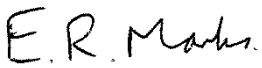
Docklands Station Options Study
Sift 2 Report

14th of February 2019

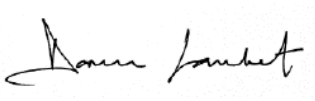
Údarás Náisiúnta Iompair
National Transport Authority

AECOM Imagine it. Delivered.

Quality information

Prepared by	Checked by	Verified by	Approved by
			
Claire Falkiner Associate Director, Transportation	Edwin Marks Associate Director, Transportation	Damien Lambert Associate Director, Transportation	Derval Cummins Director, European Advisory

Revision History

Revision	Revision date	Details	Authorized	Name	Position
2	14 Feb 2019	Incorporates feedback received on Rev.1		Damien Lambert	Associate Director, Transportation

Distribution List

# Hard Copies	PDF Required	Association / Company Name

Prepared for:

National Transport Authority

Prepared by:

Claire Falkiner
Associate Director, Transportation
M: +44 (0) 7823 389898
E: claire.falkiner@aecom.com

AECOM Ireland Limited
4th Floor
Adelphi Plaza
Georges Street Upper
Dun Laoghaire
Co. Dublin A96 T927
Ireland

T: +353 1 238 3100
aecom.com

Executive Summary

An assessment is in progress to identify the preferred solution for a DART station in the Docklands/North Lotts area. The objectives of this study are to:

- Identify the preferred location and layout of Docklands Station with the aim of achieving the minimum train capacity requirement, which would best serve the needs of the Docklands area and maximise interchange potential with the Luas; and
- Carry out a comprehensive study for the Docklands Station and how it is accessed, including all connecting rail alignments from the DART radial routes bounded by and including Newcomen, North Strand and East Wall Junctions and freight traffic from East Wall Yard. This study will take consideration of the station's interface with a potential DART Underground Station and alignment.

Identification of the preferred solution is being undertaken in several stages. Following a high level initial assessment (Sift 1) four options were short listed for further development and assessment in Sift 2. The aim of this Sift 2 process is to identify an Emerging Preferred Option for further concept design, development and costing.

The four short-listed options taken forward from Sift 1 are shown below:

These options have undergone engineering development and an initial multi-criteria assessment by a panel of experienced subject experts within AECOM. Feedback on the initial assessment from the NTA and Irish Rail project team has resulted in further engineering development and the operational assessment of each option as detailed within this report.

Options have been assessed against criterion which were agreed in advance with the NTA and which consist of three main criterion, economy, integration and environment and several sub criterions. The performance of each option was then ranked against this criterion. It is acknowledged that there is a degree of subjectivity within the multi-criteria assessment process which involves qualitative and some quantitative elements.

The impact of a new Docklands station on a possible future DART Underground station in the area is discussed but not included in the relative options assessment, as agreed.

The table below gives the results of the multi-criteria assessment for each option, with the following colour coding:

Significant advantages over other options
Some advantages over other options
Comparable to other options
Some disadvantages over other options
Significant disadvantages over other options

Main Criterion	Sub-Criterion	Option A	Option B	Option C	Option M
Economy	Capital Cost				
	Operating Cost				
	Demand				
	Overall assessment				

Main Criterion	Sub-Criterion	Option A	Option B	Option C	Option M
Integration	Land Use Policy/Plan Integration				
	Public Transport Integration				
	Walking/Cycling Integration				
	Overall assessment				

Main Criterion	Sub-Criterion	Option A	Option B	Option C	Option M
Environment	Cultural Heritage				
	Noise and Vibration				
	Landscape and Visual				
	Overall assessment				

Main Criterion	Sub-Criterion	Option A	Option B	Option C	Option M
Economy	Overall assessment				
Integration	Overall assessment				
Environment	Overall assessment				
	Combined overall assessment				

Overall, Options A and B both have some advantages over the other options.

While Option A benefits from the lower level of investment required to develop the site, the adjacent dedicated cycle routes and the presence of attractive walking routes along the canal, Option B performs strongly given its closer proximity to higher density employment zones on the south and western side of the study area.

Option C has some disadvantages, primarily driven by its location at the periphery of the higher density development area. Option M also has some disadvantages, primarily driven by the development currently taking place on the third-party-owned site and the costs associated with the purchase of non CIÉ lands.

In summary, Option A would cost less to develop whereas Option B would serve more people.

Table of Contents

Figures

Tables

1. Introduction

1.1 Background

The National Transport Authority (NTA) has appointed AECOM to undertake a Docklands Station Options Study to determine the preferred location and layout of Docklands DART Station.

1.2 Docklands Station Options Study Objectives

The objectives stated within the client's brief[1] are:

- *To identify the optimal location and layout of Docklands Station with the aim of achieving the minimum train capacity requirement, which would best serve the needs of the Docklands area and maximise interchange potential with the Luas*; and
- *To carry out a comprehensive study for the Docklands Station and how it is accessed, including all connecting rail alignments from the DART radial routes bounded by and including Newcomen, North Strand and East Wall Junctions and freight traffic from East Wall Yard. This study also takes consideration of the station's interface and alignment with a potential future DART Underground Station and alignment.*

The capacity demands on the station include the ability to cater for a total of up to eighteen trains per hour, requiring a degree of flexibility to split capacity between the three rail routes accessing the Docklands area. The station requires the potential for operation of 8-car electric trains. The platforms and other facilities require designs to operate as a busy commuter station.

1.3 Sift 2 Report Context

This Sift 2 report details the process followed to identify the Emerging Preferred Option for Docklands Station. The final Docklands Station Options Report will cover the whole study process, as set out in Figure 1 Study Process.

This report is intended to be read as a follow-up to the Sift 1 report, so does not repeat much of the background information contained within that report. This Sift 2 report describes:

- The assessment methodology;
- An updated overview of rail operational issues applicable to all options;
- Revised descriptions of each option, taking into consideration further engineering feasibility since Sift 1;
- The Multi-Criteria Assessment carried out; and
- Broad conclusions regarding the performance of each short listed option.

The detailed drawings referenced within this document can be found in Appendix A. A detailed capital cost breakdown can be found in Appendix B, with detailed operational assessment in Appendix C.

[1] Tender and Schedule for The Provision of Engineering Consultancy Services for Docklands Station Options Study

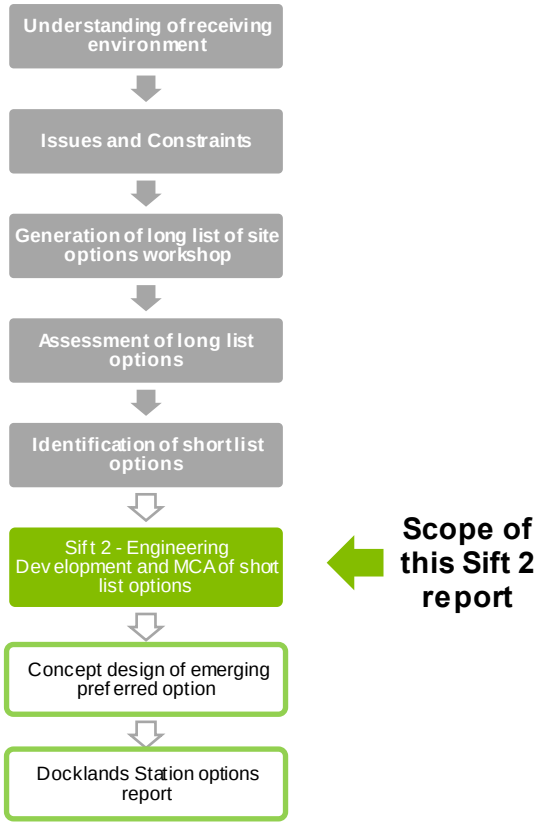


Figure 1 Study Process

2. Multi-Criteria Analysis Methodology

Following completion of Sift 1, the emerging options have been assessed in Sift 2 through Multi-Criteria Analysis (MCA). The results of the assessment are presented in Section 0. This stage comprises a more detailed qualitative and quantitative assessment than was carried out at Sift 1. The aim of the Sift 2 process is to identify an Emerging Preferred Option for further concept design development and costing.

The 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes' (CAF) published by the Department of Transport, Tourism and Sport (DTTAS), March 2016, requires schemes to undergo a 'Multi-Criteria Analysis' (MCA) under the following six criteria:

- Economy
- Integration
- Environment
- Accessibility and Social Inclusion
- Safety
- Physical Activity.

The CAF criteria informed by project specific considerations are used as the basis for this Sift 2 MCA.

The approach taken for each assessment criterion is described below. Where an assessment criterion (as identified by the CAF) has been deemed not to be applicable for inclusion within the analysis, the rationale for this determination is also described.

As agreed with the NTA, Sift 2 does not explicitly assess compatibility with any previous or potential future DART Underground scheme, but section 3 comments in broad terms on compatibility of options with an underground scheme.

2.1 Economy

2.1.1 Capital Cost

Order of magnitude capital cost estimates were prepared for indicative scheme infrastructure works. These included the costs of tracks, signalling, station construction and urban realm improvements.

The assessment does not include the potential costs and revenues of over-site development opportunities. Land acquisition costs are taken into consideration for options requiring third party land.

2.1.2 Operating Cost

Significant operating issues were compared between options, to assess their relative operating costs and any extra capital cost that might be incurred to improve operational flexibility. Complexity of station design is a proxy for variations in maintenance cost between options. Section 3.2 discusses operational aspects.

2.1.3 Demand

A qualitative assessment has been undertaken of the workplaces/employment figures within an approximate 5 and 10 minutes walking catchment using GIS-based analysis on data obtained from the 2035 Eastern Regional Model (ERM).

2.2 Integration

2.2.1 Land Use Integration

A qualitative assessment was undertaken, and commentary provided on the compatibility of each option against the Dublin City Council Development Plan 2016-22 in the context of the National Development Plan. Particular reference is made to the North Lotts and Grand Canal Dock Strategic Development Zone. As agreed with NTA, no specific consideration is made with respect to a possible future DART Underground station in the area.

2.2.2 Public Transport Integration

Walking interchange time (distance between station entrance and closest Luas platform/bus stop in each direction) was used to assess integration with Luas and the Core Bus Corridor network.

2.2.3 Walking/Cycling Integration

A qualitative assessment was undertaken, and commentary provided on the relative potential for each option to integrate with the pedestrian and cycle network in the area.

2.2.4 Impact on Road Network

This is not considered relevant for differentiating between options for this scheme because at the current level of design development it is assumed all options can maintain the existing road capacity.

2.2.5 Geographical Integration

Integration across geographic and judicial boundaries is not considered relevant for differentiating between options for this scheme as all lie within the same administrative boundaries.

2.2.6 Other Government Policy Integration

This is not considered relevant for differentiating between options for this scheme because all options will have the same level of fit with other Government policies.

2.3 Environment

2.3.1 Cultural Heritage

A qualitative assessment has been undertaken, and commentary provided with reference to Recorded Protected Structures, Architectural Conservation Areas and National Inventory of Architectural Heritage Structures impacted by each option.

2.3.2 Biodiversity

This was agreed with NTA as not relevant for differentiating between options for this scheme because there are no Special Areas of Conservation, Special Protection Areas and Natural Heritage sites affected by any of the shortlisted options.

2.3.3 Air Quality

This was agreed with NTA as not relevant for differentiating between options for this scheme as all short-listed options fall within the same measurement zone.

2.3.4 Noise and Vibration

A qualitative assessment has been undertaken, and commentary provided in relation to the proximity of each option to sensitive receptors, which have been determined during this stage of the study.

2.3.5 Landscape and Visual Quality

A qualitative assessment has been undertaken, and commentary provided in relation to the impact on areas of specific character and visual sensitivity including urban landmarks, land uses, spaces and streetscapes, identified within Dublin City Development Plan 2016-22.

2.3.6 Land Use

This criterion is defined within the CAF, however in the context of this study the 'Impact on value for intended use' is already covered under the Integration criterion – sub-criterion Land Use Integration. As agreed with NTA, it is not therefore assessed further.

2.3.7 Water Resources

As agreed with NTA, this criterion is not considered relevant for differentiating between options for this scheme as the presence of water features, designated flood zones and potential discharge impacts to groundwater is the same across all options.

Flood risk has been taken into consideration in the design and costing of each option, so is covered under the Economy criterion.

2.3.8 Accessibility and Social Inclusion

Under the broad meaning of 'accessibility' applied in the CAF (i.e. access to jobs for Deprived Geographic Areas), this criterion is not considered relevant for differentiating between options for this scheme as the origins of services bringing passengers into Docklands station will be the same for all options. Accessibility to jobs more generally (as a proxy for demand) is picked up under the Economy criterion.

2.4 Safety

As agreed with NTA, this criterion is not considered relevant for differentiating between options for this scheme as all options would be designed in accordance with applicable safety standards.

2.5 Physical Activity

As agreed with NTA, this criterion is not considered relevant for differentiating between options for this scheme because all schemes would be expected to have a broadly similar impact on physical activity.

2.6 Assessment

The table below lists the selection criteria used for the assessment.

Table 1. Summary of Selection Criteria

Criterion	Sub-Criterion
Economy	Capital Cost
	Operating Cost
	Demand
Integration	Land Use Policy/Plan Integration
	Public Transport Integration
	Walking/Cycling Integration
Environment	Cultural Heritage
	Noise and Vibration
	Landscape and Visual

Each criterion was initially assessed by one or more of AECOM's individual subject matter experts and verified/challenged through an internal workshop by a wider panel of team members. Feedback from NTA and Irish Rail was incorporated into the further assessment presented here.

Each sub-criterion was assessed against the five-point scale outlined below. The performance of each option against these sub-criterions determined the options performance against the main criterion and in turn the overall assessment of each option.

Table 2. Assessment Scale

Significant advantages over other options
Some advantages over other options
Comparable to other options*
Some disadvantages over other options
Significant disadvantages over other options

**only applied in instances where 3 or more options are comparable against a given criteria*

3. Development of Short Listed Options

Figure 2: Shortlist of Site Options

Station options have been developed for each of the four sites brought forward from Sift 1. The engineering assessment concentrated particularly on those issues that differentiate the sites, so are most relevant to selection of a preferred option. Hence the buildings and platforms have a similar form under all options and provide equivalent facilities, subject to variations to suit the particular site constraints.

Appendix A contains the drawings of the options.

3.1 Requirements

The following principal operational and design requirements are considered to be applicable to all options.

3.1.1 General

A maximum of 1% gradient is generally recommended for freight or mixed traffic lines. However steeper gradients currently exist on routes used by freight in the Docklands area. For passenger-only lines a 2.5% maximum, with 3-3.5% allowed over short distances, is defined by standards.

Station platforms are to be a minimum of 174m long. The vertical alignment of the platforms will be limited to a maximum gradient of 0.2%[2]. This minimises the risk of stationary vehicles in the platform rolling away. A 20m exclusion zone is required behind buffer stops.

[2] Standard I-PWY-1141, Section 2.1.1

The normal minimum horizontal radius is 200m with an exceptional minimum of 150m[3]. The horizontal alignment of the platforms should ideally be straight, to minimise the gaps between train and platform. The relevant standard[4] recommends platforms should be straight or, if unavoidable, curved on a radius not less than 1000m, but also mentions smaller radii down to 350m. The increased stepping distance at a curved platform is a particular consideration for a busy city station because it increases risk to passengers and train dwell time, so the study assumes the higher limit of 1000m.

All sites include parking for staff cars and for small vans used for maintenance. Cycle racks are provided. No public car parking is provided.

3.1.2 Capacity

The Appendix to the client's brief states:

> *The Docklands Station Study shall aim to achieve a target capacity of c.18 tphpd [trains per hour per direction] from the combined three radial routes Northern Line, Maynooth Line and Phoenix Park Tunnel Line … If beneficial, the … Consultant may look at combining the Western trains from Maynooth/Phoenix Park Tunnel onto the existing North Strand line [GSWR] – which in turn would have the effect of the combined Western trains accessing Docklands via the existing Newcomen Jnct Line [MGWR] – but any required development at Glasnevin is outside the scope of this study.*

This implies a flexible layout which can accommodate the 18 trains arriving and departing by various combinations of the three routes, over a 3 hour peak period. This requirement is assessed in more detail within the operational assessment sections of this report.

Several freight trains per day run to and from the facilities accessed via the tracks on Alexandra Road. The minimum provision for freight within the study area is:

- Single track access between Alexandra Road and the Maynooth, Phoenix Park and Northern routes (this could involve switching between routes at Glasnevin Junction);
- Double track section for the longest freight trains (450m) to refuge and pass each other between the East Wall Road crossing and any interface to passenger trains. This is assumed to be worked manually so it applies to a distance between fouling points, with provision for variation in stopping position but no allowance for signalling overlaps;
- Measures such as signals and trapping[5] are required to protect passenger trains from freight train movements;
- Construction of safe walkways is required for staff to access trains and hand-worked points.

3.1.3 Electrification

The costings included assume that the existing Northern Line electrification will be extended into the new station but do not include any costs for the possible electrification of the other two routes. However, the feasibility and design work within the study is based on passive provision for 25kV on passenger lines, so the proposed works will not make any future 25kV or 1500V electrification more difficult.

Specifically, vertical profiles are considered to be compatible with providing clearance for a 25kV overhead line at overbridges, but electrification of the Phoenix Park and Maynooth lines is likely to require significant works to those bridges. The infrastructure costs currently allow for replacement of the West Road overbridge, but further development of the preferred option may establish that this work is not necessary until electrification takes place and therefore remove it

[3] Standard CCE-TMS-340, section 4.2.1.
[4] Standard I-PWY-1141, section 2.1.2 and 6.1.9.
[5] A device to intentionally derail unauthorised train movements from sidings or yards towards passenger lines.

from the final costings. As this applies equally to all Sift 2 options, it does not act as a differentiator and does not influence the choice of preferred option.

3.2 Operational Assessment

Operational assessments for the four options are presented below. Options A and B are examined in detail. Option C and M are commented on based on applying the results from the other options. Further information on the methodology, assumptions and detailed results for the operational assessment are found in Appendix C.

3.2.1 Passenger

Capacity assessments are based on calculations of the intervals between trains entering and leaving the station that are necessary to avoid trains being slowed by signals. This ensures that trains entering the station do not have to brake excessively and allows compliance with station speed restrictions. Train journey times are estimated for an 8-car unit with similar performance to DART, and assume each train is scheduled to spend a minimum of 8min turnaround time in the platform.

Throughput of each route approaching the station is considered in isolation, assuming that any shared platforms or other tracks are fully available to that route when needed. Comments are made where this is not possible, or where re-routeing at Glasnevin can result in greater capacity, and combinations of routes are then considered.

The throughputs are presented assuming no interaction with Connolly trains. To maximise the capacity available for Connolly trains, the assessment assumes trains are timetabled to run at intervals that are multiples of 3min, and that trains on the same route pass each other close to the junctions where Connolly and Docklands trains diverge.

3.2.2 Freight

All options provide facilities for freight to access Alexandra Road to and from all three routes, although all but option C requires access to and from the Maynooth line to be via North Strand and the connection at Glasnevin. The removal of the tracks where freight trains can wait to enter or leave these facilities will lead to some changes in freight working practices:

- Freight trains destined for East Wall Yard or Alexandra Road can currently be signalled up to a stop board where they can wait to continue eastward without blocking passenger services. This will no longer be possible, so the signaller will have to confirm that a train can be accepted into the yard area before it is sent towards Church Road.
- Freight trains leaving these facilities will have to wait between East Wall Yard and Church Road for a path over Church Road Junction and beyond. All options provide standage for a 450m train from Alexandra Dock, without blocking a train of similar length in the other direction.
- If East Wall Yard is retained, some shunting moves may have to go out onto passenger lines under the control of the signaller.
- Freight in either direction over Church Road Junction will be moving slowly as it is entering or leaving the yard where there are hand-worked points and staff may be on the track. If a longer freight train is brought to a halt in either direction between this junction and North Strand or East Wall junctions (and Newcomen Junction in option C) its tail will be blocking other movements. Thus the passenger timetable needs to allow a significant “time window” for freight movements at the off-peak times when they are likely to take place.

These freight constraints are not considered to be differentiators between options, as they are similar whichever option is selected.

The capacity assessment is based on peak passenger service when freight is assumed not to operate.

3.3 Option A: Existing Docklands station site

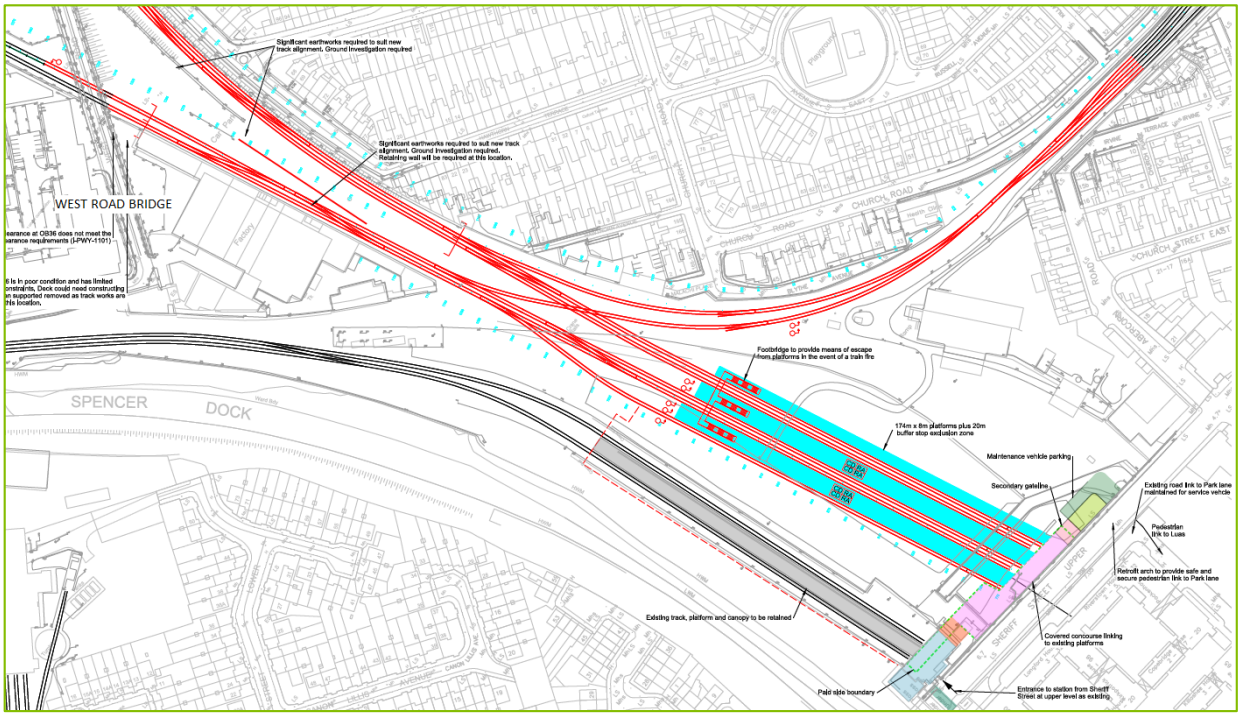


Figure 3: Extract from Option A General Layout

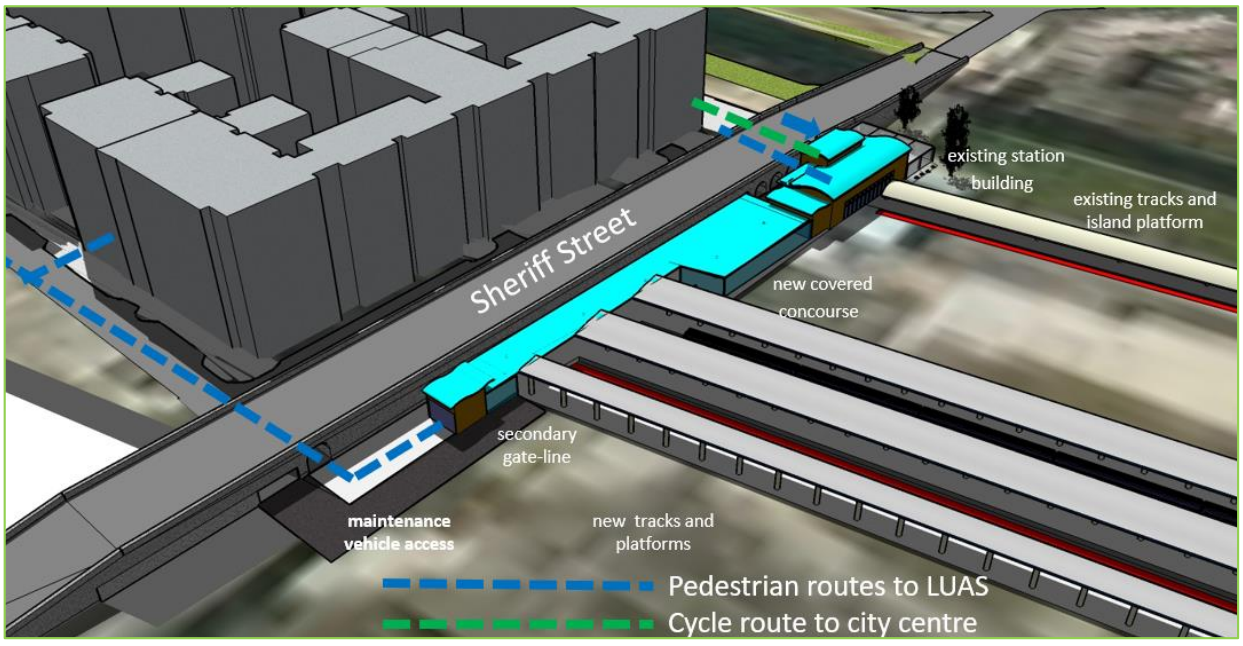


Figure 4 Option A Design Model

3.3.1 Engineering

The major constraint in development of this option is the short distance between the northern end of the platforms and the divergence of the three rail routes the station is to serve. This is exacerbated by the difference in gradient between the routes, since the necessary vertical curves cannot generally coincide with switches and crossings. The new layout requires two diamond crossings for the freight connection to and from North Strand to cross the tracks linking the platforms with East Wall Junction. 25km/h is possible on all routes on the layout.

It has been possible to develop an option where all tracks and platforms are approximately at grade. However, due to the space limitations, it has not been possible to provide any inter-connections between the routes, so each platform is accessible to and from only one route.

Furthermore the new platforms serving the Phoenix Park and Northern lines are located a short distance to the east of the existing platforms which are retained to serve the Maynooth line. To allow use of a standard angle on the diamond crossings the two platform tracks leading to the Northern line must be parallel with no island platform between them. Within these constraints it has been possible to provide an extra platform for operational flexibility, which is connected to the route via North Strand Junction, making a total of seven platforms. For these reasons the footprint of option A is larger than that of the other options.

As West Road bridge is assumed to be retained, the tracks must avoid the central pier. If the bridge was replaced for electrification or other reasons, the tracks could be made parallel and the nearby crossovers optimised with a small operational benefit from exchanging the positions of the facing and trailing crossovers.

The existing platforms and 30km/h approach tracks are retained without modification and continue to serve the route via Newcomen Junction, with the new platforms and canopies broadly replicating the existing. The existing station building is assumed to be modified with eastward extension to access the new platforms.

Passenger access to and from the new station would continue via the existing western at-grade entrance, leading to a walkway under the Sheriff Street Upper viaduct and along the canal bank to Mayor Street Upper. Additional access is provided onto Sheriff Street Upper via lifts and stairs, and by a new route from the east of the extended building through an existing span of the Sheriff Street Upper viaduct to reach the north end of Park Lane.

Provision is made for emergency egress in the event of a train fire by the introduction of a footbridge and stairs at the North end of the platforms, and safety refuges for those unable to use stairs.

Should DART Underground be built in line with previously-approved designs, the existing platforms serving the Maynooth line could continue to operate. However, the throat of the proposed eastern platforms clashes with the area of the Underground portal. It is likely that during and after the Underground construction, this part of the station could be no more than two platforms connected via Newcomen Junction and probably one or two more platforms with a single line connection via North Strand Junction.

3.3.2 Operations

The table below summarises the maximum service of Docklands trains on the three routes for three alternate routing options.

Table 3. Maximum route capacity (tphpd) for station Option A

Routeing option	Maynooth line	Phoenix Park line	Northern line
No diversion at Glasnevin	8	12	10
Routeing of 10tphpd Docklands Maynooth trains via existing Glasnevin connection and North Strand Junction	18	2	10
Routeing of 6tphpd Docklands Phoenix Park trains via potential new Glasnevin connection and Newcomen Junction	2	18	10

Capacity is limited to 10tphpd from the Northern line, but this is likely to be adequate as a significant proportion of the service on that line is always likely to continue to serve Connolly. Because option A is effectively three separate stations side by side, the above maximum services can operate simultaneously, subject to any constraints at Glasnevin. However the lack of connections between the platforms serving the three routes limits operational flexibility; for example there is no scope to interwork trains between routes except by use of the Glasnevin connections.

A third platform has been included in the design for Option A, serving the route via North Strand. However this only increases the capacity by that route from 10tphpd to 12tpd, and at

the cost of extending turnaround times from 7.5min to 10.5min which would require an extra train in service.

A disadvantage of Option A is the lack of space to hold trains between the station and Newcomen Junction. This is likely to be a severe operational restriction if significant numbers of trains access both Docklands and Connolly by this route.

3.4 Option B: East of Spencer Dock, north of Mayor Street Upper

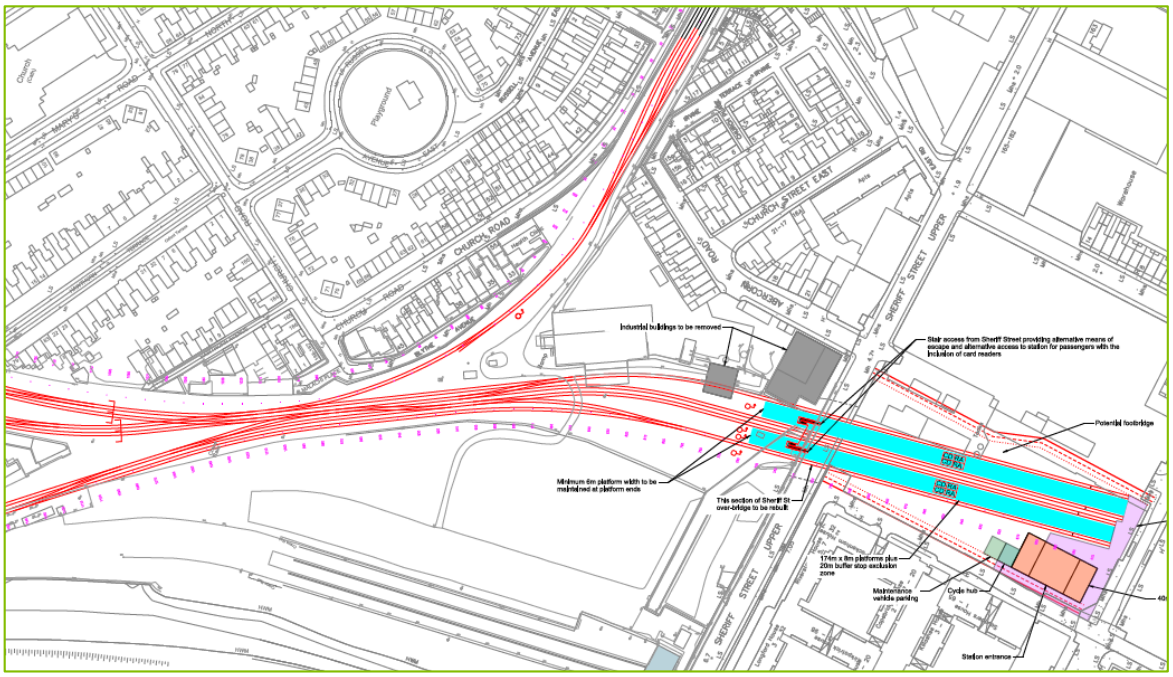


Figure 5: Extract from Option B General Layout

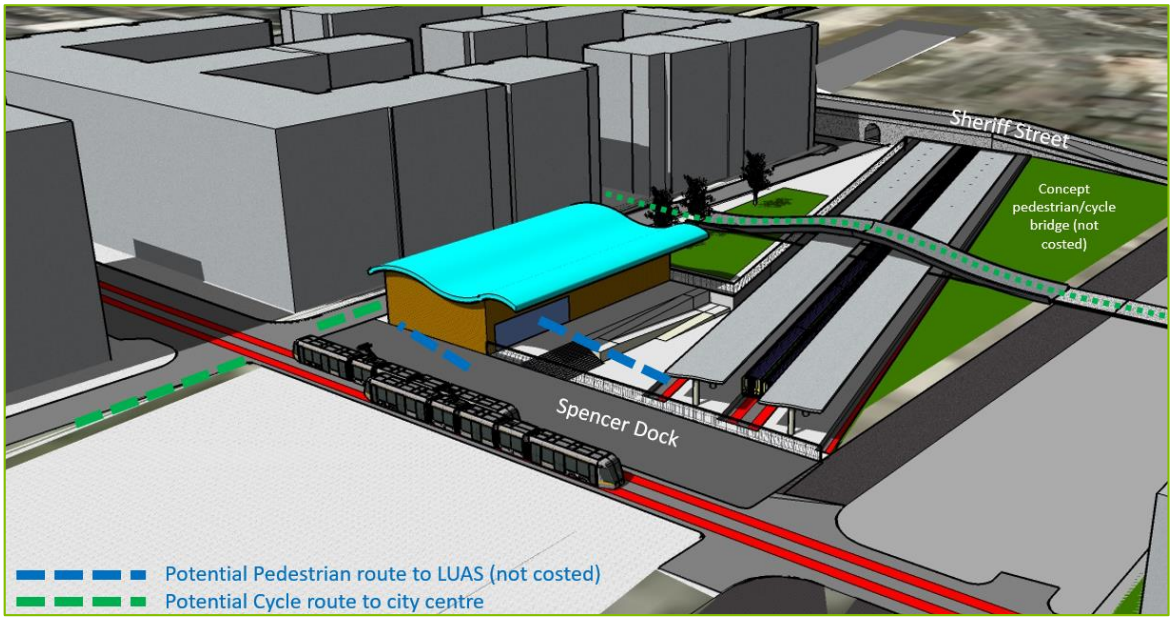


Figure 6 Option B Design Model

3.4.1 Engineering

To keep the platform straight and to limit curves outside the platform to a 200m radius, the platforms of option B have been angled relative to Park Lane. The southern end of the eastern platform track is now at the western boundary of the development now under construction between Mayor Street Upper, New Wapping Street and Sheriff Street Upper. The northern end of the western platform track is similarly as close as possible to Park Lane without blocking it, requiring re-configuration of the turning head in this area to run underneath Sheriff Street Upper. Use of a 1000m radius on the platform was also considered but does not significantly improve the geometry, so platforms are straight throughout their length and tracks continue straight for 20m beyond. This width constraint limits the station to four platforms, and the station blocks the access beneath Sheriff Street Upper to the current coach park.

Sheriff Street Upper spans the platforms, requiring replacement of the existing bridge. Even with minimisation of the depth of this structure, clearance for 25kV electrification requires the station area to be sunk so that top of rail is approximately 1m below grade. Because of the high water table, this in turn requires the station to sit in a concrete trough with pumped drainage.

Like Option A the centre pier of West Road overbridge affects the nearby crossovers. However the effect is less severe for option B, with re-building of the bridge allowing only minor re-alignment and standardisation of components with no operational benefit.

The station building is located west of the tracks, between the buffer stops and Park Lane (but still within CIÉ land) with a cross-walk separating the buffer stop exclusion zones from Mayor Street. The station entrance is on the northern platform of the Luas stop, level with the top of the Luas platform, with a ramp and stairs provided down to railway platform level. Emergency stairs are also incorporated from near the northern end of the platforms up to Sheriff Street Upper, with safety refuge for those unable to use stairs. An enhanced facility with lifts might be developed to provide a secondary entrance to the station but has not been included in the costings.

Option B has a greater distance between the platform ends and Church Road Junction than Option A. Hence it has been possible to develop a 25km/h throat layout with four parallel approach tracks and crossovers to give access between any platform and any of the three rail routes, as well as freight access via North Strand and East Wall junctions.

Most of the footprint of Option B clashes with that of the proposed DART Underground. It is unlikely that any part of the station would remain operable during or after any Underground construction. However the existing Docklands station platforms could be kept and re-connected to the rail network should the Underground cause demolition of Option B.

3.4.2 Operations

Table 4. Option B results

tphpd	Via Newcomen Jn	Via North Strand Jn	Via East Wall Jn
Sustained trains per hour (turnaround ≥8min, service interval multiple of 3min, no conflicting services on other routes)	12	12	12
Maximum simultaneous services (subject to some constraints on timetabling conflicting routes)	4	12 shared between the routes	
	8	8 shared between the routes	
	12	4 shared between the routes	

Table 5. Maximum route capacity (tphpd) for station Option B

Routeing option	Maynooth line	Phoenix Park line	Northern line
No diversion at Glasnevin	see Table 4	see Table 4	see Table 4
Routeing of up to 8tphpd Docklands Maynooth trains via existing Glasnevin connection and North Strand Junction	0	16	0
Routeing of up to 8tphpd Docklands Phoenix Park trains via potential new Glasnevin connection and Newcomen Junction	16	0	0

Train journey times for option B will be approximately 30s longer than for option A in each direction. Together with the longer minimum turnaround times for option B, some timetable options will require more trains to run the services.

Option B has considerable operational flexibility with access between all three routes and all platforms. However fewer platforms and the shared approach tracks mean that total capacity is

lower than option A, particularly when connections at Glasnevin are considered. This simple analysis suggests that total capacity falls slightly short of the 18tphpd required by project objectives. However by reducing turnarounds to 7min via East Wall Junction and 6.5min on the other two routes, 10tphpd could be operated via Newcomen Junction and a total of 10tphpd via East Wall Junction and North Strand Junction, giving a total station capacity of 20tphpd. However these short turnaround times would require driver step-back or other measures to ensure operational robustness.

3.5 Option C: East Wall Yard

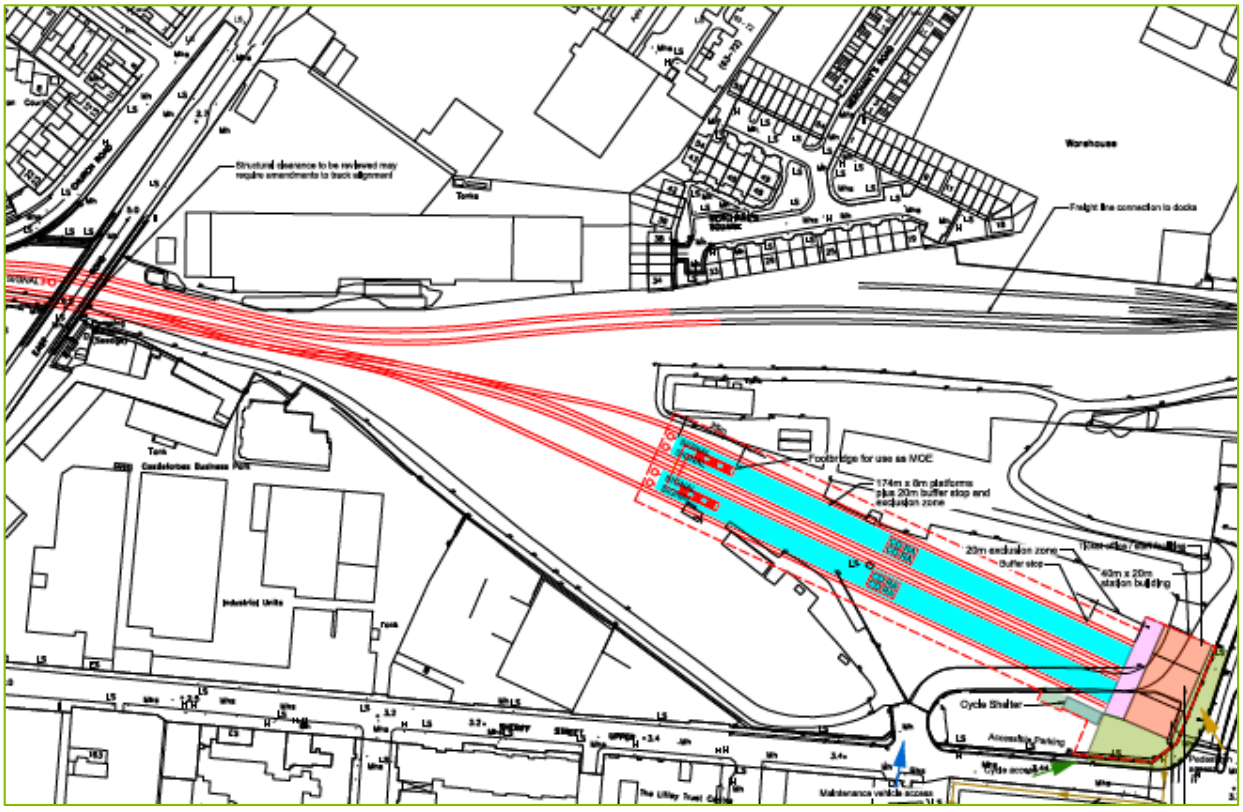


Figure 7: Extract from Option C General Layout

3.5.1 Engineering

A configuration with the station towards the south of the site was adopted. This minimises the walking distance to Luas and the destinations in the Docklands area, and also avoids conflict between passenger and freight operations.

Two double junctions at Church Road allow trains on all three routes to access the link to the current East Wall Yard. This link is increased to four tracks, the southern pair serving the passenger station and the northern pair connecting to Alexandra Road. We assume that East Road overbridge could be modified to provide electrification clearance, or the tracks lowered beneath it, but this would require confirmation should this option go forward.

25km/h is assumed for the layouts at Church Road and the station throat and would also apply to the short distance between them.

Except for the tracks to Alexandra Road, the facilities at East Wall Yard would have to move, to make room for the station. The costings assume provision of alternatives in the Dublin area, but this study does not include identification of suitable sites.

The station building is positioned behind the buffer stop exclusion zones with the entrance at the corner of East Wall Road and Sheriff Street Upper. A footbridge is provided at the western end of the platforms for emergency exit purposes, with safe refuges for those unable to use steps.

The DART Underground proposal clashes with Option C in the area of Church Road Junction. During or after any Underground construction, Option C could have double track connections to the Maynooth line but the connection to the Phoenix Park and Northern lines would probably be single. A significant period of closure of the Docklands station would be required to create a cut-and-cover trench, which would pass beneath the switches and crossings at Church Road. The existing Docklands station could be retained and re-connected to the railway if Underground works led to temporary or permanent closure of Option C

3.5.2 Operations

The Option C station is further from Church Road Junction than the other options, so there the opportunity to insert another signal between them. This would improve operational robustness to some degree by allowing trains to wait here for an onward path. However it does not improve capacity because the capacity analysis assumes trains would not be checked by signals. To avoid encountering adverse aspects requires a clear route through Church Road Junction to or from the platforms.

By analogy with Option B, Option C is expected to allow 12tphpd shared between the three routes, and in normal operation only three platforms would be necessary. To achieve this maximum, trains on the same routes must be scheduled to pass each other in the vicinity of the three existing junctions.

Journey times for Option C are expected to be approximately 90s longer than option B and 120s longer than option A in each direction. This will result in one extra train being required to operate the more intensive timetable scenarios. The capital or lease costs of any extra rolling stock are not included within the infrastructure costs provided in Appendix A but are taken into consideration in the relative operational criterion assessment between options.

3.6 Option M: New Wapping Street

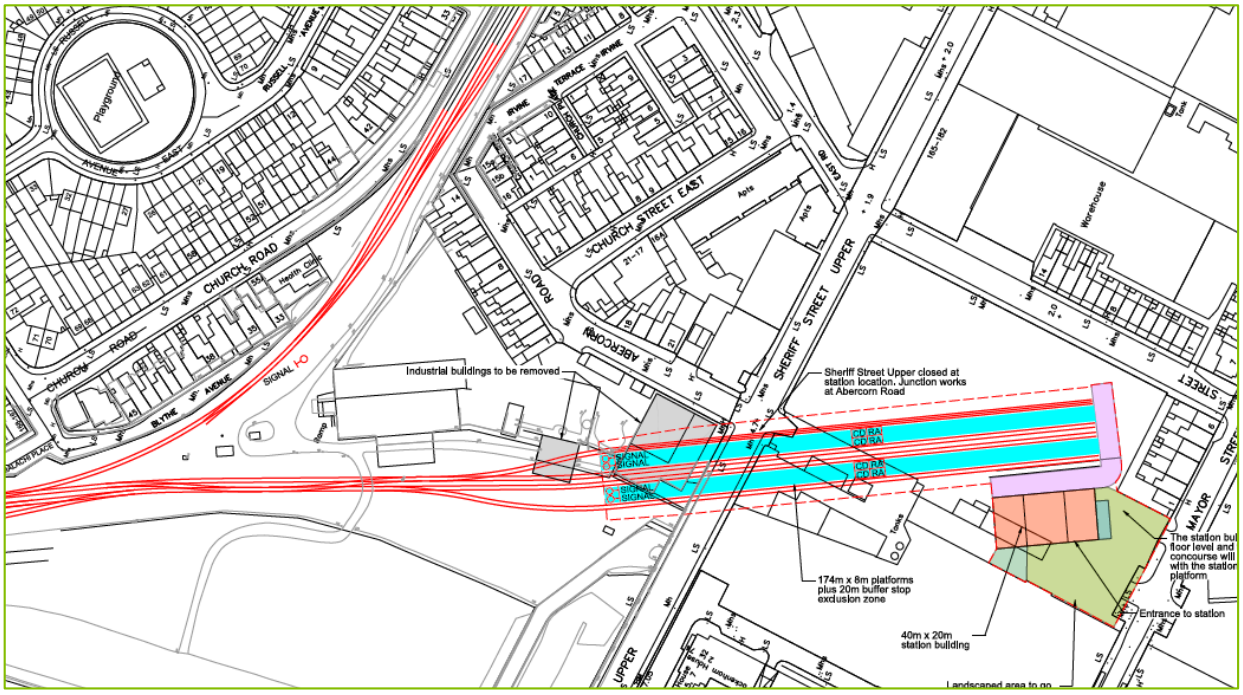


Figure 8: Extract from Option M General Layout

3.6.1 Engineering

Option M has similarities to option B, but was shortlisted in order to test an alternative that eliminates the tight curves required to route the line into the option B.

A number of sub-options of option M are possible within the block bounded by Sheriff Street Upper, Wapping Street, Mayor Street Upper and Spencer Dock. The one shown in

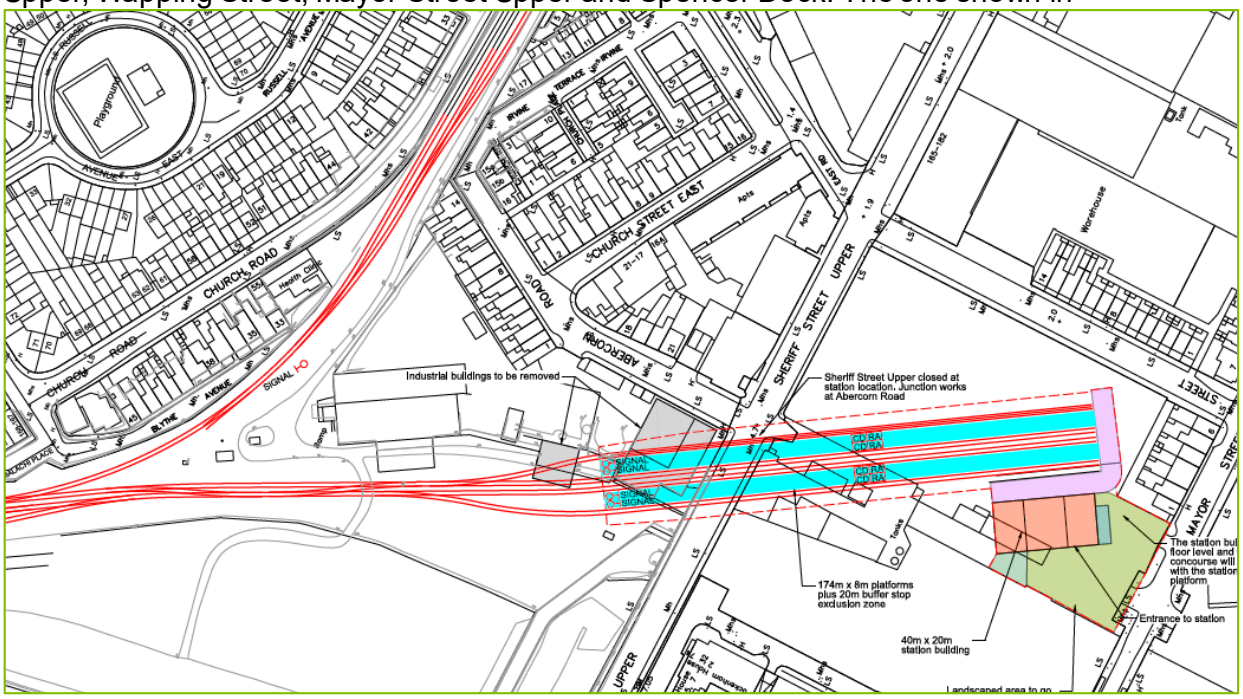


Figure 8 avoids the existing housing, and the two-track throat shown could be enhanced to a four-track layout like option B. However all sub-options clash significantly with the development now under construction in the eastern part of this block.

The platforms must extend underneath Sheriff Street Upper. Like option B, option M has steps up to Sheriff Street Upper for emergency evacuation, and places of safety refuge for those

unable to use steps, and these could be developed at significant extra cost into a secondary entrance.

Re-grading of Sheriff Street Upper to pass over option M would affect Abercorn Street and would be highly disruptive to nearby properties, so is assessed not to be feasible. As the streets are lower where they pass over the option M tracks than the option B tracks, option M has to be at a lower elevation than option B. Although sub-options of option M vary in detail, all would require a concrete trough and pumped drainage. They also take up much of the eastern part of the block, which is not CIÉ land and where planning permission has been granted for development. Thus they incur a large land purchase cost, included in Appendix B.

The station throat and part of the actual station for option M clash with the potential DART Underground portal and associated structures. Like Option B it is unlikely that any part of Option M could be retained during or after any DART Underground construction, but the existing Docklands platforms could be retained and re-connected in this eventuality.

3.6.2 Operations

With the same maximum number of platforms, scope for a similar station throat layout and similar distances and speeds achievable, Option M is deemed to be equivalent to Option B and can be assumed to have the same operational capabilities.

4. Multi-Criteria Assessment

4.1 Economy

4.1.1 Capital Costs

Order of magnitude infrastructure costs for each option, together with notes on assumptions and exclusions are presented in the Appendix B. It should be noted these include the cost of land acquisition outside CIÉ ownership for Option M, for which an independent estimate has been obtained and adds €73m to the construction costs for this option

Table 6. Capital Cost Assessment

Option	Relative Cost	Description
A	€91m	Significant advantages over other options
B	€138m	Some advantages over other options
C	€124m	Some advantages over other options
M	€222m	Significant disadvantages over other options

4.1.2 Operating Costs

Section 3 considers the operational implications of the four options. The assessment is derived from that discussion, taking account of the following factors:

- Station capacity, with or without diversion of trains at Glasnevin
- Operational flexibility, such as the ability to interwork trains on different routes
- Journey time, and whether this creates a need for extra trains to run the same service
- Freight access was also considered but is not assessed to be a significant differentiator.

Table 7. Operating Cost Assessment

Option	Description
A	Comparable to other options
B	Comparable to other options
C	Some disadvantages over other options
M	Comparable to other options

4.1.3 Demand

The area within a 500m and 1km walking distance was assessed for each option, with the assumption that four new pedestrian bridges crossing the Liffey would be in place. It should be noted that two of those bridges are not fully committed; therefore figures have also been estimated without those bridges in place.

An estimate of the relative employment catchment of each option was carried out using forecast 2035 data at Small Area zone level, taken from the Eastern Regional Model zones. Where the catchment area cuts across a zone boundary, a Tabulate Intersection tool in ArcGIS was applied to calculate the proportion of each zone within each option catchment. For example, if 5% of the area of a zone is within the catchment, 5% of the forecasted 2035 jobs are assumed to be within the catchment. It is acknowledged that this approach has some limitations as it assumes jobs are evenly distributed and does not account for areas containing water, where no jobs are located. This method was considered appropriate for relative assessment purposes at this stage of assessment.

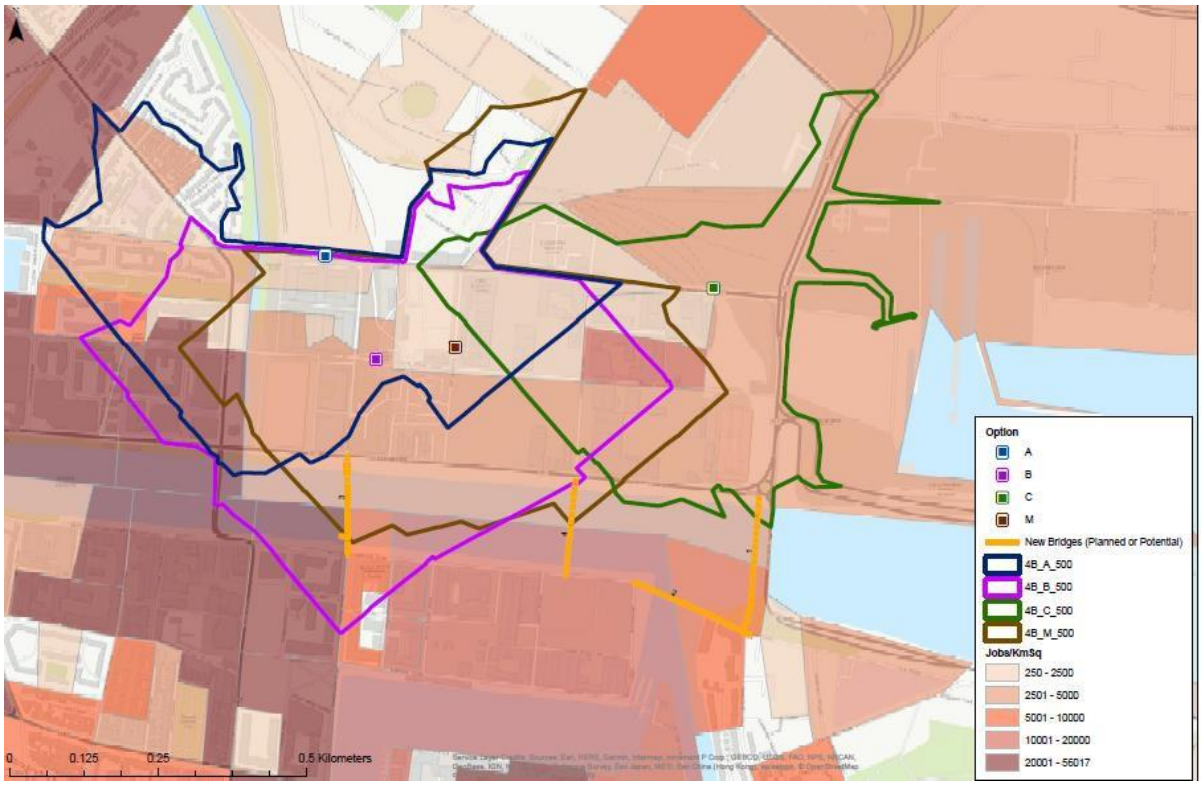


Figure 9: 2035 Employment 500m Catchment (assuming four bridges in situ)

Figure 9 above shows the 500m catchment for each option overlaid on the 2035 employment data, assuming all four bridges are in place. Similar maps have been prepared for 1km catchment and the scenario with only two bridges.

Table 8. Estimated Employment Catchment

Distance	Option	Four Bridges	Tw o Bridges
500m	A	1660	1606
	B	3451	2405
	C	974	950
	M	1489	1236
1km	A	17880	16511
	B	20163	16094
	C	4904	3691
	M	15198	10724

Option B performs strongly on this assessment, given its closer proximity to higher density employment zones on the south and western side of the study area. Option C performs worst. Option A similar to Option M on this criterion.

The overall assessment is given in Table 9.

Table 9. Demand Assessment

Option	Description
A	Some advantages over other options
B	Significant advantages over other options
C	Significant disadvantages over other options
M	Some advantages over other options

4.2 Integration

4.2.1 Land Use Integration

The following were taken into consideration in the option assessment:

- National Development Plan 2018-2027;
- Site zoning (Dublin City Development Plan 2016 – 2022); and
- Site specific objectives outlined in the above development plan.

The following National Strategic Outcomes of the Project Ireland 2040, National Development Plan 2018 – 2027 (the NDP) are of most relevance to the proposed station relocation:

- NSO 4: Sustainable Mobility; and
- NSO 8: Transition to a Low-Carbon and Climate-Resilient Society

NSO 4 states that a step change is required to put environmentally sustainable public transport systems in place which represent a decisive shift away from polluting and carbon-intensive propulsion systems. The NDP aims to deliver a public transport network that will provide high-quality passenger interchange points which facilitate convenient transfer between efficient and integrated public transport services. Key projects noted in the NDP are Metro Link (Dublin), BusConnects (Dublin, Cork and Galway) and priority elements of DART Expansion (such as the subject of this study), but not DART Underground.

NSO 8 notes that a comprehensive integrated public transport network for Ireland's cities connecting more people to more places is a key objective of the NDP.

As agreed, while commentary relating to the impact of station options on potential future Dart Underground plans is discussed it is not used as an assessment criterion within the MCA. It is also noted that reference to Dart Underground in local development plans pre-date the NDP and given the status of DART Underground within the NDP it is assumed that any planning permission sought by the NTA to develop a station (in an area identified in a local development plan, as requiring consideration) would not be considered a material contravention of said local development plan.

Table 10 below gives the definition of the relevant terms within the Dublin City 2016-2022 development plan used in this section.

Table 10. Planning definitions

Item	Definition
Strategic Development Zone (SDZ)	Sites that are deemed to be capable of delivering development that is of economic or social importance to the State. There is no third-party right to appeal for certain planning applications within SDZs which could result in a fast-tracked planning application process subject to certain criteria being met.
Strategic Development and Regeneration Area (SDRA)	Key sites identified in the Dublin City Development Plan 2016– 2022 as sites capable of delivering a significant number of homes and employment within the city.
Z1 Zoning	Residential zoning. The zoning objective is "to protect, provide and improve residential amenities".
Z14 Zoning	Regeneration Areas. The zoning objective is "to seek the social, economic and physical development and/or rejuvenation of an area with mixed uses of which residential and "Z6" would be predominant uses". It is a key objective of the Dublin City Development Plan 2016 – 2022 for development proposals on Z14 lands within SDRA 6 to: • Support sustainable transport initiatives which facilitate pleasant, accessible and easy movement to, from and within the Docklands area; • Develop an integrated transport strategy for the entire Docklands area and to pro-actively promote sustainable smarter travel.

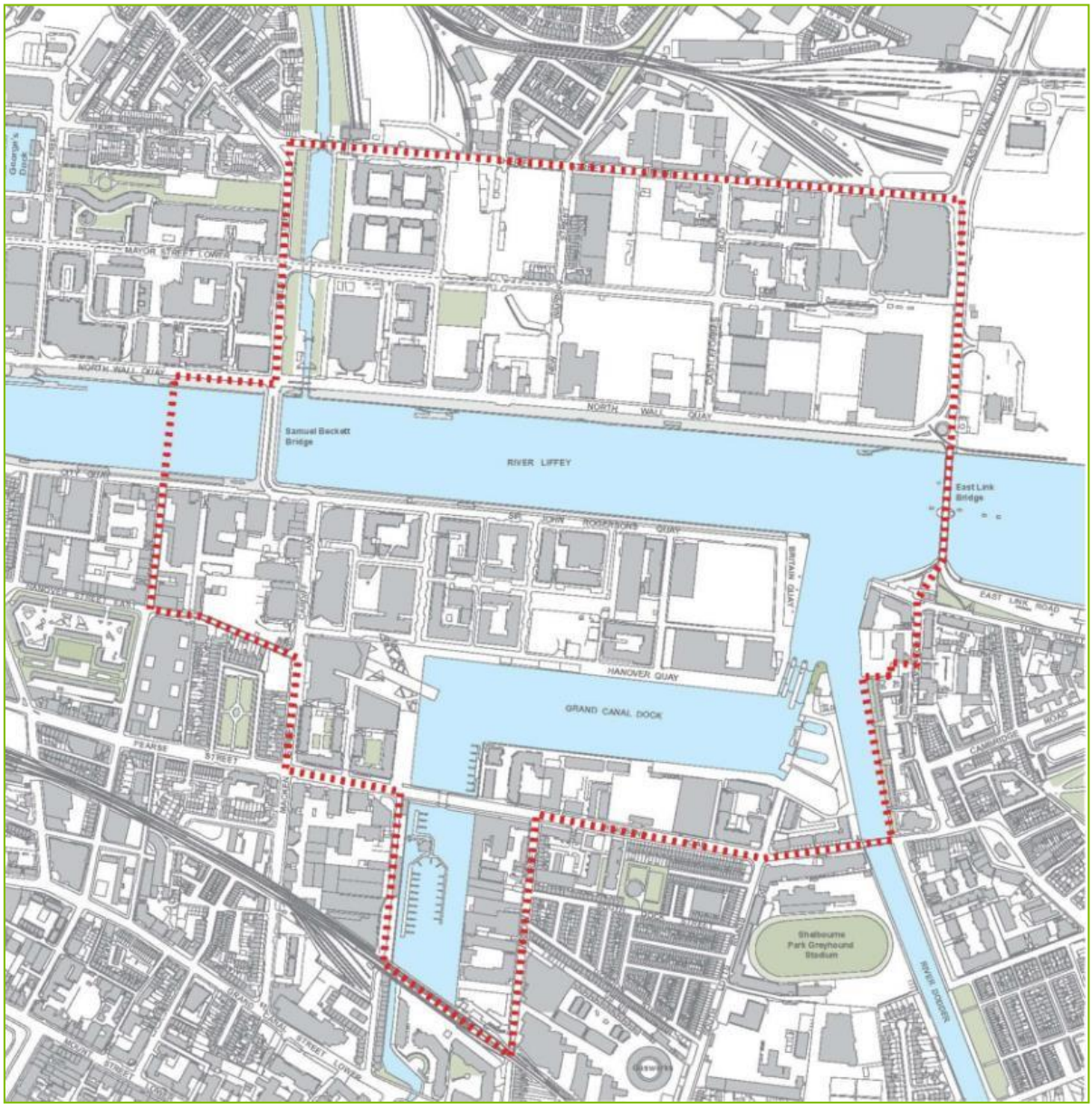


Figure 10: Docklands SDZ

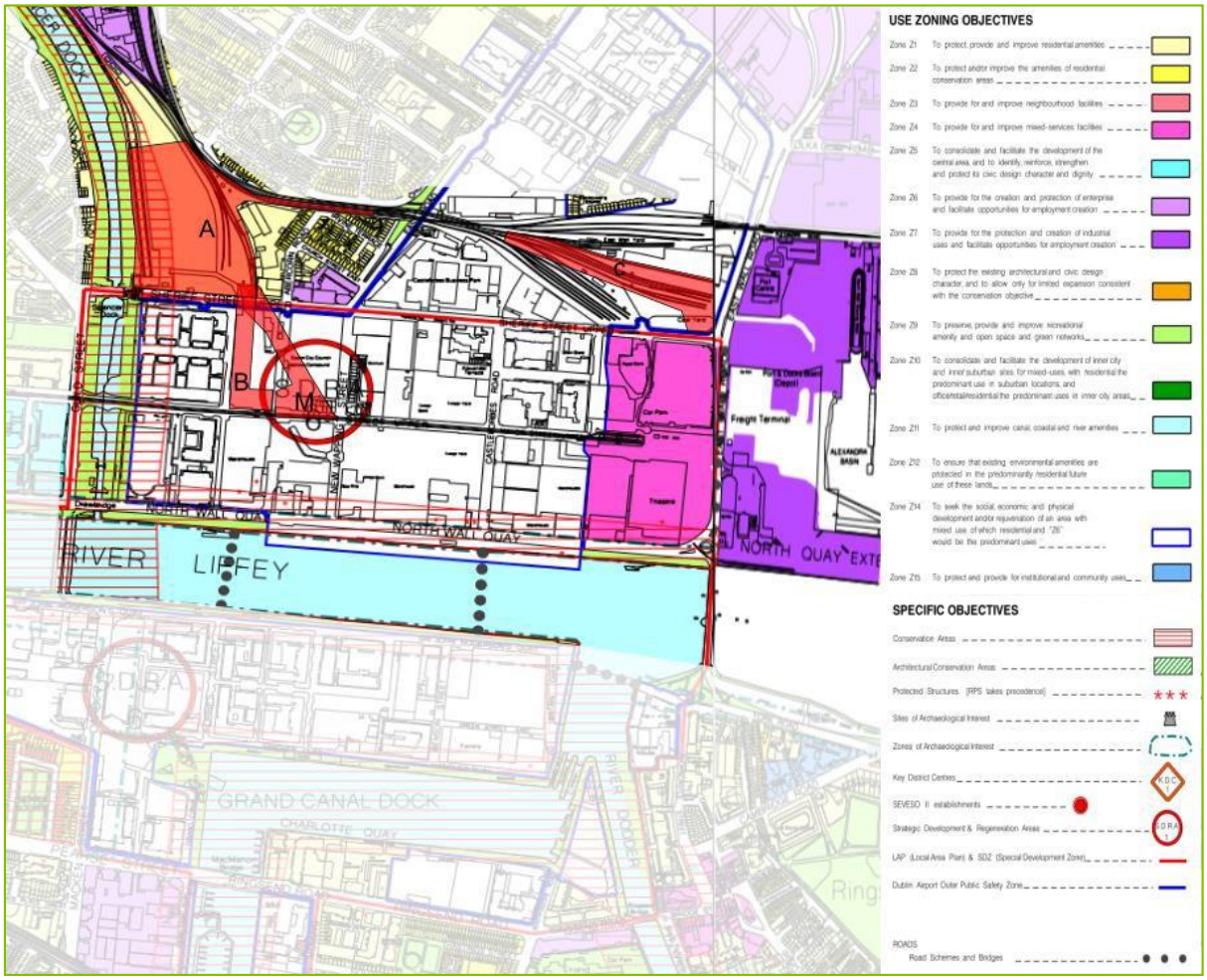


Figure 11: Planning considerations of site options

Figure 11 shows the general sites of each proposed option overlaid on the Dublin City Development Plan 2016 – 2022 zoning map.

Option A is located on the site of the existing Docklands Station. The location falls within a site zoned as Z1 (Sustainable Residential Neighbourhoods) and is located outside of both the SDZ and the SDRA. It may therefore not benefit from the fast-track routes to obtaining planning permission that would apply if the site was located within the SDZ. However this may not impede planning approval on this site because the station is already in this location, and there are no site-specific objectives in the Development Plan.

Options B and M are located within both the North Lotts and Grand Canal Dock SDZ and SDRA 6. The sites are predominantly zoned as Z14 (regeneration areas); however a small portion of both sites (the section to the north of Sheriff Street Upper) is located on lands which are zoned as Z1 (sustainable residential neighbourhoods). Part of the site of Option M has planning permission for residential development and is currently under construction.

Option C is site is wholly located within SDRA 6 on lands zoned as Z14 (regeneration area). It is not located within the North Lotts and Grand Canal Dock SDZ. The site would therefore not benefit from the fast-track routes to obtaining planning permission that would apply if it was located within the SDZ.

At this stage, options A, B and C are considered comparable, with M having disadvantages due to the granting of planning permission for a residential development, currently under construction.

Table 11. Land Use Integration Assessment

Option	Description
A	Comparable to other options
B	Comparable to other options
C	Comparable to other options
M	Some disadvantages over other options

4.2.2 Public Transport Integration

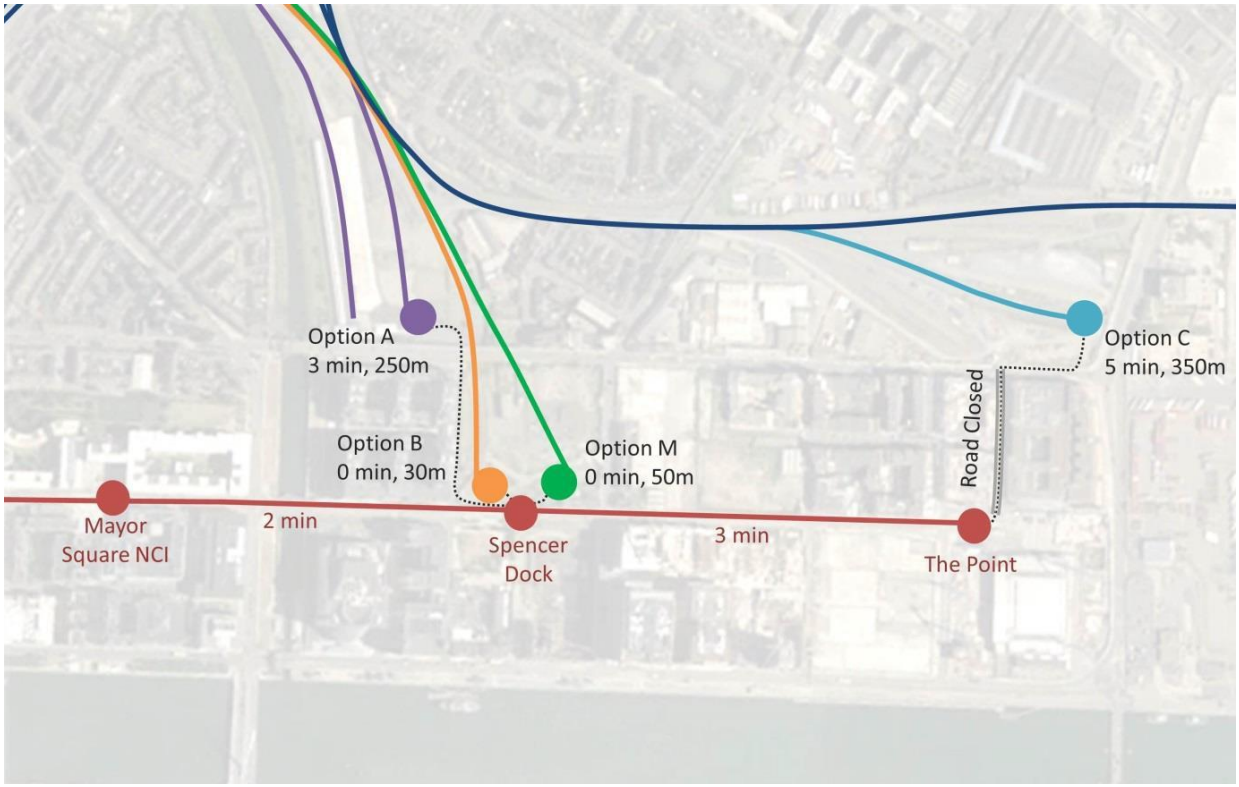


Figure 12: Luas integration

Table 12. Walking to Public Transport

Option	Nearest Luas stop	Walking distance (m)	Nearest bus Stop	Walking distance (m)
A	Spencer Dock	250	Convention centre	450
B	Spencer Dock	30	Irish Rail Building North Wall	280
C	The Point	350	East Wall Road	0
M	Spencer Dock	50	North Wall Quay (New Wapping Street)	220

Options B and M have entrances with direct access to the Luas Red Line (eastbound) platform at Spencer Dock and are located only a short walk from bus stops serving a range of destinations within the Core Bus Network along the North Quays. Option C provides access to a smaller range of bus services along East Wall Road but is a short walk away from the Luas between two high-rise buildings. Option A does not have direct access to Luas or to the current/proposed core bus network post-Bus Connects.

Table 13. Public Transport Integration Scores

Option	Description
A	Some disadvantages over other options
B	Comparable to other options
C	Comparable to other options
M	Comparable to other options

4.2.3 Walking/Cycling integration

The study area is served by a number of nationally recognised cycling routes and high quality walking and cycling provision is established. These lie primarily towards the west of the study area. Figure 13 below gives an indication of cycling provision in the area, although it is acknowledged this may not be reflect all routes regarded as cycle routes.

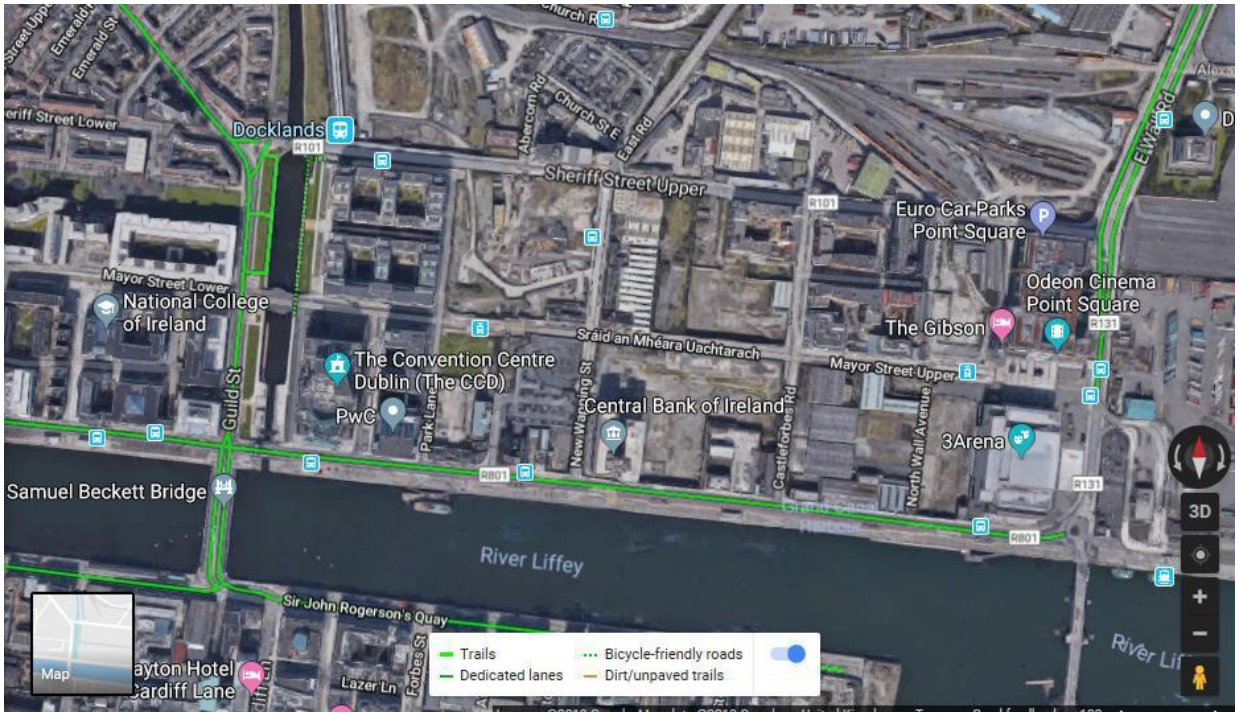


Figure 13: Cycling routes (source: Google Maps)

Option A is served by designated cycling routes, and the proposed station plans provide grade-separated pedestrian access towards Mayor Street and the wider Docklands area underneath Sherriff Street Upper, using the historic existing brick arches. The proposed Royal Canal Greenway on the western side of the Royal Canal would also link closely with Option A. Options B and M have their entrance on Mayor Street, which carries some vehicular traffic in addition to the Luas lines. There is some dedicated cycling provision along East Wall Road in addition to the Slí na Slaínte East Coast walking route, but the general environs of Option C are not currently well suited for walking and cycling. There is some potential for improvement given proposals for a new Liffey Crossing to the east of East Link (Tom Clarke) bridge.

Table 14. Walking/Cycling Integration Scores

Option	Description
A	Some advantages over other options
B	Comparable to other options
C	Comparable to other options
M	Comparable to other options

4.3 Environment

4.3.1 Cultural Heritage

A further desktop review was conducted in addition to that undertaken for Sift 1, to identify any potential archaeological and cultural heritage constraints within the study area. This included the following:

- Record of Monuments and Places (RMP sites) (including National Monuments under State care and Preservation Order);
- Record of Protected Structures (RPS);
- Buildings and historic landscapes / demesnes recorded on the National Inventory of Architectural Heritage (NIAH), which provides the basis for recommending the inclusion of particular structures in the RPS; and
- Architectural Conservation Areas (ACA) and Conservation Areas.

The majority of the data used for this section was obtained from the Dublin City Development Plan (2016-2022). Additional cultural heritage data was obtained from the National Monuments Service Historic Environment Viewer[6] and Dublin Bay Area Heritage Maps[7].

An area of approximately 70m on the western side of Option A falls within a designated Conservation Area associated with the Royal Canal and the River Liffey. This area includes the existing platforms and tracks forming the existing approach into Docklands station which would remain unchanged in this option.

Options B, C and M have no known archaeological features identified within any of the site footprints.

There are a number of protected structures and NIAH sites located outside of each site option, including:

- Sheriff Street Lifting Bridge (NIAH Reg No. 50010016) located to the south of Option A, and to the west of works required in Options B and M.
- Detached two-storey three bay house (NIAH Reg No. 50010196) located less than 50m to the southeast of Option M.

It is not anticipated that these NIAH structures will be significantly impacted by the potential new station and associated access tracks, though there is the potential that the settings of these structures and the Conservation Area could be impacted during the construction and operational phases.

Based on the above, all options are considered broadly comparable. As the surrounding area has a number of archaeological and cultural heritage sites, it is important to note that there is potential for previously unrecorded archaeological features to be discovered during the construction at any of the site options.

Table 15. Cultural Heritage Scores

Option	Description
A	Comparable to other options
B	Comparable to other options
C	Comparable to other options
M	Comparable to other options

[6] Historic Environment View Accessed 13th December 2018
7 Dublin Bay Heritage Maps Accessed 13th December 2018

4.3.2 Noise and Vibration

A Noise and Vibration assessment was carried out comparing the number of sensitive receptors that may be impacted from changes in noise conditions within 50m of each station option.

Table 16. Sensitive receptors within 50m of station entrance

	Option A	Option B	Option C	Option M
Properties within 50m of station entrance	>76	>100	>35	Circa 39

While some residential properties north and south of the existing freight-only line are impacted on the approach to the station, Option C would be preferable as it is located in an existing train yard and is surrounded by industrial properties. Options A, B and M are all surrounded by existing and potential future residential and mixed use properties.

The implementation of appropriate mitigation measures will be required to minimise potential negative impacts to these sensitive receptors.

Table 17. Noise and Vibration Scores

Option	Description
A	Comparable to other options
B	Comparable to other options
C	Some advantages over other
M	Comparable to other options

4.3.3 Landscape and Visual

Potential visual amenity and landscape effects were assessed for the four site options.

The townscape surrounding all four site options is characterised as predominantly urban / light industrial. The following option assessments are based on information available to date:

- Option A, which includes the existing Docklands Station, is located to the east of the Royal Canal. New elements of infrastructure within Option A are located on a brownfield site, to the east of (and just outside) the Royal Canal Proposed Natural Heritage Area (pNHA) and Conservation Area. The scale of new infrastructure is unlikely to impact on the proposed Royal Canal Greenway (planning permission pending) along the western banks of the Royal Canal north of the western end of Sheriff Street Upper, however this should be taken into consideration in the final design. The location of Option A at the northern fringe of the docklands redevelopment zone would isolate the proposed station from existing and future urban and commercial developments as well as from the existing Luas network and undermine its integration in the emerging urban townscape character.
- Option B is located adjacent to an existing high density residential apartment block with sensitive receptors. The existing townscape character is in the process of changing from a brownfield area to a new mixed use quarter with urban character. Equally the visual amenity is in the process of changing rapidly from a visually poor quality former warehouse district with derelict or cleared sites to contemporary urban residential and office district. The location of the proposed station would form a part of this transition process and provide a close link to the existing Luas network along Mayor Street Upper. The proposal is located outside the Conservation Area and other landscape constraints but is confined to the road corridor along Park Lane immediately adjacent to residential quarters.
- Option C is located at the existing terminus of freight trains at the edge of Dublin Port. This remote location is located at the north-eastern edge of the docklands redevelopment zone. There are no townscape and visual constraints other than the adjacent Slí na Slaínte - East Coast Route Dublin along East Wall Road. The development will be visible

along this section of the walking route. However, the proposed development would not alter the existing townscape character significantly considering its existing use by railway operations.

- Option M, similar to Option B, is located within the centre of the changing dockland development zone. The existing townscape character is in the process of changing from a brownfield area / warehouse district to a new mixed quarter with urban character. Equally the visual amenity is in the process of changing rapidly from a visually poor quality warehouse district with derelict or cleared sites to a contemporary urban residential and office district. The location of the proposed station would form a part of this transition process and provide an opportunity to provide a transport hub between rail and Luas, which would become integrated in the new urban townscape character and visually improve the area.

Based on the findings above, Options A, B and M are considered to be comparable in having greater potential than Option C to become a focal point in the developing urban townscape character and visual amenity.

Table 18. Landscape and Visual Scores

Option	Description
A	Comparable to other options
B	Comparable to other options
C	Some disadvantages over other options
M	Comparable to other options

4.4 Summary of Assessment

Based on the assessment criteria and the methodology applied, the Sift 2 process has resulted in the assessment provided in Table 19 below. For reference, the colour coding is as follows:

Significant advantages over other options
Some advantages over other options
Comparable to other options
Some disadvantages over other options
Significant disadvantages over other options

Table 19. Assessment

Criterion	Sub-Criterion	Option A	Option B	Option C	Option M
Economy	Capital Cost				
	Operating Cost				
	Demand				
	Overall assessment				

Criterion	Sub-Criterion	Option A	Option B	Option C	Option M
Integration	Land Use Policy/Plan Integration				
	Public Transport Integration				
	Walking/Cycling Integration				
	Overall assessment				

Criterion	Sub-Criterion	Option A	Option B	Option C	Option M
Environment	Cultural Heritage				
	Noise and Vibration				
	Landscape and Visual				
	Overall assessment				

Criterion	Sub-Criterion	Option A	Option B	Option C	Option M
Economy	Overall assessment				
Integration	Overall assessment				
Environment	Overall assessment				
	Combined overall assessment				

Overall, Options A and B both have some advantages over the other options.

While Option A benefits from the lower level of investment required to develop the site, the adjacent dedicated cycle routes and the presence of attractive walking routes along the canal, Option B performs strongly given its closer proximity to higher density employment zones on the south and western side of the study area.

Option C has some disadvantages due to is location at the periphery of the higher density development area. Option M also has some disadvantages, primarily driven by the

development currently taking place on the third-party-owned site and the costs associated with the purchase of non CIÉ lands.

In summary, Option A would cost less to develop whereas Option B would serve more people.

Appendix A Drawings

The following drawings are reproduced below and also issued separately.

A.1 Document Register

Drawing Number	Description	Format	Revision
60586077-ACM-DOC-DR-RT-000100	OPTION A TRACK ALIGNMENT	PDF	P02
60586077-ACM-DOC-DR-ZZ-000101	OPTION A GENERAL LAYOUT	PDF	P02
60586077-ACM-DOC-DR-ZZ-000102	OPTION A STATION LAYOUT	PDF	P02
60586077-ACM-DOC-DR-RT-000110	OPTION B TRACK ALIGNMENT	PDF	P02
60586077-ACM-DOC-DR-ZZ-000111	OPTION B GENERAL LAYOUT	PDF	P02
60586077-ACM-DOC-DR-ZZ-000112	OPTION B STATION LAYOUT	PDF	P02
60586077-ACM-DOC-DR-RT-000120	OPTION C TRACK ALIGNMENT	PDF	P02
60586077-ACM-DOC-DR-ZZ-000121	OPTION C GENERAL LAYOUT	PDF	P02
60586077-ACM-DOC-DR-ZZ-000122	OPTION C STATION LAYOUT	PDF	P02
60586077-ACM-DOC-DR-RT-000130	OPTION M TRACK ALIGNMENT	PDF	P02
60586077-ACM-DOC-DR-ZZ-000131	OPTION M GENERAL LAYOUT	PDF	P02
60586077-ACM-DOC-DR-ZZ-000132	OPTION M STATION LAYOUT	PDF	P02

Appendix B Capital Cost estimates

Appendix C Operational Assessment

C.1 Methodology

The operations review aims to quantify the ability of the station to handle different timetables.

Each of options A and B is initially tested to establish the maximum trains per hour per direction. This depends on:

Number of platforms accessible to and from that route. Because a greater number of trains on one route implies a lesser number on another route, the assumption is made that any platforms accessible by more than one route will be available at the time they are needed by the busier route.

Minimum turnaround time spent in the platform. This is ideally 8 minutes but shorter times may be acceptable subject to measures such as driver step-back and a possible performance penalty. The minimum turnaround time to achieve a particular service frequency is calculated and represents a measure of service robustness.

Platform re-occupation time, from the departure of one train to the arrival of another train in the same platform. It has four components:

- Time from the first train starting to move until its tail is clear of the last point of conflict with an incoming train on the same route. This is assessed via AECOM's ARTEM model, using recorded performance data of an 8-car DART unit and the gradients and permitted speeds predicted for the station area.
- 10s for the setting of points and signals for the second train.
- 7s for the driver of the second train to observe and react to the signal ahead changing from yellow to green.
- Time from the second train passing (at line speed) the signal before the signal protecting the platform approach, until it stops at the platform. This is also taken from ARTEM and represents an approach without signal checks.

The minimum sustained interval can be reduced for a short period, if several platforms are simultaneously empty for trains to arrive in quick succession, but such a period will be preceded and followed by a period during which the normal minimum sustained interval is not achievable.

Consideration is also given to whether arriving and departing trains conflict with each other. A conflict occurs when all of the following apply at any moment:

- A departing train is somewhere between starting to move in the platform and its tail passing over the last point of conflict with an arriving train.
- An arriving train is somewhere between passing the signal before the signal protecting the station approach and stopping in the platform.
- The two trains must take conflicting rather than parallel routes.

The duration of the first two conditions is the same as the times calculated when assessing the platform reoccupation time. The third condition depends on track layout, but for a simple layout with parallel tracks to two available platforms, linked by two crossovers, it represents a probability of 50%. The probability of conflict increases with the number of accessible platforms, so adding extra platforms does not increase the station capacity proportionately. It also tends to result in longer turnaround times for trains, thereby reducing the efficiency of train utilisation.

Capacity at both Connolly and Docklands is maximised if trains to and from the same station pass each other close to the three junctions where their routes diverge. To facilitate this, and to maximise the use of the 20tphpd nominal capacity of each route, timetables are based on intervals at the three junctions being multiples of 3min.

C.2 Assumptions

Platform numbering at Docklands is assumed to run from south/west to north/east.

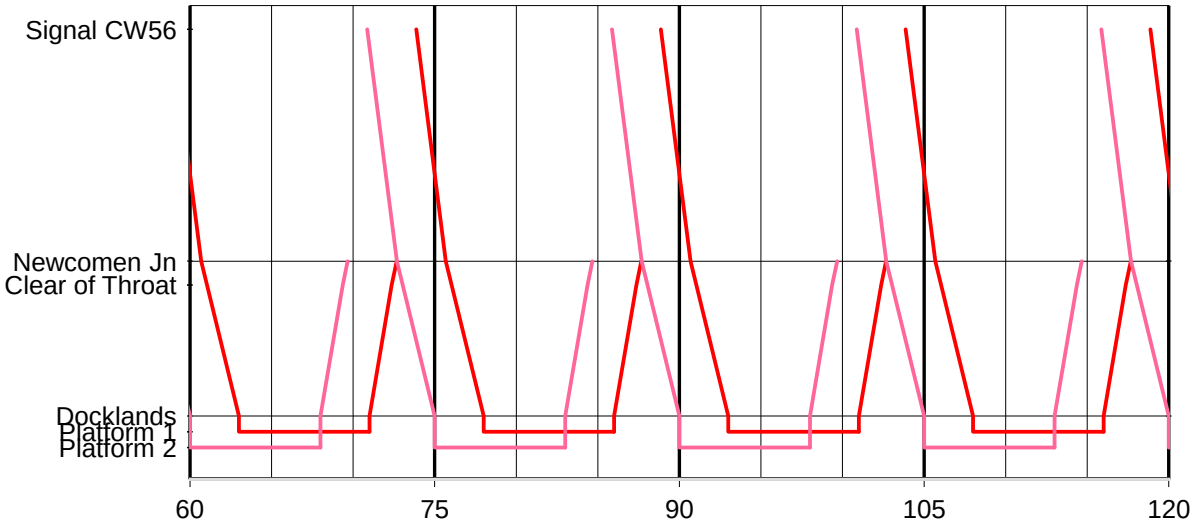
Train performance is based on acceleration recorded for a DART unit, and a braking rate in normal operation of 0.78m/s^2. A greater braking rate may be available but is assumed not to be used in normal operation. On entering a section with a greater permitted speed, the train does not accelerate until its front is 8 car lengths beyond the start of the section.

Permitted speeds on unmodified track are taken from the Irish Rail Working Timetable, with any available speed information from signalling plans being used to confirm exact position of restrictions. The speeds as quoted in km/h are taken as definitive.

In the Docklands area the speeds developed for the proposed layouts are used, with all trains assumed to take a turnout route and therefore not take advantage of any faster "straight through" speeds. A 15km/h speed is assumed for arriving trains within the platforms.

Unless otherwise shown on signalling plans, speed restrictions for lower-speed diverging junctions are assumed to apply from the signal protecting the junction.

C.3 Option A Results

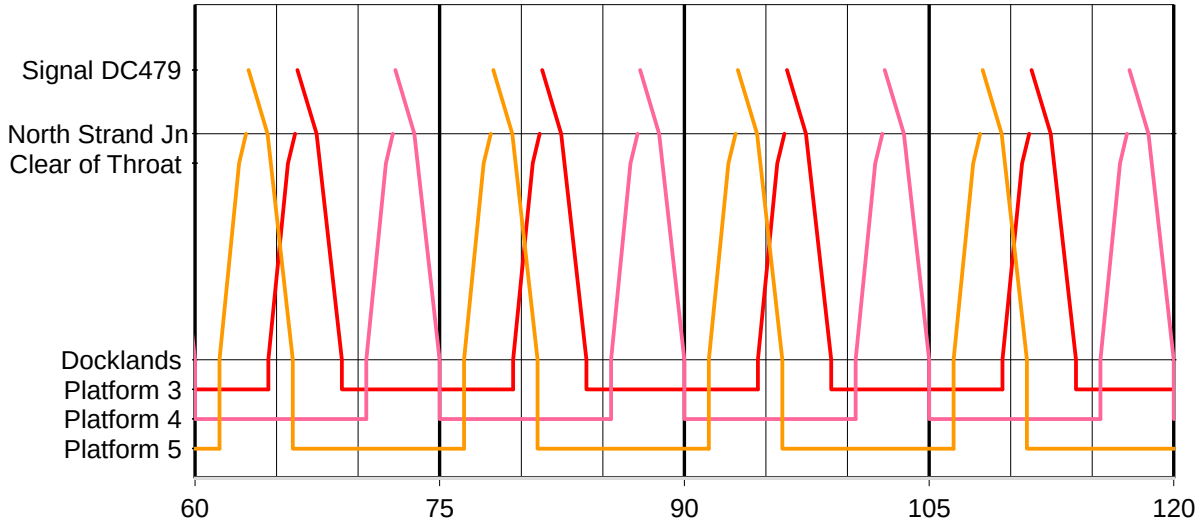


Graph for Option A via Newcomen Junction

Trains accessing Option A via Newcomen Junction use the existing tracks and station. The platform re-occupation time is significantly longer than for the other routes, because there is insufficient length for a signal between the platforms and Newcomen Junction so the route into the platform must be available much earlier for the approaching train to avoid signal checks. Lack of these signals in both directions is also a risk to reliable operation if significant numbers of trains are routed via Newcomen Junction to both Connolly and Docklands, as the route has to be available over both the station throat and the junction for a Docklands train to proceed.

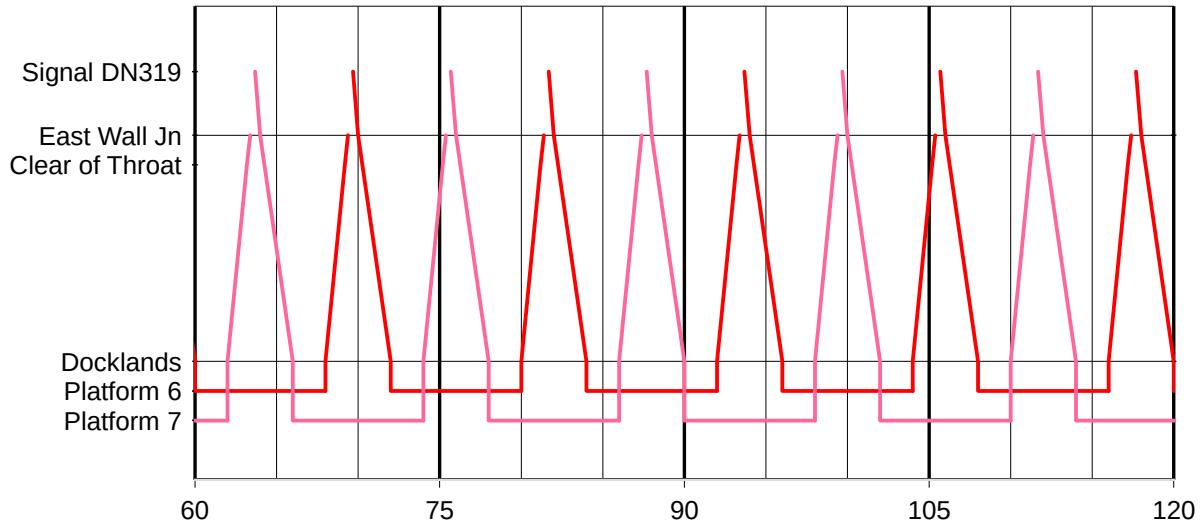
Hence the maximum achievable service is 8tphpd, shown as solid lines. The figure above shows an uneven service with trains passing each other close to Newcomen Junction at multiples of 3min intervals. This maximises the capacity available for Connolly trains by this

route. Alternatively, if there was no significant Connolly service via Newcomen Junction, a more even interval could be worked into Docklands at the same frequency.



Graph for Option A via North Strand Junction

Option A includes a third platform having access to and from the route via North Strand Junction. However the number of potential conflicts between incoming and outgoing trains limits the benefit of the extra platform. The service shown above gives 12tphpd, spaced at multiples of 3min but with the turnaround time extended to 10.5min. Alternatively a 10tphpd service could be operated using only two platforms and turnarounds of 7.5min.

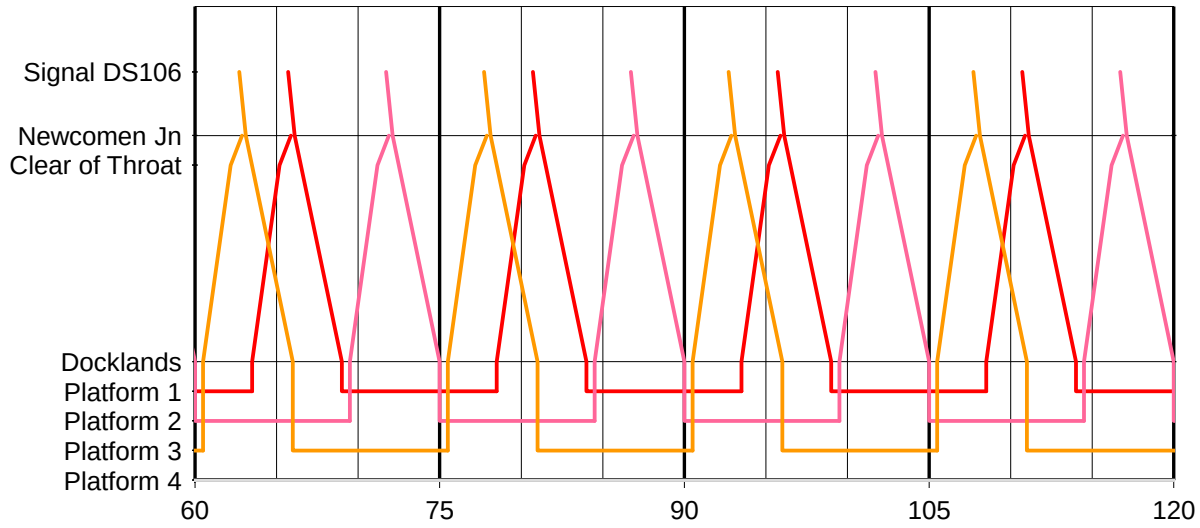


Graph for Option A via East Wall Junction

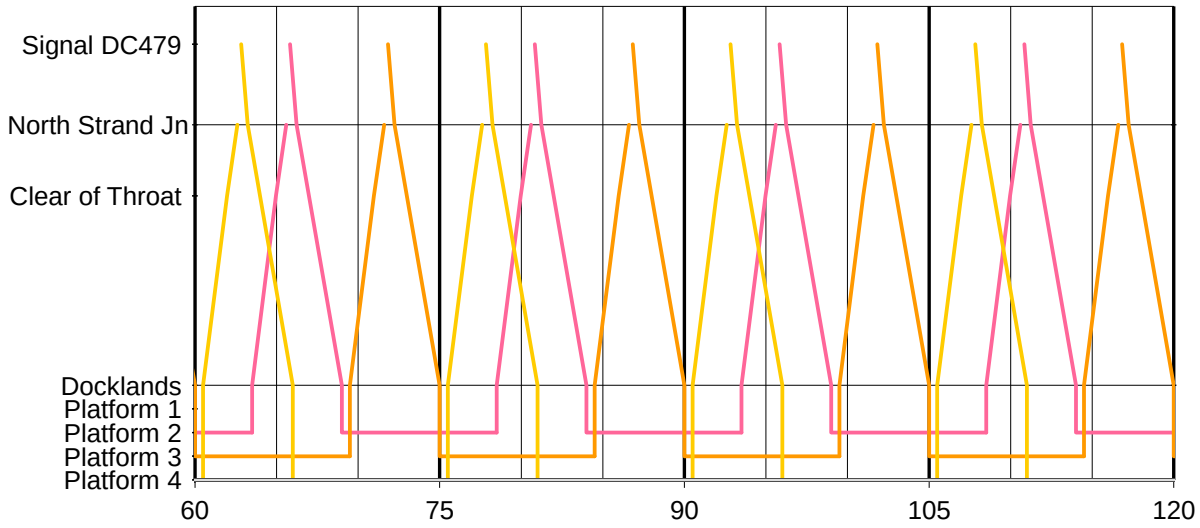
For the route via East Wall Junction the maximum service with an 8min turnaround is 10tphpd. This service has trains at regular 6min intervals, passing each other close to East Wall Junction, so is consistent with maximising the number of trains on the Northern line assuming it is signalled for 20tphpd.

Time (minutes:seconds)	Via Newcomen Jn	Via North Strand Jn	Via East Wall Jn
Departing train to clear throat	1:22	1:12	1:11
Arriving train from second signal	4:08	2:43	2:19
Interlocking and point operation and signal sighting	0:17	0:17	0:17
Platform re-occupation time, sum of above	5:47	4:12	3:50
Sustained trains per hour (turnaround ≥8min, service interval multiple of 3min)	8	12	10

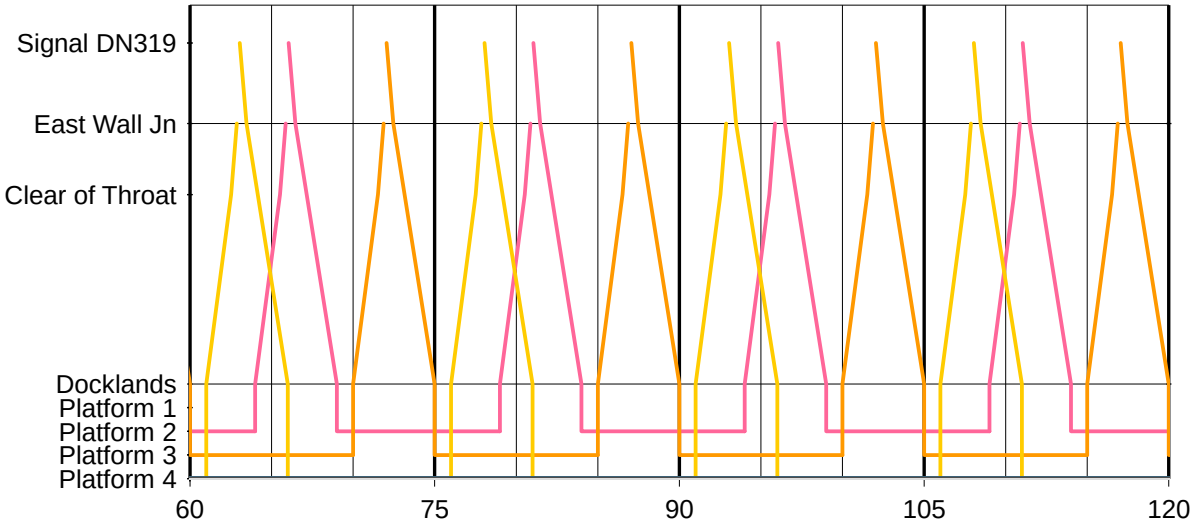
C.4 Option B Results



Graph for Option B via Newcomen Junction



Graph for Option B via North Strand Junction



Graph for Option B via East Wall Junction

Platform re-occupation times are very similar for the three routes, and therefore a similar service is possible on each route before consideration of conflicting services. In each case 12tphpd can be operated with exclusive use of three platforms. Turnaround time is 10min for the route via East Wall and 9.5min for the other two routes. Reducing turnaround to 7min and 6.5min respectively would allow 10tphpd per route on two platforms, but this short turnaround is unlikely to be operationally robust unless using driver step-back.

However these services cannot be operated simultaneously because they share platform and throat tracks. The figure above gives possible combinations based on specific platforms either being dedicated to the Newcomen Junction route or shared between the other two routes. In these scenarios the station operates as two independent stations with no track shared between them. There are some constraints on scheduling trains towards East Wall Junction and from North Strand Junction simultaneously.

Time (minutes:seconds)	Via Newcomen Jn	Via North Strand Jn	Via East Wall Jn
Departing train to clear throat	1:41	1:28	1:33
Arriving train from second signal	3:17	3:10	2:57
Interlocking and point operation and signal sighting	0:17	0:17	0:17
Platform re-occupation time, sum of above	5:15	4:55	4:47
Sustained trains per hour (turnaround ≥8min, service interval multiple of 3min, no conflicting services on other routes)	12	12	12
Maximum simultaneous services (subject to some constraints on timetabling conflicting routes)	4	12 shared between the routes	
	8	8 shared between the routes	
	12	4 shared between the routes	