the model in the study area are:

- **Service 53** from Beresford Place to Tolka Quay (Port) via Talbot Street, Amiens Street, Clontarf Road, Alfie Byrne Road and East Wall Road. Frequency 4 per hour speed 15 – 20 kph QBC sections from Talbot Street to Clontarf Rd;
- **Service 53A** from Beresford Place to Tolka Quay (Port) via Custom House Quay, North Wall Quay and East Wall Road. Frequency 2 per hour – speed related to road traffic speeds;
- **Service 90** from Connolly station to Heuston Station. Frequency every 10 minutes Heuston to Connolly and every 5 minutes Connolly to Heuston. Speed 15 – 20 kph QBC sections between Heuston Station and O’Connell Street; and
- **Luas Line A and C** between Tallaght and Connolly Station, Luas Line B between St Stephens Green and Sandymount and all existing Dart and Suburban Rail services also within the model.

The options were coded as in the following table, walk speeds and distances between Luas, bus and rail stations at Connolly and Heuston were coded as 4km/h and 100m giving an equal walk time of 1.5 minutes.

The models were assigned using the DTO’s 2016 AM matrix containing land use forecasts based on regional planning guidelines agreed with all local authorities in the Greater Dublin Area and known as the “DTO’s standard land use forecast”. It should be noted that this forecast is compatible with RPG forecasts for the region, but lower than the latest DDDA forecast for the North Docklands Area.



Scenario	Service 90	Existing Luas Line C	Extension of Luas to The Point
1. Base	*	*	
2. Route 1 High Quality Shuttle Bus Connolly to The Point	*	*	
3 Route 1 Shuttle Bus Connolly to The Point	*	*	
4. Route 6 High Quality Bus Heuston to East Point		*	
5. Route 6 Bus Heuston to East Point		*	
6. Luas Line C Extension to The Point	*	*	*

### Economic Evaluation Assumptions

The AM peak model outputs were analysed in terms of boarding and alighting numbers, link loads and impact on Luas Line C. The data was processed within an economic evaluation spreadsheet incorporating the following assumptions and in line with RPA advice regarding the business case evaluation of Luas Line C1:

- Evaluation period 2002 to 2038 with construction between 2007 and 2008 and operations starting in 2009;
- 2002 price base, with operating and capital costs adjusted using appropriate deflation factors based on the construction and machinery indices supplied by the RPA;
- Capital costs are assumed as 50% of the total in each year and mid-life refurbishment costs are included in 2024. Bus fleet replacement costs were included every 10 years;
- Demand is converted to revenue assuming an average revenue of €1.1 per journey;
- Demand is expanded from AM peak hour to annual peak demand with a factor of 1040. Off peak hour demand is assumed to be 30% of peak hour demand (based on existing RPA forecast for Luas Line C1) and is factored by 3807 to annual off peak;
- Public Transport time savings are factored by values of time of €8.89 per hour peak and €8.62 per hour off peak;
- Non – user benefits were estimated by assuming a modal split (40% for Luas and between 20% and 30% for Bus options), assuming 33% of peak car transfer in the offpeak and assuming a benefit rate per car trip of €0.5;
- The 2016 demand forecast is divided by 67% to represent 2006 demand, based on DTO forecasts, and proportioned for intervening years. Demand is grown at 2% per annum from 2016;
- A ramp up of demand and benefits is included at a rate of 80% 2009, 85% 2010, 90% 2011 and 100% 2012;
- Value of time growth incorporated in the model is based on the following factors advised by the RPA, 2.7% until 2010, 2.37% 2011 to 2015, 2.29% from 2016 onwards; and
- A discount rate of 4.01% is applied throughout the appraisal period.