New Metro North

Luas Green Line Tie-in Study

Options Appraisal Report

Údarás Náisiúnta Iompair
National Transport Authority

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

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Table of Contents

List of Figures

List of Tables

Glossary of Terms/Acronyms

Term	Definition
Bored tunnel	Fully underground tunnel excavated by a Tunnel Boring Machine.
Cut and cover tunnel/box	A tunnel or box structure where a trench is excavated to the required dimensions and is roofed over with an overhead support system strong enough to carry the load of what is to be built above.
Escape shaft	Large vertical shaft with internal stairways positioned adjacent and connected to a bored tunnel, to provide a means of escape for passengers underground (or provide access to tunnels for emergency services).

Engineering link	A non-service track connection between two rail systems to allow movement of vehicles between them for maintenance or for stabling in a depot.
Lateral clearance	The clearance between the body of the vehicle (moving on the outermost track) to any installations or structures along the route.
Track inter-axis	Where tracks are side-by-side, the track inter-axis is the distance between the centre points of each track. The wider the distance, the more space there is between passing vehicles.
Tunnel portal	The entrance or exit to a tunnel. The interface point between the underground tunnel and the ground level.
Receiving shaft	A specially constructed cut and cover box specifically for the dismantling and removal of a tunnel boring machine, once tunnelling is complete.
Retained cut	A retained cut consists of side walls and a ramped floor level, typically used as a transition between a cut-and-cover tunnel and at-grade track levels.
Segregation	Metro tracks are fully separated from other traffic and from pedestrians. It is an essential requirement for the running of high frequency Metro vehicles.
Sensitive receptors	Any dwelling, house, hotel, hostel, health building, educational establishment, place of worship, entertainment venue or any other facility or area of high amenity which benefits from, or requires the absence of, high noise levels.

Acronym	**Definition**
CRR	Commission for Railway Regulation
DCC	Dublin City Council
DTTAS	Department of Transport, Tourism and Sport
GDA	Greater Dublin Area
GDRIRS	Guidelines for the Design of Railway Infrastructure and Rolling Stock
LGLTS	Luas Green Line Tie-in Study
MCA	Multi-criteria analysis
NCH	National Concert Hall
NMN	New Metro North
NTA	National Transport Authority
PPHPD	Passengers per hour, per direction
RAPID	Revitalising Areas by Planning, Investment and Development
TBM	Tunnel Boring Machine
TII	Transport Infrastructure Ireland

1 EXECUTIVE SUMMARY

New Metro North (NMN) is one of a number of Light Rail Infrastructure projects that is proposed to be delivered within the lifetime of the National Transport Authority's (NTA's) Transport Strategy for the Greater Dublin Area 2016–2035 (The Strategy). The Strategy defines NMN as a high speed, high capacity, high frequency public transport link from Dublin City Centre to Dublin Airport and Swords, with the city centre section underground.

The Strategy also details the requirement for upgrading the existing Luas Green Line to Metro standard, through the extension of NMN southwards, via a tunnel, and enabling the through running of Metro trams from Swords to Bride's Glen.

The objective of this Luas Green Line Tie-in Study (LGLTS) is to identify the preferred location for the future tie-in of NMN to the existing Luas Green Line. In April 2016, Transport Infrastructure Ireland (TII), using an internal multi-disciplinary team, commenced work on the LGLTS. Working in close collaboration with the NTA, a two stage appraisal methodology was agreed and adopted for the study.

The first stage appraisal (Stage 1) identified a long list of feasible options between St Stephen's Green and Milltown. Following an initial sift of ten options, a long list of seven feasible options were brought forward for preliminary appraisal. A preliminary appraisal using multi-criteria analysis (MCA) against the criteria of Economy, Environment and Integration was carried out on these options. This appraisal indicated that two of the options (Options 7 and 8), which propose to tie-in at Cowper and Milltown respectively, performed poorly against the economic appraisal criteria. The relatively high capital costs associated with these options arise from the additional length of tunnelling required, the need for additional Metro stations between the city centre NMN stop and the tie-in location and the required property acquisitions. One option (Option 4(A)) performed poorly against the environmental appraisal criteria, particularly in terms of property and architectural heritage impacts on properties in the Northbrook Road areas. It was also anticipated that there would be an increase in noise levels during construction and operation for the residents at Northbrook Avenue. It was therefore recommended that these three options (Options 7, 8 and 4(A)) were not progressed further and a shortlist of four possible tie-in options, comprising Option 3 (Adelaide Court), Option 4(B) (Ranelagh In-line), Option 5 (Beechwood North) and Option 6 (Beechwood South), were identified for detailed appraisal (Stage 2).

During the Stage 2 appraisal, designs for the four shortlisted options were further developed to a sufficient level of detail which enabled a more detailed MCA to be carried out on the options, against the criteria of Economy, Environment, Accessibility and Social Inclusion, and Integration. The design development also sought to mitigate the property and environmental impacts of the options.

For **Option 3(A)** at Adelaide Court, the NMN tunnels will be bored to the northern side of Hatch Street. A NMN stop, combined with the Tunnel Boring Machine (TBM) receiving shaft, will be provided between Hatch Street and Adelaide Road. After passing under Adelaide Road, the track will rise in retained cut on the line of the existing Luas alignment, tying in to the existing Luas Green Line ramp, immediately north of Charlemont Stop.

This option performs very poorly against the economic criteria, primarily as a result of the relatively high capital cost associated with the need to acquire significant commercial and residential properties on Adelaide Road. The option was also considered to have high construction risk, arising from large-scale demolition, excavation and construction in a congested built-up city centre area which would require high levels of mitigation. The environmental appraisal of Option 3(A) indicates that this option also performs poorly in relation to operational noise for residential properties on Adelaide Road and Peter's Place, landscape and visual impacts arising from the installation of a retained cut and ramp elements within Peter's Place, potential architectural heritage impacts on Georgian buildings on Adelaide Road and the requirement to remove a section of retained walls and embankment from the historical Harcourt Street Railway Line. This option provides a very good performance on the accessibility and social inclusion criteria, as the Harcourt Luas Stop and the Harcourt Metro Stop will

provide accessibility between the north of the city and the designated RAPID (Revitalising Areas by Planning, Investment and Development) area around Peter's Place.

In terms of integration, the option delivers a very good performance, as it has potential for direct interchange at St Stephen's Green and O'Connell Street, and indirect interchange at the Harcourt Luas Stop. The relative distance between the Harcourt Luas Stop and the new Harcourt Metro Stop is only *c*.0.25km.

Overall, the Stage 2 appraisal indicated that Option 3(A) delivers a **good performance** against the appraisal criteria.

Option 4(B) at Ranelagh is an in-line option with the NMN tunnels bored from the north, underneath the Carroll's Building which is a Protected Structure (RPS 3280), to the vacant lot to the rear of the building, where a new Metro stop will be located. The tracks will then rise in a cut and cover section, passing under Dartmouth Road and Northbrook Road. Immediately south of Northbrook Road, the track will continue to rise in a retained cut within the existing Luas Green Line embankment and then onto a ramp structure to its eventual tie-in point, north of Ranelagh Stop.

This option is considered to deliver a good performance against the economic criteria and has the lowest capital costs of the four shortlisted options. Some high risk construction activities were identified including tunnelling under the Carroll's Building; however, the majority of the works are within the current Luas alignment, providing a reduced interface with pedestrians and traffic. From an environmental perspective, the performance of this option is considered to be moderate overall, with some impacts on sensitive receptors identified in relation to noise, vibration and groundborne noise during construction. The option also performs poorly in relation to architectural heritage with impacts on Protected Structures at Dartmouth Road as well as sections of the stone retaining walls, embankments and overbridge of the historic Harcourt Street Railway Line.

In terms of accessibility and social inclusion, accessibility to/from the north of the city will be maintained via the Luas corridor and potentially enhanced by the St Stephen's Green Metro Stop (albeit a 1km walk). Accessibility to/from the south of the city is marginally worse than existing, as users will generally get on/off at Charlemont which is outside the RAPID area (0.5km). The option is considered to deliver a moderate performance in terms of accessibility and social inclusion. In relation to integration, this option provides potential for interchange at St Stephen's Green, O'Connell Street and at Charlemont (0.1km) and as such is considered to deliver a very good performance.

Overall, the Stage 2 appraisal indicated that Option 4(B) delivers a **very good performance** against the appraisal criteria.

For **Option 5(A)** at Beechwood North, the NMN tunnels will be bored to a point south of the Charleston Road Luas Bridge, beneath the existing Luas corridor and partly to the rear of houses on Oakley Road. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, immediately north of Dunville Avenue. NMN will run at-grade across Dunville Avenue.

This option delivers a good performance in the economic appraisal as it had a relatively low capital cost and also in terms of construction risk. In relation to construction risk, the majority of the works will be within the current Luas alignment which reduces the interface with pedestrians and traffic. Overall, this option delivers a moderate performance against the environmental criteria with the most significant impacts associated with the waste generation from the tunnelling and construction activities and architectural heritage arising from potential impacts on a Protected Structure on Oakley Road and the requirement to remove a section of the stone retaining walls and embankment of the historic Harcourt Street Railway Line. However, this option performs poorly in terms of accessibility and social inclusion, as accessibility to/from the south of the city is poor as travelling to/from areas south of Ranelagh will involve an interchange and walk to the Luas or Metro service and the option introduces an element of severance for the RAPID area. In terms of integration, trips to/from Ranelagh

Stop and the new Metro stop at Elmwood Avenue Upper will require a walk to interchange which was considered to deliver a poor performance.

Overall, the Stage 2 appraisal indicates that Option 5 is considered to deliver a **poor performance** against the appraisal criteria.

Option 6(A) at Beechwood South will involve the excavation of NMN bored tunnels from the north to join in-line in the Beechwood Luas Stop area where the new Metro stop will be located. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, north of Cowper Luas Stop.

The option delivers a moderate performance against the economic criteria. The relatively high capital costs arise from the length of tunnelling and property acquisitions required for this option. In terms of construction risk, the majority of the works will be within the current Luas alignment with no substantial large buildings adjacent to the works and therefore it will have a reduced interface with pedestrians and traffic. There will be no major impacts on road junctions but this option may sever existing pedestrian crossing of the Luas lines at Albany Road.

This option delivers a good performance on the environmental criteria with the only significant negative impacts associated with waste generation from the length of tunnelling required. However, this option performs poorly in terms of accessibility and social inclusion. Accessibility to/from the south of the city is poor, as travelling to/from areas further south of Ranelagh will involve an interchange and walk to the Luas or Metro services, depending on the direction of travel. There will as a result be some severance of the RAPID area in the south city centre. In terms of integration, the performance is also poor as trips to and from south of Ranelagh Stop will now incorporate a significant walk and interchange.

Overall, the Stage 2 appraisal indicates that Option 6 is considered to deliver a **poor performance** against the appraisal criteria.

1.1 The Preferred Luas Green Line Tie-in Option of NMN

The study concludes that Option 4(B) (Ranelagh In-line) is the preferred tie-in option for NMN. Option 4(B) has the lowest capital cost. In contrast to other options, particularly Option 3(A), this option has minimal requirement for property acquisition for the new Metro stop at Charlemont as it utilises an area of semi-derelict lands for the tie-in location. This option also largely mitigates the potential for construction risk by confining works within the existing Luas Green Line alignment which reduces the interface with pedestrians and traffic. Its overall economic performance, which takes account of capital costs and the potential for costs associated with risk mitigation, is therefore good.

There is some potential for negative environmental impacts, particularly in terms of architectural heritage. However, these impacts are considered less significant than those identified for Option 3(A) and broadly comparable to those identified for Option 5(A). Overall, the environmental performance is considered to be moderate. Under the accessibility and social inclusion criteria, access from the RAPID area around Peter's Place to and from the north of the city will be maintained via the Luas corridor and potentially enhanced by the new St Stephen's Green Metro Stop. This contrasts with Options 5(A) and 6(A) which introduce an element of severance for this RAPID area.

From an integration viewpoint, the potential for direct interchange at St Stephen's Green and O'Connell Street is identified for Options 3(A) and 4(B). Option 4(B) is considered preferable to Option 3(A) as it will also provide direct interchange between the Luas stop and the new Metro stop at Charlemont. The option scores an overall moderate and good performance against the criteria of accessibility/social inclusion and integration, respectively.

Overall, **Option 4(B)** (Ranelagh In-line) is considered to deliver a very good performance against the other tie-in options and is therefore selected as the preferred Luas Green Line Tie-in Option for NMN.

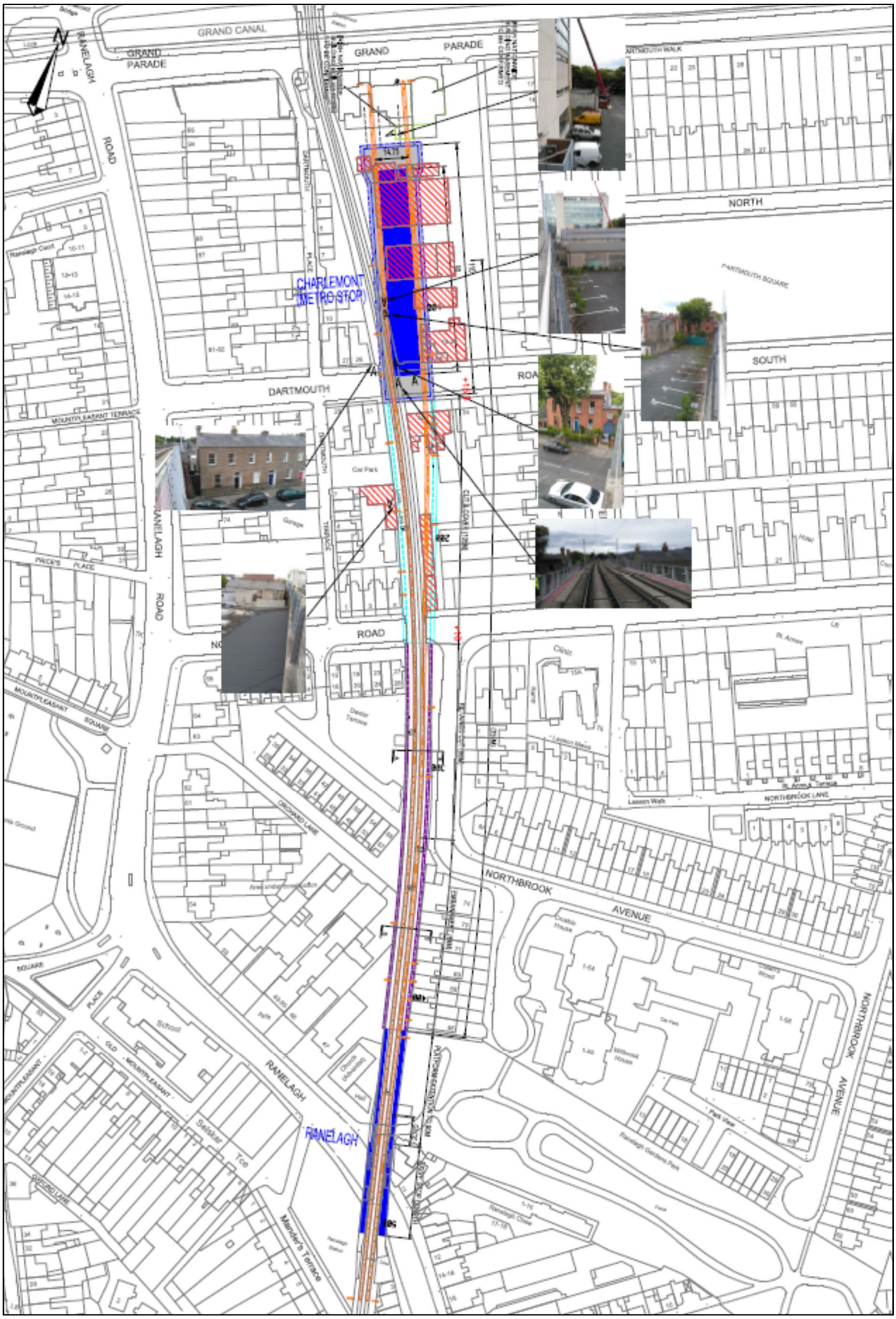


Figure 1: Option 4(B) – Ranelagh In-line

2 INTRODUCTION

The NTA's Fingal/North Dublin Study (June 2015) recommended an optimised Metro North scheme as the preferred public transport solution to service the passenger demand along the corridor between Dublin City Centre, Dublin Airport and Swords.

The Government's seven year investment plan titled "*Building on Recovery: Infrastructure and Capital Investment 2016–2021*" (October 2015) endorsed this recommendation and included for a new Metro project for Dublin, referred to as "New Metro North" (NMN).

The NTA's Transport Strategy for the Greater Dublin Area 2016–2035 provides a framework for the planning and delivery of transport infrastructure and services in the Greater Dublin Area (GDA) over the next two decades. It has built on the work undertaken in the Fingal/North Dublin Study and undertaken similar studies for all other corridors. In this regard, it provides the context for the integrated transport network within which NMN will operate.

The Strategy defines NMN as a high speed, high capacity, high frequency public transport link from Dublin City Centre to Dublin Airport and Swords. The city centre section will be underground. As described in the Transport Strategy, it is anticipated that NMN will ultimately tie into Dublin's existing Luas Green Line light rail system, enabling through running of Metro trams from Swords to Bride's Glen.

The Project Objective for NMN as agreed with the NTA is as follows:

> ***"To provide a safe, high frequency, high capacity, fast, efficient and sustainable public transport light rail service connecting Swords, Dublin Airport and Dublin City Centre."***

In delivering this objective, NMN will:

- *Cater for future public transport travel demand along this corridor;*
- *Be modern, attractive and accessible to all users;*
- *Be designed to integrate appropriately into the existing public realm;*
- *Be segregated from other transport modes between Dublin Airport and the city centre;*
- *Contribute to a reduction in urban congestion and the enhancement of the environmental sustainability of the region; and*
- *Support the continued economic development of the Dublin area and the wider State.*

2.1 Study Objective

The objective of the LGLTS is to identify the preferred location and configuration for a tie-in between NMN and the existing Luas Green Line. The tie-in will ultimately facilitate the through running of Metro services from Swords to Bride's Glen as envisioned in the NTA Transport Strategy for the Greater Dublin Area 2016–2035. The NTA and TII have agreed a staged approach to carrying out this study as described in the following two sections.

2.1.1 Stage 1

The purpose of the Stage 1 assessment is to identify a long list of feasible options and to carry out a preliminary appraisal of those options so as to arrive at a shortlist of possible tie-in options for detailed appraisal. This stage includes the following key activities:

- Development of a preliminary alignment drawing for each tie-in location;
- Initial sifting of long-list to identify feasible options;
- Preliminary appraisal of feasible options; and

- Identification of shortlist of possible tie-in options for detailed appraisal.

2.1.2 Stage 2

The purpose of the Stage 2 appraisal is to further develop the designs and carry out a detailed appraisal of the shortlisted options and to make a recommendation for a preferred NMN/Luas Green Line Tie-in. This includes the following key activities:

- Development of a preliminary engineering design for each of the shortlisted options to a sufficient level of detail for detailed appraisal; and
- Detailed appraisal of the shortlisted options and the recommendation of a preferred NMN/Luas Green Line Tie-in.

3 STUDY AREA

The study area extends from St Stephen's Green Luas Stop to Milltown Luas Stop. St Stephen's Green has been chosen as the northern boundary of the study area as it is expected to be the closest Luas Green Line stop to the NMN city centre terminus.

The tie-in will require a significant area of free space adjacent to the Luas Green Line, to allow the NMN track alignment rise to ground level in a tunnel portal box and then rise to the level of the operating line. Depending on the level of the operating line, the area required to construct the tie-in will measure approximately 20m wide by up to 400m long. This may require extensive acquisition of private property. Milltown was chosen as the southernmost boundary of the study area as a tie-in point south of Milltown would result in significant duplication of services with the Luas Green Line.

The proposed study area is illustrated in Figure 2.

Figure 2: Proposed study area

4 STUDY ASSUMPTIONS

In the absence of a complete reference design for NMN, a number of assumptions were made in order to identify and appraise the long list of options. These assumptions are listed as follows; assumptions marked with an asterisk will be confirmed during the completion of a separate Tunnel Configuration Study, currently being carried out by Arup Consulting Engineers:

1. Tunnel portals will be constructed using cut and cover tunnelling until a cover of one clear tunnel diameter has been achieved*;
2. NMN will be segregated from other transport modes between Dublin Airport and the city centre;
3. NMN will operate in twin tunnels, of approximately 5.8m external diameter, with a minimum separation of one tunnel diameter*;
4. For comparative purposes, additional lengths of bored tunnel are measured from an assumed NMN station in the vicinity of St Stephen's Green;
5. Intermediate emergency access and ventilation shafts will be required at an approximate spacing of 1km between NMN stations and the tunnel portal or tie-in Metro station. It is assumed that these can be located to avoid significant environmental impacts and property acquisition;
6. NMN can operate at a maximum gradient of 6%;
7. Tie-in locations will provide for Metro services which will operate to all Luas stops south of the tie-in as envisioned in the NTA Transport Strategy for the Greater Dublin Area;
8. Station stop boxes where illustrated shall be 100m x 25m in plan and shall have a maximum gradient of 2%; and
9. NMN system will have an initial peak hour capacity of 9,900 passengers per hour, per direction (pphpd), assuming 60m long vehicles with a capacity of 330 passengers.

4.1 Track Inter-axis

The track inter-axis distance on the existing Luas Green Line, south of Ranelagh Stop, allows for the operation of 2.65m wide vehicles, with some modification of platform edges. From Ranelagh Stop northwards, the track inter-axis distance currently only allows for the operation of 2.4m wide vehicles and will require widening. During Stage 1, it was unclear if it would be possible to carry out the required widening due to the proximity of new developments on either side of the alignment at Charlemont ramp. An engineering assessment has now been carried out and it has been determined that it is feasible to widen the inter-axis distance in this area without materially impacting the adjacent developments.

4.2 Space Required for Tie-in

Figure 3 illustrates the typical arrangement for an average "in-line" type of tie-in, and shows the space required to construct the tie-in with an underground stop/TBM shaft combined box, based on the general assumptions regarding tunnel configuration and track gradient. The in-line tie-in type is explained in Appendix B. The diagrams and cross sections illustrated in this section are based on 2.65m wide vehicles.

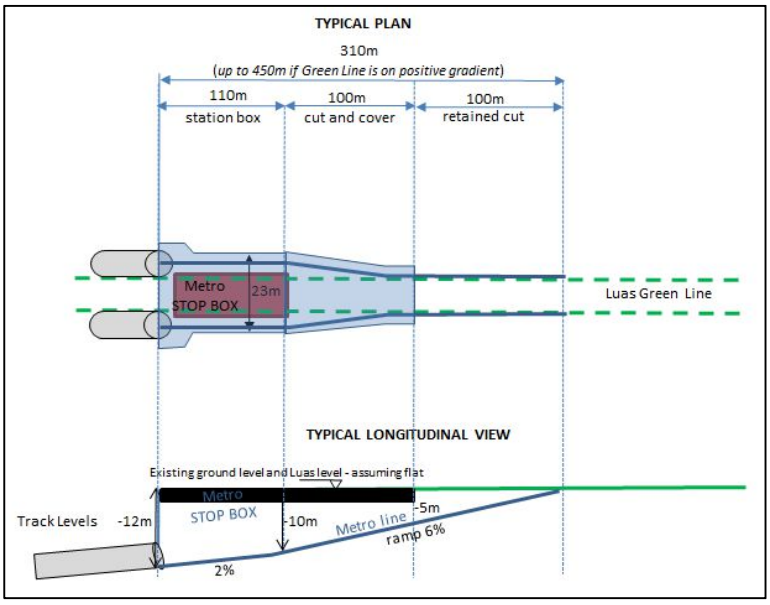


Figure 3: Typical plan and vertical section of in-line tie-in with underground stop box

The arrangement shown assumes that the existing Luas tracks are horizontal and at-grade. Where there is a positive change in elevation of the existing Luas tracks between the tunnel portal and the tie-in, such as there is south of Beechwood, then the length of retained cut will be greater. Where the Luas tracks at the tie-in location are elevated, such as at Ranelagh, then an additional length of ramp is required.

4.3 Typical Cross Section of Retained Cut

To further explain the dimensions shown in Figure 3, Figures 4 and 5 present a typical track cross section of a segregated line in a retained cut, and retained embankment. Parapet height requirements (1.8m) are derived from the Commission for Railway Regulation (CRR) Guidelines for the Design of Railway Infrastructure and Rolling Stock (GDRIRS), 1.3.3.6 – 1.3.3.12 inclusive.

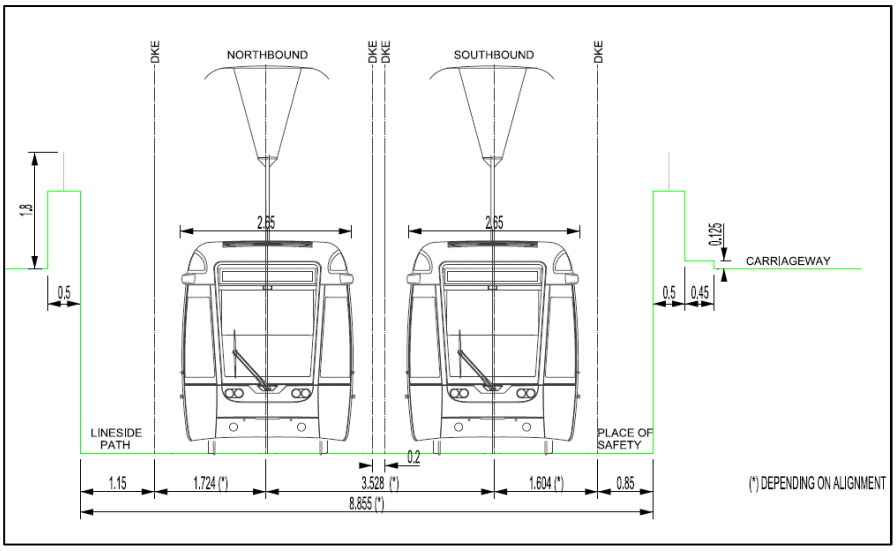


Figure 4: Retained cut typical cross section for a typical in-line tie-in (lateral clearances based on R100m alignment – worst case among shortlisted options)

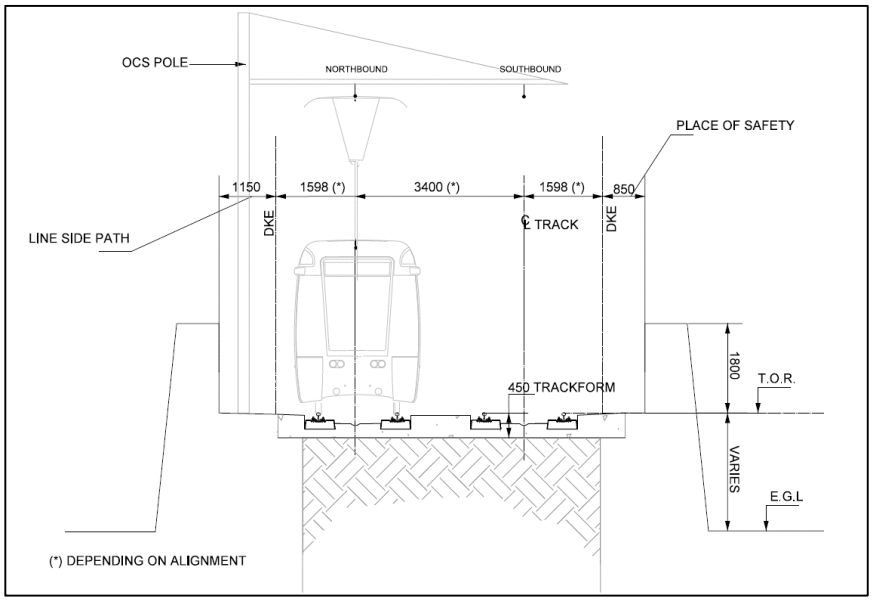


Figure 5: Retained embankment typical cross section for a typical in-line tie-in (lateral clearances based on R900m alignment – worst case among shortlisted options)

4.4 Capital Cost, Basis Assumptions and Exclusions

An estimated capital cost has been prepared for each of the tie-in options. The costs and rates have been developed from the previous Metro North scheme, benchmarked against other European Metro projects. The costs are for comparison purposes only and are intended for use in the MCA The cost should not be taken as absolute. Dimensions, costs and other design elements referenced herein have been developed solely for the purpose of allowing a comparative assessment of options to be carried out, and should not be used for any purpose outside of this study.

In developing comparative costs for tie-in options, the reader should note the following assumptions and exclusions:

Assumptions

1. The base date for this estimate is Q4 2016 prices;
2. The level of estimating uncertainty is assumed to be +/- 30% order of magnitude;
3. Costs assume normal daytime working; and
4. Tunnel 5.8m internal diameter.

Exclusions

1. Tender price increases beyond cost base date, i.e. inflation/deflation;
2. Major ground improvements or soil stabilisation;
3. Replacement of life-expired systems and components;
4. All operational testing and risks;
5. Dealing with contaminated materials as a result of tunnel excavation arisings;
6. No works to existing Luas stops;
7. No public realm works to facilitate interchange between Metro stations and Luas stops; and
8. Value Added Tax.

5 STAGE 1 – IDENIFICATION/APPRAISAL OF FEASIBLE OPTIONS

The purpose of the Stage 1 appraisal is to identify a long list of feasible options and to carry out a preliminary appraisal of those options. This section describes the methodology used to identify and assess feasible options and provides a detailed description of each option under consideration.

5.1 Identification of Long List of Feasible Options

On 25th April 2016, a TII/NTA workshop was convened to identify all possible NMN Luas Green Line Tie-in locations. The workshop considered previous studies carried out by Parsons Brinckerhoff and Jacobs Engineering, and also involved a detailed examination of the Luas Green Line alignment, superimposed on Ordnance Survey backgrounds. Eight possible tie-in locations and thirteen specific tie-in options were identified as follows:

1. One option at St Stephen's Green West – Harcourt Street;
2. Two options at St Stephen's Green East – Earlsfort Terrace – Peter's Place;
3. Three options at Iveagh Gardens – Peter's Place;
4. Two options at Ranelagh;
5. Two options at Beechwood (north of stop);
6. One option at Beechwood (south of stop);
7. One option at Milltown; and
8. One option at Cowper.

The identified options were considered at the workshop to determine their feasibility from a technical, construction and operational perspective. Two of the potential options at Iveagh Gardens were discounted due to the difficulties of passing from cut and cover to an elevated structure within the extent of Iveagh Gardens. A third option in the Iveagh Gardens area was deemed feasible with some modifications to provide for the cut and cover at a location further south at Adelaide Court and was thus retained as a feasible option for further appraisal.

An option at Beechwood (north of stop), which provided for a four-track junction platform across the road junction of Dunville Avenue, was discounted as the interface with Dunville Avenue posed significant operational difficulties. At the conclusion of the workshop, a long list of ten feasible options was brought forward for initial sifting. The long list of options is detailed in Table 1.

Table 1: Long list of tie-in locations/options

No.	Location
1	St Stephen's Green West – Harcourt Street
2(A)	St Stephen's Green East – Earlsfort Terrace – Peter's Place, elevated
2(B)	St Stephen's Green East – Earlsfort Terrace – Peter's Place, at-grade
3	Adelaide Court
4(A)	Ranelagh, at-grade
4(B)	Ranelagh, in-line
5	Beechwood (north of stop)
6	Beechwood (south of stop)
7	Cowper
8	Milltown

5.2 Initial Sifting of Long List

Preliminary alignment drawings were developed for each of the ten options identified at the TII/NTA workshop. Preliminary capital costs including infrastructure and property valuations were also established and are provided in Appendix F. This section describes the results of an initial sifting and in particular provides information on options which failed to satisfy the NMN project objectives.

All options were initially sifted against the NMN project objectives. Three of the options, Options 1, 2(A) and 2(B), were identified as being unable to meet the project objective of being *"segregated from other transport modes between Dublin Airport and the City Centre"* without unacceptable negative environmental impacts and were therefore not brought forward for preliminary appraisal.

5.3 Options 1, 2(A) and 2(B) Description

The following section provides a detailed overview of Options 1, 2(A) and 2(B).

5.3.1 Option 1 – St Stephen's Green West

Option 1 is illustrated in Figure 6. From the north, NMN tunnels will be bored to an underground Metro station at St Stephen's Green West. The tracks will rise in a cut and cover section, passing under the Cuffe Street/St Stephen's Green South junction. Immediately south of Stokes Place, the tracks will rise in a fully segregated, retained cut to reach street level, north of Clonmel Street, tying into the existing Luas Green Line track. The fully segregated track will continue along the existing Luas Green Line alignment through Harcourt Stop and onwards to Charlemont Stop.

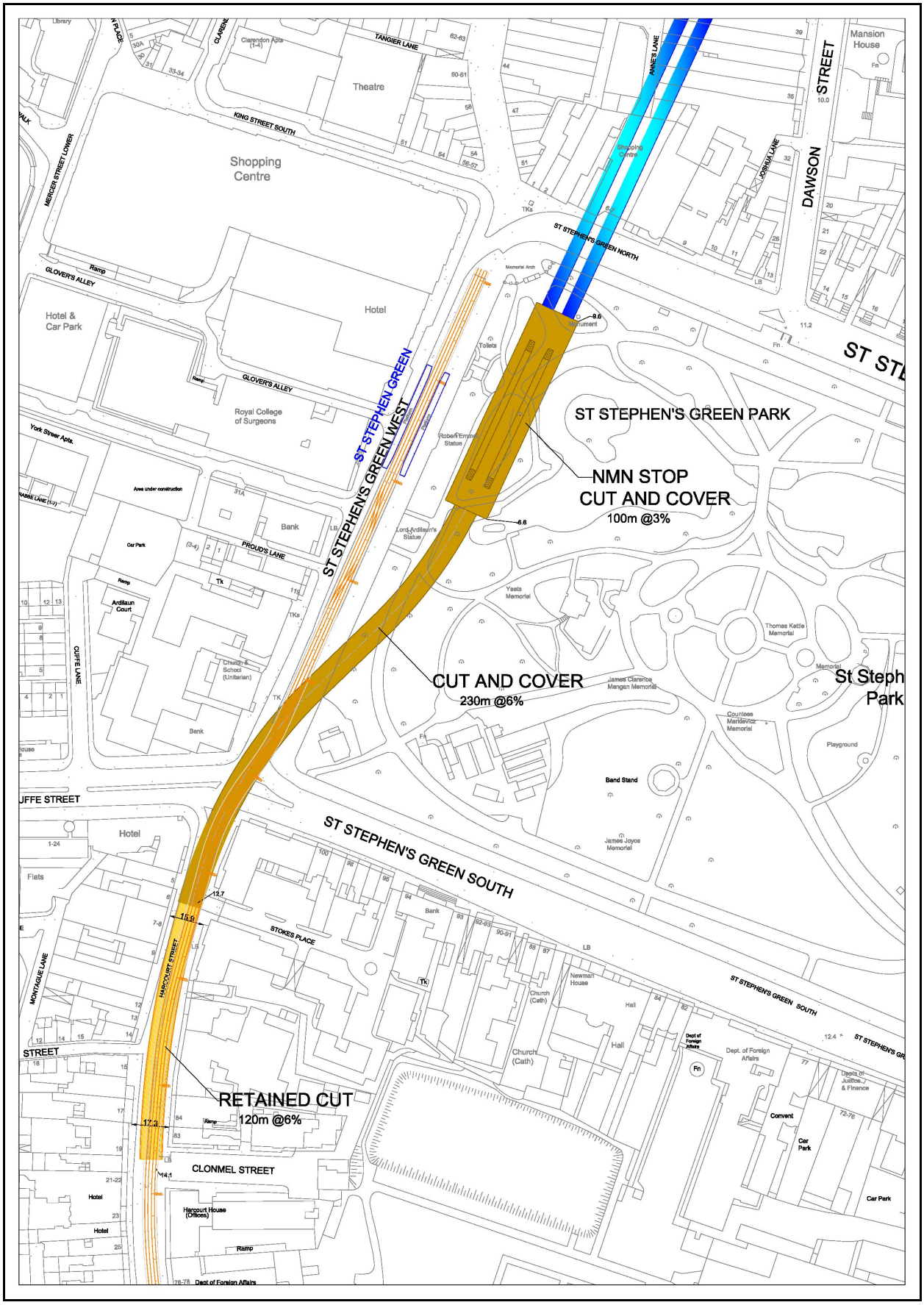


Figure 6: Option 1 – St Stephen's Green West

5.3.2 Option 2(A) – St Stephen's Green East (Earlsfort Terrace, Elevated)

Option 2(A) is illustrated in Figure 7. From the north, NMN tunnels will be bored to an underground Metro station at St Stephen's Green East. The tracks will then rise in a cut and cover section, passing under the Leeson Street/St Stephen's Green South junction, rising in a fully segregated retained cut to reach street level midway along Earlsfort Terrace.

The tracks will then run at-grade and fully segregated along Earlsfort Terrace across Hatch Street and rise up on a ramp to a bridge over Adelaide Road. The tracks will then continue on a viaduct through Peter's Place to join the Luas Green Line tracks at the northern end of Charlemont Stop.

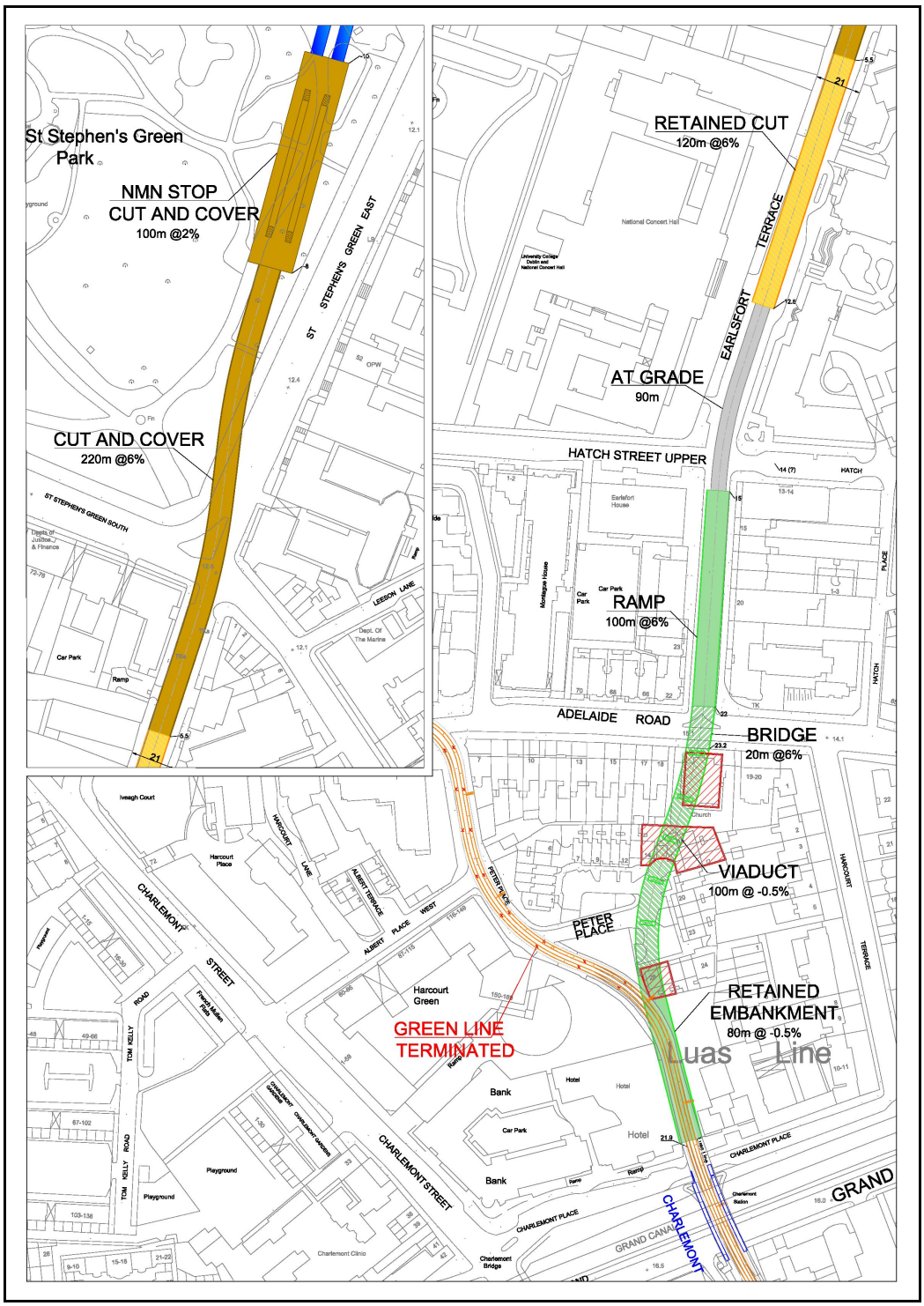


Figure 7: Option 2(A) – St Stephen's Green East elevated

5.3.3 Option 2(B) – St Stephen's Green East (Earlsfort Terrace, At-grade)

Option 2(B) is illustrated in Figure 8. From the north, NMN tunnels will be bored to an underground Metro station at St Stephen's Green East. The tracks will then rise in a cut and cover section, passing under the Leeson Street/St Stephen's Green South junction, rising in a fully segregated retained cut to reach street level midway along Earlsfort Terrace.

The tracks will then run at-grade and fully segregated along Earlsfort Terrace, across Hatch Street and Adelaide Road, rising up on a ramp and a viaduct through Peter's Place to join the Luas Green Line tracks at the northern end of Charlemont Stop.

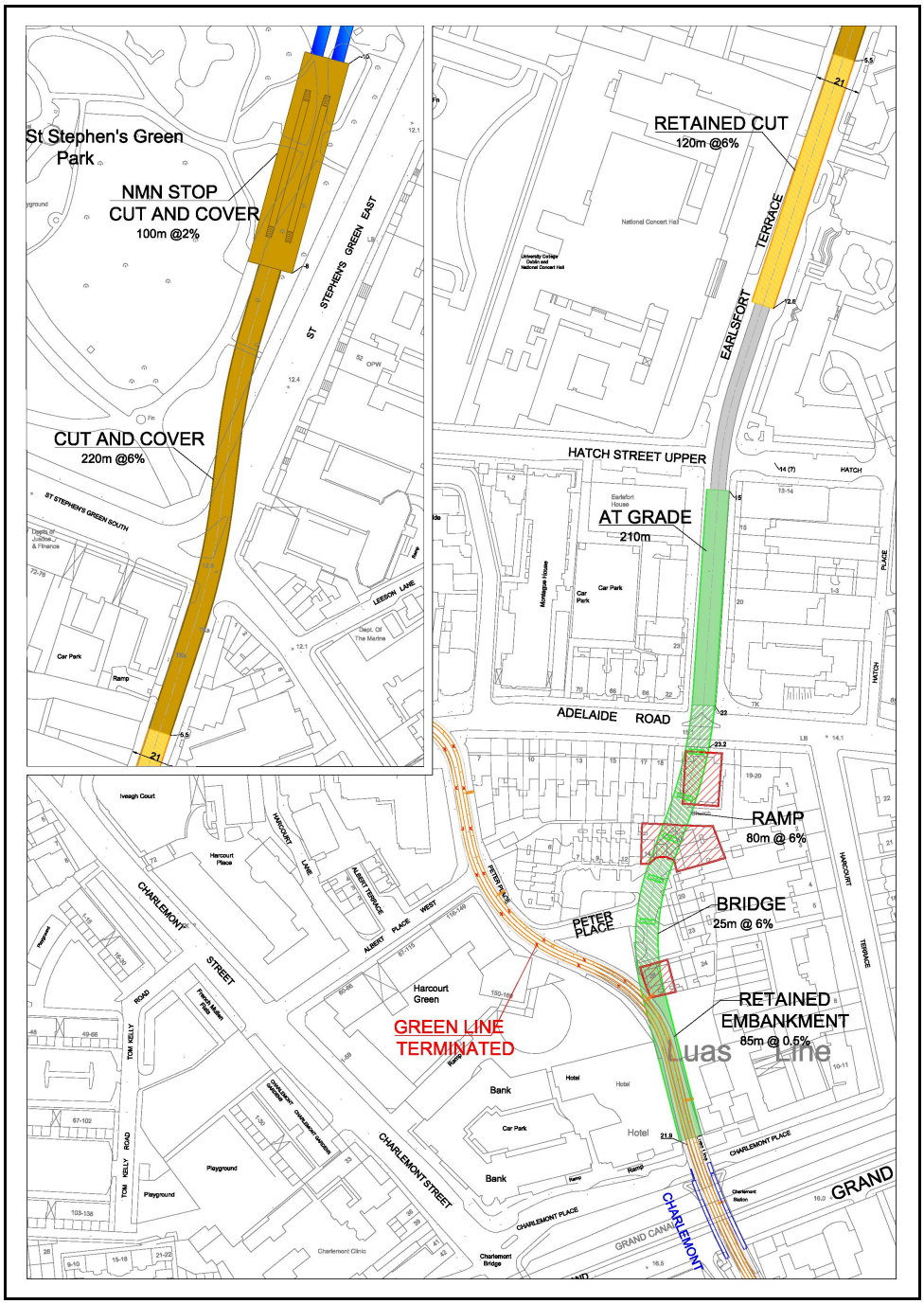


Figure 8: Option 2(B) – St Stephen's Green East at-grade

5.4 Initial Sifting Outcome (Identification of Feasible Options)

The following sections detail the outcome of the initial sifting of the long list and provide the rationale for the exclusion of Options 1, 2(A) and 2(B) from the next stage of the assessment process (i.e. Preliminary Assessment).

5.4.1 Option 1 – St Stephen's Green West (Initial Sift)

Option 1 is illustrated in Figure 6. This option has the lowest capital cost (€17m) when compared to other options, reflecting the fact that it requires little additional tunnelling and no property acquisition. However, the option requires the provision of a fully segregated tunnel portal on Harcourt Street, and full segregation of retained cut and at-grade track from the junction of Harcourt Street/St Stephen's Green South to the existing Harcourt Luas Stop. Unlike the surface Luas along Harcourt Street, the higher speed and higher frequency NMN will require full separation from traffic and pedestrians through this area. Typical cross sections, illustrating the impact of the full segregation on the streetscape, are presented in Figures 4 and 5 and show the requirement for a physical barrier of up to 1.8m in height along either side of the tracks.

The presence of the tunnel portal, fully segregated track and the severance arising from it, will have very significant adverse landscape and visual impacts on the historical Georgian streetscape. The Georgian buildings, fronting the northern end of Harcourt Street, were predominantly developed between 1791 and 1843 whilst the southern end of the street was developed later, following the opening of the Dublin, Wicklow & Wexford Railway in 1854 and the construction of the Harcourt Station building in 1859. The houses along Harcourt Street are predominantly red brick with four storeys over basement and two to three bays wide.

This option would also adversely impact the existing traffic and transportation arrangements on Harcourt Street, requiring the street to be completely closed to traffic and facilitating local access only.

Given the detrimental landscape and visual impacts on the Harcourt Street Georgian buildings and the streetscape generally, the option of providing a fully segregated tie-in at St Stephen's Green West did **not** proceed to the preliminary appraisal stage.

5.4.2 Option 2(A) – St Stephen's Green East, Elevated (Initial Sift)

Option 2(A) is illustrated in Figure 7. This option has a lower capital cost (€48m) when compared to other options, reflecting the fact that it requires little additional tunnelling. The option does however require the acquisition of six residential properties and the Adelaide Road Presbyterian Church. The option requires the provision of a fully segregated tunnel portal on Earlsfort Terrace and full segregation of a retained cut and at-grade track from the junction of Earlsfort Terrace/St Stephen's Green South along Earlsfort Terrace to just south of its junction with Hatch Street due to the higher speed and higher frequency nature of a Metro system. Typical cross sections, illustrating the impact of the full segregation on the streetscape, are presented in Figures 4 and 5 and show the requirement for a physical barrier of up to 1.8m in height along Earlsfort Terrace on either side of the tracks.

The requirement for a segregated retained cut and at-grade track along Earlsfort Terrace and the severance arising from it will have very significant adverse landscape and visual impacts on the existing historical Georgian streetscape. The tunnel portal in this area and the required 1.8m high barriers to segregate the system will negatively impact on an adjacent large landmark building which houses the National Concert Hall (NCH) venue (Figure 9). This building was constructed in 1865 and was designed as part of an architectural competition by Arthur Gresham Jones on behalf of the Dublin Exhibition and Winter Garden Company. Some parts of the Jones's Exhibition Building survive within the internal layout of the building on this site, but the imposing limestone façade was built when the building became part of University College Dublin (UCD) in 1914. The NCH opened here in 1981.

The 19th century building which is a Protected Structure is of significant architectural heritage merit and is an important public landmark building in Dublin so the presence of a tunnel portal in the

streetscape in front of the building would have very significant adverse impacts on its setting and visual amenity. Furthermore, the NCH which is the main venue for classical music is one of the principal national cultural institutions for the country. The provision of the tunnel portal will also have the potential for very significant adverse impacts on the cultural amenity of this venue with potential for severance, visual and noise quality impacts.

To the south of the Hatch Street junction, where this option rises in a ramp before crossing Adelaide Road, there are a number of additional Protected Structures fronting onto Earlsfort Terrace. The presence of the ramp will impact negatively on the landscape and visual quality of the historic streetscape and on the architectural heritage setting and amenity of these structures in particular. Furthermore, many of the buildings along this terrace are currently in use as bed and breakfast establishments and the presence of the ramp with its associated potential for severance, visual and noise quality impacts has the potential to negatively impact on socio-economic aspects of these businesses.

This option would also require the acquisition and demolition of the Adelaide Road Presbyterian Church. Valuation Records from 1920 to present date would indicate that the church is valued as "a place of worship" and searches carried out in the Registry of Deeds would indicate that the ownership and use has not changed subsequently.

Traffic impacts for this option will also include the requirement to close Hatch Street Upper to through traffic which would present significant traffic management challenges for the area.

Given the very significant and detrimental landscape and visual impacts on the Earlsfort Terrace buildings and the streetscape generally, the option of providing a fully segregated tie-in at St Stephen's Green East did not proceed to the preliminary appraisal stage.

Figure 9: NCH on Earlsfort Terrace

5.4.3 Option 2(B) – St Stephen's Green East, At-grade (Initial Sift)

Option 2(B) is illustrated in Figure 8. This option also has a low capital cost (€46m) when compared to other options, reflecting the fact that it requires little additional tunnelling. The option requires the same property acquisition as Option 2(A).

The option requires the provision of a fully segregated tunnel portal on Earlsfort Terrace and full segregation of retained cut and at-grade track from the junction of Earlsfort Terrace/St Stephen's Green South along Earlsfort Terrace through the Hatch Street junction and on to a point just south of Adelaide Road junction.

This option has equally negative environmental, property, landscape and visual impacts as Option 2(A) with the added traffic impact of closing Adelaide Road to traffic. The at-grade section along Earlsfort Terrace, south of Hatch Street, will be less visually intrusive than the ramp required for Option 2A. However, the presence of the barriers required to ensure the segregation of the system has similar potential to result in negative impacts on the landscape and visual amenity of the street and its architectural heritage context as well as resulting in potential severance, visual and noise quality impacts on residents and bed and breakfast establishments along this street. Given the very significant and detrimental landscape and visual impacts on the Earlsfort Terrace buildings and the streetscape generally, this alternative Option 2(A) did not proceed to the preliminary appraisal stage.

5.5 Long List of Feasible Options

Following the initial sift of the original ten tie-in options, seven feasible options were brought forward for preliminary assessment. The list of feasible options is provided in Table 2.

Table 2: Long list of feasible options

Feasible Options	
No.	**Location**
3	Adelaide Court
4(A)	Ranelagh, at-grade
4(B)	Ranelagh, in-line
5	Beechwood (north of stop)
6	Beechwood (south of stop)
7	Cowper
8	Milltown

5.6 Feasible Options Detailed Description

A brief description of each of the options is provided in the following sections. A more detailed description for each option is also provided in Appendix A. The tables describe in detail the configuration of each tie-in including the extent of tunnel, cut and cover, retained cut and elevated sections, the number of additional intermediate escape shafts and Metro stations required, the surrounding built and natural environment, and the resultant service pattern operating on the Luas Green Line and future Metro.

5.6.1 Option 3 – Adelaide Court

Option 3 is illustrated in Figure 10 and has an estimated capital cost of €244m. From the north, NMN tunnels will be bored to the southern side of Hatch Street. The tunnel portal will be formed in cut and cover on the site of 3 Park Place (currently under construction) and St James House, Adelaide Road

(Figures 11 and 12). The track will rise in retained cut on the line of the existing Luas alignment, tying in to the existing Luas Green Line ramp, immediately north of Charlemont Stop.

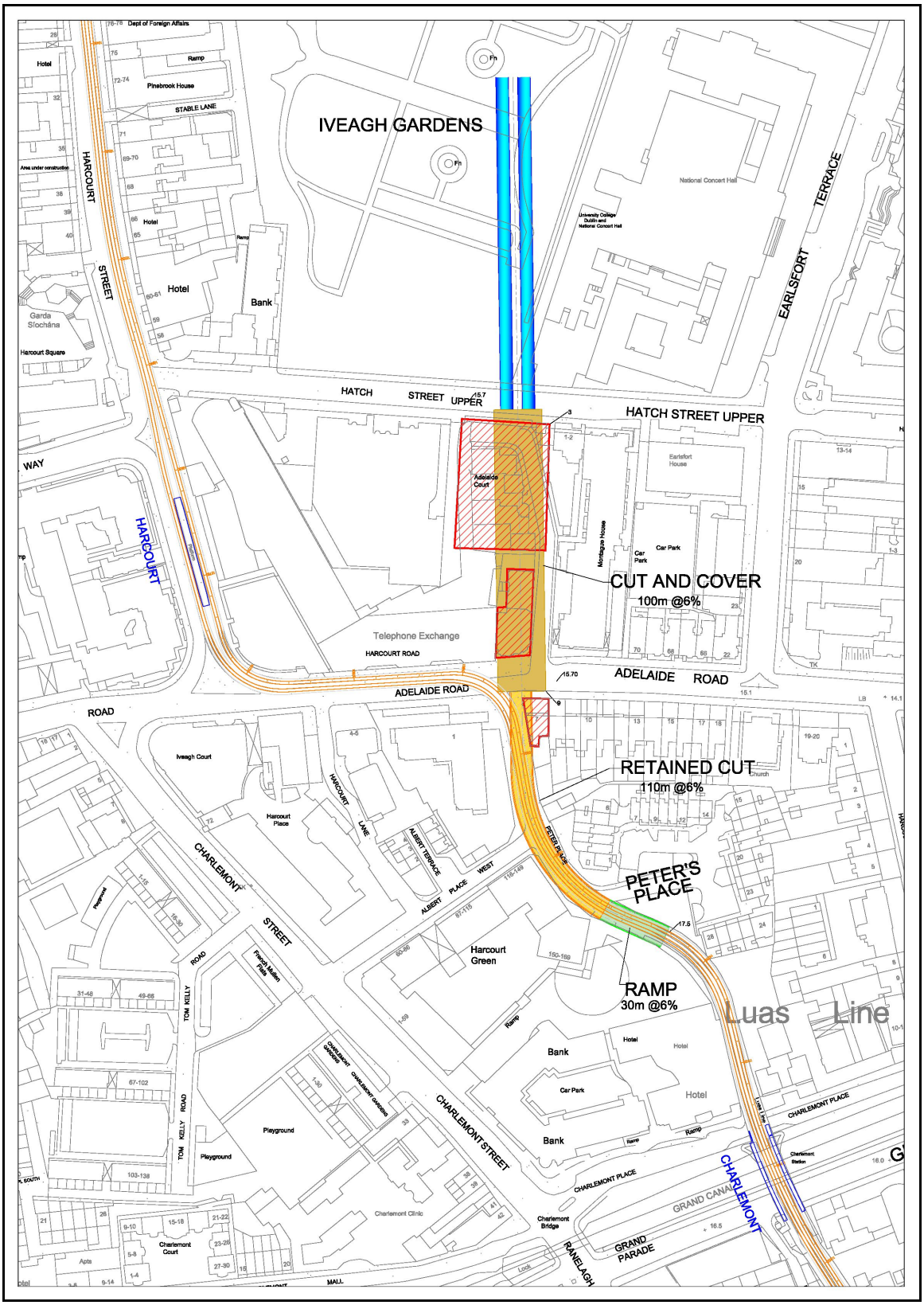


Figure 10: Option 3 – Adelaide Court

The final operating configuration will result in the severance of the existing Luas Green Line, with only Metro vehicles operating south of the tie-in point in order to enable through Metro services from

Swords to Bride's Glen. Luas Green Line services will operate between Harcourt Stop and Broombridge Stop. Harcourt Stop will become the terminus for the Luas Green Line and a turnback facility will be provided on Adelaide Road.

Figure 11: 3 Park Place (under construction)

Figure 12: St James House, Adelaide Road

5.6.2 Option 4(A) – Ranelagh At-grade

Option 4(A) is illustrated in Figure 13 and has an estimated capital cost of €187m. From the north, NMN tunnels will be bored under the Carroll's Building on Grand Parade which is a Protected Structure (RPS 3280), to the vacant lot to the rear of the building where a new Metro stop will be located. The Metro stop construction would be in cut and cover and would require the demolition of an existing derelict building on the lot and the demolition of derelict offices at 19–25 Dartmouth Road. The track would continue in cut and cover beneath Dartmouth Road and rise in a fully segregated retained cut, necessitating the permanent closure of Northbrook Road to traffic.

South of Northbrook Road, the track will rise on a ramp structure to join the existing Luas Green Line, immediately north of Ranelagh Stop. The ramp structure will require the acquisition of 32 and 33 Dartmouth Road (Figure 14), the front gardens of 1–6A Northbrook Avenue and the houses at 65–74 Northbrook Avenue (Figure 15).

The final operating configuration will result in the partial severance of the Luas Green Line with only Metro vehicles operating south of the tie-in point in order to enable through Metro services from Swords to Bride's Glen. Luas Green Line services would operate between Charlemont Stop and Broombridge Stop. A Luas Green Line engineering link would be retained to enable access to Sandyford Depot for Luas vehicle maintenance. Charlemont Stop will become the terminus for the Luas Green Line and a turnback facility will be provided south of the stop.

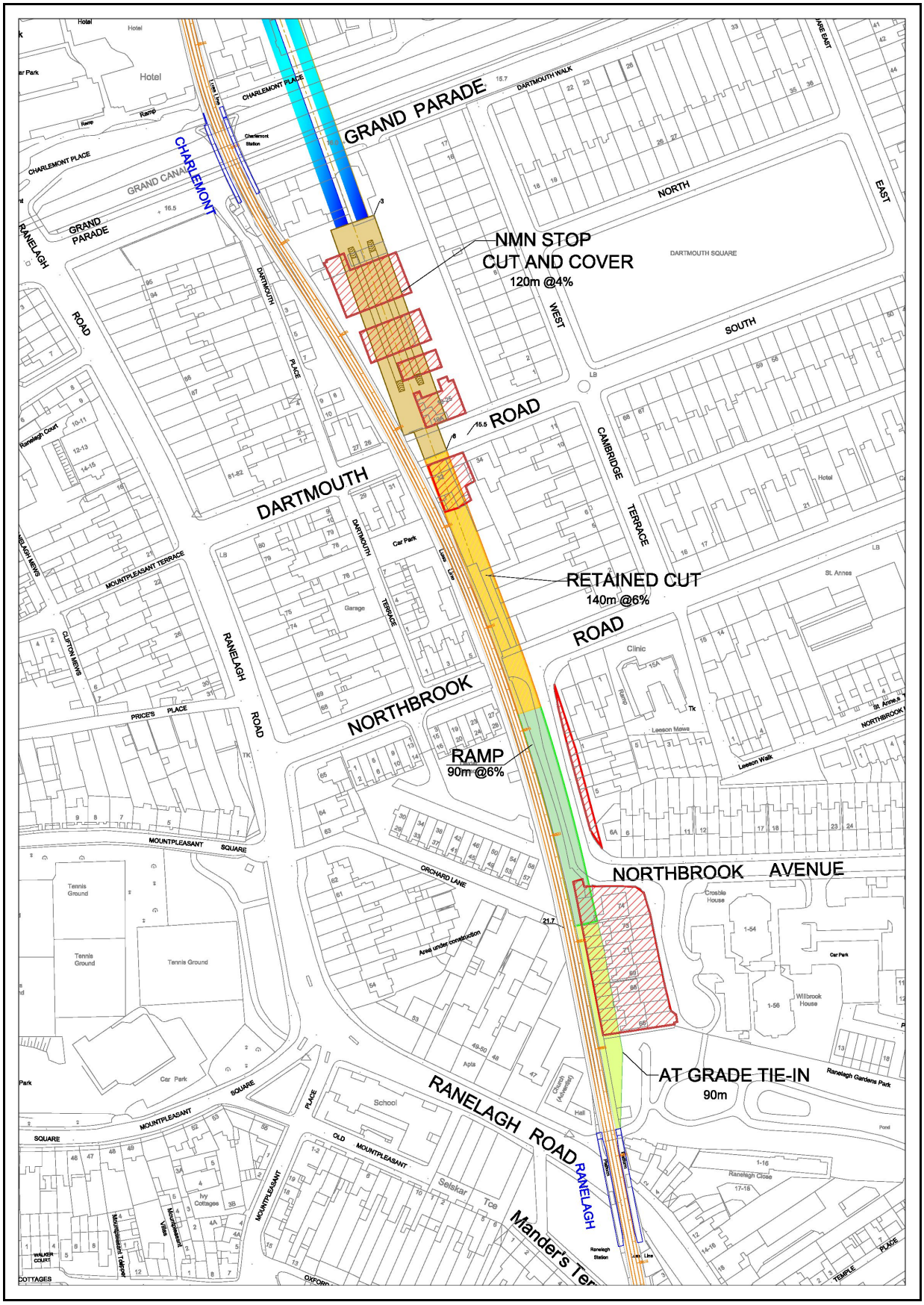


Figure 13: Option 4(A) – Ranelagh At-grade

Figure 14: 32 and 33 Dartmouth Road

Figure 15: 65–74 Northbrook Avenue

5.6.3 Option 4(B) – Ranelagh In-line

Option 4(B) is illustrated in Figure 16 and has an estimated capital cost of €177m. This option is similar to Option 4(A), with the key difference being that the alignment is moved approximately 15m west to avoid property impacts at 32 and 33 Dartmouth Road, 1–6A Northbrook Avenue and 65–74 Northbrook Avenue associated with Option 4(A). The option also removes the requirement to close Northbrook Road to through traffic.

From the north, NMN tunnels will be bored under the Carroll's Building on Grand Parade which is a Protected Structure (RPS 3280), to the vacant lot to the rear of the building where a new Metro stop will be located. The tracks will then rise in a cut and cover section, passing under Dartmouth Road and Northbrook Road. Immediately south of Northbrook Road, the track will continue to rise in a retained cut along the line of the existing Luas Green Line embankment and then onto a ramp structure to its eventual tie-in point, north of Ranelagh Stop. The final operating configuration will result in the severance of the existing Luas Green Line at Charlemont with future Metro vehicles operating exclusively south of the tie-in point in order to enable through Metro services from Swords to Bride's Glen. Luas Green Line services will operate between Charlemont Stop and Broombridge Stop. In this option, due to the in-line nature of the tie-in, an engineering link to Sandyford Depot would not be retained for Luas vehicle maintenance. Charlemont Stop will become the terminus for the Luas Green Line and a turnback facility will be provided, south of the stop.

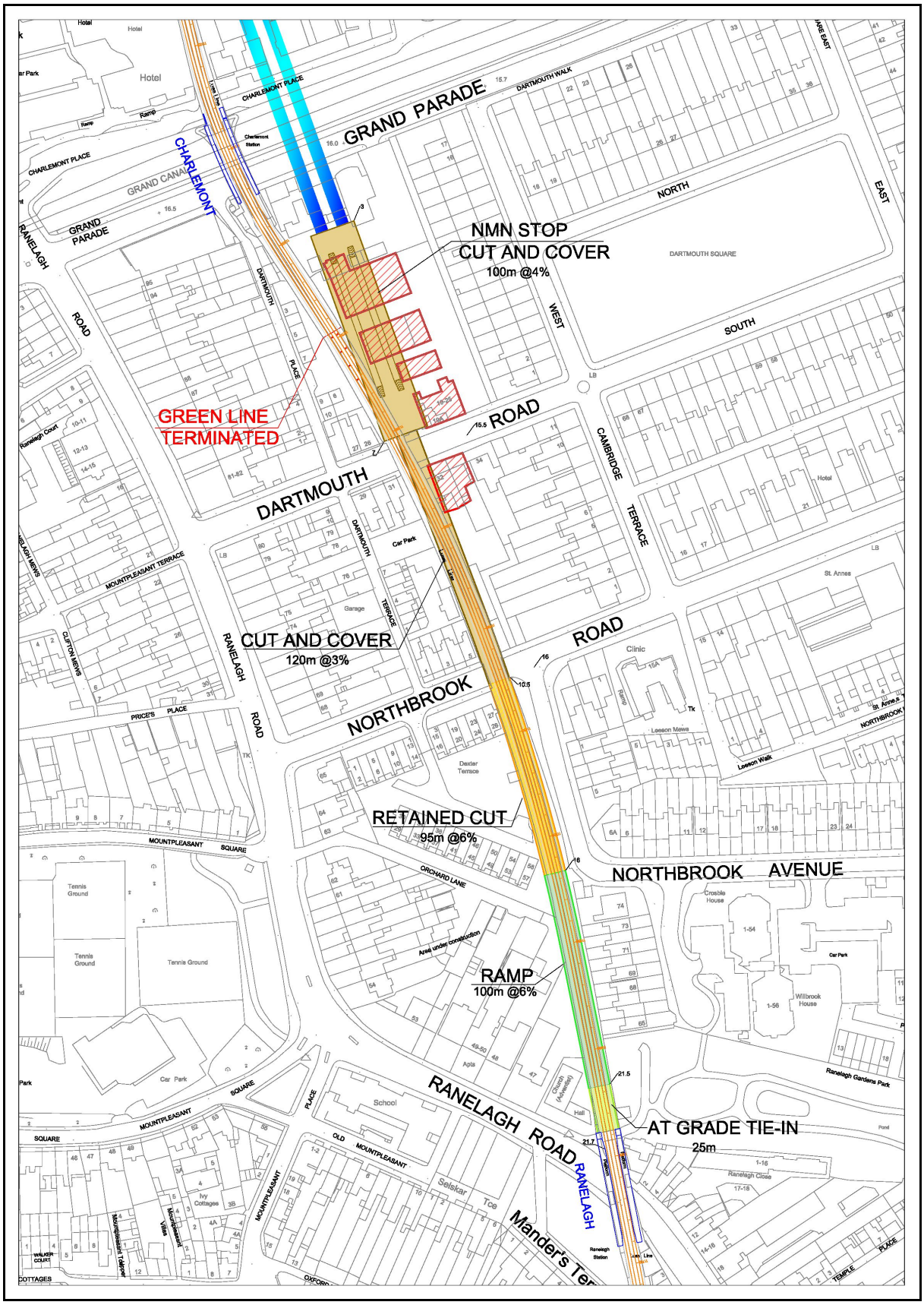


Figure 16: Option 4(B) – Ranelagh In-line

5.6.4 Option 5 – Beechwood North

Option 5 is illustrated in Figure 17 and has an estimated capital cost of €232m. From the north, NMN tunnels will be bored to a point to the west of and adjacent to the existing Luas tracks at the rear of houses on Oakley Road. The Metro stop construction would be in cut and cover and would require the demolition of 46–53 Oakley Road, 13–36 Oakley Court (apartments) (Figures 18 and 19) and a house at 2 Brendan Vale.

The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, immediately north of Dunville Avenue. In this option, NMN will run at-grade across Dunville Avenue. A fully segregated Metro will however require the closure of Dunville Avenue to traffic. The final operating configuration will result in the partial severance of the existing Luas Green Line at Ranelagh with future Metro vehicles operating exclusively south of the tie-in point in order to enable through Metro services from Swords to Bride's Glen. Luas Green Line services will operate between Ranelagh Stop and Broombridge Stop. An engineering link will be retained to enable access to Sandyford Depot for Luas vehicle maintenance. Ranelagh Stop will become the terminus for the Luas Green Line with the provision of a turnback facility, south of the stop.

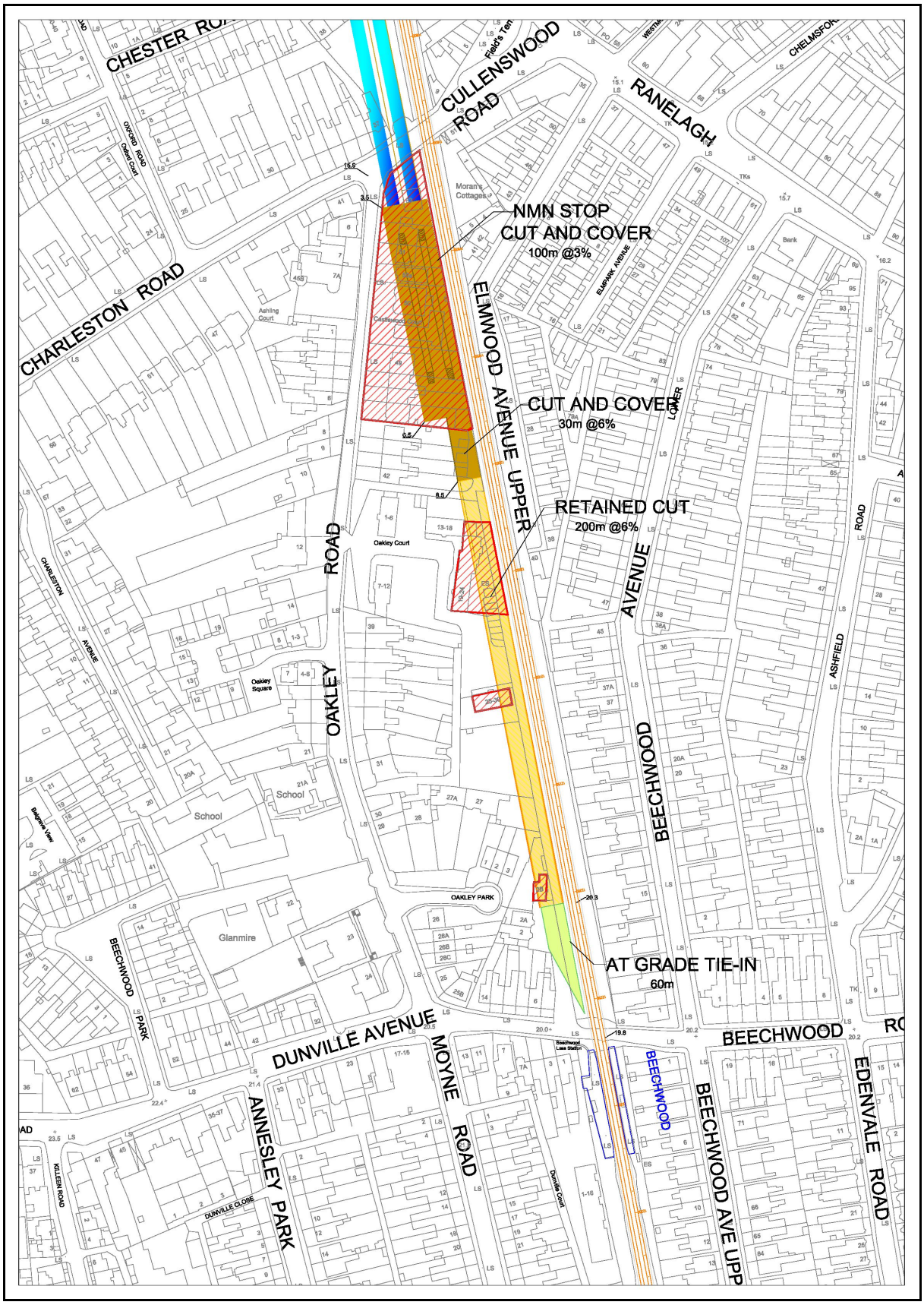


Figure 17: Option 5 – Beechwood North

Figure 18: 36–53 Oakley Road

Figure 19: 36 Oakley Court

5.6.5 Option 6 – Beechwood South

Option 6 is illustrated in Figure 20 and has an estimated capital cost of €254m. From the north, NMN tunnels will be bored to a point on the west of and adjacent to Beechwood Stop, where the new Metro stop will be located. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, north of Cowper Luas Stop.

The Metro stop construction will be in cut and cover and will require the demolition of the Luas Kiosk at Beechwood Stop and three houses at 1–5 Dunville Avenue (Figures 21 and 22). The tracks will then rise in cut and cover, requiring the demolition of Dunville Court Apartments, continuing on in cut and cover to join with the existing Luas Green Line track, immediately north of Cowper Stop, requiring the acquisition of 2–6 Moyne Court.

The final operating configuration will result in the partial severance of the existing Luas Green Line at Beechwood Stop with future Metro vehicles operating exclusively south of the tie-in point in order to enable through Metro services from Swords to Bride's Glen.

Passengers will interchange with the Luas Green Line at the Metro stop at Beechwood South. Luas Green Line services will operate between Beechwood Stop and Broombridge Stop. An engineering link will be retained to enable access to Sandyford Depot for Luas vehicle maintenance.

Figure 20: Option 6 – Beechwood South

Figure 21: 1–5 Dunville Avenue

Figure 22: Beechwood Kiosk

5.6.6 Option 7 – Cowper

Option 7 is illustrated in Figure 23 and has an estimated capital cost of €366m. From the north, NMN tunnels will be bored to a point on the west side of Cowper Luas Stop. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, north of Milltown Luas Stop. This option will not require the acquisition of any buildings. It will however require the temporary acquisition of gardens to the rear of houses at 22–46 Merton Road to facilitate cut and cover construction and the permanent acquisition of gardens to the rear of houses at 2–20 Merton Road and 1–3 Richmond Avenue for the construction of the retained cut and at-grade sections.

The final operating configuration will result in the partial severance of the existing Luas Green Line at Cowper with future Metro vehicles operating exclusively south of the tie-in point, thus enabling through Metro services from Swords to Bride's Glen. Luas Green Line services will operate between Cowper Stop and Broombridge Stop. An engineering link will be retained to enable access to Sandyford Depot for Luas vehicle maintenance.

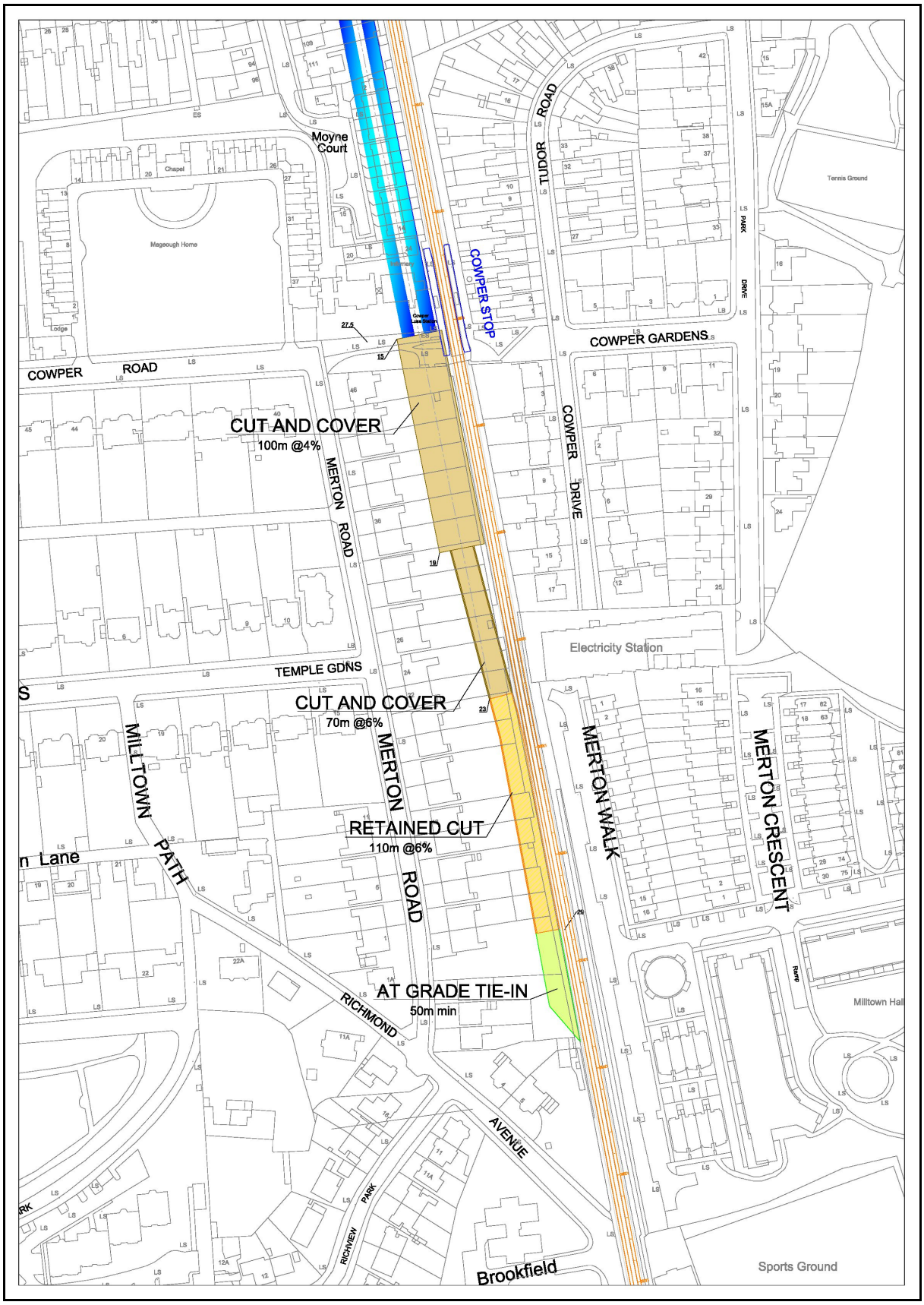


Figure 23: Option 7 – Cowper

5.6.7 Option 8 – Milltown

Option 8 is illustrated in Figure 24 and has an estimated capital cost of €478m. From the north, NMN tunnels will be bored to the northern perimeter of the Alexandra College Sports Grounds. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, north of Milltown Stop. This option will require the acquisition of Alexandra College Sports Hall.

The final operating configuration will result in the partial severance of the existing Luas Green Line at a point north of Milltown Stop with future Metro vehicles operating exclusively south of the tie-in point in order to enable through Metro services from Swords to Bride's Glen. Luas Green Line services will operate between Cowper Stop and Broombridge Stop. An engineering link will be retained to enable access to Sandyford Depot for Luas vehicle maintenance.

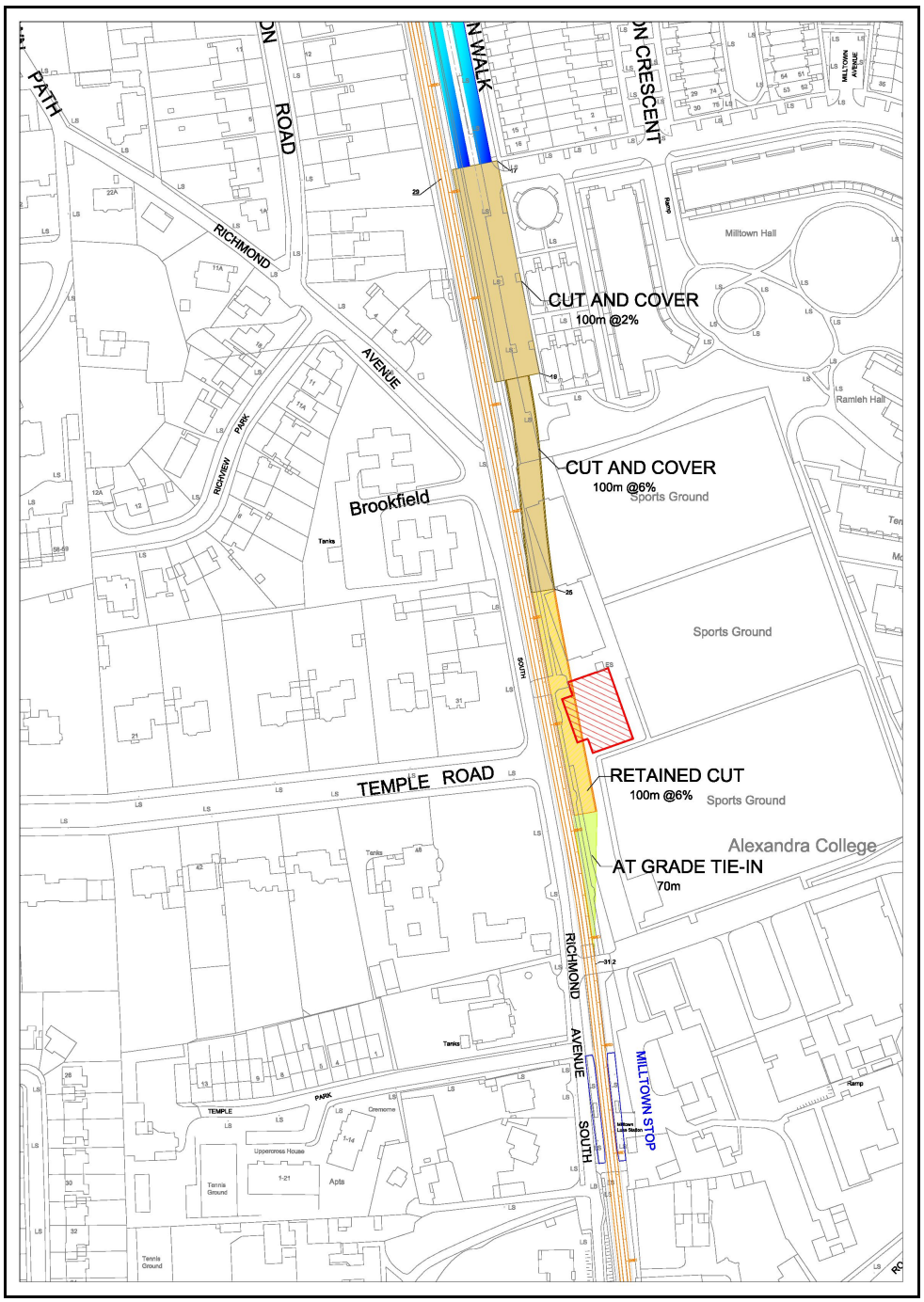


Figure 24: Option 8 – Milltown

5.7 Stage 1 – Preliminary Appraisal

The seven options were appraised using MCA in order to identify a shortlist of options to be taken forward for more detailed design development and Stage 2 detailed appraisal. MCA is an objective led appraisal tool used to evaluate alternatives based on identified criteria and ranked on the basis of an aggregation procedure. The appraisal carried out was based on the criteria identified in the Common Appraisal Framework for Transport Projects and Programmes (DTTAS, 2016) which recommends the following topics are considered in a qualitative appraisal of options:

- Economy (including non-quantifiable economic impacts)
- Safety
- Physical Activity
- Environment
- Accessibility and Social Inclusion
- Integration

The criteria for the Stage 1 appraisal are detailed in Table 3.

Table 3: Criteria, description and metric for Stage 1 appraisal

Criteria	Criteria Description	Metric
Economy	Minimise capital costs	Quantitative appraisal of potential property and per km costs of proposed options *
Environment	Minimise the potential for adverse impact on the natural and built environment and the community	A high level qualitative appraisal on potential adverse environmental impacts
Integration	Integrate effectively with the Luas Green Line and the existing and proposed public transport network	A high level qualitative appraisal of the potential for integration with the existing and proposed transport networks

*TII Optimised Metro North costings

5.7.1 Rationale for Exclusion of Certain Common Appraisal Framework Criteria

The topic of Physical Activity, which provides for consideration of the health benefits derived from using different transport modes, was considered neutral as all options are the same transport mode and will deliver similar health benefits.

Safety, accessibility and social inclusion were not assessed at this stage as the study area is within a relatively small geographical area and the operational similarities of the options under consideration would most likely result in the options being neutral. Safety, accessibility and social inclusion are assessed at Stage 2, when greater design detail on the proposed options is available and thus their potential for integration with the existing and proposed transport network is understood.

In respect of the environmental criteria, it was considered that the feasibility of the options had the potential to differ in terms of land use, private property impacts, traffic and transportation, landscape and visual, archaeological and architectural heritage and biodiversity impacts. However, they did not differ in terms of socio-economic, soil and geology, air and climate including adaptation to climatic factors, human health/population and production of waste. Potential impacts on radiation, stray current and agronomy are not currently anticipated. These environmental sub-criteria were therefore not considered at this stage of the assessment.

This appraisal did not take into account the environmental impacts arising from the requirement for additional Metro stops associated with Option 7 (Cowper) and Option 8 (Milltown) as the locations of these have not been determined and if these options are progressed to Stage 2 and emerge as a preferred option, the stop locations will be assessed in the context of Metro South. The appraisal did however include the capital costs of providing additional stops associated with these options. All capital cost and property estimates are included in Appendix E.

5.7.2 Scoring

For each of the three main criteria, the options have been compared against how well they deliver on the criteria description using a three-point scale, ranging from an overall good performance to an overall poor performance. This three-point scale is colour coded as presented in Table 4, with advantageous routes graded to 'green' and disadvantaged routes graded to 'red'.

Table 4: Options appraisal colour coding system

Colour	Description
	Overall good performance against the criteria
	Overall moderate performance against the criteria
	Overall poor performance against the criteria

5.7.3 Appraisal of Options

Each of the seven options on the long list was appraised against the criteria using the appraisal system described in Section 5.7. The results are included in the Appraisal Summary Table in Appendix D, and summarised in the following sections.

5.7.4 Option 3 – Adelaide Court

Economically, this option has a relatively high capital cost (€244m), largely associated with the need to acquire and demolish two large high specification modern office blocks located at 3 Park Place and St James House at 72 Adelaide Road as well as houses at 7 Adelaide Road and a house in Peter's Place. As a result, this option is considered to deliver an overall moderate performance against the economic criteria.

In addition to the impacts to private property noted previously, this option has negative impacts on architectural heritage as 7 Adelaide Road is a Protected Structure. This impact arises where the tracks will rise from under Adelaide Road and continue to rise in a retained cut to join the Luas Green Line tracks at the bottom of the Charlemont ramp. The retained cut through Peter's Place will also have negative landscape and visual impacts on this residential area.

During the construction stage (estimated to be between 6 and 9 months), services on the existing Luas Green Line would be severed with inbound passengers disembarking at Charlemont Stop and proceeding on foot to Harcourt Stop to continue their journey. Outbound passengers would be similarly affected during construction. Overall, this option was therefore considered to perform moderately against the environmental criteria.

From an integration viewpoint, this option performs well, with direct vertical interchange between Luas and the NMN stop at St Stephen's Green West. However, there is no operational or engineering link between the Luas Green Line and Sandyford Depot, reducing operational flexibility. There are no

predicted impacts on the existing/proposed public transport network. This option delivers an overall good performance against the integration criteria.

Taking into account the overall performance of this option against economic, environmental and integration criteria, this option was considered to deliver an overall **moderate performance**.

5.7.5 Option 4(A) – Ranelagh At-grade

This option has a slightly lower capital cost (€187m) than Option 3, arising from the additional length of tunnelling required (0.9km) and the need to acquire and demolish a large number of properties, comprising two houses at 32 and 33 Dartmouth Road and ten houses at 65–74 Northbrook Avenue as well as the front gardens and driveways of seven houses on Northbrook Avenue and derelict buildings and substrata at the Grand Parade site, south of the Carroll's Building. As a result, this option is considered to deliver an overall good performance against the economic criteria.

In terms of the environmental appraisal, this option has negative environmental impacts, particularly in relation to the private property impacts as detailed previously and architectural heritage impacts arising from the acquisition of the two houses at 32 and 33 Dartmouth Road which are Protected Structures.

In addition to the property impacts on their gardens and driveways, residents at Northbrook Avenue will also potentially experience an increase in noise levels during construction and operation, and landscape and visual impacts arising from the passing trams moving closer to the façades of their properties.

In terms of traffic, this option will require the closure of Northbrook Road which will be permanently severed and the Luas Green Line will be closed for approximately three months between the Charlemont Stop and Harcourt Stop. Further south, this option will adversely impact on biodiversity and mature trees in Ranelagh Gardens Park where it will acquire a portion of the park to facilitate the installation of the ramp before it ties in, north of the existing Ranelagh Stop. Overall, this option was therefore considered to deliver a poor performance against the environmental criteria.

During the construction stage (estimated to be three months), services on the existing Luas Green Line will be severed with inbound passengers disembarking at Ranelagh Stop and proceeding on foot to Charlemont Stop to continue their journey. Outbound passengers will be similarly affected during construction. Dartmouth Road would be temporarily closed during the completion of cut and cover tunnelling.

From an integration viewpoint, this option performs well, with direct vertical interchange between Luas and Metro possible at Charlemont, subject to the construction of a Metro station at this location. An operational and engineering link is maintained between the residual Luas Green Line and Sandyford Depot, offering operational flexibility. There are no predicted impacts on the existing/proposed public transport network. This option delivers an overall good performance against the integration criteria.

Taking into account the overall performance of this option against economic, environmental and integration criteria, this option was considered to deliver an overall **poor performance**.

5.7.6 Option 4(B) – Ranelagh In-line

Similar to Option 4(A), this option has a low capital cost (€177m). The costs associated with this option arise from the length of tunnelling required (0.9km) and the need to acquire and demolish a number of properties comprising two houses at 32 and 33 Dartmouth Road and derelict buildings and substrata at the Grand Parade site, south of the Carroll's Building. As a result, this option is considered to deliver an overall good performance against the economic criteria.

Confining the tie-in works largely within the existing Luas alignment either reduces or eliminates the negative environmental impacts associated with Option 4(A). Similar to Option 4(A), this option will have negative architectural heritage impacts, arising from the required acquisition of 32 and 33 Dartmouth Road which are Protected Structures.

Another significant negative impact on Luas transportation is identified with this option as it will require the closure of the Luas Green Line for approximately one year between Beechwood Stop and St Stephen's Green Stop. Overall, this option is therefore considered to deliver a moderate performance against the environmental criteria.

This option performs the same as Option 4(A) from an integration viewpoint as direct vertical interchange between Luas and Metro is possible at Charlemont. However, an operational and engineering link is not maintained between the residual Luas Green Line and Sandyford Depot, limiting operational flexibility. There are no predicted impacts on the existing/proposed public transport network. This option delivers an overall moderate performance against the integration criteria.

Taking into account the overall performance of this option against the economic, environmental and integration criteria, this option was considered to deliver an overall **moderate performance**.

5.7.7 Option 5 – Beechwood North

This option has a relatively high capital cost (€232m) associated with the additional length of tunnel required (1.5km) and the need to acquire and demolish a large number of properties, comprising eleven houses at 46–53 Oakley Road, a block of apartments in Oakley Court and a house at 2 Brendan Vale. As a result, this option is considered to deliver an overall moderate performance against the economic criteria.

In terms of the environmental appraisal, it will, in addition to impacts on private property as detailed previously, have negative architectural heritage impacts as it requires the demolition of five houses on Oakley Road which are Protected Structures. The removal of these houses and the other houses on Oakley Road will also have negative impacts on the heritage area which is zoned a Residential Neighbourhood Conservation Area.

In terms of traffic and transportation impacts, there will only be a minor disruption to Luas services during tie-in works. The option requires the closure of Dunville Avenue to enable full segregation of Metro services. Overall, this option was therefore considered to perform moderately against the environmental criteria.

From an integration viewpoint, this option performs well, with vertical interchange between Luas and Metro possible at Ranelagh with a 100m walk, subject to the construction of a Metro station at this location. An operational and engineering link is maintained between the residual Luas Green Line and Sandyford Depot, offering operational flexibility. There are no predicted impacts on the existing/proposed public transport network. This option delivers an overall good performance against the integration criteria.

Taking into account the overall performance of this option against the economic, environmental and integration criteria, this option was considered to deliver an overall **moderate performance**.

5.7.8 Option 6 – Beechwood South

This option has a very high capital cost (€254m), associated with the additional length of tunnel (1.9km) and additional Metro station required, and the need to acquire and demolish a large number of properties, comprising three houses at 1–5 Dunville Avenue, a block of apartments at Dunville Court and the house and garage to the rear, a coffee kiosk adjacent to Beechwood Stop and five houses at

Moyne Court. As a result, this option is considered to deliver an overall **moderate performance** against the economic criteria.

In terms of the environmental appraisal, the option will, in addition to the impacts on private property detailed previously, have a negative architectural heritage impact as the three impacted houses on Dunville Avenue are Protected Structures. It is anticipated that the area of the tie-in at Beechwood Stop will be redeveloped so this will also have negative impacts on the existing landscape character of this area which is zoned a Residential Neighbourhood Conservation Area. This option delivers an overall moderate performance against the environmental criteria.

From an integration viewpoint, this option performs well, with vertical interchange between Luas and Metro possible at Beechwood, subject to the construction of a Metro station at this location. An operational and engineering link is maintained between the residual Luas Green Line and Sandyford Depot, offering operational flexibility. There are no impacts on the existing/proposed public transport network. This option is therefore considered to deliver an overall good performance against the integration criteria.

Taking into account the overall performance of this option against the economic, environmental and integration criteria, this option was considered to deliver an overall **moderate performance**.

5.7.9 Option 7 – Cowper

This option also has a relatively high capital cost (€366m), associated with the additional length of tunnel (2.5km), two additional Metro stations required and the need to temporarily and permanently acquire a large number of gardens on Merton Road. As a result, this option is considered to deliver an overall poor performance against the economic criteria.

In terms of the environmental appraisal, this option performs well. The option neither requires the acquisition of any property nor has a negative architectural heritage impact on its environs. The option will require the temporary and permanent acquisition of gardens to the rear of residential properties and there will be a resultant deterioration in the existing noise environment, arising from the Metro alignment (albeit in a retained cut) moving closer to existing residents along Merton Road and Richmond Avenue. Notwithstanding this, the option is considered to deliver an overall good performance against the environmental criteria.

From an integration viewpoint, this option performs well with an at-grade connection with through services on the Luas Green Line at Cowper Stop possible and direct vertical interchange in the city centre also possible. There are no predicted impacts on the existing/proposed public transport network. This option is therefore considered to deliver a good performance against the integration criteria.

Taking into account the overall performance of this option against the economic, environmental and integration criteria, this option was considered to deliver an overall **poor performance**.

5.7.10 Option 8 – Milltown

This option has the highest capital cost of all options (€478m) due to the additional length of tunnel (2.9km) and the three additional Metro stations required. This option will also require the acquisition of the Alexandra College Sports Hall. As a result, this option is considered to deliver an overall poor performance against the economic criteria.

This option delivers a good performance against the environmental objective. The only significant environmental impact being the aforementioned impact on private property, associated with the required permanent acquisition and demolition of the Alexandra College Sports Hall.

From an integration viewpoint, this option performs well with through Luas services possible on the Luas Green Line, north of Milltown. Direct vertical interchange between NMN and Luas is also possible in the city centre at St Stephen's Green. There are no predicted impacts on the existing/proposed public transport network. This option is therefore considered to deliver an overall good performance against the integration criteria.

Taking into account the performance of this option against the economic, environmental and integration criteria, this option was considered to deliver an overall **poor performance**.

5.8 Stage 1 Outcome – Options for Stage 2 Detailed Appraisal

An Appraisal Summary is provided in Table 5. The table collates and summarises the appraisal of every option, under each of the assessment criteria.

The Overall Appraisal Summary Table for each option is presented in Appendix D.

Table 5: Summary of results of Stage 1 option appraisal

Option	3	4(A)	4(B)	5	6	7	8
Location	Adelaide Court	Ranelagh At-grade	Ranelagh In-line	Beechwood North	Beechwood South	Cowper	Milltown
Economy							
Environment							
Integration							
Overall							

The results of the comparative appraisal of the long list of seven tie-in locations are provided in Appendix D. The results indicate that Options 7 and 8 perform poorly against the economic appraisal criteria and Option 4(A) performs poorly against environmental appraisal criteria. It is therefore recommended that Options 3, 4(B), 5 and 6 are progressed for detailed appraisal.

Option 3, in the Grand Canal area, performs moderately against all criteria and is thus recommended for the shortlist. Its biggest drawback is the need to acquire and demolish two office blocks, which also contributes to its relatively high capital cost.

Of the two Ranelagh options, Option 4(B) performs better against the economic and environmental appraisal criteria. Option 4(B) has a lower capital cost than 4(A) and performs better from an environmental viewpoint, with a significantly lower impact on private properties on Northbrook Avenue. It is therefore recommended that Option 4(B) is shortlisted for detailed appraisal.

Options 5 and 6 at Beechwood North and South also perform well across all sub-criteria, and both options are recommended for detailed appraisal. The biggest drawback with these options is the requirement to acquire and demolish a large number of private properties. Options 7 and 8 perform similarly from an environmental viewpoint but these options are significantly disadvantaged by vastly higher capital costs and a poor performance against the economic criteria.

5.9 Stage 1 Shortlisted Options

It is thus recommended that the following options are progressed for detailed appraisal:

- Option 3 – Adelaide Court
- Option 4(B) – Ranelagh In-line
- Option 5 – Beechwood North
- Option 6 – Beechwood South

6 STAGE 2 – SHORTLISTED OPTIONS DESIGN DEVELOPMENT

The purpose of the Stage 2 appraisal is to further develop the designs for the shortlisted options, carry out a detailed appraisal of the shortlisted options and make a recommendation for a preferred NMN/Luas Green Line Tie-in location. This section details variations and enhancements that were considered during the development of the design for each shortlisted option.

6.1 Option 3 – Adelaide Court

During the course of the design development of this option, a number of variations emerged. In an attempt to avoid impact on the new office building, located at 3 Park Place, the possibility of locating the tunnel portal and TBM receiving shaft in the grounds of the old Harcourt Railway Station and the telephone exchange building on Adelaide Road was explored. An initial design for this option (Option 3(B)) is provided in Appendix C. The option was discounted on the basis that it delivers a sub-standard Metro alignment, with four reversing curves and an estimated speed of 15kph from the TBM box to Charlemont Bridge, and requires the building of a TBM box adjacent to a Protected Structure (Harcourt Railway Station), while relying on the demolition of the existing telephone exchange building.

Two feasible variations to Option 3 did however emerge during the design development stage as described in the following sections.

6.1.1 Option 3(A) – Adelaide Court Stop

Option 3(A) is illustrated in Figure 25 and is a design development of Option 3. The main difference is in the provision of an underground stop at 3 Park Place, which in the future could be integrated with the building to be reconstructed over the stop itself. The provision of an underground stop here will increase the capital costs for this option over the Stage 1 – Option 3. However, the integration benefits of providing a stop here within *c*.0.25km of the Harcourt Luas Stop was considered a significant advantage over Option 3.

As per the original Option 3, NMN tunnels will be bored to the northern side of Hatch Street. A NMN stop, combined with the TBM receiving shaft, will be provided at the site of 3 Park Place (currently under construction) and St James House, Adelaide Road.

After passing under Adelaide Road, the track will rise in retained cut on the line of the existing Luas alignment, tying in to the existing Luas Green Line ramp, immediately north of Charlemont Stop.

Option 3(A) does not require an additional stop at Charlemont; therefore, the existing Charlemont Luas stop, will become a plain line with the platforms removed and the track inter-axis widened by 500mm. This is unlikely to require a new deck structure for Charlemont Bridge as track widening can be accommodated within the existing platform footprint.

The existing Luas Green line track configuration will also be modified to widen track inter-axis by up to 420mm between the Charlemont and Ranelagh Stops. This is technically feasible within the existing retained embankment structure and will not require modification of the existing two bridges decks (Dartmouth and Northbrook). Finally, the short section of maintained Luas Green Line, north of

Charlemont Stop (part of the so called “Charlemont ramp”), will also see the tracks widened within the existing structure footprint, but with some level of relaxation on the lateral clearances, where it is likely that only structural clearance will be achieved on one side.

The final operating configuration will result in the severance of the existing Luas Green Line. Harcourt Stop will become the terminus for the Luas Green Line and a turnback facility will be provided on Adelaide Road.

Figure 25: Option 3(A) – Adelaide Court Stop

6.1.2 Option 3(C) – Adelaide Road

Option 3(C) is illustrated in Figure 26 and is designed to avoid impact on the new office building, located at 3 Park Place, while providing a smoother and more direct alignment than Option 3(A) and tying in at a similar location.

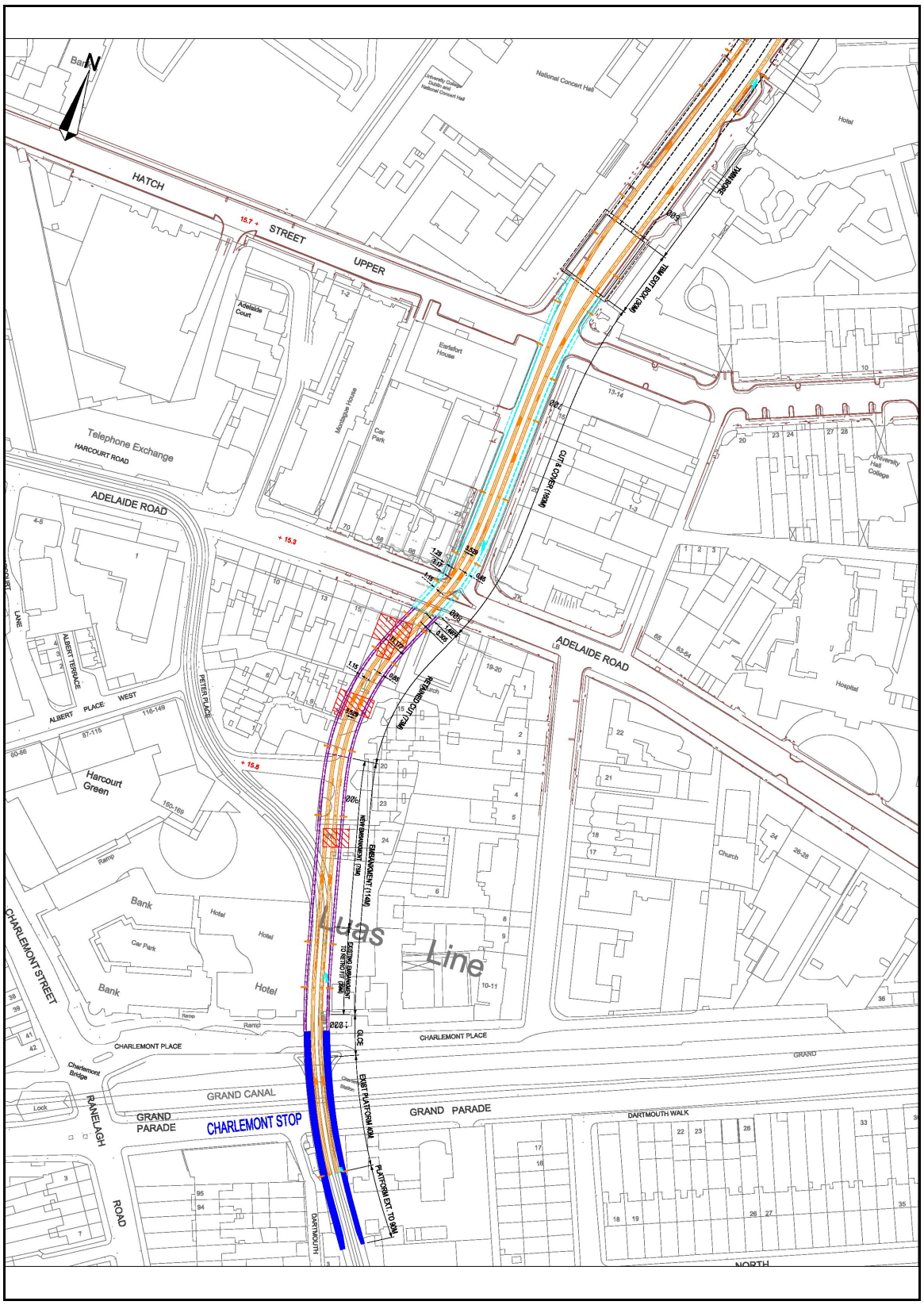


Figure 26: Option 3(C) – Adelaide Road

From the north, NMN tunnels will be bored to Earlsfort Terrace, at a suitable location between the Conrad Hotel/NCH and Hatch Street junction, where the road is approximately 22m wide. The tunnel portal and TBM receiving shaft will be formed in cut and cover within the public road space, with limited impact on surrounding buildings. During construction, the road will be closed to traffic in both directions and the footpaths will have to be temporarily accommodated within the NCH grounds.

The tracks will then rise in a cut and cover section beneath the Earlsfort Terrace, Hatch Street and Adelaide Road junctions, to then rise in open retained cut, immediately south of Adelaide Road, on the west side of the Adelaide Road Presbyterian Church, tying in to the existing Luas Green Line ramp, immediately north of Charlemont Stop.

6.1.3 Options 3 – Conclusions

Option 3(A) is very similar to Stage 1 – Option 3 while providing additional interchange benefits with a stop at Adelaide Court, without additional impacts. The option also has the added advantage that it does not require the upgrading of Charlemont Bridge. Option 3(A) is therefore deemed a better solution than original Option 3 and it is brought forward for detailed appraisal instead of Option 3.

Option 3(C) delivers a potentially feasible alternative alignment for Stage 1 – Option 3. There are however significant environmental and logistical challenges associated with constructing a TBM receiving shaft and cut and cover section on Earlsfort Terrace. There are also significant technical challenges to be overcome in terms of the design and construction of a cut and cover tunnel section on Earlsfort Terrace and in particular the close proximity of the alignment to Adelaide Road Presbyterian Church and several buildings with basements and lightwells on the northwest corner of the Adelaide Road/Earlsfort Terrace junction.

Given the extent of technical difficulties and significant environmental challenges associated with Option 3(C), this option is not brought forward for detailed appraisal.

6.2 Option 4(B) – Ranelagh In-line

From the north, NMN tunnels will be bored under the Carroll's Building on Grand Parade which is a Protected Structure (RPS 3280), to the vacant lot to the rear of the building where a new Metro stop will be located. The tracks will then rise in a cut and cover section, passing under Dartmouth Road and Northbrook Road. Immediately south of Northbrook Road, the track will continue to rise in a retained cut along the line of the existing Luas Green Line embankment and then onto a ramp structure to its eventual tie-in point, north of Ranelagh Stop.

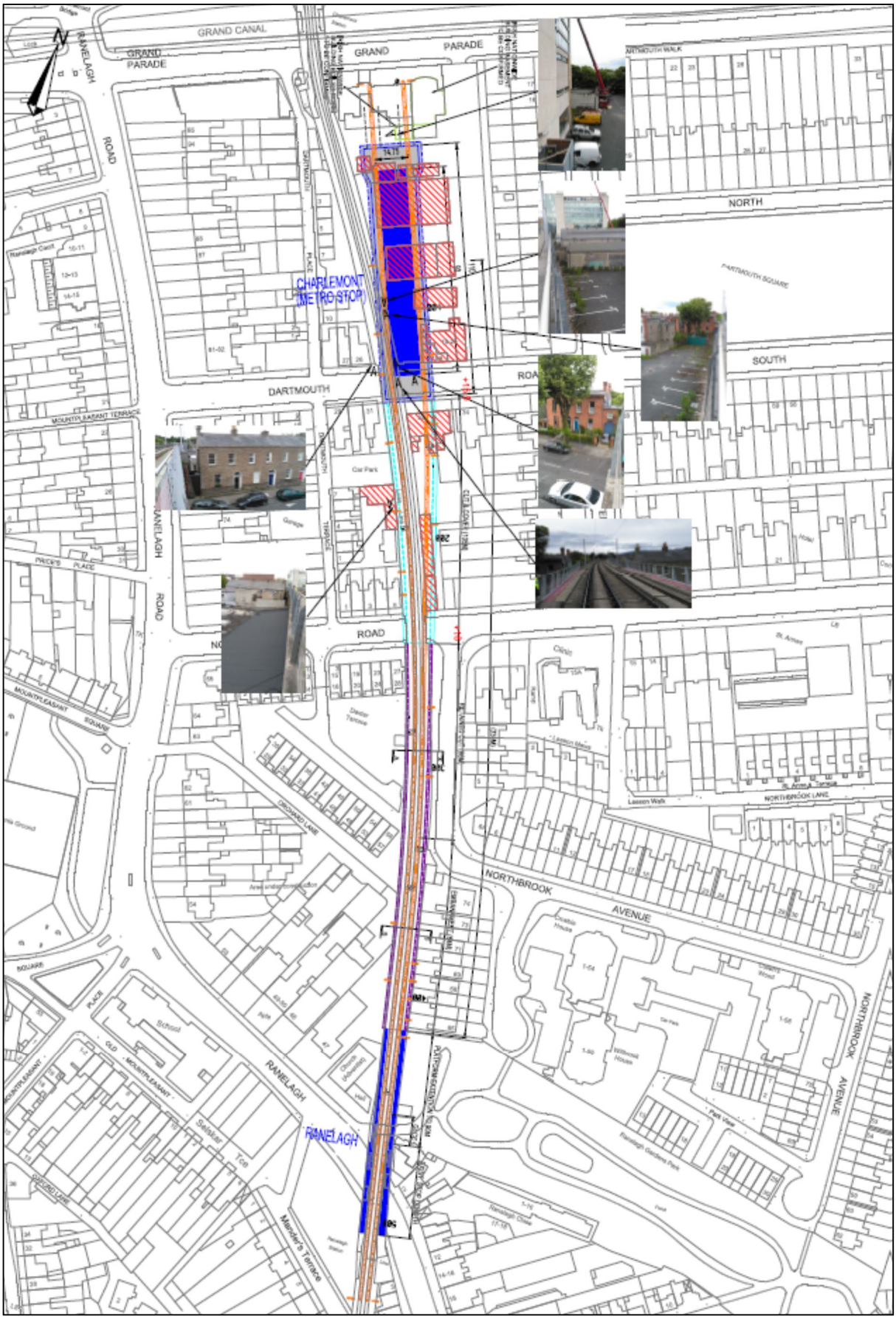


Figure 27: Option 4(B) – Ranelagh In-line

6.3 Option 5(A) – Beechwood North

A developed design for Option 5, called Option 5(A), is illustrated in Figure 28. Consistent with Options 3 and 4, this option has been changed to an in-line tie-in solution. As a result, the tie alignment moves approximately 30m south and 13m east, thus significantly reducing property impacts on Oakley Road.

From the north, NMN tunnels will be bored to a point south of the Charleston Road Luas Bridge, beneath the existing Luas corridor, partly to the rear of houses on Oakley Road. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, immediately north of Dunville Avenue. NMN will run at-grade across Dunville Avenue. A fully segregated Metro will require the closure of Dunville Avenue to traffic.

The final operating configuration will result in the severance of the existing Luas Green Line at Ranelagh with future Metro vehicles operating exclusively south of the tie-in point in order to enable through Metro services from Swords to Bride's Glen. Luas Green Line services will operate between the Ranelagh and Broombridge Stops. Ranelagh Stop will become the terminus for the Luas Green Line with the provision of a turnback facility, south of the stop.

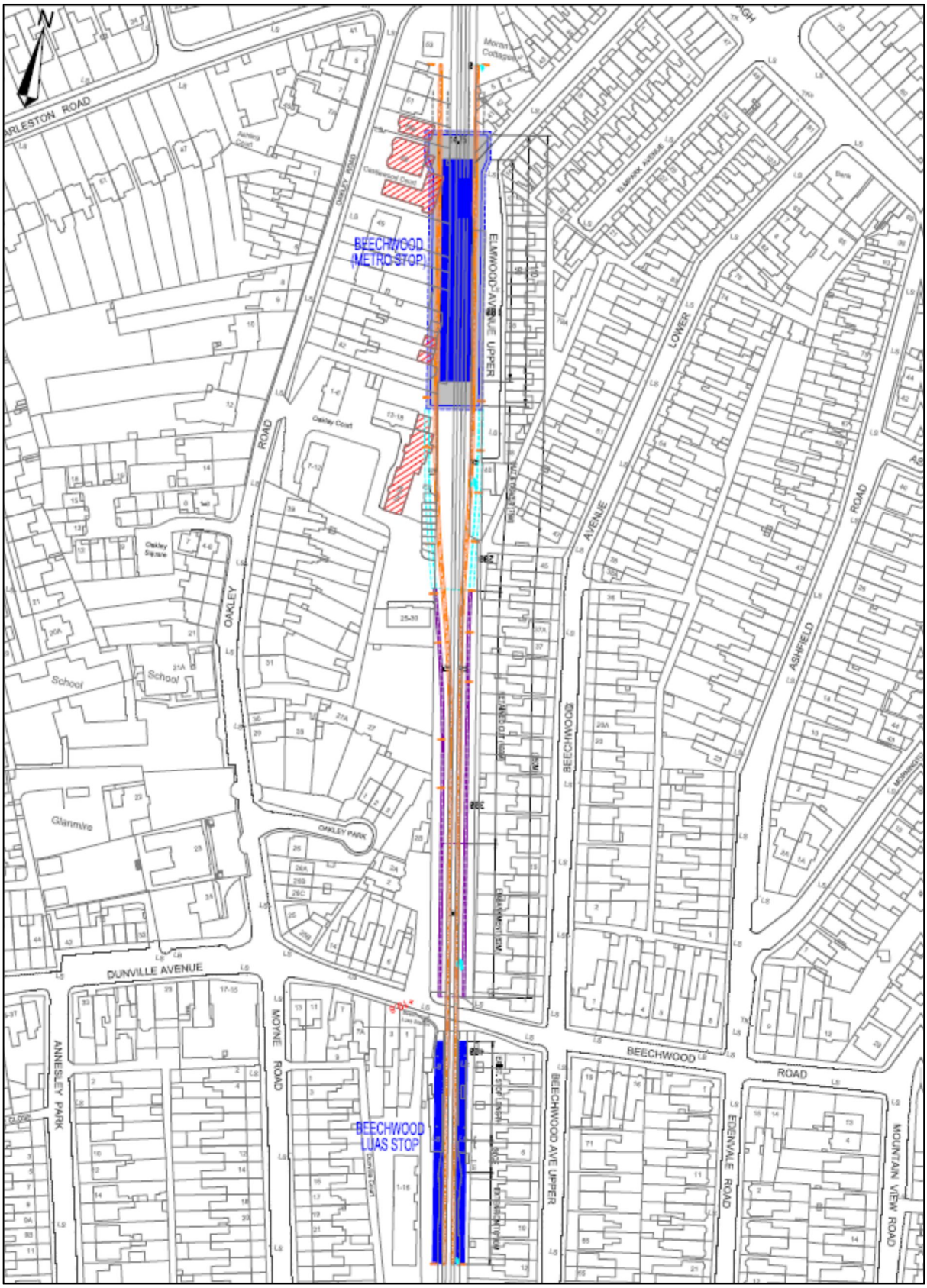


Figure 28: Option 5(A) – Beechwood North In-line

6.4 Option 6(A) – Beechwood South

A developed design for Option 6, called Option 6(A), is illustrated in Figure 29. Consistent with Options 3 and 4, this option has been changed to an in-line tie-in solution. As a result, the alignment moves approximately 30m east, significantly reducing property impacts on Dunville Avenue and Moyne Road. The final operating configuration will result in the severance of the existing Luas Green Line at Ranelagh with future Metro vehicles operating exclusively south of the tie-in point in order to enable through Metro services from Swords to Bride's Glen. Luas Green Line services will operate between the Ranelagh and Broombridge Stops. Ranelagh Stop will become the terminus for the Luas Green Line with the provision of a turnback facility, south of the stop.

Figure 29: Option 6(A) – Beechwood South In-line

7 STAGE 2 – SHORTLISTED OPTIONS DETAILED APPRAISAL

7.1 Methodology

The four shortlisted options described in Section 6 were appraised using MCA in order to identify a preferred tie-in option to the Luas Green Line. The appraisal was carried out based on the criteria identified in the Common Appraisal Framework for Transport Projects and Programmes (DTTAS, 2016).

Common Appraisal Framework recommends that the following topics are considered in a qualitative appraisal of options:

- Economy (including non-quantifiable economic impacts)
- Safety
- Physical Activity
- Environment
- Accessibility and Social Inclusion
- Integration

The criteria of Physical Activity is considered neutral in the context of the Stage 2 appraisal as all options use the same transport mode and will deliver similar health benefits for users. Safety issues are addressed as construction and operational risks under the Economic criteria. As a result, the options will be appraised against the criteria and sub-criteria presented in Table 6.

Table 6: Criteria, sub-criteria, description and metric for Stage 2 appraisal

Criteria	Sub-criteria	Description	Metric
Economy	Capital costs	Minimise capital costs	Quantitative appraisal of potential property and infrastructure costs of proposed options
	Construction risk	Minimise the potential for significant construction risk	Quantitative appraisal of potential construction health and safety risks to people affected by the works
	Traffic and transportation	Minimise impact of delays to road users arising from changes to traffic arrangements and junctions	Qualitative appraisal of potential impacts of delays to road users arising from changes to traffic arrangements and junctions
Environment	Land use character	Comply with existing land use zoning objectives	Qualitative appraisal of potential impacts of proposed options on

Criteria	Sub-criteria	Description	Metric
			receiving environment including Dublin City Council (DCC) zoning objectives (Dublin City Development Plan 2011–2017)
	Noise, vibration and groundborne noise during construction	Minimise impact on the noise, vibration and groundborne noise environment	Qualitative appraisal of potential impact of proposed options on construction noise, vibration and groundborne noise environment through appraisal of sensitive receptors within 100m
	Noise, vibration and groundborne noise during operations	Minimise impact on the noise, vibration and groundborne noise environment	Qualitative appraisal of potential impact of proposed options on operational noise, vibration and groundborne noise environment through appraisal of sensitive receptors within 100m
	Biodiversity (impacts on habitats/species arising from landtake)	Avoid and mitigate adverse effects on biodiversity arising from proposed scheme	Qualitative appraisal of potential effects of proposed option on internationally and nationally important designated sites and associated flora and fauna
	Water resources (surface water and groundwater impacts arising from landtake)	Minimise impacts on water resources arising from implementation of proposed scheme	Qualitative appraisal of potential impacts of proposed option on existing surface water bodies and aquifers
	Landscape and visual	Protect existing landscape and visual amenity	Qualitative appraisal of potential impacts of proposed option on protected views/prospects and protected trees

Criteria	Sub-criteria	Description	Metric
	Archaeological architectural and cultural heritage	Minimise impact on the archaeological, architectural and cultural heritage environment	Qualitative appraisal of potential impacts of proposed options on legally protected sites
	Waste	Minimise the volume of waste generated	Qualitative appraisal of potential quantity of waste generated from proposed options
Accessibility and Social Inclusion	Access from deprived geographical areas e.g. RAPID areas (Revitalising Areas by Planning, Investment and Development)	Facilitate access from RAPID areas at interchange points	Qualitative appraisal of potential options to facilitate access from RAPID areas at interchange points with Luas network
Integration	Integration with Luas Green Line	Maximise potential for interchange with Luas Green Line	Qualitative appraisal of the potential for integration with Luas Green Line
	Integration with the existing and proposed transport network	Comply with the transport proposals set out in the NTA's Transport Strategy and other supporting documents	Qualitative appraisal of potential impacts for integration with proposed transport networks

In respect of the economic sub-criteria, capital costs will, in addition to infrastructure and property acquisition costs, include demolition and track upgrade costs. Operational and maintenance costs have been omitted from the appraisal on the basis that the shortlisted options are closely located geographically and will therefore not differ significantly between options. Furthermore, operational and maintenance costs required for any additional length of system required for the southernmost tie-in options will be offset by savings in operational and maintenance costs from the redundant elements of the Luas Green Line, north of the tie-in. The impacts on Luas Green Line operations, arising from disruption and loss of revenue during the construction of the tie-in options, are omitted as the delays posed are considered neutral in the context of the overall Luas upgrade works to provide for through running to Metro South. The impacts on construction risk, and impacts on traffic and transportation are also appraised under the economic criteria.

In respect of the environment sub-criteria, a review of the topics that are required to be considered under the Environmental Impact Assessment (EIA) Directive 2016/2017 was undertaken and it was considered that the options had the potential to differ in terms of land use, noise, vibration and groundborne noise for construction and operation, biodiversity, water resources, landscape and visual, archaeological and architectural heritage and waste.

However, it was considered that the options would not differ in terms of socio-economic, soil and geology, air and climate including adaptation to climatic factors and human health/population. Potential impacts on radiation, stray current and agronomy are not currently anticipated. These environmental sub-criteria were therefore not considered at this stage of the assessment.

7.1.1 Scoring

For each criteria, the options were compared against how well they deliver on the criteria description using a five point scale, ranging from an overall very good performance to an overall very poor performance. This five-point scale is colour coded as presented in Table 7, with advantageous routes graded to 'green' and disadvantaged routes graded to 'red'.

Table 7: Options appraisal colour coding system

Colour	Description
	Overall very good performance against the criteria
	Overall good performance against the criteria
	Overall moderate performance against the criteria
	Overall poor performance against the criteria
	Overall very poor performance against the criteria

7.2 Appraisal of Options

Each of the four short-listed options were appraised against the criteria using the appraisal system described in Section 7.1. The results are included in the Stage 2 – Overall Appraisal Table in Appendix G. The outcome of the appraisal for each shortlisted option is described in the following sections.

7.2.1 Option 3(A) – Adelaide Court

7.2.1.1 Economic appraisal

Economically, this option has a relatively high capital cost (€344m), largely associated with the need to acquire and demolish two large high specification modern office blocks, located at 3 Park Place and St James House at 72 Adelaide Road as well as two houses at 7 and 8 Adelaide Road, a commercial unit to the rear of 7 Adelaide Road and a house at 1 Peter's Place. The total capital costs for Stage 1 – Option 3 and the developed Stage 2 – Option 3(A) increased by €101m, from €244m to €345m. The increase in capital costs arises from the provision of a new Metro Station at Adelaide Court and additional property acquisitions, costs arising from property demolitions and track widening. The option is considered to have very high construction risk, arising from large-scale demolition, excavation and construction in a congested built-up area/city centre environment which will require high levels of mitigation. In terms of traffic and transportation, this tie-in option also performs poorly. The retained cut section will potentially sever Albert Place West from Peter's Place for both vehicles and pedestrians, resulting in a negative localised impact. As a result, this option is considered to deliver a **very poor performance** against the economic criteria.

7.2.1.2 Environmental appraisal

Noise, vibration and groundborne noise are appraised separately for construction and operational stages. A range of sensitive receptors, comprising residential properties, three childcare/pre-primary education facilities, two hotels, a theatre and a church, are located within 100m of the construction works for this tie-in option. The primary construction activities associated with this tie-in option include significant demolition of property, the construction of the TBM receiving shaft and the operation of the TBM, the construction of the stop box/cut and cover/retained cut sections, the dismantling and rebuilding of approximately 50m of the Luas Green Line in Adelaide Road and the dismantling of the Charlemont Luas Stop.

During the operational phase, noise, vibration and groundborne noise associated with NMN can be mitigated at source through the design and construction of the railway track and subsequent maintenance of the railway. Operational impacts will therefore be confined to impacts on residential properties on Adelaide Road and Peter's Place due to Metro operations within the retained cut. There may also be a slight negative indirect impact on sensitive receptors associated with Harcourt Stop becoming the terminus for the Luas Green Line and a turnback facility located on Adelaide Road.

There will be no direct impacts on habitats protected under the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended). The nearest Natura site is South Dublin Bay and River Tolka Estuary Special Protection Area (SPA) which is located approximately 3km from the proposed tie-in options. With regard to water resources, there will be no direct impacts on any surface water bodies, arising from the construction or operation of this option but there will be temporary construction impacts on the underlying poorly productive bedrock aquifer.

There will be changes to the landscape and visual character, arising from the retained cut and ramp elements of this tie-in option, particularly in the residential estate of Peter's Place. The option will also require the demolition of properties, previously described under the economic criteria. There will be no impact on DCC's Key Views, parks or Tree Preservation Orders.

The excavation of *c.*500m of twin-bore tunnel, *c.*140km of cut and cover tunnel and *c.*109m of retained cut will generate a considerable volume of waste which will have a direct impact on traffic movements and an indirect impact on noise and air quality during the construction stage. For archaeological, architectural and cultural heritage, the appraisal confirms that there are no impacts on known archaeological and/or cultural heritage sites; however, the tie-in option will impact on the Georgian three-storey over basement houses at 7 and 8 Adelaide Road which are Protected Structures. Additionally, this option will require the removal of *c.*115m of retained walls and embankment from the historical railway (Harcourt Street Railway Line) from Adelaide Road to the rear of the Hilton Hotel on Charlemont Place. As a result, this option is considered to deliver a **poor performance** against the environmental objective, particularly in relation to landscape and visual and archaeological, architectural and cultural heritage issues.

7.2.1.3 Accessibility and social inclusion appraisal

Under the accessibility and social inclusion criteria, access from deprived geographical areas, e.g. RAPID areas, is appraised. For this tie-in option, the Harcourt Luas Stop and the Harcourt Metro Stop will provide good accessibility between the north of the city and the RAPID area around Peter's Place, while the new Metro stop will provide good accessibility to the south. As a result, this option is considered to deliver a **very good performance** against the accessibility and social inclusion criteria.

7.2.1.4 Integration appraisal

From an integration viewpoint, the appraisal considered how well the tie-in option provided interchange with the Luas Green Line and the public transport network. For this tie-in option, the potential for direct interchange at St Stephen's Green and O'Connell Street and indirect interchange from the Harcourt Stop was identified. In terms of integration with the existing and proposed transport network, this tie-in option does not provide a direct interchange between the Harcourt Luas

Stop and the Harcourt Metro Stop but the walking distance is only *c*.0.25km. This option therefore delivers an overall **very good performance** against the integration criteria.

7.2.1.5 Appraisal summary

Taking into account the overall performance of this option against economic, environmental, accessibility and social inclusion, and integration criteria, this option was considered to deliver a **good performance**.

7.2.2 Option 4(B) – Ranelagh In-line

7.2.2.1 Economic appraisal

This option has the lowest capital cost (€178m) of the four options being appraised during Stage 2. Costs arise from the length of tunnelling required and the need to acquire and demolish properties at 32 and 33 Dartmouth Road, four derelict single to two storey warehouse buildings and substrata at the Grand Parade site to the rear of the Carroll's Building and two single storey office buildings at 14A Dartmouth Terrace and 16A Northbrook Road. In terms of the economic appraisal of construction risk, the works required for this tie-in option include the high risk construction activities of shallow tunnelling under the Carroll's Building which is a Protected Structure, the construction of the stop box and the short cut and cover sections across Dartmouth Road and Northbrook Avenue. The longer tunnel would only minimally increase the risk; however, the majority of the works are within the current Luas alignment with reduced interface with pedestrians and traffic. The economic appraisal of traffic and transportation identified no major impacts upon the road and bus networks. As a result, this tie-in option was considered to deliver a **good** performance against the economic criteria.

7.2.2.2 Environmental appraisal

Noise, vibration and groundborne noise are appraised separately for construction and operational stages. A range of sensitive receptors, comprising residential properties, three childcare/pre-primary education facilities, a hotel, a church and one primary school are located within 100m of the construction works for this tie-in option. The primary construction activities associated with this tie-in option include some demolition of property, the operation of the TBM, the construction of the stop box and retained cut sections, the dismantling and rebuilding of approximately 70m of the Luas Green Line, south of Charlemont Stop, the demolition and rebuilding of an element of the embankment and the extension of the Ranelagh Luas Stop and new deck structure.

During the operational phase, noise, vibration and groundborne noise associated with NMN can be mitigated at source through the design and construction of the railway track and subsequent maintenance of the railway. Operational impacts will therefore be confined to impacts on residential properties on Dartmouth Road, Dartmouth Terrace, Cambridge Terrace and Northbrook Road due to Metro operations within the retained cut. There may also be a slight negative indirect impact on sensitive receptors associated with Charlemont Stop becoming the terminus for the Luas Green Line and a turnback facility, south of the stop.

There will be no direct impacts on habitats protected under the European Communities (Birds and Habitats) Regulations 2011 (as amended). The nearest Natura site is South Dublin Bay and the River Tolka Estuary SPA which is located approximately 3km from the proposed tie-in option. There will also be no direct impacts on any surface water bodies arising from this tie-in option but there will be temporary construction impacts on the underlying poorly productive bedrock aquifer. There will be changes to the landscape and visual character, particularly in proximity to properties on Dartmouth Road, Dartmouth Terrace and Cambridge Terrace as a result of limited property take and the visibility of this tie-in option. There will be no impact on DCC's Key Views, parks or Tree Preservation Orders.

The excavation of *c*.940m of twin-bore tunnel (a comparative distance from an assumed St Stephen's Green Metro Stop, *c*.218km of cut and cover tunnel, *c*.86m of retained cut and *c*.86m of retained embankment) will generate a considerable volume of waste which will have a direct impact on traffic movements and have an indirect impact on noise and air quality during the construction stage. For

archaeological, architectural and cultural heritage, the appraisal has indicated that there are no impacts on known archaeological and/or cultural heritage sites. However, the tie-in option will impact on a Georgian two-storey house at 32 Dartmouth Road (DCC RPS 2144) which is a Protected Structure. Additionally, this option will require the removal of *c*.335m of retained walls and embankments from the historical Harcourt Street Railway Line, from south of Dartmouth Road to the Ranelagh Luas Stop. There will also be an indirect visual impact on the Dartmouth Square Architectural Conservation Area (ACA).

Overall, this option was considered to deliver a **moderate performance** against the environmental criteria with the most negative impacts arising from construction noise, vibration and groundborne noise and archaeological, architectural and cultural heritage.

7.2.2.3 Accessibility and social inclusion appraisal

Under the accessibility and social inclusion criteria, access from deprived geographical areas, e.g. RAPID areas, is appraised. For this tie-in option, accessibility to and from the north of the city is maintained via the Luas corridor and potentially enhanced by the new St Stephen's Green Metro Stop (albeit a 1km walk from the area). Accessibility to and from the south of the city is marginally worse than existing arrangements, as users will likely get on and off at Charlemont which is outside the RAPID area (0.5km walk), despite the fact that the Luas Green Line currently operates between Harcourt and Charlemont. As a result, this tie-in option was considered to deliver a **moderate performance** against the accessibility and social inclusion appraisal.

7.2.2.4 Integration appraisal

From an integration viewpoint, the appraisal considered how well the tie-in option provided interchange with the Luas Green Line and the public transport network. For this option, the potential for direct interchange at St Stephen's Green and O'Connell Street and direct interchange from Charlemont was identified. In terms of integration with the existing and proposed transport network, this tie-in option provides a direct interchange between the Charlemont Stop and the new Metro Stop with a walking distance *c*.100m. This option therefore delivers a **very good performance** against the integration criteria.

7.2.2.5 Appraisal summary

Taking into account the overall performance of this option against the economic, environmental, accessibility and social inclusion, and integration criteria, this option was considered to deliver a **very good** performance.

7.2.3 Option 5(A) – Beechwood North

7.2.3.1 Economic appraisal

This option has the second lowest capital cost (€223m) of the four options being appraised. These costs arise from the 1.64km of tunnelling required and the need to acquire and demolish a number of properties on Oakley Road, comprising a small apartment block at Castlewood Court (eight apartments), a residential house at Castlewood House at 50 Oakley Road, and a residential property at 50A Oakley Road. Additionally, this option will require some permanent acquisition of small sections of the rear gardens at 43–45 Oakley Road and a three-storey apartment block at 39–24 Oakley Road.

Construction risk was appraised as part of the economic appraisal and the appraisal confirmed that for this option there will be a risk associated with the longer tunnelling required than for Options 3(A) and 4(B) as well as the required construction of the stop box at Elmwood Avenue Upper, the retained cut and the retained embankment where the tunnel rises from the stop box to tie-in with the existing Luas Green Line track, north of Beechwood Avenue. However, the majority of the works are within the current Luas alignment with no substantial large buildings adjacent to the works and there is a reduced interface with pedestrians and traffic.

The economic appraisal of traffic and transportation identified no major impacts upon the road and bus networks. As a result, this tie-in option was considered to deliver a **good performance** against the economic criteria.

7.2.3.2 Environmental appraisal

The construction appraisal of noise, vibration and groundborne noise identified the potential for impacts on residential properties within 100m of Option 5(A) during the TBM operation, stop box construction, cut and cover, retained cut and embankment construction, and demolition of Castlewood Court and Castlewood House at 50 and the apartments at 50A Oakley Road and 19–24 Oakley Court and all associated reinstatement works. There will be temporary construction impacts on noise sensitive receptors, associated with the dismantling and rebuilding of approximately 50m of the Luas Green Line, south of Ranelagh Stop.

It is assumed that operational noise, vibration and groundborne noise, associated with this option, can be mitigated at source through the design and construction of the railway track and subsequent maintenance of the railway. Therefore, it is not identified as a constraint as the project will mitigate the impacts through design. There may be a slight negative indirect impact on sensitive receptors associated with Ranelagh Stop becoming the terminus for the Luas Green Line and the provision of a turnback facility, south of the stop. There will be an impact on residential properties, adjoining the existing Luas Green Line, where Option 5(A) is rising in a retained cut along Beechwood Avenue.

There will be no direct impacts on habitats protected under the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended). The nearest Natura site is South Dublin Bay and River Tolka Estuary SPA which is located approximately 3km from the proposed tie-in options. With regard to water resources, there will be no direct impacts on any surface water bodies, arising from this tie-in option but there will be temporary construction impacts on the underlying poorly productive bedrock aquifer.

There will be a change to the character of the local landscape, particularly to residential properties on Oakley Road and Elmwood Avenue Upper as a result of the visibility of this tie-in option and the demolition of two properties at 50 Oakley Road and an apartment at 50A Oakley Road and the 19–24 Oakley Court apartments. There will be no impacts on DCC's Key Views, parks or Tree Preservation Orders.

Waste generation associated with this tie-in option will arise from the excavation of *c*.1,640m of twin bore, *c*.185m cut and cover tunnel, *c*.103m of retained cut and *c*.52m of retained embankment. During the construction stage, this will have a direct effect on traffic movements and an indirect effect on noise and air quality, associated with traffic movements for collecting and transporting the waste.

As with all options being appraised, this tie-in option does not impact on any known archaeological and/or cultural heritage sites. However, in terms of architectural heritage, this option will directly impact on a two-storey three bay brick dwelling at 50 Oakley Road (DCC RPS 5989), requiring its demolition. This option will also require the demolition of rear sheds and the partial removal of boundary walls associated with the curtilage of 43–45 (DCC RPS 5982–5984). The option will also require the removal of approximately 350m of the stone retaining walls and embankments of the Harcourt Street Railway Line in the section between Elmwood Avenue Upper to Beechwood Luas Stop. Option 5(A) will also have a negative visual impact on one ACA (Elmwood Avenue Upper and Lower).

Overall, this option was therefore considered to deliver a **poor performance** against the environmental criteria, particularly in relation to waste and archaeological, architectural and cultural heritage sub-criteria.

7.2.3.3 Accessibility and social inclusion appraisal

Under the accessibility and social inclusion criteria, access from deprived geographical areas, e.g. RAPID areas, is appraised. Accessibility to/from the north of the city is maintained via the Luas corridor and potentially enhanced by the new St Stephen's Green Metro Stop (albeit a 1km walk). Accessibility

to and from the south of the city is poor as travelling to/from areas further south of Ranelagh will involve an interchange and walk to the Luas or Metro services, dependent on direction of travel. This option introduces an element of severance for the RAPID area, but the time savings on the Metro services may alleviate some of the negative impacts of the walk and interchange. In light of the interchange and associated walk, this option delivers a **poor performance** with respect to access to the RAPID area.

7.2.3.4 Integration appraisal

From an integration viewpoint, the appraisal considered how well the tie-in option provided interchange with the Luas Green Line and the public transport network. For Option 5(A), the potential for direct interchange at St Stephen's Green, O'Connell Street and indirect interchange from Ranelagh/Beechwood was identified. In terms of integration with the existing and proposed transport network, Option 5(A) provides poor interchange with Harcourt and Charlemont Luas Stops, as Metro will travel in tunnel directly to the city centre terminus (1–1.5km). It will also have a poor interchange with Ranelagh Luas Stop, with Metro customers required to disembark at the proposed Metro stop and walk 120m to Ranelagh Luas Stop. This option therefore delivers a **poor performance** against the integration criteria.

7.2.3.5 Appraisal summary

Taking into account the overall performance of this option against the economic, environmental, accessibility and social inclusion, and integration criteria, this option was considered to deliver an **overall poor** performance.

7.2.4 Option 6(A) – Beechwood South

7.2.4.1 Economic appraisal

Option 6(A) ties in further south than Options 3(A), 4(B) and 5(A) and has therefore increased costs, arising from approximately 2km of tunnelling (a comparative distance from an assumed St Stephen's Green Metro Stop). However, the capital costs for Option 6 are slightly less than for Option 5 at €252m and this is accounted for by the reduced requirement for property acquisition. There are some property costs associated with the requirement to acquire a detached bungalow to the rear of the gated Dunville Apartment complex. This tie-in option will also require the part acquisition of rear sheds and garden to the rear of 111 Moyne Road, and the part acquisition of six rear gardens at 2–7 Moyne Court and the part temporary acquisition of rear gardens at 1–38 Beechwood Avenue.

The economic appraisal of construction risk, identified an increased risk from the longer tunnelling required, the construction of the Beechwood North stop box and the retained cut and the retained embankment where this option ties in with the existing Luas Green Line, north of the existing Cowper Luas Stop. However, the majority of the works are within the current Luas alignment with no substantial large buildings adjacent to the works and therefore it has a reduced interface with pedestrians and traffic.

The economic appraisal of traffic and transportation, identified no major impacts upon the road and bus networks. However, the retained cut section may sever the existing pedestrian crossing of the Luas lines at Albany Road.

As a result, this tie-in option was considered to deliver a **moderate performance** against the economic criteria.

7.2.4.2 Environmental appraisal

The construction appraisal of noise, vibration and groundborne noise, identified the potential for impacts from Option 6(A) on a significant number of residential receptors and a church within 100m of this tie-in option. There will be short-term noise, vibration and groundborne noise impacts on these receptors during the TBM operation, stop box construction, cut and cover, retained cut and

embankment construction, and property take (Beechwood kiosk, temporary take of rear gardens on Moyne Road and Beechwood Avenue Upper, and a house and garage at Dunville apartments) and all associated reinstatement works.

There will also be temporary construction impacts on noise sensitive receptors, associated with the dismantling and rebuilding of *c*.440m double track and reconstruction of *c*.60m double embedded track and *c*.120m double slab track of the Luas Green Line, south of Ranelagh Stop. The demolition of the existing Luas Beechwood Stop and the construction of the new Metro Stop at this location will also generate potential impacts.

As is the case with the other options, it is assumed that operational noise, vibration and groundborne noise, associated with this option, can be mitigated at source through the design and construction of the railway track and subsequent maintenance of the railway. Therefore, it is not a constraint as the project will mitigate the impacts through design. There will be an impact on residential properties adjoining the existing Luas Green Line cutting, particularly along the Beechwood Avenue Upper section. There may be a slight negative indirect impact on sensitive receptors, associated with Ranelagh Stop becoming the terminus for the Luas Green Line and a turnback facility, south of the stop.

Option 6(A) will have no direct impacts on habitats protected under the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended). The nearest Natura site is South Dublin Bay and River Tolka Estuary SPA which is located approximately 3km from the proposed tie-in option. With regard to water resources, there will be no direct impacts on any surface water bodies but there will be temporary construction impacts on the underlying, poorly productive, bedrock aquifer.

There will be a change to the character of the local landscape, particularly for residential properties at Dunville Court and Beechwood Avenue Upper as a result of the visibility of the cut and cover section of this tie-in option. There will be no impacts on DCC's Key Views, parks or Tree Preservation Orders.

Waste generation associated with this tie-in option will arise from the excavation of *c*.2,000m of twin bore, *c*.275m cut and cover tunnel and *c*.153m of retained cut. During the construction stage, this will have a direct effect on traffic movements and an indirect effect on noise and air quality, associated with traffic movement, collecting and transporting the waste.

As with all options being appraised, this tie-in option does not impact on any known archaeological and/or cultural heritage sites. In terms of architectural heritage, Option 6(A) will not require the demolition of Protected Structures. However, it will require the demolition of some curtilage elements of 111 Moyne Road (DCC RPS 5788) including rear sheds and the partial removal of its boundary wall. This option will also require the removal of approximately 362m of the stone retaining walls and embankments of the Harcourt Street Railway Line from Beechwood to Cowper Luas Stops.

Overall, this option was therefore considered to deliver a **good performance** against the environmental criteria with poor performance identified on the waste sub-criteria.

7.2.4.3 Accessibility and social inclusion appraisal

Under the accessibility and social inclusion criteria, access from deprived geographical areas, e.g. RAPID, areas is appraised. Accessibility to and from the north of the city is maintained via the Luas corridor and potentially enhanced by the St Stephen's Green Metro Stop (albeit a 1km walk). However, accessibility to and from the south of the city is poor as travelling to and from areas further south of Ranelagh will involve an interchange and walk to the Luas or Metro services, dependent on direction of travel. This option introduces an element of severance for the RAPID area, but there may be time savings on the Metro services which may alleviate the impacts of the walk and interchange. In light of the interchange and associated walk, this option delivers a **poor performance** with respect to access to the RAPID area.

7.2.4.4 Integration appraisal

From an integration viewpoint, the appraisal considered how well the tie-in option provided interchange with the Luas Green Line and the public transport network. For Option 6(A), the potential for indirect interchange at St Stephen's Green, O'Connell Street and Ranelagh was identified but because this will require a significant walk, this was considered to be poor performance. Furthermore, trips to and from Harcourt Stop and Charlemont Stop, to and from south of Ranelagh Stop, will now incorporate a significant walk and interchange. This option therefore delivers a **poor performance** against the integration criteria.

7.2.4.5 Appraisal summary

Taking into account the overall performance of this option against the economic, environmental, accessibility and social inclusion, and integration criteria, this option was considered to deliver a poor performance.

7.3 Conclusion and Recommendation

An Appraisal Summary Table has been prepared which collates and summarises the appraisal of every option, under each of the assessment criteria.

The Overall Appraisal Summary Table for each option is presented in Appendix G.

Table 8: Summary of results of Stage 2 option appraisal

Green Line Tie-in Option	Option 3(A)	Option 4(B)	Option 5(A)	Option 6(A)
Location	Adelaide Court	Ranelagh	Beechwood North	Beechwood South
Economy				
Environment				
Accessibility and Social Inclusion				
Integration				
Overall				

In conclusion, Option 4(B) is identified as the preferred option. This option has the lowest capital cost (€178m) of the four options appraised during Stage 2. In terms of the economic appraisal of construction risk, high risk construction activities, e.g. shallow tunnelling under the Carroll's Building, were identified but the majority of the works are within the current Luas alignment with reduced interface with pedestrians and traffic. The economic appraisal of traffic and transportation, identified no major impacts upon the road and bus networks.

In terms of the environment, the negative impacts were associated with noise, vibration and groundborne noise, particularly on sensitive receptors in the Dartmouth and Northbrook areas during construction. For archaeological and architectural heritage, there is a negative impact on 32 and 33 Dartmouth Road (DCC RPS 2144 and 2145) and on elements of the Harcourt Street Railway Line. However, the overall environmental performance was considered to be moderate.

Under the accessibility and social inclusion criteria, access from the RAPID area around Peter's Place, to and from the north of the city, is maintained via the Luas corridor and potentially enhanced by the new St Stephen's Green Metro Stop (albeit a 1km walk from the area).

From an integration viewpoint, the potential for direct interchange at St Stephen's Green and O'Connell Street and indirect interchange at Charlemont was identified.

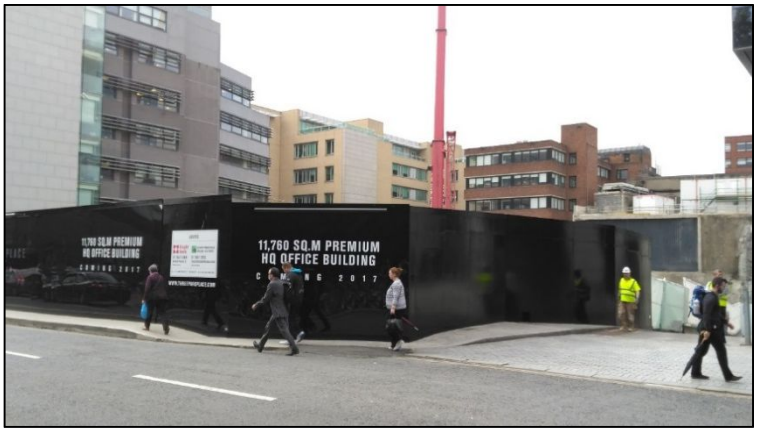
Taking into account the overall performance of this option against the economic, environmental, accessibility and social inclusion, and integration criteria, this option was considered to deliver a very good performance against the other tie-in options and as such is identified as the preferred tie-in option.

8 APPENDIX A: DETAILED OPTIONS DESCRIPTION

8.1 Option 3 – Adelaide Court

Option	**3**	
Location	Adelaide Court	
Tie-in	In-line ✓ At-grade ✗ Grade separated ✗	
Description	From the north, NMN tunnels would be bored to the southern side of Hatch Street. The tracks will then rise in a cut and cover section through Adelaide Court and under Adelaide Road and continue to rise in a retained cut to join the Luas Green Line tracks at the bottom of Charlemont ramp.	
Infrastructure (south of NMN terminus)	Bored tunnel	0.5km
	Cut and cover tunnel	0.1km
	Retained cutting	0.1km
	At-grade track	0km
	Elevated/viaduct	0km
	Intermediate escape shafts	0
	Additional Metro stations	0
Operating service patterns	Metro	Swords to Bride's Glen Poor alignment between tie-in and Charlemont
	Luas Green Line	Broombridge to Harcourt (new crossover required)
	Operating link	No
	Engineering link	No
	Interchange	Charlemont Metro to Harcourt Street Luas Potential for better interchange further north
Construction	The Luas Green Line would be severed between Charlemont and Harcourt during construction, with services from the north terminating at Harcourt and the services from the south terminating at Charlemont. Adelaide Road part closed for construction of cut and cover tunnel.	
Property acquisition	3 Park Place (under construction) St James House 7 Adelaide Road (derelict) 1 Peter's Place (for new road access)	
Traffic	Access to Peter's Place severed (requires additional property acquisition to reinstate access). Metro would run at-grade across Dunville Avenue.	
Archaeological and heritage constraints	None	
Variants	An option to emerge from tunnel in Iveagh Gardens and rise up to be elevated over Hatch Street was considered but is not feasible as there is insufficient space within Iveagh Gardens to get from the tunnel portal to an elevated structure over Hatch Street.	

Photographs



3 Park Place (under construction in 2016)

7 Adelaide Road

St James House, Adelaide Road

Peter's Place

8.2 Option 3(A) – Adelaide Court Stop

Option	3(A)	
Location	Adelaide Court	
Tie-in	In-line ✓ At-grade ✗ Grade separated ✗	
Description	From the north, NMN tunnels would be bored to the northern side of Hatch Street. A NMN stop, combined with the TBM receiving shaft, will be provided at the site of 3 Park Place (currently under construction) and St James House, Adelaide Road. After passing under Adelaide Road, the track rises in retained cut on the line of the existing Luas alignment, tying in to the existing Luas Green Line ramp, immediately north of Charlemont Stop.	
Infrastructure (south of NMN terminus)	Bored tunnel	500m
	Cut and cover tunnel	140mm (of which 110m for the stop box)
	Retained cutting	109m
	At-grade track	64m
	Elevated/viaduct	0km
	Intermediate escape shafts	0
	Additional Metro stations	1 (Adelaide Court)
Upgrade works on existing Luas Green Line infrastructure	For Luas operation	Dismantling and reconstruction of approx. 50m embedded double track in Adelaide Road with installation of scissor crossover and buffer stops for Luas turnback.
	For Metro operation	Track inter-axis widening between tie-in point (80m north of Charlemont Stop) and Ranelagh Stop (excluded). Total approx. 510m.
		Decommissioning of Charlemont Luas stop and platforms dismantling.
Operating service patterns	Metro	Swords to Bride's Glen Poor alignment between tie-in and Charlemont
	Luas Green Line	Broombridge to Harcourt
	Operating link	No
	Engineering link	No
	Interchange	Adelaide Court Metro Stop to Harcourt Luas Stop (approx. 150m walking distance)
Construction	The Luas Green Line would be severed between Charlemont and Harcourt during construction, with services from the north terminating at Harcourt during scissor crossover installation (approx. 2 months) and at Harcourt thereafter. Luas services from the south terminating at Ranelagh during full tie-in construction duration. Adelaide Road part closed for construction of cut and cover tunnel.	
Property acquisition	3 Park Place (under construction) St James House 7 Adelaide Road (derelict) 8 Adelaide Road Garage to rear of 7–10 Adelaide Road, i.e. Tayto building	
Traffic	Access to Peter's Place severed (requires additional property acquisition to reinstate access).	
Archaeological and heritage constraints	7 and 8 Adelaide Road are Protected Structures (RPS 23 and 24)	

Photographs

7 and 8 Adelaide Road

Garage to rear of 7 Adelaide Road

8.3 Option 4(A) – Ranelagh At-grade

Option	4(A)	
Location	Ranelagh at-grade	
Tie-in	In-line ✗ At-grade ✓ Grade separated ✗	
Description	From the north, NMN tunnels would be bored to the vacant lot to the rear of the Carroll's Building on Grand Parade, where a new Metro stop would be located. The tracks will then rise in a cut and cover section, passing under Dartmouth Road. South of Dartmouth Road, the tracks rise in a retained cut behind the houses on Cambridge Terrace, across Northbrook Road, and then continue on a ramp structure to join the Luas Green Line tracks to the north of the existing Ranelagh Stop.	
Infrastructure (south of NMN terminus)	Bored tunnel	0.9km
	Cut and cover tunnel	0.12km
	Retained cutting	0.14km
	At-grade track	0km
	Elevated/viaduct	0.18km
	Intermediate escape shafts	0
	Additional Metro stations	1 (Charlemont)
Operating service patterns	Metro	Swords to Bride's Glen
	Luas Green Line	Broombridge to Charlemont (new crossover required)
	Operating link	No
	Engineering link	Yes
	Interchange	Charlemont Metro to Charlemont Luas
Construction	The Luas Green Line would be severed between Charlemont and Ranelagh Stops during tie-in works with all services from the north terminating at Harcourt and services from the south terminating at Beechwood. Dartmouth Road would be part closed for construction of cut and cover tunnel. Northbrook Avenue would be realigned.	
Traffic	Northbrook Road would be permanently severed. Metro would run at-grade across Dunville Avenue.	
Property acquisition	Substrata of lot to rear of Carroll's Building 19–25 Dartmouth Road (derelict offices) 32 and 33 Dartmouth Road The Arch at 16A Northbrook Road and adjacent new development 65–74 Northbrook Avenue Front gardens of 1–6A Northbrook Avenue	
Archaeological and heritage constraints	Carroll's Building (RPS 3280) 32 and 33 Dartmouth Road, Protected Structures (RPS 2144 and 2145)	
Variants	Refer to option 4(B)	

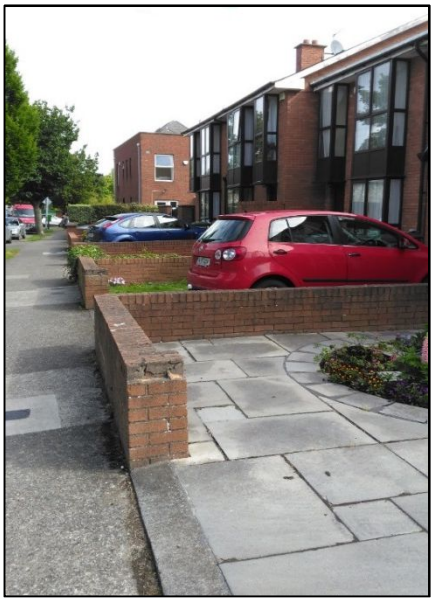
Photographs

Northbrook Road

32 and 33 Dartmouth Road

The Arch 16A Northbrook Road

65–74 Northbrook Avenue



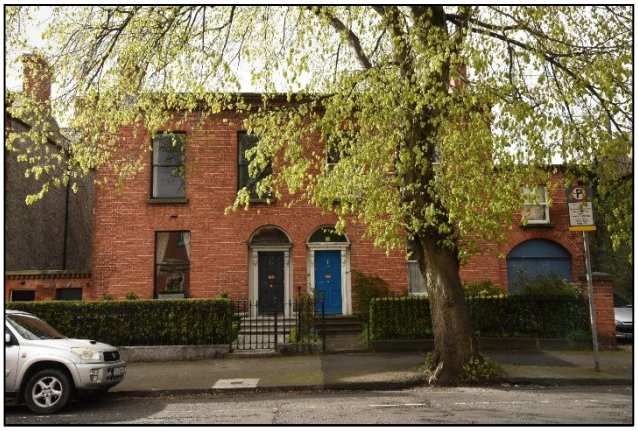
Gardens at 1–6A Northbrook Avenue

8.4 Option 4(B) – Ranelagh In-line

Option	4(B)	
Location	Ranelagh In-line	
Tie-in	In-line ✓ At-grade ✗ Grade separated ✗	
Description	From the north, NMN tunnels will be bored under the Carroll's Building on Grand Parade which is a Protected Structure (RPS 3280), to the vacant lot to the rear of the building where a new Metro stop will be located. The tracks will then rise in a cut and cover section, passing under Dartmouth Road and Northbrook Road and then continue to rise in a retained cut and on a viaduct, all constructed within the original Luas Green Line alignment, to join the Luas Green Line tracks at the north end of Ranelagh Stop.	
Infrastructure (south of NMN terminus)	Bored tunnel	0.9km
	Cut and cover tunnel	0.2km
	Retained cutting	0.1km
	At-grade track	0km
	Elevated/viaduct	0.1km
	Intermediate escape shafts	0
	Additional Metro stations	1 (Charlemont)
Operating service patterns	Metro	Swords to Bride's Glen
	Luas Green Line	Broombridge to Charlemont (new crossover required)
	Operating link	No
	Engineering link	No
	Interchange	Charlemont Metro to Charlemont Luas
Construction	This option requires the prior demolition of the existing Luas retained embankment for approximately 400m between Ranelagh and Charlemont Stops with all services from the north terminating at St Stephen's Green and services from the south terminating at Beechwood. Dartmouth Road and Northbrook Road will be part-closed for construction of cut and cover tunnel.	
Traffic	Metro would run at-grade across Dunville Avenue	
Property acquisition	Substrata of lot to rear of Carroll's Building 19–25 Dartmouth Road (derelict offices) 32 and 33 Dartmouth Road 14A Dartmouth Terrace 16A Northbrook Road	
Archaeological and heritage constraints	Carroll's Building (RPS 3280) 32 and 33 Dartmouth Road, Protected Structures (RPS 2144 and 2145)	

Variants	In conjunction with this option, the Luas Green Line could be extended from Harcourt Stop to Ranelagh along Ranelagh Road. This would mitigate the severance of the line during construction and would eliminate the need for a Metro station at Charlemont.

Photographs



32 and 33 Dartmouth Road

14A Dartmouth Terrace

8.5 Option 5 – Beechwood North

Option	5	
Location	Beechwood North	
Tie-in	In-line ✗ At-grade ✓ Grade separated ✗	
Description	From the north, New Metro tunnels would be bored to a point to the west of the existing Luas tracks at the rear of houses on Oakley Road. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, immediately north of Dunville Avenue.	
Infrastructure (south of NMN terminus)	Bored tunnel	1.5km
	Cut and cover tunnel	0.12km
	Retained cutting	0.2km
	At-grade track	0.05km
	Elevated/viaduct	0km
	Intermediate escape shafts	1
	Additional Metro stations	1 (Ranelagh)
Operating service patterns	Metro	Swords to Bride's Glen
	Luas Green Line	Broombridge to Ranelagh (new crossover required)
	Operating link	No
	Engineering link	Yes
	Interchange	Ranelagh Metro (Oakley Road) to Ranelagh Luas
Construction	The Luas Green Line would be severed between St Stephen's Green and Beechwood during track tie-in and during some phases of the construction, adjacent to the existing Luas embankment.	
Traffic	Metro would run at-grade across Dunville Avenue.	
Property acquisition	46–53 Oakley Road (10 houses) 13–36 Oakley Court (24 apartments) 2B Brendan Vale	
Archaeological and heritage constraints	46–49 Oakley Road Protected Structures (RPS 5985–5989) Castlewood Court 50 Oakley Road (Protected Structure (RPS 5989))	
Variants	None identified	

Photographs

51 and 52 Oakley Road

50A Oakley Road

Castlewood Court 50 Oakley Road

36 Oakley Court (one of 4 blocks of 6 apartments required)

49 Oakley Road

8.6 Option 5(A) – Beechwood North, In-line

Option	5(A)	
Location	Beechwood North	
Tie-in	In-line ✓ At-grade ✗ Grade separated ✗	
Description	From the north, NMN tunnels will be bored to a point south of Charleston Road Luas Bridge, at the "elbow" of Elmwood Avenue Upper, centred beneath the existing Luas corridor, partly at the rear of houses on Oakley Road. The Metro stop construction would be in cut and cover. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, immediately north of Dunville Avenue.	
Infrastructure (south of NMN terminus)	Bored tunnel	1,640m
	Cut and cover tunnel	185m
	Retained cutting	103m
	At-grade track	10m
	Elevated/viaduct	52m
	Intermediate escape shafts	1
	Additional Metro stations	1 (Beechwood)
Upgrade works on existing Luas Green Line infrastructure	For Luas operation	Dismantling and reconstruction of *c.*50m double track (slab open track type), south of Ranelagh Stop, for installation of a scissor crossover and buffer stops at the end of reversing tracks (existing). Demolition of Charleston Bridge and construction of pedestrian access (stairs-lifts-escalators) to the retained Luas embankment from Charleston Road (pedestrian link between Metro and Luas stop).
	For Metro operation	None specific for tie-in
Operating service patterns	Metro	Swords to Bride's Glen
	Luas Green Line	Broombridge to Ranelagh (new turnback facility required)
	Operating link	No
	Engineering link	No
	Interchange	Ranelagh Metro (Oakley-Cullenswood Road) to Ranelagh Luas (200m walking distance)
Construction	The Luas Green Line will be severed between Harcourt and Beechwood (with the provision of a temporary emergency crossover in Adelaide Road) during construction of Ranelagh Luas turn-back facility (approx. 2 months). The Luas Green Line would be severed between Ranelagh and Beechwood during NMN tie-in works. Following construction completion, the Luas Green Line will terminate in Ranelagh, with Beechwood becoming the first at-grade Metro Stop, south of St Stephen's Green.	

Traffic	Metro would run at-grade across Dunville Avenue or else the avenue will be permanently blocked off.
Property acquisition	50 and 50A Oakley Road, and 19–24 Oakley Court (apartments)
Archaeological and heritage constraints	Rear sheds (possibly curtilage elements) of 43–45 Oakley Road which are Protected Structures (RPS 5982–5984) Castlewood House at 50 Oakley Road is a Protected Structure (RPS 5989)

Photograph

19–24 Oakley Court

8.7 Option 6 – Beechwood South

Option	6	
Location	Beechwood South	
Tie-in	In-line ✗ At-grade ✓ Grade separated ✗	
Description	From the north, NMN tunnels would be bored to a point on the west side of Beechwood Luas Stop, where the new Metro stop would be located. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, north of Cowper Luas Stop.	
Infrastructure (south of NMN terminus)	Bored tunnel	1.9km
	Cut and cover tunnel	0.17km
	Retained cutting	0.24km
	At-grade track	0.09km
	Elevated/viaduct	0km
	Intermediate escape shafts	0
	Additional Metro stations	2
Operating service patterns	Metro	Swords to Bride's Glen
	Luas Green Line	Broombridge to Beechwood (no new crossover)
	Operating link	No
	Engineering link	Yes
	Interchange	Beechwood Metro to Beechwood Luas
Construction	Potential closure of Beechwood Stop during construction	
Traffic	No traffic impacts	
Property acquisition	Luas kiosk at Beechwood Stop 1–5 Dunville Avenue (3 houses) 16 apartments at Dunville Court House and garage to the rear of the apartments 2–6 Moyne Court (5 houses) Parts of rear gardens of 71–111 Moyne Road	
Archaeological and heritage constraints	None	
Variants	The retained cut could be constructed partly within the existing Luas alignment, retaining one track for an engineering link. This would mitigate the impacts on the houses on Moyne Road and Moyne Court, but would result in much greater disruption to Luas operations during construction.	

Photographs

Beechwood Kiosk

House at rear of Dunville Court

Dunville Court apartments

1–5 Dunville Avenue

8.8 Option 6(A) – Beechwood South, In-line

Option	6(A)	
Location	Beechwood South	
Tie-in	In-line ✓ At-grade ✗ Grade separated ✗	
Description	From the north, NMN tunnels will be bored to a point just south of Beechwood Avenue, centred under the existing Beechwood Luas Stop, where the new Metro stop box will be located. The tracks will then rise in cut and cover and retained cut sections, mainly within the existing Luas corridor, to join the existing Luas tracks at an in-line junction, north of Cowper Luas Stop. For Option 6(A), the standard central platform configuration was preferred to the flute configuration as the flute did not deliver additional benefits in terms of property impacts and would require running the bored tunnels beneath houses rather than partly under the Luas corridor.	
Infrastructure (south of NMN terminus)	Bored tunnel	2,000m
	Cut and cover tunnel	275m
	Retained cutting	153m
	At-grade track	none
	Elevated/viaduct	none
	Intermediate escape shafts	0
	Additional Metro stations	2
Upgrade works on existing Luas Green Line infrastructure	For Luas operation	Dismantling of 440m double track (60m embedded and 380 ballast) and reconstruction of 60m double embedded track and 120m double slab track including double crossover and buffer stops at the end of reversing tracks. Demolition and reconstruction of Luas stop.
	For Metro operation	None specific for tie-in
Operating service patterns	Metro	Swords to Bride's Glen
	Luas Green Line	Broombridge to Beechwood
	Operating link	No
	Engineering link	No
	Interchange	Beechwood Metro to Beechwood Luas (10m walking distance)
Construction	The Luas Green Line will be severed between Harcourt and Milltown (with the provision of two temporary emergency crossovers in Adelaide Road and south of Milltown, on the green track section) during construction.	
Traffic	No running at-grade through junctions	
Property acquisition	Luas kiosk at Beechwood Stop Some temporary loss of garden to rear of 1–42 Beechwood Avenue Upper (including garden sheds) House and garage to the rear of Dunville Court apartments Garden sheds to rear of 111 Moyne Road	

Archaeological and heritage constraints	Moyne Road is a Protected Structure (RPS 5788)

8.9 Option 7 – Cowper

Option	7	
Location	Cowper	
Tie-in	In-line ✗ At-grade ✓ Grade separated ✗	
Description	From the north, NMN tunnels would be bored to a point on the west side of Cowper Luas Stop. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, north of Milltown Luas Stop.	
Infrastructure (south of NMN terminus)	Bored tunnel	2.5km
	Cut and cover tunnel	0.17km
	Retained cutting	0.11km
	At-grade track	0.05km
	Elevated/viaduct	0km
	Intermediate escape shafts	0
	Metro stations	2
Operating service patterns	Metro	Swords to Bride's Glen
	Luas Green Line	Broombridge to Cowper (new crossover required)
	Operating link	No
	Engineering link	Yes
	Interchange	Milltown Metro to Cowper Luas
Construction	There will be minor disruption to Luas services during tie-in works.	
Traffic	No impacts	
Property acquisition	Parts of rear gardens of 22–46 Merton Road (temporary) Parts of rear gardens of 2–20 Merton Road (permanent) Parts of rear gardens of 1–3 Richmond Avenue (permanent)	
Archaeological and heritage constraints	None identified	
Variants	The retained cut could be constructed partly within the existing Luas alignment, retaining one track for an engineering link. This would mitigate the impacts on the houses on Merton Road and Richmond Avenue, but would result in greater disruption to Luas operations during construction. A new Metro station could be built at Cowper to improve interchange.	

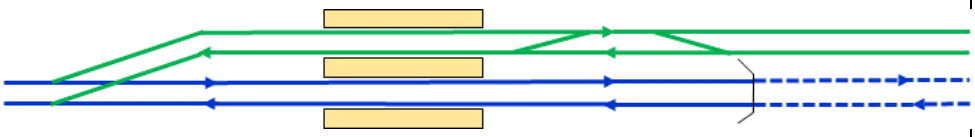
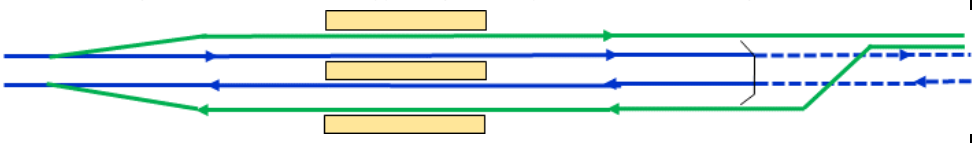
8.10 Option 8 – Milltown

Option	8	
Location	Milltown	
Tie-in	In-line ✗ At-grade ✓ Grade separated ✗	
Description	From the north, NMN tunnels would be bored to the northern perimeter of the Alexandra College Sports Grounds. The tracks will then rise in cut and cover and retained cut sections to join the existing Luas tracks at an at-grade junction, north of Milltown Luas Stop.	
Infrastructure (south of NMN terminus)	Bored tunnel	2.9km
	Cut and cover tunnel	0.2km
	Retained cutting	0.1km
	At-grade track	0.1km
	Elevated/viaduct	0km
	Intermediate escape shafts	0
	Metro stations	2
Operating service patterns	Metro	Swords to Bride's Glen
	Luas Green Line	Broombridge to Cowper
	Operating link	No
	Engineering link	Yes
	Interchange	Milltown Metro to Cowper Luas
Construction	There will be minor disruption to Luas services during tie-in works.	
Traffic	No impacts	
Property acquisition	Alexandra College Sports Hall	
Archaeological and heritage constraints	No constraints	
Variants	The retained cut could be constructed partly within the existing Luas alignment, retaining one track for an engineering link. This would mitigate the impacts on Alexandra College, but would result in greater disruption to Luas operations during construction.	

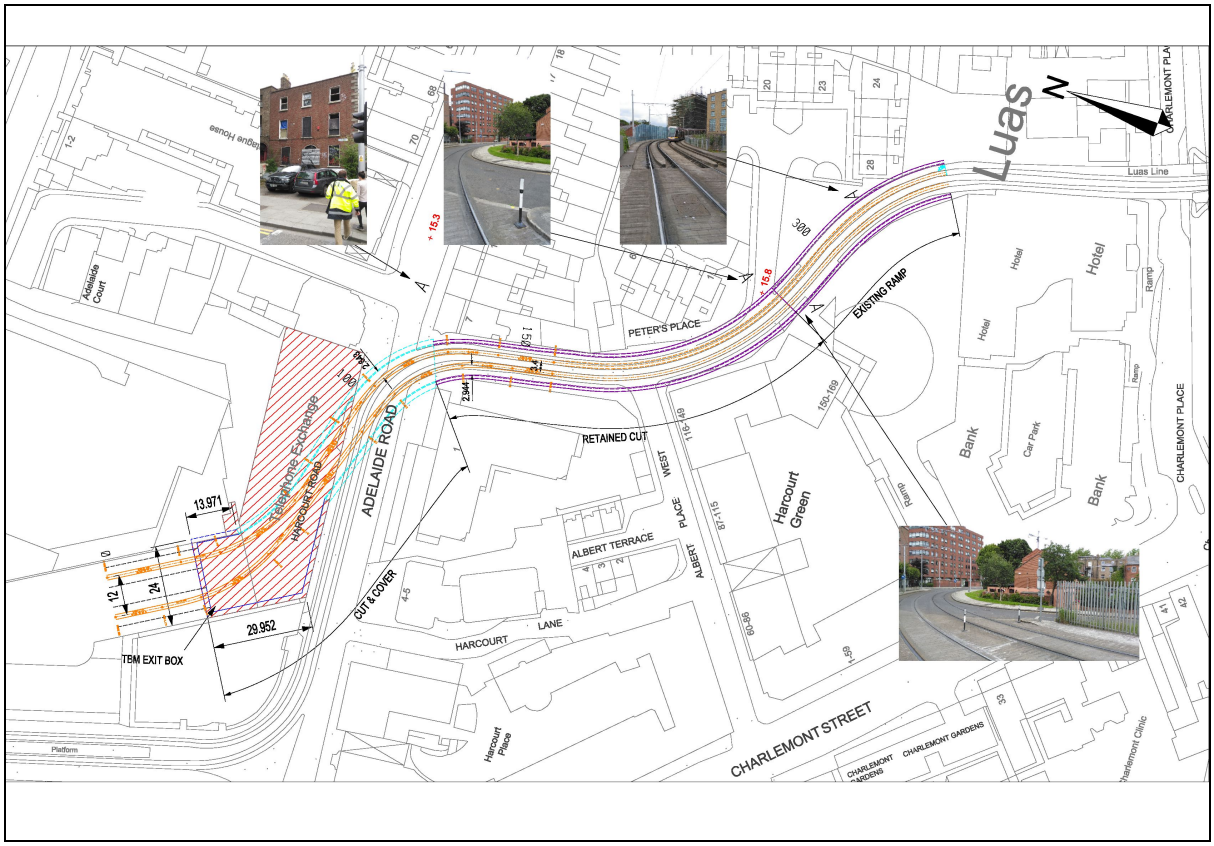
Photograph

Alexandra College Sports Hall

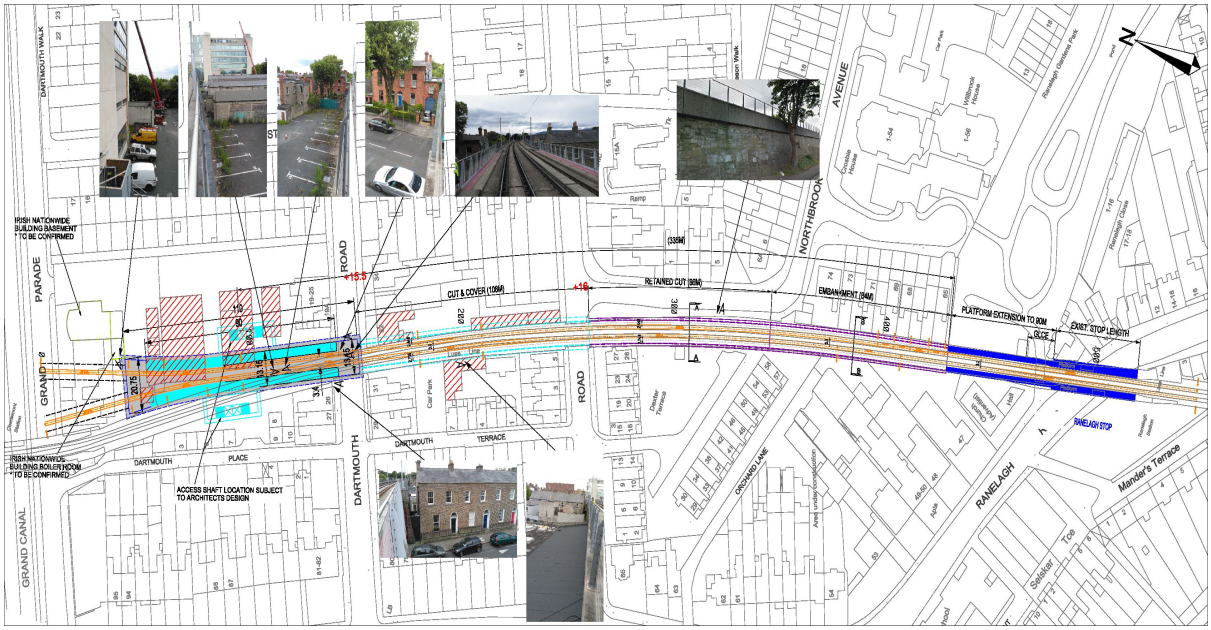
9 APPENDIX B: TIE-IN CONFIGURATIONS EXPLAINED

Configuration	Description
In-line	An in-line tie-in directly connects the Luas tracks, south of tie-in point, with NMN tracks. There is no provision of a railway junction and as such there is no physical track connection between the Luas Green Line, north of the tie-in, and the tracks, south of the tie-in. The Luas Green Line, south of the tie-in, will become Metro only. One of the benefits of this configuration is that a section of the existing Luas corridor can be used for the retained cut, cut and cover and TBM launch shaft, minimising land take and impacts. With this configuration, the Luas Green Line has to terminate at the nearest stop, north of the tie-in. Ideally, a new Metro underground stop would be provided at that location for passenger interchange. With this configuration, there is no connection between the remaining northern section of the Luas Green Line and Sandyford Depot, and Broombridge would become the only Luas Green Line depot. Depending on the location of the tie-in, and thus the residual length of the Luas Green Line, some additional maintenance and stabling facilities may have to be provided at Broombridge.
Configuration	**Description**
At-grade	With this configuration, a physical connection between tracks is maintained but there is a high level of conflicting movements at the tie-in point. For this reason, if located north of a Luas Green Line stop, this configuration only allows very limited Luas traffic to continue, south of the tie-in. Thus, with this configuration, it should be assumed that only Metro services continue south of the junction. However, a physical engineering link is retained between the Luas Green Line and Sandyford Depot. The following sketches illustrate typical at-grade junctions at a stop, and between stops:  **At stop**  **Between stops**
Grade separated	With this configuration, the physical connection between tracks is maintained and there is a low level of conflicting movements. It allows both Luas and NMN traffic to continue south of the tie-in. Several of the at-grade solutions presented could work as grade-separated junctions if the two Metro tracks are split and join the Luas from both sides. However, this would mean additional property impacts on both sides of the line. The following sketch illustrates a typical grade separated tie-in arrangement: 

10 APPENDIX C: DESIGNS FOR OPTIONS 3(B) AND 4(B1)



Option 3(B) – Harcourt Railway Station



Option 4(B1) – Ranelagh In-line with Fluted Arrangement

11 APPENDIX D: STAGE 1 – OVERALL APPRAISAL TABLE

Table 9: Appraisal summary table

Option	**3**	**4(A)**	**4(B)**	**5**	**6**	**7**	**8**
Location	Adelaide Court	Ranelagh At-grade	Ranelagh In-line	Beechwood North	Beechwood South	Cowper	Milltown
	In-line	At-grade	In-line	At-grade	At-grade	At-grade	At-grade
Economic Appraisal							
Capital Cost – TOTAL (TII Optimised Metro North)	€m 244	€m 187	€m 177	€m 232	€m 254	€m 366	€m 478
Overall Rank for Economic *							
Environmental Appraisal							
	This option has a moderate performance against the environmental objective. It has some negative environmental impacts including the requirement to acquire office blocks at 3 Park Place and St James House at 72 Adelaide Road as well as a derelict Protected Structure at 7 Adelaide Road. One residential house is also required to provide a new access road to Peter's Place where access will be severed by the option. The Luas Green Line will be closed for c.3 months between Charlemont and Harcourt.	This option has an overall poor against the environmental objective. It has negative environmental impacts, particularly in relation to property as it requires the acquisition of 12 houses (2 Protected Structures at 32 and 33 Dartmouth Square and 10 houses at 65–74 Northbrook Avenue). The front gardens and driveways of 7 houses (1– 6A Northbrook Avenue) and derelict buildings and substrata at the Grand Parade site. In addition to the property impacts on their gardens and driveways, residents of Nos. 1–6A Northbrook Avenue will also experience an increase in noise levels during construction and operation, and landscape and visual impacts arising from passing trams moving closer to their properties. In terms of traffic this option will require the realignment of Northbrook Road which will be permanently severed and the Luas Green Line will be closed for *c.*3 months between Charlemont and Harcourt.	This option performs moderately against the environmental objective. The option will require the acquisition of 2 houses at 32 and 33 Dartmouth Road which are Protected Structures as well as the acquisition of derelict buildings and substrata at Grand Parade site. The latter acquisition will provide some positive landscape and visual impacts arising from the subsequent redevelopment of this area. However, this option will require the closure of the Luas Green Line for *c.*1 year between Beechwood and St Stephen's Green.	This option performs moderately against the environmental objective. It will require the acquisition of 11 houses on at 46–52 Oakley Road (5 of these are Protected Structures), a block of apartments in Oakley Court and a house at 2B Brendan Vale. It is anticipated that the area above the cut and cover stop will be redeveloped so this will impact on the DCC Residential Neighbourhood Conservation Area. There will only be a minor disruption to Luas services during tie-in works. Dunville Avenue will be closed to through traffic to enable full segregation of Metro services.	This option performs moderately against the environmental objective. The option will require the acquisition of 3 houses at 1, 3 and 5 Dunville Avenue (these are also Protected Structures), a block of 16 apartments in Dunville Court and the houses and garage to the rear, a coffee shop adjacent to Beechwood Stop and 5 houses at 2–6 Moyne Court. It is anticipated that the area of the tie-in at Beechwood Stop will be redeveloped so this will also have negative impacts on the existing landscape character of this area which is zoned a Residential Neighbourhood Conservation Area.	This option has an overall good performance against the environmental objective. The option will require the permanent part acquisition of 11 rear gardens and the temporary part acquisition of 13 rear gardens on Merton Road. The option does not require the acquisition of any property nor does it have a negative architectural heritage impact on its environs. The option does require the permanent part acquisition of 11 rear gardens and the temporary part acquisition of 13 rear gardens on Merton Road. The temporary and permanent acquisition of gardens to the rear of residential properties will result in a deterioration in the existing noise environment arising from the Metro alignment (albeit in a retained cut) moving closer to existing residents along Merton Road and Richmond Avenue. Notwithstanding this, the option is considered to deliver an overall good performance against the environmental objective.	**This option has an overall good performance against the environmental objective.** **The option will require the permanent acquisition of the Alexandra College Sports Hall.**

Option	3	4(A)	4(B)	5	6	7	8
		Further south, this option will impact on biodiversity and mature trees in Ranelagh Gardens Park.					
Overall Rank for Environment							
Integration Appraisal							
Interchange with Luas Green Line and impact on Luas Green Line Services	In-line connection with through service on Luas Green Line not possible. Direct vertical interchange possible at St Stephen's Green. No impacts on other transport proposals.	At-grade connection with through service on Luas Green Line is possible. Direct vertical interchange possible at Charlemont and in city centre. No impacts on other transport proposals.	In-line connection with through service on Luas Green Line not possible. Direct vertical interchange possible at Charlemont and in city centre. No impacts on other transport proposals.	At-grade connection with through service on Luas Green Line is possible. 100m walk and then vertical interchange to Ranelagh. No impacts on other transport proposals.	At-grade connection with through service on Luas Green Line is possible. Direct vertical interchange possible at Beechwood. No impacts on other transport proposals.	At-grade connection with through service on Luas Green Line is possible. Direct vertical interchange in city centre possible. No impacts on other transport proposals.	At-grade connection with through service on Luas Green Line is possible. Direct vertical interchange in city centre possible. No impacts on other transport proposals.
Overall Rank for Integration							
Overall Stage 1 Appraisal Score							

Note:

* Overall Rank for Economic – In deciding on a score for the Economic criteria, it was considered the options fall within three distinct bands: €170–€185m, €225–€260m and €360–€470m. They were then relatively assigned a Green, Yellow and Red score against the criteria.

12 APPENDIX E: STAGE 1 – CAPITAL COSTS

Table 10: Estimated capital costs

New Metro North

Summary of Capitial Costs of Options (Estimated)

Value					€m					
Option	1	2A	2B	3	4A	4B	5	6	7	8
Description	St. Stephen's Green West	St. Stephen's Green East Elevated	St. Stephen's Green East At-Grade	Adelaide Court	Ranelagh At-grade	Ranelagh In-line	Beechwood North	Beechwood South	Cowper	Milltown
Capital Cost	18	34	32	44	168	167	205	237	357	471
Bored Tunnel	0	0	0	34	61	61	102	129	170	197
Stations	0	0	0	0	86	86	86	86	171	256
Other	18	34	32	10	21	20	17	22	16	18
Property Acquisition*	0	11	11	200	19	10	27	17	9	7
Total Capital Cost	18	45	43	244	187	177	232	254	366	478

* Based in Lisney Report dated Aug 2016 (combined value figures)

13 APPENDIX F: PROPERTY VALUATIONS FOR STAGE 1

14 APPENDIX G: STAGE 2 – OVERALL APPRAISAL TABLE

Table 11: Overall appraisal table

Option	3(A)	4(B)	5(A)	6(A)
Location	Adelaide Court	Ranelagh In-line	Beechwood North	Beechwood South
	In-line	In-line	In-line	In-line
Economy Appraisal				
Capital Cost - TOTAL	€m 344	€m 178	€m 223	€m 252
Rank for Capital Cost				
Construction Risk (Qualitative)	Very high construction risk activities, resulting from large-scale demolition, excavation and construction in a congested built-up area/city centre environment and will require high levels of mitigation measures.	The works include risks associated to construction activities of shallow tunnelling under the Carroll's Building, the construction of the stop box and the short cut and cover sections across Dartmouth Road and Northbrook Avenue. The longer tunnel would only minimally increase the risk. However, the majority of the works are within the current Luas alignment with reduced interface with pedestrians and traffic.	The works include the increased risk of the longer tunnelling required, the construction of the stop box, the retained cut and the retained embankment. However, the majority of the works are within the current Luas alignment with no substantial large buildings adjacent to the works and reduced interface with pedestrians and traffic.	The works include the increased risk of the longer tunnelling required, the construction of the stop box, the retained cut and the retained embankment. However, the majority of the works are within the current Luas alignment with no substantial large buildings adjacent to the works and reduced interface with pedestrians and traffic.
Rank for Construction Risk				
Traffic and Transportation (Qualitative)	Retained cut section will potentially sever Albert Place West from Peter's Place (vehicles and pedestrians), resulting in a negative localised impact.	No major impacts upon road and bus networks.	No major impacts upon road and bus networks.	No major impacts upon road and bus networks. Retained cut section may sever existing pedestrian crossing of Luas lines at Albany Road.
Rank for Traffic and Transportation				

Option	3(A)	4(B)	5(A)	6(A)
Overall Rank for Economy				
Environmental Appraisal				
Land Use Character	The proposed tie-in option will pass through and directly impact Residential, industrial/enterprise/employment lands and other mix of uses lands.	The proposed tie-in option will pass through and directly impact industrial/enterprise/employment and residential lands.	The proposed tie-in option will pass through and directly impact residential lands.	The proposed tie-in option will pass through and directly impact residential lands.
Rank for Land Use Character				
Noise, Vibration and Groundborne Noise during Construction	There will be short-term noise, vibration and groundborne noise impacts on residential properties, 3 childcare/pre-primary education facilities, 2 hotels, a theatre and a church located within 100m of the works during the construction of the TBM receiving shaft, TBM operation, stop box construction, cut and cover construction, retained cut construction, demolition of properties (3 Park Place, St James House, 7 and 8 Adelaide Road and a garage to the rear of 7–10 Adelaide Road) and all associated reinstatement works. There will be temporary construction impacts on noise sensitive receptors associated with: - the dismantling and rebuilding of approximately 50m of the Luas	There will be short-term noise, vibration and groundborne noise impacts on a significant number of residential properties, 3 childcare/pre-primary education facilities, a hotel, a church and 1 primary school within 100m of the works during the TBM operation, stop box construction, cut and cover construction, retained cut construction and properties located on Dartmouth Road, Dartmouth Terrace, Northbrook Road and all associated reinstatement works. There will be temporary construction impacts on noise sensitive receptors associated with: - the dismantling and rebuilding of approximately 70m of the Luas Green Line, south of Charlemont Luas Stop - the demolition and rebuilding of	There will be short-term noise, vibration and groundborne noise impacts on a significant number of residential receptors within 100m of the works during the TBM operation, stop box construction, cut and cover, retained cut and embankment construction, and demolition of 50 and 50A Oakley Road and 19–24 Oakley Court apartments and all associated reinstatement works. There will be temporary construction impacts on noise sensitive receptors associated with: - the dismantling and rebuilding of approximately 50m of the Luas Green Line, south of Ranelagh Luas Stop - The extension of Luas stops to	There will be short-term noise, vibration and groundborne noise impacts on a significant number of residential receptors and a church within 100m of the works during the TBM operation, stop box construction, cut and cover, retained cut and embankment construction, and property take (Luas kiosk, temporary take of rear gardens on Moyne Road and Beechwood Avenue Upper and a house and garage at Dunville apartments) and all associated reinstatement works. There will be temporary construction impacts on noise sensitive receptors associated with: - the dismantling and rebuilding of approximately 440m double track and reconstruction of 60m double embedded track and 120m double

Option	3(A)	4(B)	5(A)	6(A)
	Green Line on Adelaide Road - the dismantling of Charlemont Luas Stop - modification of the Luas Green Line track configuration between Charlemont and Ranelagh (excluded)	an element of the embankment - the extension of Ranelagh Luas Stop and new deck structure	90m	slab track of the Luas Green Line, south of Ranelagh Luas Stop - demolition and reconstruction of Ranelagh Luas Stop - the extension of Luas stops to 90m
Rank for Noise, Vibration and Groundborne Noise during Construction				

Option	3(A)	4(B)	5(A)	6(A)
Noise, Vibration and Groundborne Noise during Operations	Operational noise, vibration and groundborne noise associated with NMN can be mitigated at source through the design and construction of the railway track and subsequent maintenance of the railway. Therefore, operational noise, vibration and groundborne noise are not constraints, providing the project is prepared to mitigate through design. There will be an impact on residential properties on Adelaide Road and Peter's Place due to Metro operations within the retained cut. There may be a slight negative indirect impact on sensitive receptors associated with Harcourt Luas Stop becoming the terminus for the Luas Green Line and a turnback facility located on Adelaide Road. There may be significant indirect effects on noise sensitive receptors with the operation of 60m/90m long Metro vehicles along the Luas Green Line from Charlemont Stop to Bride's Glen.	Operational noise, vibration and groundborne noise associated with NMN can be mitigated at source through the design and construction of the railway track and subsequent maintenance of the railway. Therefore, operational noise, vibration and groundborne noise are not constraints, providing the project is prepared to mitigate through design. There will be an impact on residential properties on Dartmouth Road, Dartmouth Terrace, Cambridge Terrace and Northbrook Road due to Metro operations within the retained cut. There may be a slight negative indirect impact on sensitive receptors associated with Charlemont Luas Stop becoming the terminus for the Luas Green Line and a turnback facility, located south of the stop. There may be significant indirect effects on noise sensitive receptors with the operation of 60m/90m long Metro vehicles along the Luas Green Line from Charlemont Stop to Bride's Glen.	Operational noise, vibration and groundborne noise associated with NMN can be mitigated at source through the design and construction of the railway track and subsequent maintenance of the railway. Therefore, operational noise, vibration and groundborne noise are not constraints, providing the project is prepared to mitigate through design. There will be an impact on residential properties adjoining the existing Luas Green Line cutting due to Metro operations. There may be a slight negative indirect impact on sensitive receptors associated with Ranelagh Luas Stop becoming the terminus for the Luas Green Line and a turnback facility, south of the stop. There may be significant indirect effects on noise sensitive receptors with the operation of 60m/90m long Metro vehicles along the Luas Green Line from Beechwood Stop to Bride's Glen.	Operational noise, vibration and groundborne noise associated with NMN can be mitigated at source through the design and construction of the railway track and subsequent maintenance of the railway. Therefore, operational noise, vibration and groundborne noise are not constraints, providing the project is prepared to mitigate through design. There will be an impact on residential properties adjoining the existing Luas Green Line cutting due to Metro operations. There may be a slight negative indirect impact on sensitive receptors associated with Ranelagh Luas Stop becoming the terminus for the Luas Green Line and a turnback facility, south of the stop. There may be significant indirect effects on noise sensitive receptors with the operation of 60m/90m long Metro vehicles along the Luas Green Line from Beechwood Stop to Bride's Glen.

Option	3(A)	4(B)	5(A)	6(A)
Rank for Noise, Vibration and Groundborne Noise during Operations	🟨	🟨	🟨	🟨
Biodiversity (Impacts on Habitats/Species arising from Landtake)	There will be no direct impacts on habitats protected under the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended). The nearest Natura 2000 site is South Dublin Bay and River Tolka Estuary SPA which is located approximately 3km from the proposed tie-in option.	There will be no direct impacts on habitats protected under the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended). The nearest Natura 2000 site is South Dublin Bay and River Tolka Estuary SPA which is located approximately 3km from the proposed tie-in option.	There will be no direct impacts on habitats protected under the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended). The nearest Natura 2000 site is South Dublin Bay and River Tolka Estuary SPA which is located approximately 3km from the proposed tie-in option.	There will be no direct impacts on habitats protected under the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended). The nearest Natura 2000 site is South Dublin Bay and River Tolka Estuary SPA which is located approximately 3km from the proposed tie-in option.
Rank for Biodiversity (Impacts on Habitats/Species arising from Landtake)	🟩	🟩	🟩	🟩
Water Resources (Surface Water and Groundwater Impacts arising from Landtake)	There will be no direct impacts on surface water bodies, arising from landtake. There will be temporary construction impacts on the underlying poorly productive bedrock aquifer.	There will be no direct impacts on surface water bodies, arising from landtake. There will be temporary construction impacts on the underlying poorly productive bedrock aquifer.	There will be no direct impacts on surface water bodies, arising from landtake. There will be temporary construction impacts on the underlying poorly productive bedrock aquifer.	There will be no direct impacts on surface water bodies, arising from landtake. There will be temporary construction impacts on the underlying poorly productive bedrock aquifer.
Rank for Water Resources (Surface Water and Groundwater Impacts arising from Landtake)	🟩	🟩	🟩	🟩

Option	3(A)	4(B)	5(A)	6(A)
Landscape and Visual	The proposed tie-in option will pass through and directly impact residential, industrial/enterprise/employment and other mix of uses lands. There will be a change to the character of the local landscape, particularly to the residential estate of Peter's Place, arising as a result of the visibility of this tie-in option and the demolition of properties (3 Park Place, St James House, 7 and 8 Adelaide Road and a garage to the rear of 7–10 Adelaide Road). There will also be a direct impact on the new office building under construction at 3 Park Place. There will be no impacts on DCC Key Views, parks or Tree Preservation Orders.	The proposed tie-in option will pass through and directly impact industrial/enterprise/employment and residential lands. There will be a change to the character of the local landscape, particularly to residential properties on Dartmouth Road, Dartmouth Terrace and Cambridge Terrace as a result of limited property take and the visibility of this tie-in option. There will be no impacts on DCC Key Views, parks or Tree Preservation Orders.	The proposed tie-in option will pass through and directly impact residential lands. There will be a change to the character of the local landscape, particularly to residential properties on Oakley Road and Elmwood Avenue Upper as a result of the visibility of this tie-in option and the demolition of 50 and 50A Oakley Road and 19–24 Oakley Court apartments. There will be no impacts on DCC Key Views, parks or Tree Preservation Orders.	The proposed tie-in option will pass through and directly impact residential lands. There will be a change to the character of the local landscape, particularly to residential properties on Dunville Court and Beechwood Avenue Upper as a result of the visibility of this tie-in option. There will be no impacts on DCC Key Views, parks or Tree Preservation Orders.
Rank for Landscape and Visual				
Waste	This tie-in option consists of an estimated 500m of twin bore, 140m cut and cover tunnel, and 109m of retained cut. All of these activities will result in the generation of waste. Waste generation associated with	This tie-in option consists of an estimated 940m of twin bore, 218m cut and cover tunnel, 86m of retained cut and 84m of retained embankment. All of these activities will result in the generation of waste.	This tie-in option consists of an estimated 1,640m of twin bore, 185m cut and cover tunnel, 103m of retained cut and 52m of retained embankment. All of these activities will result in the generation of waste.	This tie-in option consists of an estimated 2,000m of twin bore, 275m cut and cover tunnel and 153m of retained cut. All of these activities will result in the generation of waste. Waste generation associated with

Option	3(A)	4(B)	5(A)	6(A)
	the GLTI works will have a direct effect on traffic movements during the construction stage and the capacity at facilities accepting such waste. There will be an indirect effect on noise and air quality during the construction stage, associated with traffic movement, collecting and transporting the waste.	Waste generation associated with the GLTI Works will have a direct effect on traffic movements during the construction stage and the capacity at facilities accepting such waste. There will be an indirect effect on noise and air quality during the construction stage, associated with traffic movement, collecting and transporting the waste.	Waste generation associated with the GLTI Works will have a direct effect on traffic movements during the construction stage and the capacity at facilities accepting such waste. There will be an indirect effect on noise and air quality during the construction stage, associated with traffic movement, collecting and transporting the waste.	the GLTI Works will have a direct effect on traffic movements during the construction stage and the capacity at facilities accepting such waste. There will be an indirect effect on noise and air quality during the construction stage, associated with traffic movement, collecting and transporting the waste.
Rank for Waste				

Option	3(A)	4(B)	5(A)	6(A)
Archaeological, Architectural and Cultural Heritage	This option does not impact on any known archaeological and/or cultural heritage sites. In terms of architectural heritage, this option will have a direct impact on two Protected Structures, 7 and 8 Adelaide Road (DCC RPS 23 and 24), requiring their demolition. These comprise two three storey over basement Georgian brick buildings, of which number 8 is currently in derelict condition. Works associated with the retained cut to facilitate tie in with the existing Luas Green Line track have a direct impact on the retaining walls and embankments of one historic railway (Harcourt Street Railway Line) from Adelaide Road to the rear of the Hilton Hotel on Charlemont Place (approx. 115m), requiring their removal.	This option does not impact on any known archaeological and/or cultural heritage sites. In terms of architectural heritage, this option will have a direct impact on two Protected Structures. Works to 32 and 33 Dartmouth Road (DCC RPS 2144) will require the demolition of these structures. Works at 2 Grand Parade (DCC RPS 3280) will require the demolition of a rear shed, located within the building's curtilage. Works associated with the cut and cover/retained cut and retained embankment to facilitate tie-in with the existing Luas Green Line track will have a direct impact on the stone retaining walls, embankments and overbridge of one historic railway (Harcourt Street Railway Line) from south of Dartmouth Road to the Ranelagh Luas Stop (approx. 335m), requiring their removal. An indirect visual impact on one ACA (Dartmouth Square) may also arise.	This option does not impact on any known archaeological and/or cultural heritage sites. In terms of architectural heritage, this option will have a direct impact on five Protected Structures. Works will have a direct impact on 50 Oakley Road (DCC RPS 5989), comprising a two storey three bay brick dwelling, requiring its demolition. The demolition of rear sheds and partial removal of boundary walls associated with the curtilage of 42–45 (DCC RPS 5981–5984) Oakley Road will also be required. Works associated with the construction of the Beechwood stop box cut and cover to facilitate tie-in with the existing Luas Green Line will have a direct impact on the stone retaining walls and embankments of one historic railway (Harcourt Street Railway Line) from Elmwood Avenue Upper to Beechwood Luas Stop (approx. 350m), requiring their removal. This option will also have a negative visual impact on one ACA (Elmwood Avenue Upper and Lower).	This option does not impact on any known archaeological and/or cultural heritage sites. In terms of architectural heritage, this option will impact on the curtilage of one Protected Structure, 111 Moyne Road (DCC RPS 5788), requiring the demolition of rear sheds and the partial removal of the boundary wall. Works associated with the construction of the stop box cut and cover to facilitate tie-in with the existing Luas Green Line track will have a direct impact on the stone retaining walls and embankments of one historic railway (Harcourt Street Railway Line) from Beechwood to Cowper Luas Stops (approx. 362m), requiring their removal.

Option	3(A)	4(B)	5(A)	6(A)
Rank for Archaeological, architectural and cultural heritage				
Rank for Environment				
Accessibility and Social Inclusion				
Access from Deprived Geographical Areas, e.g. RAPID Area	A Luas stop and Metro stop are both located within the RAPID area. The Luas stop will provide good accessibility between the north of the city and the RAPID area, while the Metro stop will provide good accessibility to the south.	Accessibility to/from the north of the city is maintained via the Luas corridor and potentially enhanced by the St Stephen's Green Metro Stop (albeit a 1km walk). Accessibility to/from the south of the city is marginally worse than existing as users will likely get on/off at Charlemont which is outside the RAPID area (0.5km walk), despite the fact that the Luas Green Line currently operates between Harcourt and Charlemont.	Accessibility to/from the north of the city is maintained via the Luas corridor and potentially enhanced by the St Stephen's Green Metro Stop (albeit a 1km walk). Accessibility to/from the south of the city is poor as travelling to/from areas further south of Ranelagh will involve an interchange and walk to the Luas or Metro services, dependent on direction of travel. This option introduces an element of severance for the RAPID area, but there may be time savings on the Metro services which may alleviate the impacts of the walk and interchange. In light of the interchange and associated walk, this option is considered poor with respect to access to the RAPID area.	Accessibility to/from the north of the city is maintained via the Luas corridor and potentially enhanced by the St Stephen's Green Metro Stop (albeit a 1km walk). Accessibility to/from the south of the city is poor as travelling to/from areas further south of Ranelagh will involve an interchange and walk to the Luas or Metro services, dependent on direction of travel. This option introduces an element of severance for the RAPID area, but there may be time savings on the Metro services which may alleviate the impacts of the walk and interchange. In light of the interchange and associated walk, this option is considered poor with respect to access to the RAPID area.
Rank for Accessibility and Social Inclusion				
Integration Appraisal				

Option	3(A)	4(B)	5(A)	6(A)
Integration with Luas Green Line	Potential for interchange at St Stephen's Green, O'Connell Street and Harcourt (indirect). Very Good.	Potential for interchange at St Stephen's Green, O'Connell Street and Charlemont (indirect). Very Good.	Potential for interchange at St Stephen's Green, O'Connell Street and Ranelagh/Beechwood (indirect). Good.	Potential for interchange at St Stephen's Green, O'Connell Street and Ranelagh (indirect with significant walk). Poor.
Rank for Integration with Luas Green Line				
Integration with Existing and Proposed Transport Network	Moderate, no direct interchange at Harcourt Stop but walking distance is reasonable (*c*.0.25km).	Moderate, no direct interchange at Charlemont Stop (*c*.0.1km).	Trips to/from Harcourt Stop and Charlemont Stop to/from south of Ranelagh Stop now incorporate a walk and interchange. Poor.	Trips to/from Harcourt Stop and Charlemont Stop to/from south of Ranelagh Stop now incorporate a significant walk and interchange. Poor.
Rank for Integration with Transport Network				
Overall Rank for Integration				
	Overall Stage 2 Appraisal Score			

15 APPENDIX H: STAGE 2 – UPDATED CAPITAL COSTS

New Metro North

Summary of Capitial Costs of Options (Estimated)

Value				
Option	3A	4B	5A	6A
Description	Adelaide Court Stop	Ranelagh In-line	Beechwood North	Beechwood South
Capital Cost	143	167	213	242
Bored Tunnel	34	64	111	136
Stations / Exit Box	86	86	86	86
Other	23	17	16	20
Property Acquisition*	202	11	11	12
Total Capital Cost	345	178	224	254

* Based in Lisney Report dated Nov 2016 (combined value figures)

16 APPENDIX I: PROPERTY VALUATIONS FOR STAGE 2