DART+ South West

Technical Optioneering Report

Park West to Heuston Station

Area around South Circular Road Junction

Iarnród Éireann

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Glossary of Terms

ABP	An Bord Pleanála
ACA	Architectural Conservation Area
APIS	Authorisation for Placing in Service
ASA	Application for Safety Approval
AsBo	Assessment Body
ASPSC	Application Specific Project Safety Case
ATP	Automatic Train Protection
CAF	Common Appraisal Framework
Cantilever	OHLE structure comprising horizontal or near horizontal members supporting the catenary projecting from a single mast on one side of the track.
Catenary	The longitudinal wire that supports the contact wire.
CAWS	Continuous Automatic Warning System
CBI	Computer-Based Interlocking
CCE	Chief Civils Engineers Department of IE
CCRP	City Centre Re-signalling Project
CCTV	Closed Circuit Television
CDP	County Development Plan
CIE	Córas Iompair Éireann
Contact wire	Carriers the electricity which is supplied to the train by its pantograph.
CPO	Compulsory Purchase Order
Cross overs	A set of railway parts at the crossing of several tracks which helps trains change tracks to other directions.
CRR	Commission for Rail Regulation (formerly RSC – Railway Safety Commission)
CSM RA	Common Safety Method for Risk Evaluation and Assessment
CTC	Central Traffic Control
Cutting	A railway in cutting means the rail level is below the surrounding ground level.
D&B	Design & Build (contractor)
DART	Dublin Area Rapid Transit (IÉ's Electrified Network)
DART+	DART Expansion Programme
DeBo	Designated Body
Direct Current (DC)	Electrical current that flows in one direction, like that from a battery.

DCC	Dublin City Council
DRR	Design Review Report
DSR	Design Statement Report
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EIS	Environmental Impact Statement
Electrification	Electrification is the term used in supplying electric power to the train fleet without the use of an on-board prime mover or local fuel supply.
EMC	Electromagnetic Compatibility
EMU	Electric Multiple Unit (DART train)
EN	European Engineering Standard
EPA	Environmental Protection Agency
EPO	Emerging Preferred Option
ERTMS	European Rail Traffic Management System
ESB	Electricity Supply Board
Four-tracking	Four-tracking is a railway line consisting of four parallel tracks with two tracks used in each direction. Four track railways can handle large amounts of traffic and are often used on busy routes.
FRS	Functional Requirements Specification
FSP	Final Supply Points
GDA	Greater Dublin Area
GI	Ground Investigation
HAZID	Hazard Identification
Horizontal Clearance	The horizontal distance between a bridge support and the nearest railway track is referred to as horizontal clearance. Bridge supports include abutments (at the ends of the bridge) and piers (at intermediate locations).
HV	High Voltage
IA	Independent Assessor
IÉ	Iarnród Éireann
IM	Infrastructure Manager (IÉ)
IMSAP	Infrastructure Manager Safety Approval Panel
Insulators	Components that separate electricity live parts of the OHLE from other structural elements and the earth. Traditionally ceramic, today they are often synthetic materials.
KCC	Kildare County Council
Lateral Clearance	Clearances between trains and structures.
LCA	Landscape Character Area

Mast	Trackside column, normally steel that supports the OHLE.
MCA	Multi-criteria Analysis
MDC	Multi-disciplinary Consultant
MEP	Mechanical electrical and plumbing
MFD	Major Feeding Diagram
MMDC	Maynooth Multi-disciplinary Consultant
MV	Medium Voltage
NDC	National Biodiversity Data Centre
NIAH	National Inventory of Architectural Heritage
NoBo	Notified Body
NTA	National Transport Authority
OHLE	Overhead Line Equipment
Overbridge (OB)	A bridge that allows traffic to pass over a road, river, railway etc.
P&C	Points and Crossings
Pantograph	The device on top of the train that collects electric current from the contact wire to power the train.
PC	Public Consultation
Permanent Way	A term used to describe the track or railway corridor and includes all ancillary installations such as rails, sleepers, ballast as well as lineside retaining walls, fencing and signage.
POAP	Plan-On-A-Page, high-level emerging programme
PPT	Phoenix Park Tunnel
PRS	Project Requirement Specification
PSCS	Project Supervisor Construction Stage
PSDP	Project Supervisor Design Process
PSP	Primary Supply Points
QA/QC	Quality Assurance/Quality Control
RAM	Reliability, Availability, Maintainability
RC	Reinforced Concrete
Re-signalling	Re-signalling of train lines will regulate the sage movement of trains and increase the capacity of train services along the route.
RMP	Record of Monuments and Places
RO	Railway Order
RPS	Record of Protected Structures
RSC-G	Railway Safety Commission Guideline

RU	Railway Undertaking (IÉ)
SAM	Safety Assurance Manager
SAP	Safety Approval Panel
SDCC	South Dublin County Council
SDZ	Strategic Development Zone
SET	Signalling, Electrical and Telecommunications
Sidings	A siding is a short stretch of railway track used to store rolling stock or enable trains on the same line to pass
SMR	Sites and Monuments Records
SMS	IÉ Safety Management System
TII	Transport Infrastructure Ireland
TMS	Train Management System
TPH	Trains per Hour
TPHPD	Trains per Hour per Direction
TPS	Train Protection System
Track Alignment	Refers to the direction and position given to the centre line of the railway track on the ground in the horizontal and vertical planes. Horizontal alignment means the direction of the railway track in the plan including the straight path and the curves it follows.
TSI	Technical Specifications for Interoperability
TSS	Train Service Specification
TTAJV	TYPSA, TUC RAIL and ATKINS Design Joint Venture (also referred to as TTA)
Underbridge (UB)	A bridge that allows traffic to pass under a road, river, railway etc. The underneath of a bridge.
VDC	Direct Current Voltage
Vertical Clearance	For overbridges, an adequate vertical distance between railway tracks and the underside of the bridge deck (soffit) must be provided in order to safely accommodate the rail vehicles and the OHLE. This distance is known as vertical clearance and it is measured from the highest rail level.
WFD	Water Framework Directive

1 Introduction

1.1 Purpose of the Report

The purpose of this report is to provide technical input to the Preliminary Option Selection Report. This report shows the options considered as part of the project development and why the emerging preferred option was chosen.

This report provides the technical assessment of the area between Memorial Road Bridge (OBC3) and to the east of St. John's Road Bridge (OBC0A). This report presents the approach to option development, options assessment, and options selection. This optioneering process incorporates assessment by the following Design Workstreams and specialist Project Teams:

- Permanent Way
- Civils and Structures
- Signalling, Electrification and Telecommunications (SET) and Low Voltage Power
- Overhead Line Equipment (OLE)
- Environment
- Highways
- Geotechnical

The report provides:

- An area overview and a detailed description of the existing railway infrastructure and challenges.
- The Project Requirements for this area.
- The technical and environmental constraints, including the horizontal and vertical clearances at structures.
- The options considered for this area.
- The option selection process is leading to the identification of the Emerging Preferred Option, including the Sifting process and the Multi-Criteria Analysis process.

1.2 DART+ Programme Overview

The DART+ Programme is a transformative railway investment programme that will modernise and improve the existing rail services in the Greater Dublin Area. It will provide a sustainable, electrified, reliable and more frequent rail service, improving capacity on rail corridors serving Dublin.

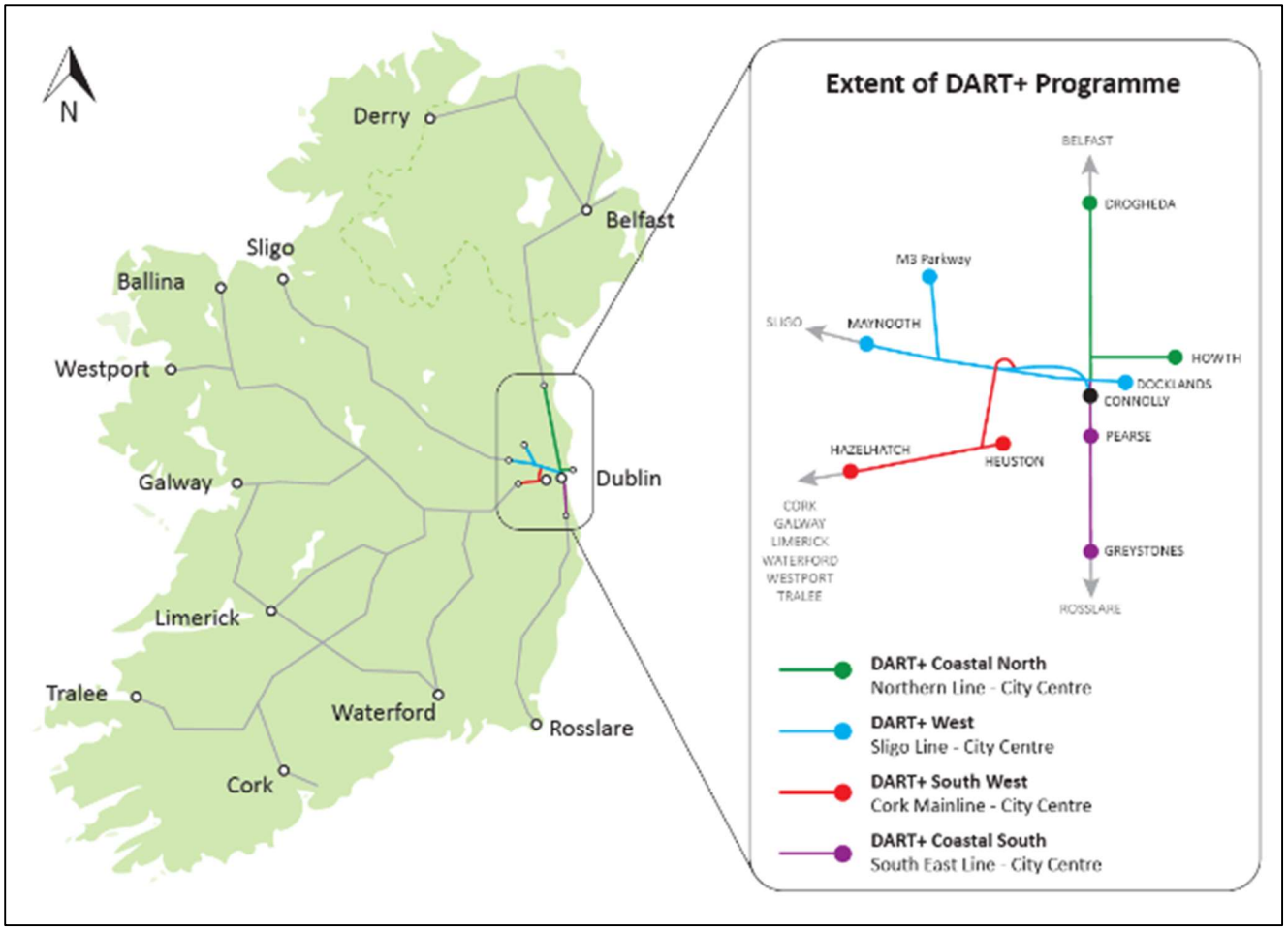

Figure 1-1 DART+ Programme

The current electrified DART network is 50km long, extending from Malahide / Howth to Bray / Greystones. The DART+ Programme seeks to increase the network to 150km. The DART+ Programme is required to facilitate increased train capacity to meet current and future demands, which will be achieved through a modernisation of the existing railway corridors. This modernisation includes the electrification, re-signalling, and certain interventions to remove constraints across the four main rail corridors within the Greater Dublin Area, as per below:

- DART+ South West (this Project) – circa 16km between Hazelhatch & Celbridge Station to Heuston Station and also circa 4km between Heuston Station to Glasnevin, via the Phoenix Park Tunnel Branch Line.
- DART+ West – circa 40km from Maynooth & M3 Parkway Stations to the City Centre.
- DART+ Coastal North – circa 50km from Drogheda to the City Centre.
- DART+ Coastal South – circa 30km from Greystones to the City Centre.
- DART+ Fleet – purchase of new electrified fleet to serve new and existing routes.

The DART+ Programme is a key element to the national public transportation network, as it will provide a high-capacity transit system for the Greater Dublin Area and better connectivity to outer regional cities and towns. This will benefit all public transport users.

The Programme has also been prioritised as part of Project Ireland 2040 and the National Development Plan 2018-2027 as it is integral to the provision of an integrated, high-quality public transport system.

Delivery of the Programme will also promote transport migration away from the private car and to public transport. This transition will be achieved through a more frequent and accessible electrified service, which will result in reduced road congestion, especially during peak commuter periods.

Ultimately, the DART+ Programme will provide enhanced, greener public transport to communities along the DART+ Programme routes, delivering economic and societal benefits for current and future generations.

1.3 DART+ South West Project

The DART+ South West Project will deliver the expansion of an improved electrified network, with increased passenger capacity and enhanced train performance between Hazelhatch & Celbridge Station to Heuston Station (c. 16km) on the Cork Mainline, and Heuston Station to Glasnevin via Phoenix Park Tunnel Branch Line (c. 4km).

DART+ South West will complete four tracking between Park West & Cherry Orchard Station and Heuston Station and will also re-signal and electrify the route. The completion of the four tracking will remove a significant existing constraint on the line, which is currently limiting the number of train services that can operate on this route. DART+ South West will also deliver track improvements along the Phoenix Park Tunnel Branch Line, which will allow a greater number of trains to access the city centre.

Upon completion of DART+ South West electrification, new DART trains will be used on this railway corridor, similar to those currently operating on the Malahide / Howth to Bray / Greystones Line.

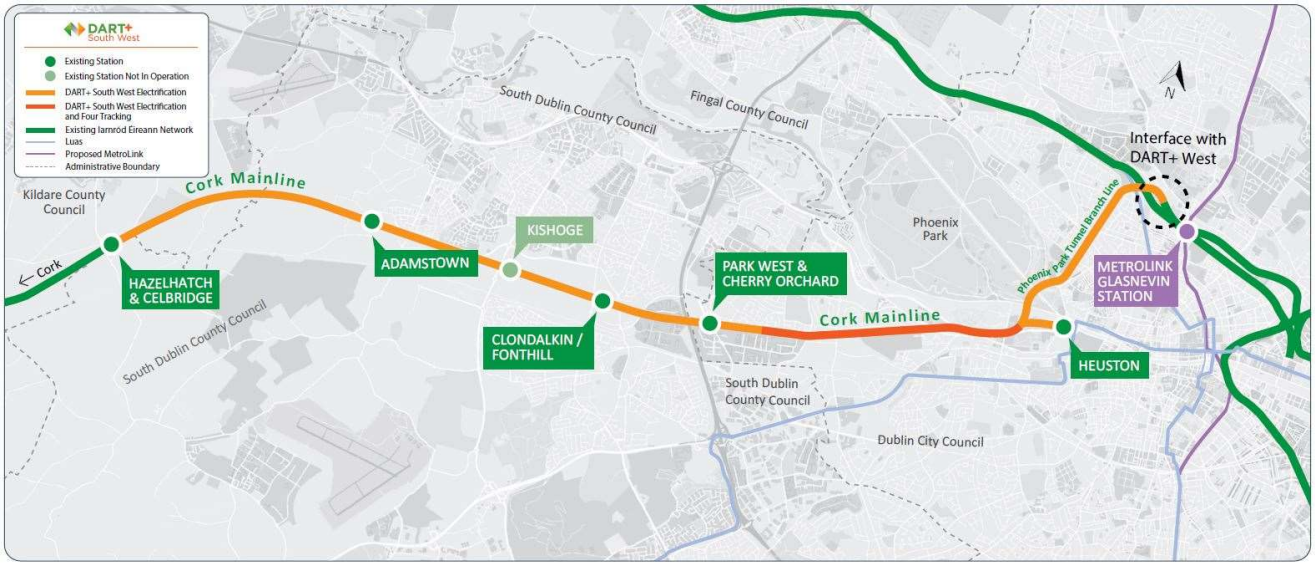

Figure 1-2 DART+ South West Route Map

1.4 Capacity increases associated with DART+ South West

DART+ South West will improve performance and increase train and passenger capacity on the route between Hazelhatch & Celbridge Station to Heuston Station and through the Phoenix Park Tunnel Branch Line to the City Centre, covering a distance of circa 20km. It will significantly increase train capacity from the current 12 trains per hour per direction to 23 trains per hour per direction (i.e. maintain the existing 12 services, with an additional

11 train services provided by DART+ South West). This will increase passenger capacity from the current peak capacity of approximately 5,000 passengers per hour per direction to approximately 20,000 passengers per hour per direction. Upon completion of the DART+ South West Project, train services will be increased according to passenger demand.

1.5 Key infrastructural elements of DART+ South West Project

The key elements of DART+ South West include:

- Completion of four-tracking from Park West & Cherry Orchard Station to Heuston Station, extending the works completed on the route in 2009.
- Electrification of the line from Hazelhatch & Celbridge Station to Heuston Station and also from Heuston Station to Glasnevin, via the Phoenix Park Tunnel Branch Line, where it will link with proposed DART+ West.
- Undertaking improvements / reconstructions of bridges to achieve vertical and horizontal clearances.
- Remove rail constraints along the Phoenix Park Tunnel Branch Line.
- Feasibility report and concept design for a potential new Heuston West Station.

The 'Emerging Preferred Option' will be compatible with the future stations at Kylemore and Cabra, although the construction of these stations is not part of the DART+ South West Project.

1.6 Route Description

The existing rail corridor extends from Heuston Station to Hazelhatch & Celbridge Station, the route also extends through the Phoenix Park Tunnel to Glasnevin. The area descriptions and extents are set out in **Table 1-1** and **Figure 1-2** below.

Table 1-1 Route Breakdown

Area Name	Sub-area Description	Extents	Main Features
Hazelhatch to Park West	Area from Hazelhatch to Park West	West side of Hazelhatch & Celbridge Station to 50m to west of Cherry Orchard Footbridge (OBC8B).	Hazelhatch & Celbridge Station Adamstown Station Clondalkin/Fonthill Station Park West & Cherry Orchard Station Cherry Orchard Footbridge (OBC8B)
Park West to Heuston Station	Area around Le Fanu Road Bridge (OBC7)	West of Cherry Orchard Footbridge (OBC8B) to the East of the proposed Le Fanu Road Bridge (OBC7).	Le Fanu Road Bridge (OBC7)
	Area around Kylemore Road Bridge (OBC5A)	East of the proposed Le Fanu Road Bridge (OBC7) to the East of IE700B (i.e. the points for the Inchicore headshunt turnout).	Kylemore Road Bridge (OBC5A)
	Area around Inchicore Works	East of IE700B (i.e. the points for the Inchicore headshunt turnout to the west of Sarsfield Road Bridge (UBC4).	Inchicore Works Depot
	Area around Khyber Pass Footbridge (OBC5)	Vicinity of Khyber Pass Footbridge.	Khyber Pass Footbridge (OBC5)
	Area around Sarsfield Road Bridge (UBC4)	West of Sarsfield Road Bridge (UBC4) to the West of Memorial Road Bridge (OBC3).	Sarsfield Road Bridge (UBC4)
	Area around Memorial Road Bridge (OBC3)	Vicinity of Memorial Road Bridge (OBC3).	Memorial Road Bridge (OBC3)
	Area around South Circular Road Junction	East of Memorial Road Bridge (OBC3) to the East of St John's Road Bridge (OBC0A).	South Circular Road Junction South Circular Road Bridge (OBC1) St John's Road Bridge (OBC0A)

Area Name	Sub-area Description	Extents	Main Features
	Area around Heuston Station and Yard	Area at the Heuston Station Yard including all platforms and sidings	Heuston Station Sidings around Heuston Station
St John's Road Bridge to Glasnevin Junction	Area from East of St John's Road Bridge (OBC0A) to East of Phoenix Park Tunnel	East of St John's Road Bridge (OBC0A) to East of Phoenix Park Tunnel	Potential New Heuston West Station Liffey Bridge (UBO1) Conyngham Road Bridge (OBO2) Phoenix Park Tunnel
	Area from Phoenix Park Tunnel to Glasnevin Junction	West of Phoenix Park Tunnel to South of Glasnevin Junction.	McKee Barracks Bridge (OBO3) Blackhorse Avenue Bridge (OBO4) Old Cabra Road Bridge (OBO5) Cabra Road Bridge (OBO6) Fassaugh Avenue Bridge (OBO7) Royal Canal and LUAS Twin Arches (OBO6) Maynooth Line Twin Arch (OB09) Glasnevin Cemetery Road Bridge (OBO10)

2 Existing Situation

2.1 Overview

This section is approximately 750m in length and extends from the east side of Memorial Road Bridge (OBC3) to 10m west of IE720A (points). The Permanent Way currently consists of 3 No. tracks between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC1). The number of tracks increases to the east side of South Circular Road Bridge (OBC1) at Islandbridge Junction. This includes 3 No. tracks which continue towards Heuston, multiple tracks that splay and enter at Heuston Station. The tracks fall in level from west to east towards Heuston Station, at an approximate gradient of 1.3%. There is not any known longitudinal drainage system installed along the Permanent Way.

There are two major road overbridges. These are South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A). Together these structures carry road traffic across the rail line and facilitate traffic movements at the junction of South Circular Road (R111), the Chapelizod Bypass (R148) and St. John's Road West (also R148). The local road network and South Circular Road junction are a major feature. This intersection is one of the busiest in Dublin and is highly congested during peak travel times.

The rail corridor is primarily in cutting (i.e. the rail level is below the surrounding ground level). The corridor is formed by retaining walls along the south side of the tracks and earthwork cutting slopes along the north side. The south side of the rail corridor between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC1) is retained with a battered masonry retaining wall. The north and south sides of the rail corridor between South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A) are retained with a reinforced concrete (RC) cantilever retaining wall. The south side of the rail corridor between St. John's Road Bridge (OBC0A) and IE720A (points) is also retained by an RC cantilever retaining wall.

There are two existing Signal gantries. Portal gantry OBC1B is located approximately 160m east of Memorial Road Bridge (OBC3). Cantilever gantry HN271/HN272 is located adjacent to IE720A (points) to the east. The area does not currently have any provisions for electrification. The major infrastructure features are illustrated in **Figure 2-1** below.

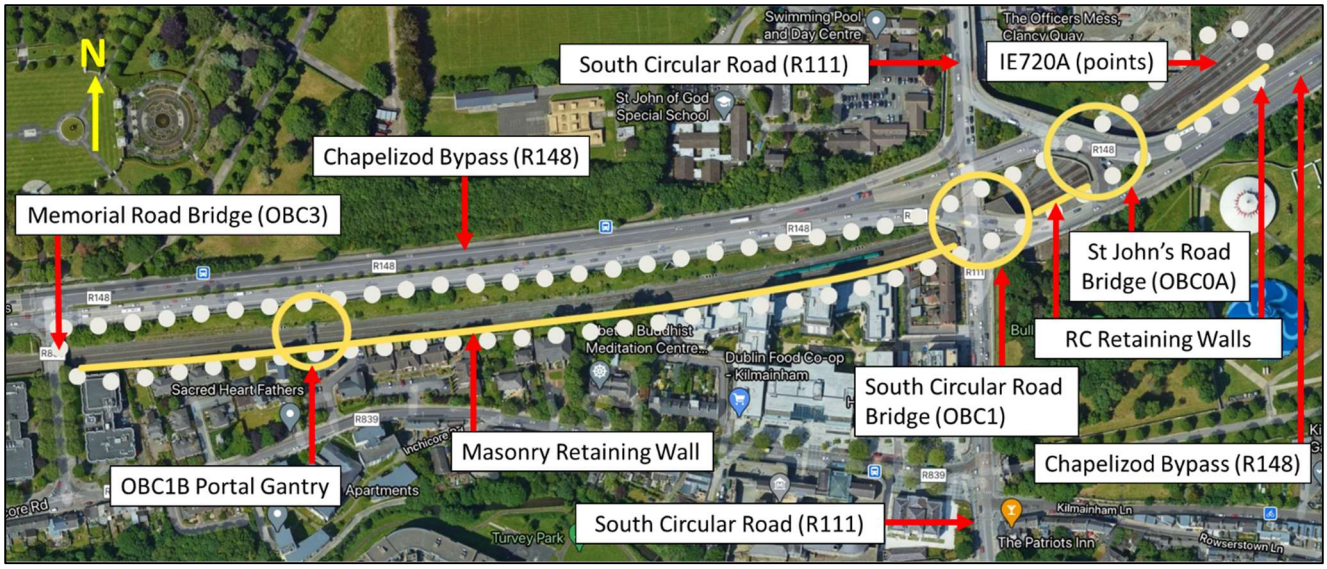

Figure 2-1 Area covered under this Technical Optioneering Report (white dotted outline)

The main Environmental features of this area are described in **Section 2.8.**

2.2 Challenges

The project requirement is to increase the number of tracks between Park West Station and Heuston Station to 4 No. of tracks and to electrify 2 No. northern tracks from Hazelhatch & Celbridge Station to Glasnevin Junction. There are significant challenges that constrain the options available to achieve the Permanent Way and Overhead Line Electrification (OHLE) project requirements.

It is not practically feasible to add an additional track on the south side of the rail corridor due to the density and proximity of commercial and residential properties between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC1). As such, all options include widening the corridor to the North to avoid the impact of the reconstruction of the existing retaining wall on the south properties. The existing tracks will also be realigned to meet design standards. The additional track can be placed on the north side by installing a retaining structure along the cutting slope between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3). The track will be placed between the existing rail line and the Chapelizod Bypass which runs parallel.

The existing South Circular Road Bridge (OBC1), which currently has 3 No. tracks beneath it, has insufficient horizontal clearance for 4 No. tracks. The solution is to either reconstruct the bridge with a wider replacement structure (to facilitate 4 No. tracks) or to retain the existing structure (2 No. tracks) and install a buried portal structure (cut and cover) on the north side to provide space for 2 No. tracks. The buried structure solution requires significant track lowering to achieve the general clearance requirements for new structures in accordance with Iarnród Éireann standards. Reconstructing South Circular Road Bridge (OBC1) to provide a wider structure for 4 No. tracks would require significant track lowering to achieve the clearance requirement for new structures and the OHLE.

In both cases (i.e. buried structure solution or bridge reconstruction solution), track lowering to absorb the vertical clearance requirements is preferable over increasing the road levels at the South Circular Road junction. Due to the existing road profiles on the approach to the junction, road level increases would require a significant extent of highly disruptive roadworks to tie-in new (increased) road levels to the existing levels. Therefore, track lowering forms the basis of feasible options considered. These issues are discussed further throughout the report.

Four-tracking and electrification could be provided by the construction of a buried portal beneath. However, this option is not compatible with the capital budget for the scheme, and as such, it has not been progressed.

2.3 Structures

2.3.1 St John's Road Bridge (OBC0A)

St. John's Road Bridge (OBC0A) is a 2-span reinforced concrete structure. The bridge carries road traffic over the rail corridor. The bridge carries traffic from west to east on the Chapelizod Bypass (R148) and from north to south on the South Circular Road (R111). The structure consists of precast concrete beams on reinforced concrete abutments and central pier. The total span of the bridge is approximately 48m. The skewed bridge width is approximately 30m. The abutments and pier sit on shallow footings. The square span is approximately 14.7m on the north and approximately 15.7m on the south span. There are currently 4 No. tracks beneath the southern span and 1 No. track beneath the north span. The vertical clearance beneath the existing structure is 4.948m . The existing bridge has sufficient horizontal clearance beneath the north span to place an additional track. The vertical clearance is sub-optimal but would be acceptable as an existing structure.

Figure 2-2 St. John's Road Bridge (OBC0A) in foreground and South Circular Road Bridge (OBC1) in background

The as-built drawings show that the front of the abutment foundations extends by 2.5m from the face of the walls, and the front of the pier foundations extends by 1.25m from the face of the pier. The foundation dimensions and depth will influence the positioning of tracks beneath the bridge if they need to be realigned horizontally to facilitate track lowering to achieve vertical clearance beneath South Circular Road Bridge (OBC1). If significant track lowering is required in close proximity to the abutment and/or pier foundations, then the stability of the supports will need to be considered, and an engineering stabilising solution may be required. A retaining structure to provide a stabilising solution may be required.

2.3.2 South Circular Road Bridge (OBC1)

South Circular Road Bridge (OBC1) is a single span structure carrying road traffic over the rail corridor. The bridge carries traffic from east to west on the Chapelizod Bypass (R148) and from south to north on the South Circular Road (R111). The bridge consists of pre flexed cast iron concrete encased beams supported on masonry abutments. The east side of the structure has been widened using splayed prestressed concrete beams supported on reinforced concrete abutments. The minimum span of the bridge is approximately 12.2m and varies due to the combined form of construction. The skewed width of the structure is approximately 30m.

Figure 2-3 South Circular Road Bridge (OBC1) - Beneath structure facing west

There are currently 3 No. tracks beneath the existing structure. The minimum vertical clearance beneath the existing structure is 4.521m. The abutments of the bridge extension sit on shallow footings. The bridge does not have sufficient horizontal clearance to construct an additional (4th track).

2.3.3 Retaining Walls

There are 5 No. existing retaining walls. The battered masonry retaining wall on the south side of the corridor between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC3) is approximately 575m long . The height of the wall is greatest at the South Circular Road Bridge (OBC1) end, where it is approximately 4.5m high. The wall appears to be in good condition generally. The wall provides support to the south side of portal gantry OBC1B. The existing southern track is in close proximity to the face of the wall. All options will consider the effect of track lowering and especially if this operation will cause instability of this wall.

Figure 2-4 Masonry retaining wall along the south side of rail corridor, facing west

The retaining wall on the north side of the corridor between South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A) is a mechanically stabilised earth (MSE) solution. The wall is approximately 40m in length and approximately 3m high. The wall supports the Chapelizopd Bypass, which is on an embankment at this location. The retaining wall is set back sufficiently such that it is unlikely to be unaffected by the works proposals.

Figure 2-5 MSE retaining wall on the north side of the corridor between South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A)

The retaining wall on the south side of the corridor between South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A) is an RC retaining wall. The wall is approximately 40m in length and approximately 4m high. The foundation level is shown to extend to 1.0m in front of the wall face on the as-built drawings.

Figure 2-6 RC retaining wall on the south side of the corridor between South Circular Road (OBC1) and St. John's Road Bridge (OBC0A)

The retaining wall on the south side of the corridor on the eastern side of St. John's Road Bridge (OBC0A) is a RC cantilever retaining wall. The retaining wall is set back sufficiently such that it is unlikely to be affected by the works proposals.

An approximately 1m high king post retaining wall retains an approximately 60m length of cutting slope 'toe' on the north side of the corridor between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3). The west end of the wall is approximately 50m from the east side of Memorial Road Bridge (OBC3). The retaining wall is in poor condition.

Figure 2-7 King post retaining wall on the north side of the corridor between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3)

2.3.4 Signal Gantries

Signal Gantry OBC1B

OBC1B is a portal signal gantry located approximately 160m to the east of Memorial Road Bridge (OBC3). The steel gantry is supported by a steel gantry column leg on the north side and is supported by the battered masonry retaining wall on the south side. The gantry has secured ladder access at north support to facilitate access for inspection and maintenance. This portal gantry will need to be replaced to facilitate the four-tracking and electrification.

Figure 2-8 Portal signal gantry OBC1B, facing west

Signal Gantry HN271/HN272

HN271/HN272 is a steel cantilever gantry located adjacent to IE720A (points) at the east boundary of the area. This gantry will need to be replaced to facilitate the installation of the electrification system.

2.4 Permanent Way and Tracks

The Permanent Way between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC1) has 3 No. tracks. All tracks fall in level from west to east towards Heuston Station at a gradient of approximately 1.3%. The tracks are labelled from north to south as the 'Up Main', the 'Down Main' and the 'Relief Line'. Islandbridge Junction is located between South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A). The junction connects the Dublin to Cork line with the branch line (via the Phoenix Park Tunnel) and to Heuston station. Points 715 and 714AB are located under South Circular Road Bridge (OBC1) and connect the Up Main and Down Main tracks to the 'Up Branch' track and via the 718 points to the 'Down Branch' track. A schematic layout of the tracks is shown below.

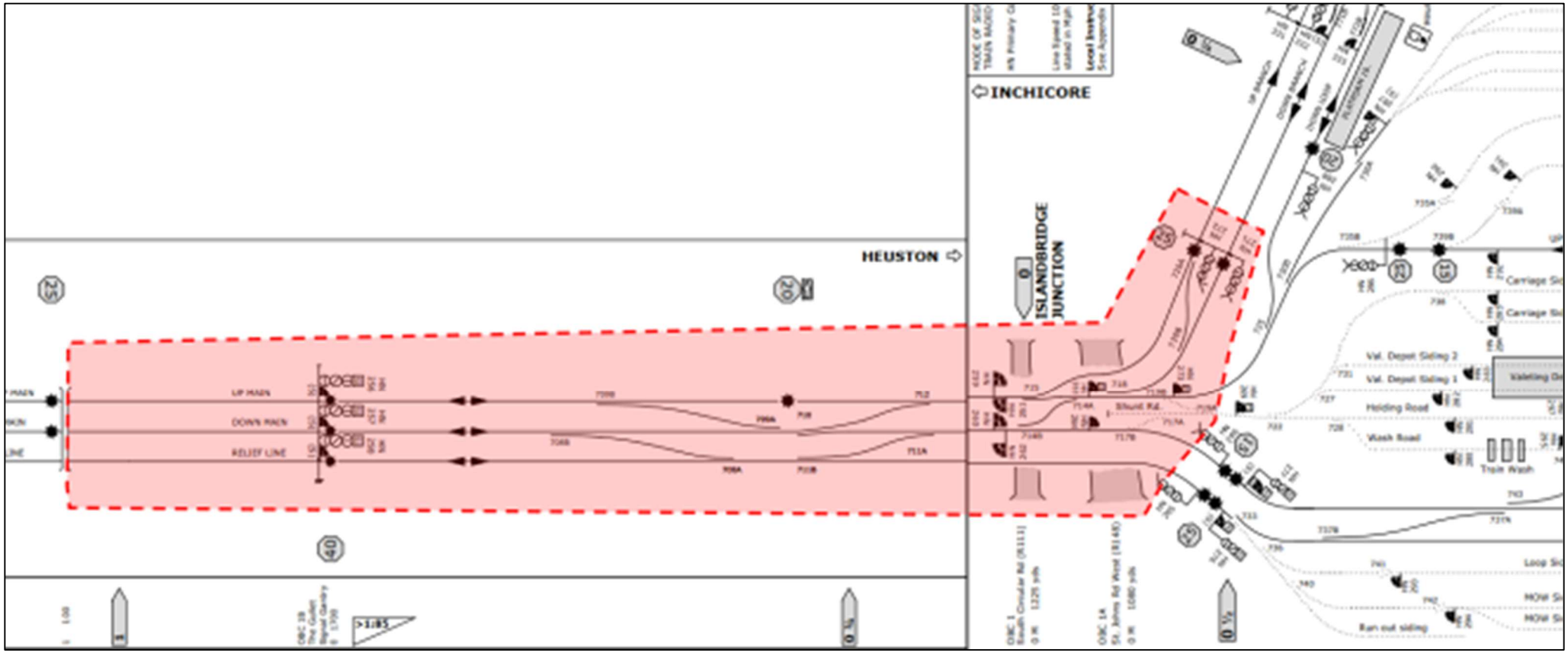

Figure 2-9 Existing track layout (from Route Information Book)

Figure 2-10 Tight horizontal radius and reduced sight distance at South Circular Road Bridge (OBC1), facing east

The track alignment in this area is constrained by the South Circular Road Bridge (OBC1) and the St. John's Road Bridge (OBC0A), which has resulted in a complex existing layout. The 3 No. tracks under South Circular Road Bridge (OBC1) feature a tight horizontal radius of 220m. The points and crossings (P&C) units are in close proximity to each other (e.g. crossover 714AB and points 715). In addition, the lateral clearances from the nearest rail to the bridge abutments are as low as 1.26m. The limited lateral clearances to the existing bridge abutments are further complicated by a tight horizontal radius resulting in limited forward sight distance.

There are a total of 5 No. tracks beneath St. John's Road Bridge (OBC0A). These are labelled from north to south as the 'Up Branch', 'Up Main', 'Down Main', 'Relief Line' and 'Shunt Road'. The P&Cs that connect the Heuston Station depot sidings (the Shunt Road) with the Up Main and Down Main tracks are located below St. John's Road Bridge (OBC0A). The Shunt Road ends in a buffer-stop under the bridge. There are 4 No. tracks beneath the south span and 1 No. track beneath the north span (**Figure 2-11**).

The Permanent Way between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC1) is within a deep cutting. There is limited lateral clearance between the southern track and the battered masonry retaining wall. The clearance from the retaining wall to the adjacent rail of the Relief Line track is approximately 1.6m. There are no safety refuges along the wall.

The track gradient falls from west to east (i.e. towards Heuston Station) at a gradient of 1.3% (approx.). The Shunt Road track is also at a gradient of 1.3%. The Shunt Road is currently used to manoeuvre trains into the carriage wash. The distance between the buffer stop and points 728 is 170m, shown in the figure 2-12 below.

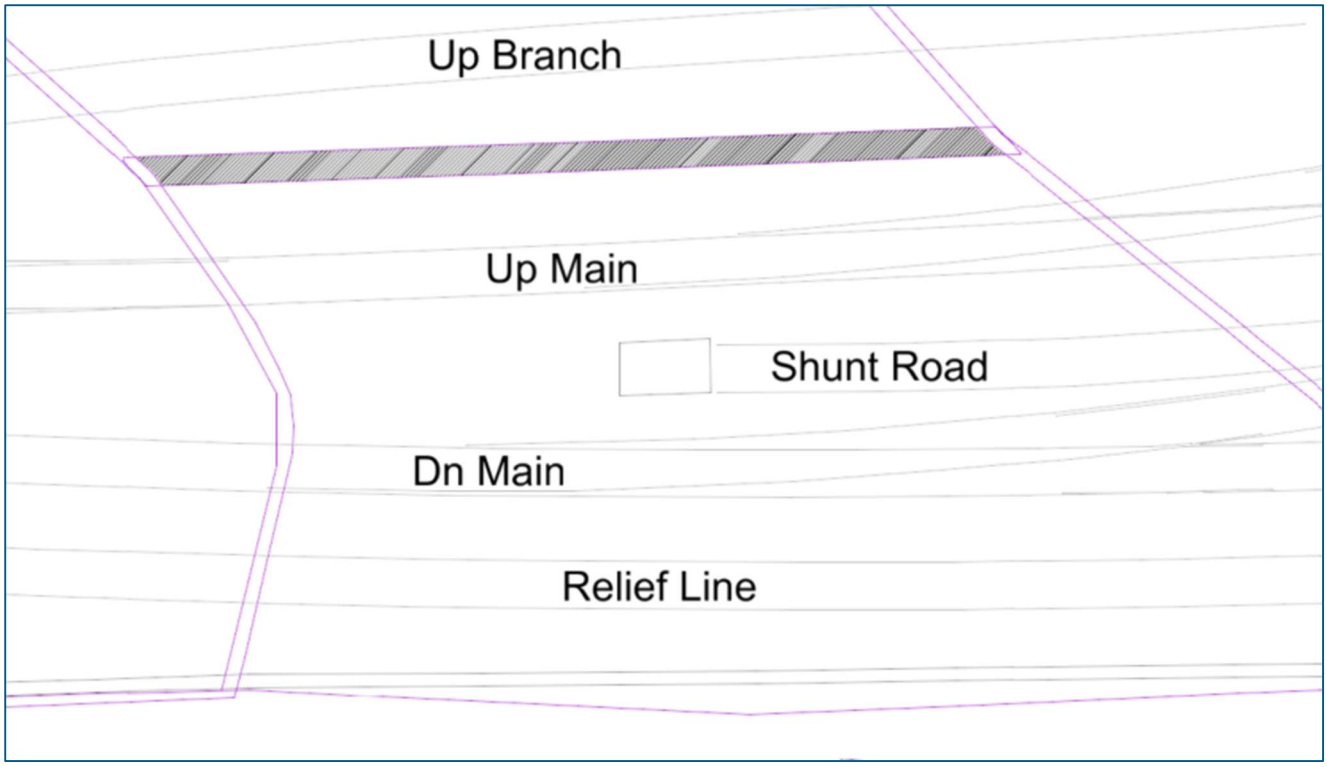

Figure 2-11 Tracks layout beneath St. John's Road Bridge (OBC0A)

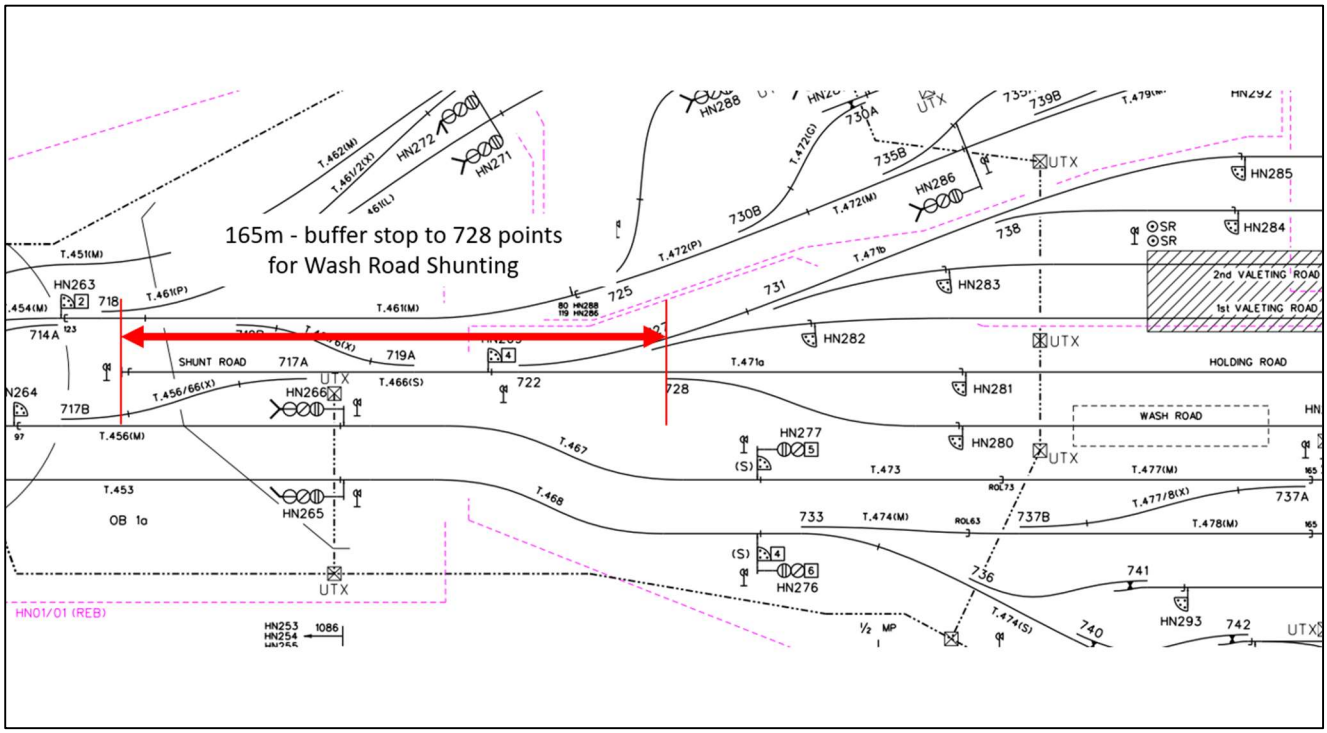

Figure 2-12 Track diagram showing Shunt Road (buffer stop to 728 points = 165m

2.5 Other Railway Facilities

There is a track access point on the Chapelizod Bypass at approximately 65m west of South Circular Road Bridge (OBC1). The access stairs traverse the steep cutting slope on the north side of the rail corridor. This access point is to facilitate access for Iarnród Éireann inspection and maintenance staff.

Figure 2-13 Location of the existing track access point from Chapelizod Bypass (highlighted in red)

2.6 Road Network

The primary road infrastructure feature is the junction of Chapelizod Bypass / Con Colbert Road (R148) and the South Circular Road (R111). The Chapelizod Bypass is a segregated 3-lane dual carriageway. The dual carriageway facilitates the main traffic flows into and out of Dublin city centre (eastbound and westbound). The South Circular Road (south of junction) has 2 No. traffic lanes on approach and departure from the junction. The South Circular Road (north of junction) has 2 No. traffic lanes on approach to the junction and 1 No. lane on departure.

Pedestrian movements are catered for in all directions through the junction. Cycling provision is limited to road marking lanes at some parts of the junction only and this is shared use with vehicular. The junction is due for a review as part of the BusConnects scheme.

The junction is a bespoke 3/4 lane gyratory system which is operating above capacity at peak periods leading to queuing in all directions.

2.7 Ground Conditions

The topography is typically flat, sloping gently towards the River Liffey to the north and towards Heuston Station to the west. As discussed above, the existing retaining walls (and bridge abutments) form the southern boundary of the rail corridor. A combination of a cutting slope, retaining walls and bridge abutments form the northern boundary.

The general superficial geology is anticipated to comprise of a thin layer of made ground underlain by a significant thickness of till overlying bedrock.

A number of historical ground investigation exploratory holes are present in the immediate vicinity of the South Circular Road Bridge (OBC1).

At 100m west of the South Circular Road Bridge (OBC1), a borehole investigation indicated that superficial deposits exist comprising 'soft to stiff 'clay, soft silt and gravel (of limestone and sandstone). This extends to bedrock which consists of strong to moderately strong limestone. Moderately strong to weak mudstone and shale was encountered at 20.50m below ground level (bgl).

At 80m north of South Circular Road Bridge (OBC1), a previous borehole investigation indicated 'made ground' between ground level and 3.5m below ground level. The made ground was shown to be underlain by a significant thickness of gravel and stiff clay. Bedrock consisted of strong to very strong limestone with weak to moderately strong mudstone and shale recorded at 18.55m below ground level.

Other sources of ground information (publicly available) regarding the depth to bedrock at the South Circular Road junction indicates that the depth to bedrock is 21m to 37m below ground level.

Groundwater was not encountered (or recorded) during any of the existing historical exploratory holes adjacent to South Circular Road.

It is not envisaged that the development of options will be governed by existing ground conditions as the ground conditions noted will facilitate all likely options.

2.8 Environment

Directly opposite Memorial Road and north of the rail corridor are the War Memorial Gardens. In addition to their role as a garden of remembrance, they are also considered to have architectural heritage interest. Further west on the same side of the rail corridor there is a Gaelscoil, St. John of Gods Special School and a swimming pool and day centre. Northeast of the South Circular Road junction there is a residential development associated with Clancy Quay. The junction itself is a site on the Record of Monument and Places (RMP) associated with a number of burials excavated during works on the junction in the past.

South of the junction are the grounds associated with the Royal Hospital Kilmainham with three National Inventory of Architectural Heritage (NIAH) designations relating to graveyards / cemetery at Bullys Acre and also an ecclesiastical site and cross which are listed on the Sites and Monuments Record (SMR). Southeast of the junction there are a small number of residences fronting onto the road and several apartment blocks directly adjacent to the rail line. Mixed use commercial activities are interspersed among the residential receptors, including Hilton Hotel along the South Circular Road. Further west, residential properties associated with Inchicore Road are again a key constraint due to their proximity to the rail corridor. In straddling Memorial Road there are two office blocks understood to be a government data centre. There are several designated landscape areas of note which include the War Memorial Gardens and the Royal Hospital Kilmainham and Gardens.

Refer also to **Section 4.1**.

2.9 Utilities

The roads network contains a significant number of utilities typical of an urban environment such as this. Service providers with network assets in this area include the following:

- Aurora Telecom
- EIR
- ESB Networks
- Virgin Media

- Gas Networks Ireland
- Dublin City Council Road Drainage (Storm Water Sewers)
- Dublin City Council / Irish Water (Foul Water Sewers)
- Dublin City Council / Irish Water (Water Supply)
- Dublin City Council Traffic Department (Traffic Signals & Communications)
- Dublin City Council Public Lighting

Data in the form of utility service records have been gathered from all providers in the area. The majority of services are located within existing streets and rail line bridge crossings. Hence, where modifications are required to any existing bridges and / or to the road network in the immediate vicinity of existing structures, impacts on utilities will be inevitable.

There are two services that cross the railway corridor below the tracks, both of which are combined sewers situated between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3). Where track lowering is proposed, consideration of the impacts on these services will also be necessary.

A number of key network infrastructure elements for particular existing services are present. Therefore, significant forward planning and coordination with the appropriate utility providers will be required to enable works, given that only limited service outage time (if any) will be permissible to each service and its customers.

3 Requirements

3.1 Specific Requirements

- Increase number of tracks from 3 No. tracks to 4 No. tracks.
- Electrification of 2 No. tracks for DART+.
- Provide vertical electrical clearance through existing structures or amend or reconstruct structures to provide the required clearance.
- Maintain functionality of existing roads.

3.2 Systems Infrastructure and Integration

In addition to the track and civil infrastructure modifications relating to them DART+ South West Project, there is a requirement to provide Overhead Line Electrification Equipment (OHLE) signalling and telecoms infrastructure.

The electrification system will be similar in style to that currently used on the existing DART network and integrated and compatible across the DART+ Programme. There will be a potential requirement to provide 6 additional power substations along the rail line to provide the requisite power for the network demand. It is envisaged that a standardised approach to electrification will be adopted, but those area-specific interventions will also be required.

The Low Voltage and Telecommunications networks required for Signalling will be 'global systems' and are unlikely to vary significantly between or within the various areas. In order to achieve the necessary capacity enhancements and performance required for the introduction of the new electric multiple unit (EMU) fleet, it will be necessary to upgrade the existing signalling system as well as replacing some of the legacy signalling system. This will include provision of Relocatable Equipment Buildings (REB) where required along the route in order to accommodate signalling equipment and associated power supplies and backup.

Upgrades to the existing telecommunications infrastructure will be required to facilitate improvements to the radio-based technologies used on the network and for signalling and communication with the existing and future network control centres.

3.3 Electrification System

The OHLE system architecture is currently being developed. The Dart wide programme will adopt a 1500V Direct Current (DC) OHLE system to provide electrical power to the network's new electric train fleet.

It should be noted that all OHLE diagrams in this report are for visual information only. Final dimensions, lengths, heights and cantilever types are to be defined in the reference design and subsequent design stages of the project.

The OHLE concept comprises a pre-sagged simple (2-wire) auto-tensioned system, supported on galvanised steel support structures.

The OHLE system architecture is being developed by the DART+ West Multi-disciplinary Consultant (MDC). The Dart wide programme will adopt a 1500V Direct Current (DC) OHLE system to provide electrical power to the network's new electric train fleet.

It should be noted that all OHLE diagrams in this report are for visual information only. Final dimensions, lengths, heights and cantilever types are to be defined in the reference design and subsequent design stages of the

project.In 4-track areas, Two Track Cantilevers (TTCs) will generally only be placed on the north side of the line, to support OHLE on the northern two tracks. Supporting the OHLE by utilising structures positioned on the south side of the 4 No. tracks is not considered to be a feasible solution due to the loads involved.

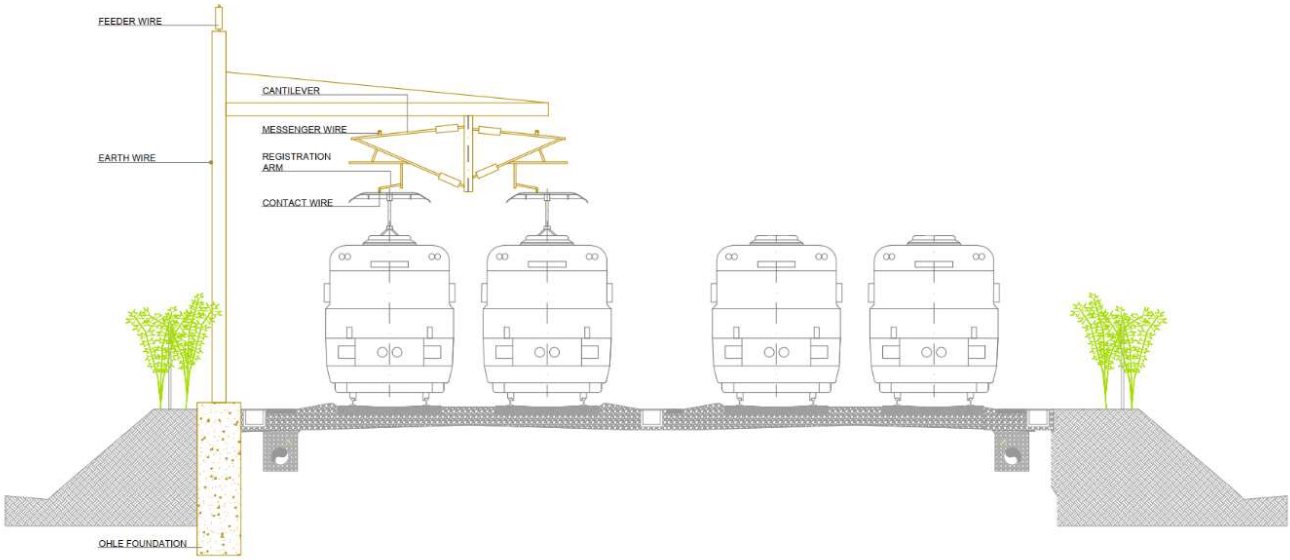

Figure 3-1 Typical OHLE arrangement in 4- four track open route

Nominal contact wire height is 4.7m, and heights through stations may be slightly higher to achieve minimum protection by clearance distances. Minimum contact wire height without a derogation is 4.4m under all conditions including sag, and it may be necessary at certain bridges to place the contact wire height at 4.2m under all conditions.

Additional feeder cables will be supported from the masts at heights between 6.5m and 8m on each side of the track. An earth wire will also be suspended from the masts.

Maximum tension length is 1600m, and maximum half tension length is 800m. Overlaps will comprise three spans, with spring tensioners used throughout. Midpoint Anchors (MPAs) will generally be of the tie-wire type, although the portal type may be needed in some locations.

At intervals of up to 1500m the OHLE wires will be anchored at an arrangement known as an overlap, and a new set of wires will take over. The anchors provide the mechanical tension that the wires need to perform reliably and safely. In areas of crossovers and junctions, additional wiring will be provided for the extra tracks, and these will also be provided with anchors.

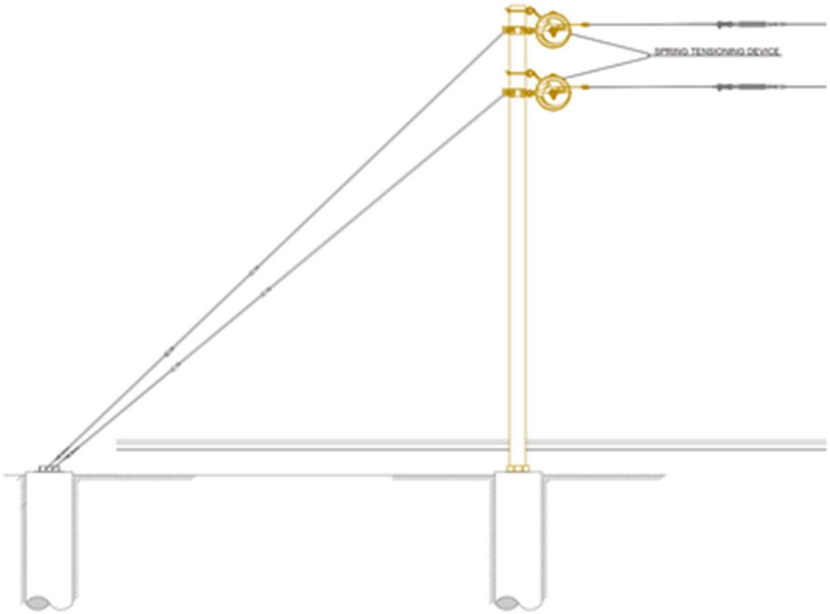

Figure 3-2 Typical anchor structure

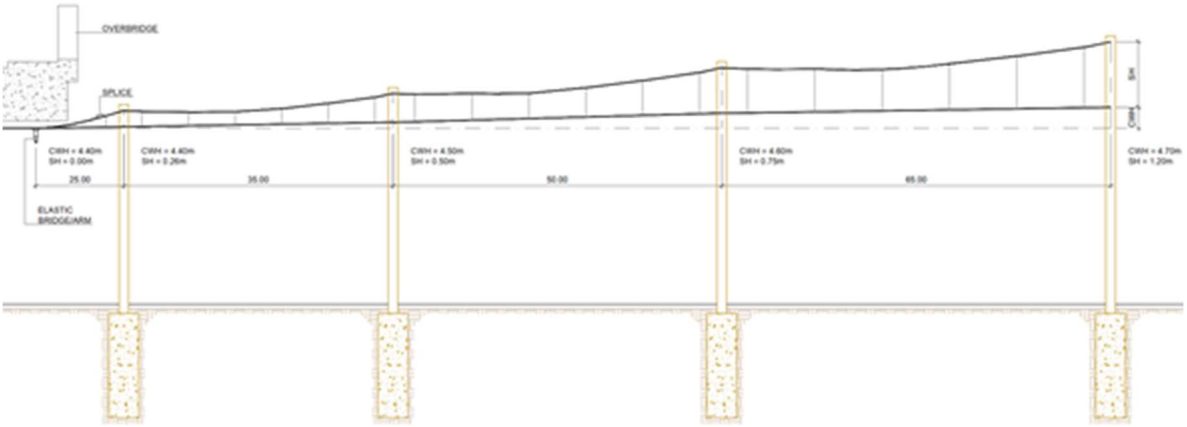

Figure 3-3 Typical arrangement on approach to a low bridge

3.4 Substations

In order to facilitate the introduction of the new OHLE scheme across the DART+ network, a power supply study has been carried out. There is a requirement to provide 6 new substations at the following locations: Le FanuKishogeIn order to facilitate the introduction of the new OHLE scheme across the DART+ network a power supply study has been carried out. There is a requirement to provide 6 new substations at the following locations:

- Islandbridge
- Le Fanu
- Park West
- Kishoge
- Adamstown
- Hazelhatch

3.5 Design Standards

Please refer to Annex 3.2 for the design standards that will be used for the scheme.

4 Constraints

4.1 Environment

Along the existing corridor, there are a number of apartment blocks directly adjacent to the rail line. These are interspersed with mix-use commercial activities. Community facilities include the War Memorial Gardens, St. John of Gods School, Kilmainham Gaol and Richmond Park. Northeast of the South Circular Road junction there is a residential development associated with Clancy Quay. Southeast of the junction there are a small number of residences fronting onto the road and a number of apartment blocks directly adjacent to the rail line. Along Memorial Road are two office blocks (Government data centres).

The junction itself is a site on the Record of Monument and Places (RMP) associated with a number of burials excavated during works on the junction in the past. There are a number of designated landscape areas which include the War Memorial Gardens and the Royal Hospital Kilmainham and Gardens. Heritage features include early burial sites and a cross at Kilmainham Ecclesiastical site / Bully's Acre.

Biodiversity constraints include invasive species as listed by Invasive Species Ireland (third schedule) at the South Circular Road (Japanese Knotweed).

4.2 Roads

The existing road network poses significant constraints in terms of achieving the project requirements of providing an additional 4th track and electrifying 2 No. tracks.

The Chapelizod Bypass is directly adjacent and parallel to the top of the cutting slope between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC1). This removes the option to provide the additional track on the north side of the corridor by means of a standard earthwork widening solution along and through the existing cutting on the north side of the corridor. A retaining structure would be required to create space for the additional track in this section.

The existing South Circular Road Bridge (OBC1) cannot accommodate an additional track due to its constrained horizontal geometry (insufficient span length). The existing vertical clearance at the bridge is also insufficient to accommodate the OHLE infrastructure required to electrify the rail line. The junction of the South Circular Road (R111) and the Chapelizod Bypass (R148) is a major constraint in terms of reconstructing South Circular Road Bridge (OBC1) to provide the clearances needed. The existing road levels on the South Circular Road fall steeply towards Island Bridge (River Liffey) on the north side of the junction. The existing road levels on the Chapelizod Bypass also fall on the west departure from the junction.

The extent of tie-in works for even a minor increase in finished road level at South Circular Road bridge (OBC1) would be significant due to the rapid fall-off in existing levels on the north and west side of the junction. The road works and traffic management scheme required to achieve this would cause major traffic disruption during the works.

There is a significant network of congested utilities beneath the existing road.

Options to reconstruct the bridges at this location would likely have a severe impact on the traffic in the area. Approximate traffic volumes in the morning peak are 1500veh/h in the east west direction while both north to south and west to south account for approx. 700 and 500 veh/h respectively. Traffic management is a major constraint to be considered in determining the most appropriate option solution.

If either the South Circular Road Bridge (OBC1) is reconstructed, or a new cut and cover buried portal option is considered, the design will consider the sequencing of the construction work to minimise traffic disruption.

4.3 Property

The density and proximity of the residential and commercial properties along the south side of the rail corridor between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3) is a major constraint in terms of achieving the project requirements. Extending the rail corridor to the south is not considered to be a feasible option. Please refer to Property Boundary lines on the Bridge and Permanent Options Drawings in Appendix C.

4.4 Permanent Way

The vertical and horizontal alignment is constrained by the elements summarised in **Table 4-1** and **Figure 4-1**.

Table 4-1 Permanent way geometrical constraints

ID	Name	Description
1	Proximity of Private Property (Residential & Commercial)	The proximity and density of private residential and commercial property on the south side of the corridor between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3) is a major constraint in terms of the horizontal Permanent Way alignment.
2	Masonry Retaining wall	The masonry retaining wall is in close proximity to the existing tracks. Normal lateral clearance should be incorporated into the new design in accordance with design standards (2.5m). This would require the new track alignment to be moved to the north, Any track lowering would be subject to a GI survey confirming the structural integrity of the retaining wall.
3	Chapelizod Bypass	The north side of the rail corridor between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3) is constrained by the level difference between the railway and highway. The proximity of the Chapelizod Bypass is a significant longitudinal constraint. A retaining structure would be required to provide the additional space for the realigned and additional track through this section.
4	Exiting OBC1	The existing structure does not have sufficient horizontal clearance to provide an additional track in accordance with the project requirements.
5	Existing OBC0A	The depth and dimensions of the abutment and pier foundations may pose a constraint on the horizontal alignment of the Permanent Way if significant track lowering is required (e.g. to achieve vertical clearance for OHLE at South Circular Road Bridge (OBC1)
6	Corner of private property	There is a pinch point between Clancy Quay property wall and the existing 'Up Branch' track. Existing distance between rail and wall is 1.68m.
7	Existing station and depot functionality	The location of the fixed valeting and carriage wash buildings pose constraints on the possible Permanent Way alignments.

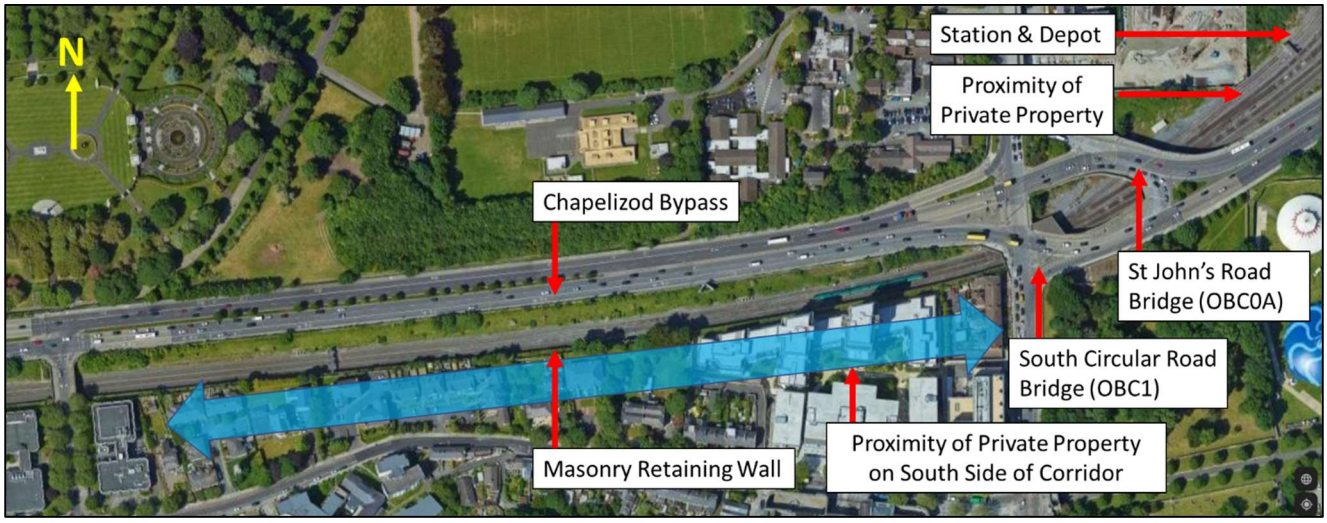

Figure 4-1 Constraints of permanent way design

The main constraint to selecting a horizontal permanent way alignment is the proximity and density of the private residential and commercial properties on the south side of the corridor between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3). To include an additional track on the south side of the existing corridor is not feasible for this reason.

In addition to the constraints that will have an effect on the track alignment, there is no track drainage system installed in this area. Although there are no known drainage issues in the area, the proposed track formation and vertical design may require the installation of a new positive drainage system.

4.5 Existing Structures

The existing South Circular Road Bridge (OBC1) has insufficient span length to accommodate a fourth track or adequate vertical clearance to implement track electrification. Proposed interventions include replacement of the bridge or construction of a new cut and cover buried portal on the north side.

If a replacement bridge is to be constructed, the bridge would require a longer span to incorporate the fourth track. New abutments will need to span (overstep) existing abutments to facilitate constructability requirements.

A new bridge would require an increased vertical clearance (standard Iarnród Éireann requirement of 5.3m for new bridges) unless a derogation is granted. A reduced or derogated vertical clearance would require either significant track lowering or bridge deck raising to facilitate the greater structural depth needed for the increased span and horizontal clearances from the new edge of outer rails to abutments, thereby increasing bridge and hence road levels at the junction which is not deemed feasible.

The existing St. John's Road Bridge (OBC0A) has sufficient horizontal clearance beneath its spans to place an additional track. A constraint to the new horizontal alignment beneath the bridge is the dimensions and depth to the existing bridge abutment and shallow pier foundations. The bridge has sufficient vertical clearance such that it can be electrified using fitted solutions. Special reduced clearance at St. John's Road Bridge (OBC0A) can be achieved with a 4.2 m contact wire height (with no structural or track intervention required) if it is acceptable to install bridge arms beneath the structure. However, this would be a sub-optimal solution.

The proximity between the two bridges is such that they need to be considered together when defining the OHLE solution.

Where track lowering is required between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3), the retaining wall at this location may be destabilised and hence horizontal realignment may be required to overcome this (i.e. realign away from the masonry retaining wall) to avoid a clash with the foundation. Where significant track lowering is required on the approach to South Circular Road Bridge (OBC1) (e.g., to achieve vertical clearance to a reconstructed bridge) then consideration of options to stabilise the wall would be necessary.

4.6 Geotechnical

Based on the existing information, onerous ground or groundwater conditions are not anticipated.

Where significant track lowering is required, the stability of the existing retaining wall along the southern boundary could be affected as discussed above. This may necessitate below ground ties, anchors or walls which for the purposes of this stage of scheme development should be assumed to be required for a track lowering option.

Bored pile walls are considered to be suitable at this stage of development, and conservative sizing will be used until such stage that detailed ground investigation data becomes available.

Existing nearby walls, buildings, structures and earthworks will require monitoring (e.g. vibration monitoring) during piling of any new structures to ensure no structural damage is caused during construction to the proposed

foundation construction works. Con Colbert House (on Memorial Road) houses a government data centre and as such may be particularly sensitive to vibration.

4.7 Existing Utilities

The significant number of utilities will be constraints during both the design and construction phases. As such, their treatment in the temporary and permanent situations has been carefully considered during the development of options. There are a large number of services crossing the rail corridor via South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A). Whether the South Circular Road Bridge (OBC1) is reconstructed or a new cut and cover buried portal is constructed to the north side of the bridge to facilitate the additional track, the services in the existing bridge would need to be maintained or outage durations absolutely minimised. All existing utilities pose constraints to the area options. Where they conflict with bridge and area-wide options, their potential treatment is being discussed with the utility providers.

5 Options

5.1 Options Summary

The existing South Circular Road Bridge (OBC1), which currently has 3 No. tracks beneath it, has insufficient horizontal clearance for four tracks. The existing vertical clearance beneath the bridge would also be sub-optimal for electrification.

The potential options are to either reconstruct the bridge with a wider replacement structure (to facilitate 4 No. of tracks) or to retain the existing structure (2 No. of tracks) and install a buried portal (cut and cover) on the north side of the bridge to provide space for 2 No. of tracks.

Permanent way options comprise realignments to provide standard clearances, both vertically and horizontally.

A total of nine 'Options' have been developed. The Options include a 'Do-Nothing' Option and a 'Do-Minimum' Option.

- A Do-Nothing option means that the design endeavours to achieve the project requirements without any intervention to the existing infrastructure.
- A Do-Minimum option means that the design endeavours to achieve the project requirements with only minor intervention to the existing infrastructure.

A summary of the Options is presented in **Table 5-1**. A detailed description of each Option is included **Section 5.2**.

Table 5-1 Options summary

Option	Description
Option 0: Do Nothing	The existing infrastructure remains unchanged. There are no interventions.
Option 1: Do Minimum	This option endeavours to achieve the four-tracking and electrification project requirements without widening the existing rail corridor or providing additional vertical and horizontal clearance at South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A).
Option 2	This option is the Concept Design. South Circular Road Bridge (OBC1) would be reconstructed with a greater span and height to provide sufficient vertical and horizontal clearance for four-tracking and electrification. All vertical clearance requirements would be absorbed by track lowering.
Option 3	This Option is similar to Option 2, but all vertical clearance requirements and increases to structural depth would be absorbed by track lowering (50%) and increasing road levels (50%).
Option 4	This option proposes to replace the existing South Circular Road Bridge (OBC1) with a wider structure. The new structure would take the form of a long over-widened single span portal. The structure would be over-widened so that it can be constructed in two phases. This potentially reduces the level of traffic disruption during the reconstruction works. All vertical clearance requirements are absorbed by track lowering.
Option 5	This Option is similar to Option 4 but all vertical clearance requirements and increases to structural depth are absorbed by track lowering (50%) and increasing road levels (50%).
Option 6	This Option would retain the existing South Circular Road Bridge (OBC1). A new 'cut and cover' buried portal structure would be constructed on the north side of the existing bridge. The existing bridge would facilitate two non-electrified tracks. The new structure would provide the space for the two electrified tracks. All vertical clearance requirements would be absorbed by track lowering and localized road level increases.
Option 7	This Option is similar to Option 2 but would incorporate a minor and localised increase to road levels on the Chapelizod Bypass on the north west side of the new bridge. The increase in levels at this location would facilitate a corresponding reduction in track lowering requirements throughout (but at the bridge in particular). This localised area would need to be reconstructed to construct the new bridge in any case so is not considered as a major intervention at road level.

Option	Description
Option 8	This Option is similar to Option 4 but would incorporate a minor and localised increase to road levels on the Chapelizod Bypass on the north west side of the new bridge. The increase in levels at this location would facilitate a corresponding reduction in track lowering requirements throughout (but at the bridge in particular). This localised area would need to be reconstructed to construct the new bridge in any case so is not considered as a major intervention at road level.

5.2 Options Description

This section describes the Options that have been considered. With the exception of Option 0 (Do-Nothing) and Option 1 (Do-Minimum), there are some design disciplines that have technical features that are common to all Options (e.g. OHLE and Cable & Containment). Similarly, there are technical aspects that have been considered but are determined to have no (or insignificant) bearing on the development or selection of Options (e.g. ground conditions). To remove repetition among the Option descriptions, these issues are addressed at the end of the Option description section.

5.2.1 Option 0: Do-Nothing

The Do-Nothing Option proposes no changes to the existing road or rail infrastructure. The rail corridor would not be widened (inside or outside the Iarnród Éireann property boundary). The horizontal and vertical constraints at South Circular Road Bridge (OBC1) would not be resolved. As such, this option would not facilitate the inclusion of the additional fourth track or the installation of an OHLE system. The project requirements would not be achieved.

5.2.2 Option 1: Do-Minimum

This Option seeks to achieve the four-tracking and electrification by means of minor interventions only. A review of the constraints has concluded that there are no minor interventions that by themselves alone could achieve the project requirements.

5.2.3 Option 2

This option is the original Concept Design proposed for the Kildare Line Upgrade Project developed by ARUP (2018). South Circular Road Bridge (OBC1) would be reconstructed with a greater span and height to provide sufficient vertical and horizontal clearance for four-tracking and electrification in accordance with the design standards. A vertical clearance of 5.3m (standard Iarnród Éireann requirement for new bridge) would be pursued, however if deemed unfeasible, a derogated reduced vertical clearance would be requested. All vertical clearance requirements and increases to structural depth would be achieved by track lowering. The junction alignment would be reinstated to the existing layout when construction is completed. Road construction works would be required adjacent to the abutments to tie the pavement on the new bridge deck into the existing approach roads.

The replacement bridge would be of reinforced concrete beam and slab construction and would be of similar width to the existing bridge (approximate plan area is 1,880 m^2). The prestressed bridge beams would be of varying type and span and have a high and variable skew. The skew is such that bearings and joints would be required. Inspection galleries and bearing shelves would be constructed to facilitate inspection, maintenance and replacement of the bearings throughout the life of the structure.

The construction costs will be higher than a structure of comparable dimensions utilising standardised beams and spans. The bearing requirement will increase the construction cost and increase the operational expenditure and whole life cost of the structure. Bearings typically have a design life much shorter than the design life of the

main bridge structure. As such they would need to be replaced over the lifetime of the bridge. This is a relatively complex procedure that will likely require rail possession access to execute.

From Memorial Road Bridge (OBC3) to South Circular Road Bridge (OBC1) the existing tracks would be renewed. Horizontally, they would be repositioned to provide a compliant horizontal clearance to the masonry retaining wall that runs along the south side of the rail corridor between the two bridges. The new position of the Fast lines would see its lateral distance to the retaining wall increase up to 2.5m (the existing lateral clearance between the retaining wall and the nearest rail is as low as 1.5m in some instances), improving the pre-existing situation regarding safety in the event of derailment. A continuous safe walkway could be installed resulting in benefits in maintainability and safety between these two bridges. The space for the additional fourth track would be created on the north side of the rail corridor by constructing a retaining wall through and along the existing cutting slope. The required retaining structure would be approximately 575m in length and up to 6metres high (varies). The retaining structure may take the form of a bored pile retaining wall or similar. At this section a standard 10-foot dimension would be provided: i.e., the distance between the Slow (northern 2 No. electrified tracks) and Fast tracks (southern 2 No. inter-city non-electrified tracks).

Between South Circular Road Bridge (OBC1) and St. John's Road Bridge (OBC0A), the horizontal alignment complies with the new Islandbridge junction configuration that provides a direct connection from the Slow track to the DART Platforms (Platforms 6, 7 & 8). 4 No. of tracks would be installed under South Circular Road Bridge (OBC1) and 6 No. of tracks beneath the existing St. John's Road Bridge (OBC0A). The distance from nearest rail to the bridge abutment would be 2.5m as a minimum.

Significant changes in the existing rail vertical levels are required to provide the minimum vertical clearance for the electrification of the Slow lines at the new South Circular Road Bridge (OBC1). The existing road levels at South Circular Road junction would be maintained.

All track and ballast would be removed and the rail corridor excavated to install the new track formation. This would result in an excavation depth of more than 2.0m. The excavation would have an impact on the existing masonry retaining wall. A structure would be installed to the base of the existing masonry retaining wall to counteract any destabilising effects of adjacent track lowering works. This structure would be installed over a significant length of the existing retaining wall.

The horizontal alignment for this option is common across Options 2, 4, 7 and 8 – as shown on the drawings listed in **Appendix** C. Please refer to **Table 5-2** for a description of the Permanent Way proposed designs. The design speed at Islandbridge junction would be 40km/h for the Fast lines and 30km/h for the Slow tracks, based on current design development.

The horizontal clearance from the edge of the new outer rail of the northernmost track to the face of the new north abutment of South Circular Road Bridge (OBC1) would be less than 4.5m and as such the north abutment would be designed for derailment loading.

Signalling, Telecommunications and Low Voltage cable containments would be moved to new positions. OHLE masts would be installed along the north side of the rail corridor, as the 2 No. northern tracks are the ones to be electrified. OHLE equipment would be fitted to the underside of the new South Circular Road Bridge (OBC1) and to the existing St. John's Road Bridge (OBC0A) to allow for continuous electrification through the structures. The existing signal gantries would be removed.

This Option has low merit in terms of its constructability and would be extremely disruptive to traffic. To reduce the impact on both the traffic above and the operation of the railway below, new abutments would be piled behind the existing abutments. The existing bridge would then be demolished, and the new single-span bridge deck constructed. The proposal to place beams at a high skew (46 degrees approximately) would result in the removal

of several traffic lanes for the duration of the construction period, and this means that a phased deck re-construction strategy could not be implemented.

There are two options for traffic management to enable construction works. The first would involve using the current western circulatory carriageway to accommodate eastern circulatory traffic in a contraflow operation. This would leave fewer lanes in each direction, less queueing space and would create high conflict turning movements.

The second option would involve diverting all north and west bound traffic away from the junction via the South Circular Road, Inchicore Road and R839. This would put further demand on these roads.

Both options would severely affect traffic in the area with potential for unsafe driver responses borne out of frustration. The options would also have a detrimental effect on vulnerable road user safety, with reduced lane widths, the removal of dedicated provisions and changing provision (causing uncertainty).

There are a significant number of utilities crossing the existing South Circular Road Bridge (OBC1). This Option would require the utilities to be diverted temporarily (via St. John's Road Bridge (OBC0A) or on a temporary utility bridge). A second utility diversion would subsequently be required to relocate utilities to their permanent positions on the reconstructed bridge. The existing Gas and Fibre Optic utilities could not be disconnected without (temporary) disruption as there are no alternative back feeds to the supply areas. The road works that would be required to facilitate such utility diversions would be highly disruptive. **Figure 5-1** and **Figure 5-2** show the indicative plan and cross section arrangement of South Circular Road Bridge (OBC1) for this Option.

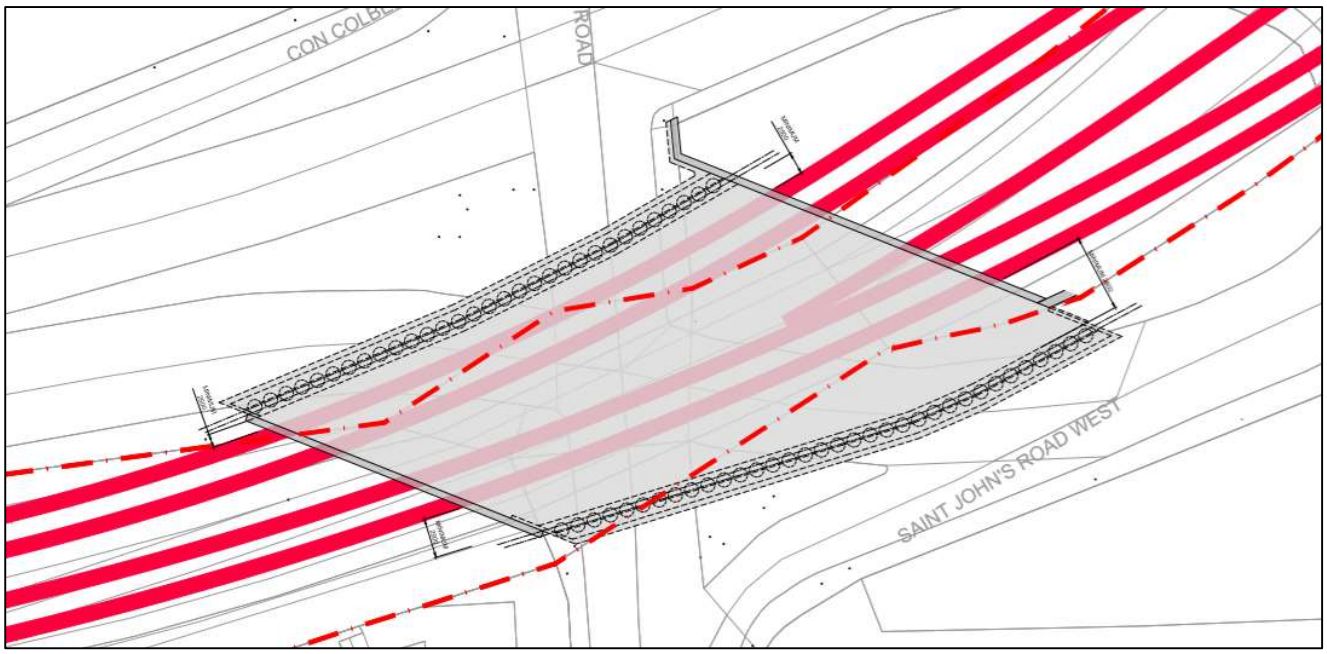

Figure 5-1 Option 2 plan

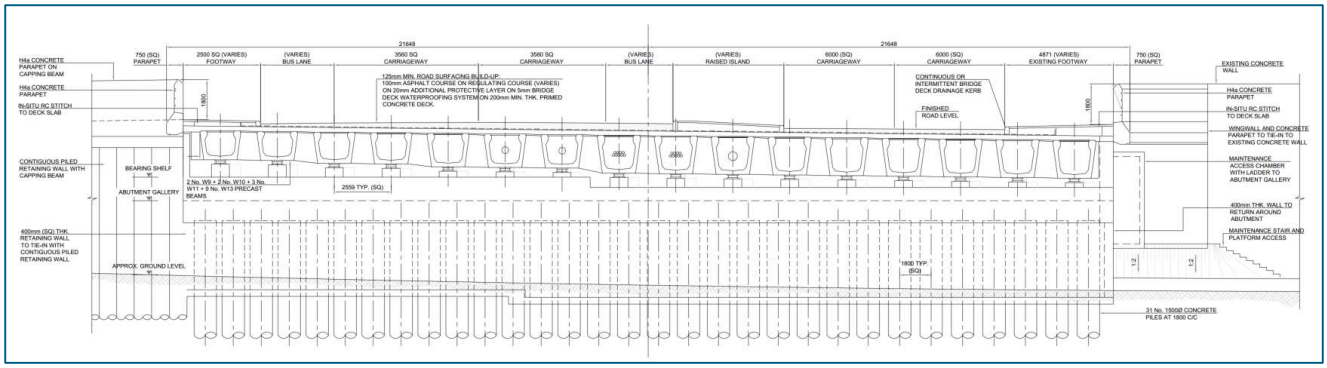

Figure 5-2 Option 2 typical cross section

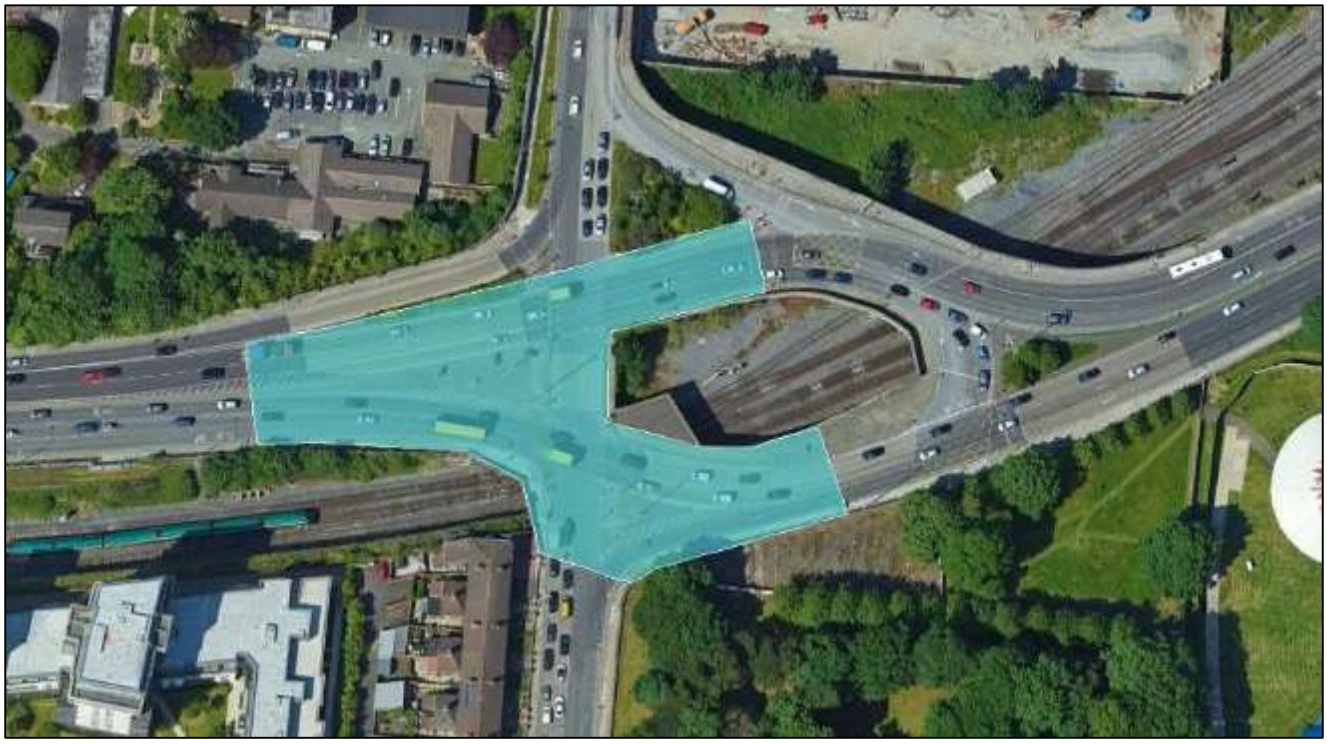

Figure 5-3 Pavement construction impact with road reinstatement at grade

5.2.4 Option 3

Option 3 is similar to Option 2, but the vertical clearance requirements would be achieved by raising the road levels and lowering the track levels. Both the road levels and tracks levels would be adjusted by 50% of the total adjustment required for this Option. For example, if an adjustment of 0.7m is required to achieve adequate vertical clearance, then the road levels would be raised by 0.35m, and the track levels would be lowered by 0.35m also. A vertical clearance of 5.3m (standard Iarnród Éireann requirement for new bridge) would be pursued, however if deemed unfeasible, a derogated reduced vertical clearance would be requested.

Even minor increases to the road levels at South Circular Road Bridge (OBC1) would require significant areas of road works to tie-in the new levels to the existing levels. The South Circular Road on the north side of the junction falls steeply towards Islandbridge (River Liffey). The tie-in works would need to 'chase' the vertical profile of the South Circular Road over a significant distance to create tie-in at gradients that are in accordance with the standards.

A similar (but less significant) situation exists on the Chapelizod Bypass on the north-west side of the structure where the road levels decrease on the departure (to the west) from the bridge. This would require the levels to be 'chased' along the westbound dual carriageway until they can tie-in using gradients that are in accordance with the standards.

Full-depth pavement layer reconstruction works would be required on all approaches to the junction structure within approximately 50m of the bridge structure and would likely require some road works on St John's Road Bridge (OBC0A). The extent of the works depends on the vertical clearance to be provided at South Circular Road Bridge (OBC1). All the parapets at the top of the retaining walls at the junction (in all directions) would need to be raised or rebuilt. Utility companies would be unlikely to accept large increases in the cover above their existing utilities without a requirement to relay their services. Works to utilities to raise their levels would be required in the vicinity of the bridge.

Figure 5-4 Pavement construction impact for new road levels >0.6m above existing levels

5.2.5 Option 4

This option proposes to replace the existing South Circular Road Bridge (OBC1) with a wider structure. The new structure would take the form of a long over-widened single span portal. The structure is over-widened to enable a two-phase construction of the works. This potentially reduces the level of traffic disruption during the reconstruction works compared to Options 2 and 3.

The new structure has a span and height that would provide sufficient vertical and horizontal clearance for four-tracking and electrification. The replacement bridge is much wider than the existing bridge. A vertical clearance of 5.3m (standard Iarnród Éireann requirement for new bridge) would be pursued, however if deemed unfeasible, a derogated reduced vertical clearance would be requested. All vertical clearance requirements and increases to structural depth are absorbed by track lowering only.

The proposed bridge has a single span of approximately 31m and a width of approximately 76m. The plan area of the structure is approximately 2,500m^2. The bridge deck would consist of precast prestressed Super W8 beams

(1.2m deep). The bridge beams would be parallel and have no or negligible skew. Unlike Option 2 and 3, the bridge could be designed to be fully integral, and as such would not require bearings, expansion joints, inspection galleries, bearing shelves or bearing replacement works over the lifetime of the structure.

The permanent way configuration would be the same as that described for Option 2 with adjustments to the vertical levels.

Signalling, Telecommunications and Low Voltage cable containments would be moved to new positions. OHLE masts would be installed along the north side of the rail corridor. OHLE equipment would be fitted to the new South Circular Bridge (OBC1) and to the existing St. John's Road Bridge (OBC0A) to allow for continuous electrification through the structures. The existing signal gantries would be removed.

This Option would be designed to facilitate improved Traffic Management when compared with Options 2 and 3. The wide structure could be be constructed in two phases. An over-widened structure allows a two-phase traffic management approach and maintains very similar lane allocations and movements as is currently present when compared to all other options.

While the maintenance costs of this integral structure would be considered less than the Option 2 and 3 structure, the capital cost would be higher. Large out-build areas of the portal would be utilised in the temporary construction phases only and would require inspection and maintenance throughout the lifetime of the structure. However, the over widened portion would provide potential flexibility / adaptability for enhancing vulnerable user safety as well as for the installation of new utilities with limiting impact on the South Circular Road carriageways.

The Option would seek to minimise traffic disruption through phased construction. As this Option would not impact on St John's Road Bridge (OBC0A), traffic management would be marginally better when compared with Options 2 and 3. However, it would be expected that the level of disruption / impact on traffic movements would be significant given the scale and duration of the construction work required.

At least one residential property on the south-west side of the structure would need to be acquired. It may be possible to minimise the impact at this location at the detail design stage by stepping, flaring or curving the abutment. This would be assessed at the detailed design stage. **Figure 5-5** and **Figure 5-6** show the indicative plan and cross-section arrangement of South Circular Road Bridge (OBC1) for this Option.

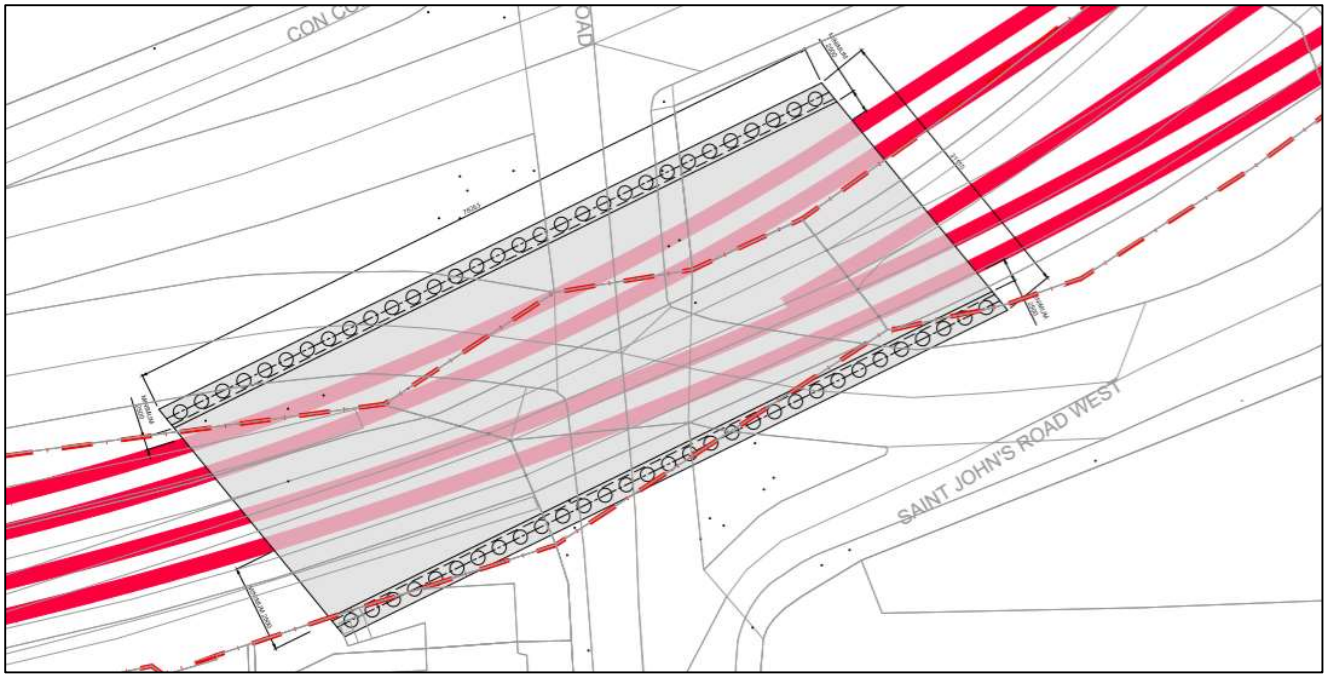

Figure 5-5 Option 4 plan

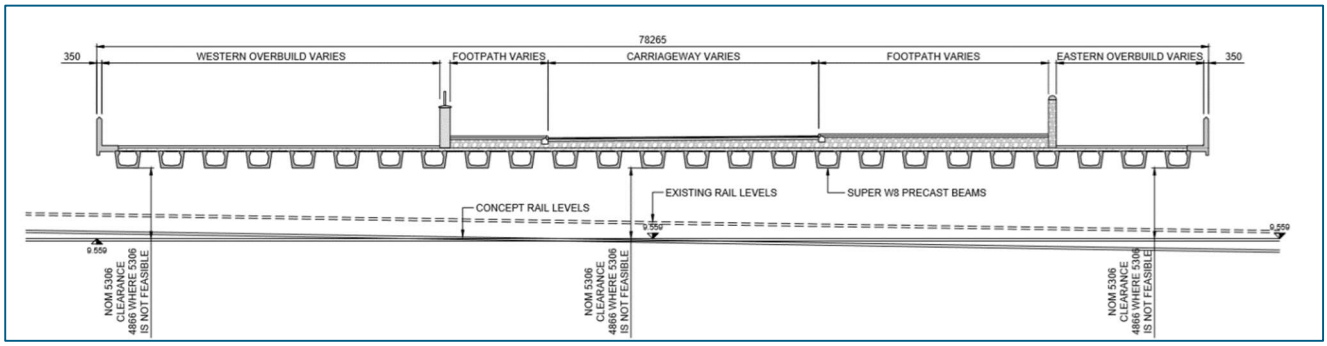

Figure 5-6 Option 4 typical cross section

Figure 5-7 Pavement construction impact with road reinstatement at grade

5.2.6 Option 5

Option 5 is similar to Option 4, but the vertical clearance requirements are achieved by raising the road levels and lowering the track levels. Both the road levels and tracks levels are adjusted by 50% of the total adjustment required for this Option. A vertical clearance of 5.3m (standard Iarnród Éireann requirement for new bridge) would be pursued, however if deemed unfeasible, a derogated reduced vertical clearance would be requested.

As discussed previously in the report, even minor increases to the road levels at South Circular Road Bridge (OBC1) would require significant areas of roadworks to tie-in the new levels to the existing levels. Pavement works would be required on all approaches to the junction within approximately 50m of the bridge structure and likely requiring some road works on St John's Road Bridge (OBC0A). The extent of the works depends on the vertical clearance to be provided at South Circular Road Bridge (OBC1). All the parapets at the top of the retaining walls at the junction (in all directions) would need to be raised or rebuilt.

Figure 5-8 Pavement construction impact for new road levels >0.6m above existing levels

5.2.7 Option 6

This Option retains the existing South Circular Road Bridge (OBC1). A new 'cut and cover' buried portal structure would be constructed on the north side of the existing bridge (immediately north of the existing north abutment). The buried portal would provide space for 2 No. electrified tracks. The existing bridge would now facilitate 2 No. non-electrified tracks, therefore removing the requirement for installation of OHLE (and additional vertical clearance) under the existing structure.

The proposed cut and cover buried portal would be approximately 120m long and have a clear span of approximately 10m. The horizontal clearance to both abutments would be 2.5m and as such the abutments would be designed for derailment impact loading. The structure would be fully integral and would not require bearings, expansion joints or inspection galleries. A vertical clearance of 5.3m (standard Iarnród Éireann requirement for new bridge) would be pursued, however if deemed unfeasible, a derogated reduced vertical clearance would be requested.

It is proposed that both abutments of the buried structure would be piled from the existing road level. It is envisaged that the abutment piling works would be carried out in short sections at night-time and under traffic management. It may be possible to temporarily reinstate and cover the ongoing works each night with road plates to allow full use of the existing carriageway during the day. If this is not possible, the piling and roof slab works could be carried out in two or three phases under traffic management. Similar to Option 4, the existing traffic island on the north side of South Circular Road Bridge (OBC1) would be temporarily reconstructed to facilitate two temporary lanes to allow traffic to flow from east to west on the Chapelizod Bypass. The roof slab (which may be constructed of precast units) may also be installed in short sections at night-time and made integral to the abutments using an in-situ stitch. The fill within the new structure could be subsequently excavated at track level from the east end of the buried portal so that this activity would not cause disruption to traffic. This Option would provide the optimum solution in terms of minimising traffic disruption.

The two Slow tracks would be realigned towards the north to pass through the new cut and cover structure and, after this, through the north span of St. John's Road Bridge (OBC0A). The track level of the Slow tracks would be significantly lower than the existing rail levels to achieve the required vertical clearance for the electrification along the new structure. The proposed vertical profile shows a track lowering of 3m at the west entrance of the cut and cover (subject to further design development), necessary to achieve the standard vertical clearance of 5.3m. This is due to the low level required for the buried portal soffit, which is constrained by existing road levels and existing utilities.

As a result, the track gradient of the west approach of the structure would be 1.85% (greater than 1.3% which is the existing track gradient at the area). In addition, the track level of the Slow tracks would be significantly lower than the existing through the St John's Road bridge (OBC0A), from 1m to 0.7m (refer to **Figure 5-9**).

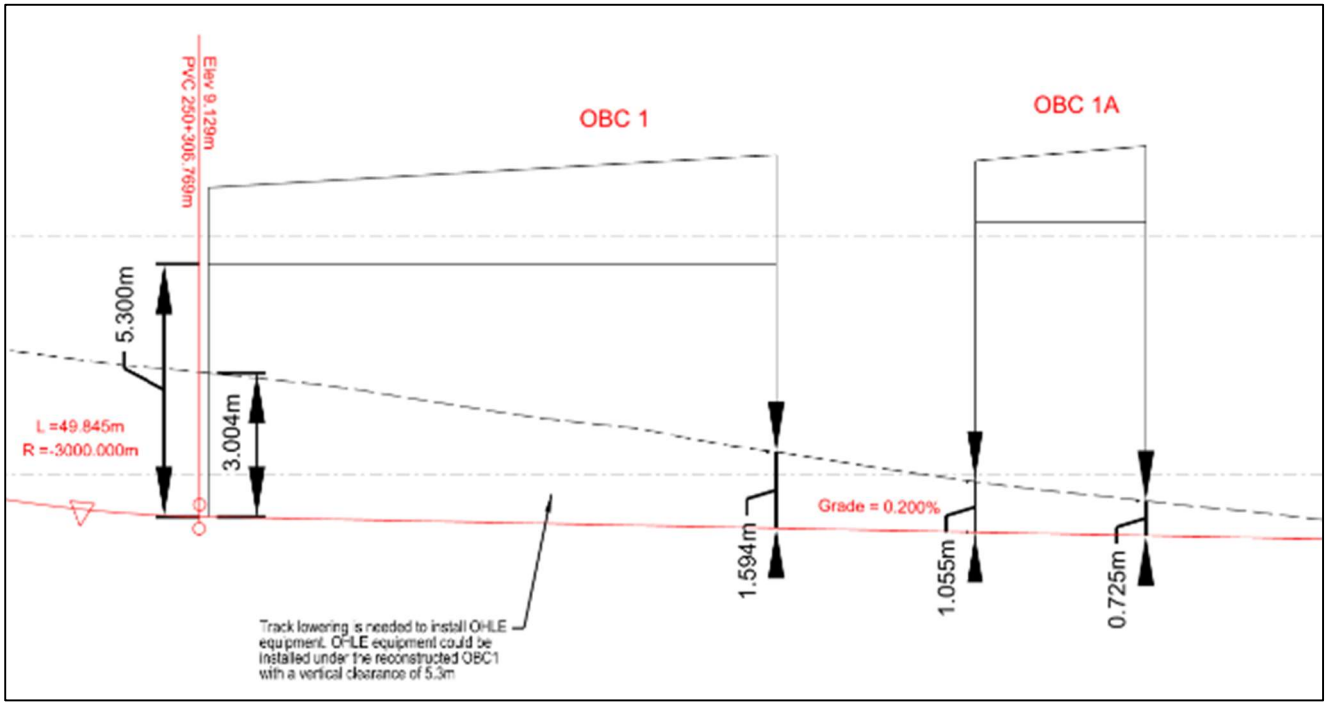

Figure 5-9 Longitudinal gradients

The proposed Fast tracks would be realigned, separated further from the existing masonry retaining wall along the south side of the corridor between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3), to remove the limited clearance area. Also, because the number of tracks through the existing South Circular Road Bridge (OBC1) would be decreased from 3 No. tracks to 2 No. tracks, the separation between tracks and the existing abutments would be enough for the installation of a continuous walkway. Considering the Fast tracks would not be electrified, significant track lowering to achieve OHLE clearances in the vicinity of South Circular Road bridge (OBC1) would not be required.

This configuration would result in the Slow and Fast tracks being at different levels, with a differential close to 3m at the cut and cover entrance. A retaining wall would need to be installed in the 10ft from Memorial Road up to the start of the cut and cover structure.

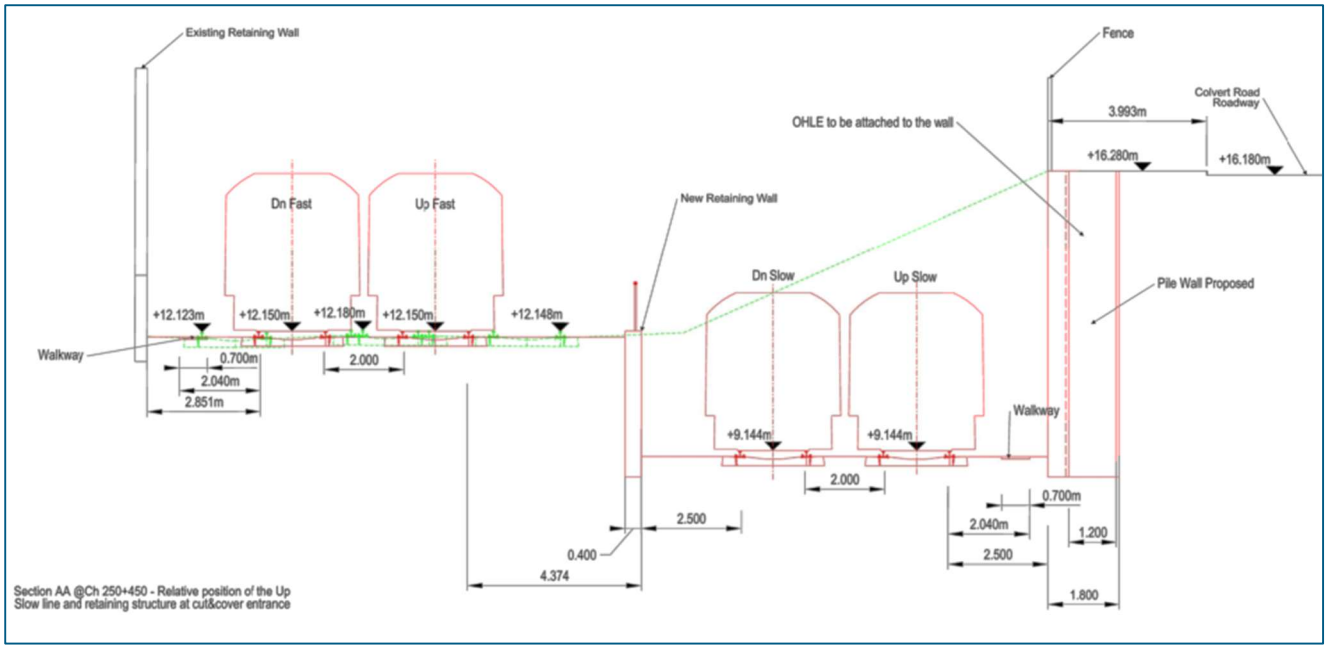

Figure 5-10 Cross section, view looking west

The differential level between the two set of tracks, Slow and Fast, would preclude the connection of the Fast and Slow tracks with crossovers. This would represent a reduction in the operational flexibility of this solution with respect to the permanent way layout presented in the other options. However, further operational optimisation of the layout could be examined as part of the design development process.

As aforementioned the Slow tracks beneath St. John's Road Bridge (OBC0A) would be from 1m to 0.7m lower than the existing level. The dimensions and depth of the existing bridge abutment and pier foundations may be such that they constrain the available track lowering directly beneath the current track locations. A careful study would be required to validate the Slow track alignment against the position of the foundations. A geotechnical investigation is ongoing and will determine the line and level of the foundations. Where track lowering extents is necessary to a level at which bridge foundations would be impacted, a structural solution may be required to ensure their continued stability.

This option would be the most favourable in terms of utility diversions. The sequencing of the buried portal construction would allow utilities to be diverted across the top of the roof slab to temporary and permanent locations as required and with relatively little disruption compared to other options. This option would not propose to increase road levels at the junction itself, and as such it would not require existing utility networks beyond the extents of the existing and proposed structures to be raised to levels / depths that are acceptable for inspection and maintenance by the Utility providers. The existing horizontal road geometry at the junction and along the west bound carriageway would be reinstated after construction. The only vertical alignment adjustments will be made to the westbound carriageway, west of South Circular Road. Road raising of 300mm (approx.) is anticipated at the low point. The length of the carriageway reconstruction is anticipated to extend 30m (approx.)past the cut and cover buried portal structure.

Similar to Options 2 to 5, the existing tracks would be renewed and repositioned to provide sufficient clearance in accordance with design standards. Space for the additional fourth track would be created on the north side of the rail corridor by constructing a retaining wall through and along the cutting slope. The retaining structure required would be significant at approximately 575m in length and several metres high (varies). The retaining structure may take the form of a bored pile retaining wall or similar.

Signalling, Telecommunications and Low Voltage cable containments would be relocated to new positions and existing access points from street level (Con Colbert Road) repositioned accordingly. OHLE masts would be installed along the north side of the rail corridor. OHLE equipment would be fitted to the new 'cut-and-cover' structure and to the existing St. John's Road Bridge (OBC0A) to allow for continuous electrification through the structures. The existing portal gantries would be removed.

Figure 5-11 and **Figure 5-12** show the indicative plan and cross-section arrangement for the 'cut and cover' structural element of this Option.

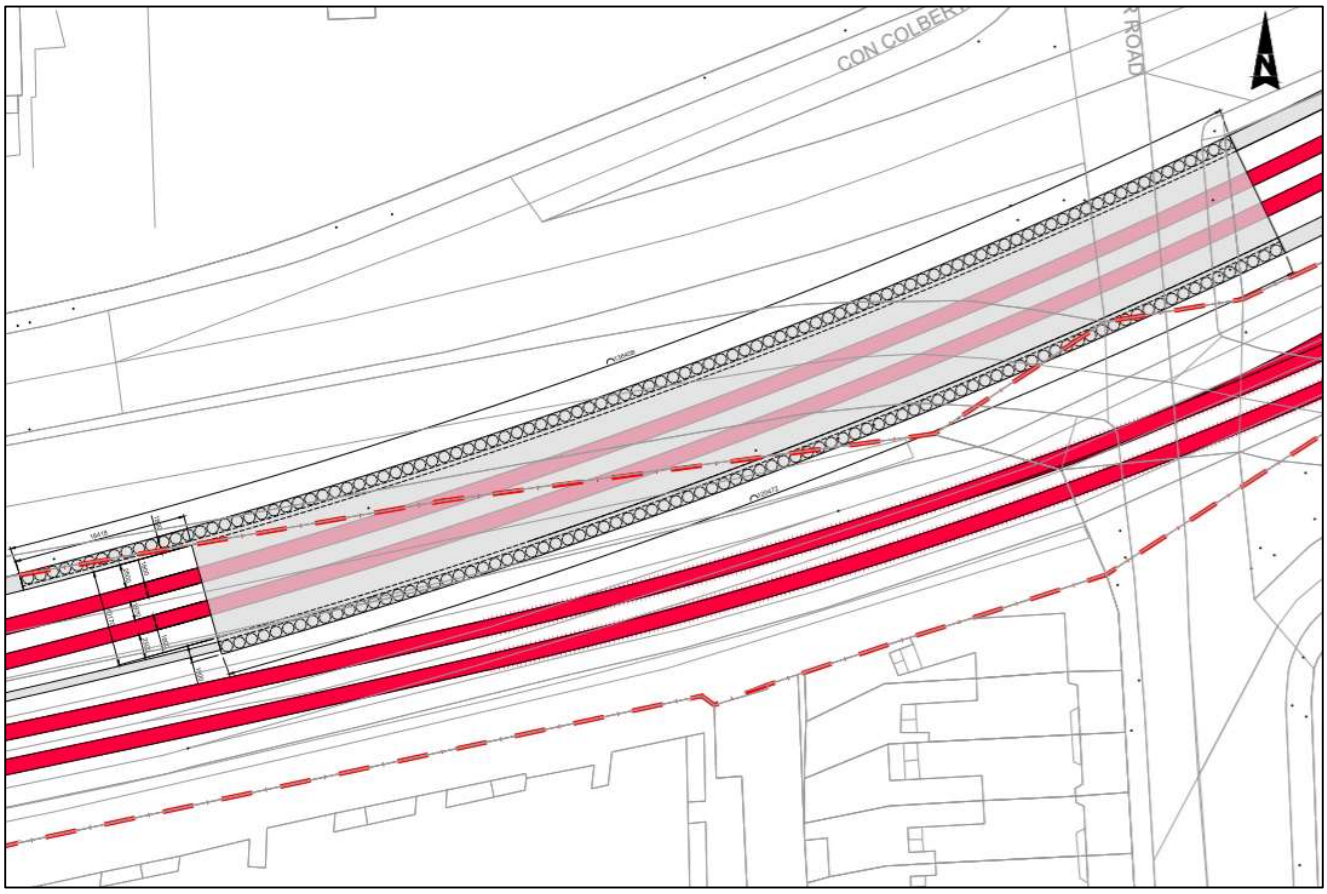

Figure 5-11 Option 6 plan

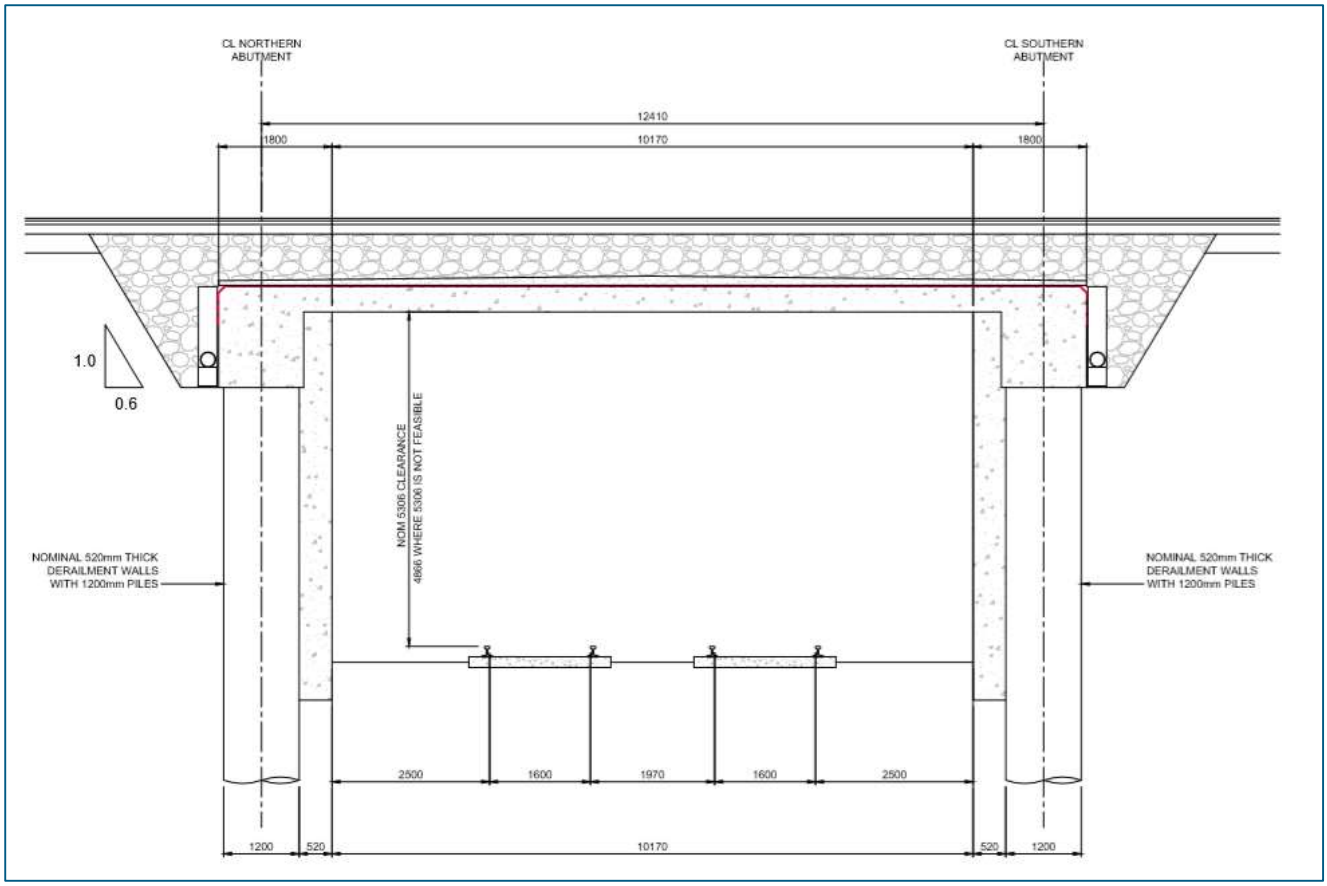

Figure 5-12 Option 6 typical cross section

5.2.8 Option 7

This option is similar to Option 2 but incorporates a minor and localised increase to road levels on the Chapelizod Bypass on the north-west side of the new bridge (to the westbound carriageway and median). The increase in levels at this location facilitates a corresponding reduction in track lowering requirements throughout (but at the bridge in particular). This localised area of the road would need to be reconstructed to construct the new South Circular Road Bridge (OBC1) in any case so is not considered as a major intervention at road level. A vertical clearance of 5.3m (standard Iarnród Éireann requirement for new bridge) would be pursued, however if deemed unfeasible, a derogated reduced vertical clearance would be requested.

5.2.9 Option 8

This option is similar to Option 4 but incorporates a minor and localised increase to road levels on the Chapelizod Bypass on the north-west side of the new bridge (to the westbound carriageway and median). The increase in levels at this location would facilitate a corresponding reduction in track lowering requirements throughout (but at the bridge in particular). This localised area of the road would need to be reconstructed in order to construct the new South Circular Road Bridge (OBC1) in any case so is not considered as a major intervention at road level. A vertical clearance of 5.3m (standard Iarnród Éireann requirement for new bridge) would be pursued, however if deemed unfeasible, a derogated reduced vertical clearance would be requested.

5.3 OHLE Arrangement – All Do-Something Options

St. John's Road Bridge (OBC0A) has sufficient vertical clearance such that it can be electrified under all Options (using fitted solutions) without any track lowering or major structural interventions. However, its proximity to South Circular Road Bridge (OBC1) is such that the two bridges have been considered together when defining the OHLE solution for each Option.

The existing South Circular Road Bridge (OBC1) has insufficient vertical clearance to provide an OHLE solution. Therefore, Options 0 and 1 are not feasible.

Where a 5.3m vertical clearance at South Circular Road Bridge (OBC1) is found to be unfeasible, and a derogation for a reduced vertical clearance of 4.886m is granted, the reduced clearance would be sufficient to provide an OHLE configuration with graded contact wire, twin contact equipment (zero system height), and a contact wire height of 4.4m through the bridge. Due to the width of the structure, the OHLE would be fitted with elastic bridge arms supported from the structure at multiple locations. Electrical clearances would be 100mm static, and 50mm passing. Allowance has been made for 25mm of upward track movement.

Due to the width of the St John's Road Bridge (OBC0A), the OHLE would be connected to the bridge at multiple locations to counteract sagging. The contact wire would be graded upwards from 4.4m to nominal wire height towards the east side of the bridge. This would assist with achieving minimum separation distances at Heuston Station. The system height under the bridge would be increased where possible to minimise the use of elastic bridge arms. The support and registration through the bridge are likely to comprise of small system height cantilevers supported from the bridge deck or abutment.

Where a 5.3m vertical clearance at South Circular Road (OBC1) is found to be feasible, the OHLE configuration through the bridges would be similar, but the contact wire height would be 4.7m throughout, and so no grading is required. Electrical clearances would be 150mm static and 100mm passing, and an allowance has been made for 75mm of upward track movement. This also applies to the electrification in the cut&cover structure in Option 6.

5.4 Permanent Way

A total of 2 No. Permanent Way configurations have been developed. They follow the existing rail corridor footprint as much as possible. Widening of the rail corridor is proposed on the north side for all Options. Widening the rail corridor towards the south is not feasible due to the density and proximity of private residential and commercial properties. A summary of the Permanent Way variations is set out in the table below.

Table 5-2 Permanent Way Options

ID	Drawing No	Description
Per Way alignment for Options 2-4-7-8 (common track layouts for these integrated multi-disciplinary options)	DP-04-23-DWG-PW-TTA-55747 DP-04-23-DWG-PW-TTA-55748	Per Way Option 2-4-7-8 is similar to the Concept Baseline solution: • Design speed through Islandbridge Junction is 30km/h (20mph) for the Slow tracks and 40km/h (25mph) for the Fast lines. • Complete track renewal is required. • Standard 10-foot dimension is proposed between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC1). • Track lowering is needed to achieve vertical clearances at bridge Options. The rail levels will be adjusted to fit final designs of road, overbridge and OHLE system. • Track gradients are increased from 1.3% to 1.5% (approximate, depending on bridge options) • Complete upgrade of track formation is required.

ID	Drawing No	Description
		• New drainage may be required. An access walkway can be installed to both cess's.
Per Way alignment for Option 6	DP-04-23-DWG-PW-TTA-55752 DP-04-23-DWG-PW-TTA-55753 DP-04-23-DWG-PW-TTA-55751	The proposed Slow tracks are slewed towards the north and would cross the road junction through a cut and cover buried structure solution. The existing South Circular Road Bridge (OBC1) and St John's Road Bridge (OBC0A) structures would be retained. • Design speed through Islandbridge is 30km/h • Complete track renewal is required. • Significant track lowering is required for the Slow lines to achieve the required vertical clearance at the cut and cover structure. Slow and Fast tracks would be at different levels (up to 3m) • Track gradients of Up Slow track are increased from 1.3% to 1.8%. • Upgrade of track formation is required. • New drainage may be required. • An access walkway can be installed to both cess's. • Configuration of Islandbridge junction is constrained by the differential level of Slow and Fast tracks. The connection of the Slow and Fast track may only be possible to the west of St John's Road Bridge (OBC0A). • A retaining wall is to be installed in the 10foot between the Slow and Fast tracks. 10foot dimension may need to be increased up to 5.4m to ensure continuous position of safety.

The geometrically constrained area requires the track alignment to consist of tight track radii and the P&Cs to be installed on curves.

5.5 Geotechnical (All Do-Something Options)

The general superficial geology in this area is anticipated to comprise a thin layer of made ground underlain by a significant thickness of Glacial Till overlying bedrock. From an assessment of the available historical ground investigation summarised in this report, no onerous ground or groundwater conditions are expected that would significantly impact any of the Options proposed based on the available ground investigation information at the time of writing. Therefore, the ground and groundwater conditions currently do not pose any significant concerns from a geotechnical design perspective (e.g. selection of shallow foundations or piling).

5.6 Roads (All Intervention Options)

The South Circular Road junction is used by vulnerable users (pedestrians, cyclists, disabled, blind, partially sighted), primarily making north and southbound movements along South Circular Road. Dublin City Council has requested that the Options provide the same level of service for pedestrians and cyclists as the existing.

Both the Lucan and Liffey Valley Bus Connect Schemes are currently at Stage 3 - Public Consultation and if implemented prior to DART+ South West could potentially impact the reinstatement and temporary traffic management strategies envisaged for use with the Options under review in this report. Consultation with the relevant stakeholders is ongoing.

5.7 Cable and Containments (All Do-Something Options)

With the exception of Option 0, all Options will require the relocation of a variety of service cables, utilities and containments throughout and the integration of the existing maintenance access point from Chapelizod Bypass

into the proposed retaining structure between Memorial Road Bridge (OBC3) and South Circular Road Bridge (OBC1).

Dublin City Council has requested that its existing CCTV traffic monitoring system is to remain active throughout the construction project; this will require further consultation to determine suitable temporary or permanent relocation location of this system.

6 Options Selection Process

6.1 Options Selection Process

A clearly defined appraisal methodology has been used in the selection of the Emerging Preferred Option for the Project. Consistent with other NTA projects, it is based on 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes' (CAF) published by the Department of Transport, Tourism, and Sport (DTTAS), March 2016 (updated 2020) and informed by TII's Project Management Guidelines (TII PMG 2019). The Option Selection Process involves a three-stage approach as summarised below:

- Stage 1 Preliminary Assessment (Sifting)
- Stage 2 Multi Criteria Analysis (MCA)
- Stage 3 Emerging Preferred Option

The starting principle of the optioneering process and a focus of the Project Team has been to reduce the potential impacts on the surrounding environs by accommodating necessary works and interventions within the existing rail corridor, where practicable. However, it is acknowledged that as the Cork Main Line is an existing operational rail line operating in a pre-defined corridor, the options to accommodate the necessary works at some locations along the route are limited due to spatial constraints.

6.2 Stage 1: Preliminary Assessment (Sifting)

The Stage 1: Preliminary Assessment (Sifting) involves an initial assessment of a long list of options, each of which are assessed against Engineering, Economics and Environmental criteria.

The assessment is based on whether an option meets the Project Objectives / Requirements and whether the option is technically feasible. All feasible options are brought forward to the second stage of the assessment process (MCA) to be explored in greater detail.

The area under consideration covers approximately 750m and extends from the Memorial Road Bridge (OBC3) to the east of the St John's Road Bridge (OBC0A). A total of nine 'Options' were initially developed for this area. The options assessed, ranged from a 'Do-Nothing' Option, 'Do-Minimum' Option to a range of 'Do-Something' Options, each of the options were assessed to determine if they were feasible and met the Project Objectives / Requirements.

The 'Do-Something' Options in this area involve the widening of the existing rail corridor to accommodate the required four tracks. Widening of the rail corridor is proposed on the north side of the existing tracks to minimise impact on the private residential and commercial properties located on the southern side of the existing rail corridor. Existing structures in this area were analysed to determine if they could accommodate the additional tracks and installation of the new Overhead Line Electrification (OHLE) system. The existing road network poses significant constraints in terms of achieving the project requirements of providing an additional fourth track and electrifying 2 No. tracks in this area.

6.2.1 Preliminary Assessment (Sifting)

Table 6-1 provides details of the assessment undertaken as part of the Stage 1 Preliminary Assessment (Sifting) Process. Options which were assessed as feasible and fulfilled the project requirements were brought forward to Stage 2 MCA for a more detailed assessment.

Table 6-1 Preliminary Assessment (Sifting) Findings

Option	Requirements		Description
0	Engineering	Constructability	Not applicable. No intervention proposed.
		Geometrical fitness for intervention	Not applicable. No intervention proposed.
		Safety	Not applicable. No intervention proposed.
		four-tracking Park West-Heuston	FAIL. No intervention proposed. four-tracking is not achieved.
		Electrification of DART+ tracks	FAIL. No intervention proposed. Electrification of the DART+ tracks not achieved.
		Vertical electrical clearance in structures	FAIL. No intervention proposed. Vertical electrical at structures not achieved.
		Bridge Design Standards	Not applicable. No intervention proposed.
		Keep current functionality of roads	PASS. No intervention proposed.
	Economy		Compatible with the investment guidelines and programme for DART+
	Environment		No impact on Environmental sites of National or International significance.
	SIFTING OUTCOME		**FAIL. Do not progress to Stage 2 Assessment**
1	Engineering	Constructability	PASS. Minor interventions to the rail corridor are possible.
		Geometrical fitness for intervention	PASS. Minor interventions without geometrical fitness concerns are possible.
		Safety	PASS. Minor interventions that pose no safety concerns are possible.
		four-tracking Park West-Heuston	FAIL. Minor interventions only cannot achieve four-tracking.
		Electrification of DART+ tracks	FAIL. Minor interventions only cannot achieve electrification of the DART+ tracks.
		Vertical electrical clearance in structures	FAIL. Minor interventions only cannot achieve vertical electrical clearance requirements at structures.
		Bridge Design Standards	PASS. Minor interventions to the rail corridor in accordance with standards are possible.
		Keep current functionality of roads	PASS. Minor interventions to rail corridor that do not affect road functionality are possible.
	Economy		Compatible with the investment guidelines and programme for DART+.
	Environment		No impact on Environmental sites of National or International significance.
	SIFTING OUTCOME		**FAIL. Do not progress to Stage 2 Assessment**
2	Engineering	Constructability	PASS. This Option would be difficult to construct, but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a maximum track lowering of 1.650m. This track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. Current road functionality maintained.

		Economy	Compatible with the investment guidelines and programme for DART+
		Environment	No impact on Environmental sites of National of International significance.
		SIFTING OUTCOME	**PASS. Proceed to Stage 2 Assessment**
3	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a minimum road level increase and track lowering of 0.825m. This track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	FAIL. This would require a minimum road level increase and track lowering of 0.825m. This level of road level increase at OBC1 would require extensive works to the junction and to the approach roads. It is not a feasible solution in terms of maintaining the functionality of roads.
		Economy	Compatible with the investment guidelines and programme for DART+
		Environment	No impact on Environmental sites of National of International significance.
		SIFTING OUTCOME	**FAIL. Do not progress to Stage 2 Assessment**
4	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a track lowering of 1.781m. This track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. Current road functionality maintained.
		Economy	Compatible with the investment guidelines and programme for DART+
		Environment	No impact on Environmental sites of National of International significance.
		SIFTING OUTCOME	**PASS. Proceed to Stage 2 Assessment**
5	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a minimum road level increase and track lowering of 0.890m. This track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.

		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	FAIL. This would require a minimum road level increase and track lowering of 0.890m. This level of road level increase at OBC1 would require extensive works to the junction and to the approach roads. It is not a feasible solution in terms of maintaining the functionality of roads.
	Economy		Compatible with the investment guidelines and programme for DART+
	Environment		No impact on Environmental sites of National of International significance.
	SIFTING OUTCOME		**FAIL. Do not progress to Stage 2 Assessment**
6	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require track lowering, for the Slow lines, of 3.0m at the proposed Cut and Cover Structure. Existing track levels on the Fast lines would be nominally maintained the existing bridge approx 3.0m. This track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ track levels.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. Current road functionality maintained.
	Economy		Compatible with the investment guidelines and programme for DART+
	Environment		No impact on Environmental sites of National of International significance.
	SIFTING OUTCOME		**PASS. Proceed to Stage 2 Assessment**
7	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a road level increase of 0.2m and a minimum track lowering of 1.450m. This track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. This would require a road level increase of 0.2m and track lowering of 1.450m.
	Economy		Compatible with the investment guidelines and programme for DART+

	Environment		No impact on Environmental sites of National of International significance.
	SIFTING OUTCOME		**PASS. Proceed to Stage 2 Assessment**
8	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a road level increase of 0.2m and track lowering of 1.581m. This track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	This would require a road level increase of 0.2m and a minimum track lowering of 1.581m.
	Economy		Compatible with the investment guidelines and programme for DART+
	Environment		No impact on Environmental sites of National of International significance.
	SIFTING OUTCOME		**PASS. Proceed to Stage 2 Assessment**

6.2.2 Preliminary Assessment Summary

A total of 9 No. Options were developed for the area from the Memorial Road Bridge (OBC3) to the east of the St John's Road Bridge (OBC0A). Following the assessment completed as part of the Sifting Process, as shown in **Table 6-2**, a total of 5 No. Options have been shortlisted and will progress to Stage 2 (MCA) of the assessment process.

Table 6-2 Summary of Sifting Process Results

Main Option	Short Listed for Stage 2 MCA
Option 0: Do Nothing	FAIL
Option 1: Do Minimum	FAIL
Option 2	PASS
Option 3	FAIL
Option 4	PASS
Option 5	FAIL
Option 6	PASS
Option 7	PASS
Option 8	PASS

The following options did not meet the necessary Engineering Feasibility and Project Requirements and shall not be brought forward to Stage 2 (MCA) of the assessment process:

- **Option 0** - The Do-Nothing Option proposes no changes to the existing road or rail infrastructure, as such, this option would not facilitate the inclusion of the required four tracks or the installation of the OHLE system. The project requirements would not be achieved as such this option was not brought forward.
- **Option 1** – The Do-Minimum Option seeks to achieve the four-tracking and electrification by means of minor interventions only. Due to the constraints in this area, minor interventions would not be sufficient to achieve the project requirements, as such this option was not brought forward.
- **Option 3** - This option involves the reconstruction of the South Circular Road Bridge (OBC1) with a greater span and height, it would require the road level to be increased by 0.825m in addition to lowering the track by 0.825m. This option was not brought forward due to the required road level increase, which would require extensive works to the junction and to the approach roads, significant disruption would also be caused during construction.
- **Option 5** – This option involves the replacement of South Circular Road Bridge (OBC1) with a wider structure. The new structure would take the form of a long over-widened single span portal. This option would require the road level to be increased by 0.890m in addition to lowering the track by 0.890m. This option was not brought forward due to the required road level increase, which would require extensive and disruptive works to the junction and to the approach roads.

The following options met the necessary Engineering Feasibility and Project Requirements and were brought forward to Stage 2 (MCA) for detailed assessment:

- **Option 2** – This option involves the reconstruction of the South Circular RoadBridge (OBC1), replacing it with a larger span and higher structure, the works would also involve track lowering.
- **Option 4** – This option involves the replacement of the South Circular RoadBridge (OBC1) with an over widened portal which could be constructed in phases, works would also involve track lowering.
- **Option 6** – This option involves the retention of the existing South Circular RoadBridge (OBC1) and the construction of a new cut and cover portal structure.
- **Option 7** – This option is similar to Option 2 but would incorporate a minor and localised increase to road levels on the Chapelizod Bypass on the north west side of the new bridge.
- **Option 8** – This option is similar to Option 4 but would incorporate a minor and localised increase to road levels on the Chapelizod Bypass on the north west side of the new bridge.

6.3 Stage 2: Multi-Criteria Analysis (MCA)

Stage 2 Multi-Criteria Analysis (MCA) comprises a detailed multi-disciplinary comparative analysis of those options which passed through Stage 1: Preliminary Assessment (Shifting). The options are assessed against the criteria of Economy, Safety, Environment, Accessibility and Social Inclusion, Integration and Physical Activity in line with the criteria required for multi-criteria analysis under the Department of Transport, Tourism and Sport (DTTAS), Common Appraisal Framework (CAF) for Transport Project and Programmes (March 2016).

The assessment compares the options, identifying and summarising the comparative merits and disadvantages of each alternative under all applicable criteria and sub-criteria leading to an Emerging Preferred Option.

Relevant considerations include:

- This is a comparative analysis between the various options, not an impact assessment of each option. The impact from the Emerging Preferred Option will be assessed in the Environmental Impact Assessment Report in the next phase of the development.
- Not all sub-criteria and qualitative and/or quantitative indices may be relevant in every case.
- For each option there are potential design variations. In due course design variations will be subject to detailed technical analysis (in respect of the Emerging Preferred Option).
- For each option an indicative envelope was identified for permanent and temporary works, property and/or land take; a worst-case scenario was considered. Detailed design, technical and construction related solutions will seek to minimise land take in respect of the Emerging Preferred Option.
- The envelope around each Option was used to spatially represent environmental constraints within / proximate to the options.

The options which were brought forward from the Preliminary Screening were developed further to facilitate the more detailed Stage 2 Multi Criteria Analysis. General arrangement drawings were developed for all options, focusing on key design aspects – bridges, roads, and permanent way.

These arrangement drawings were overlain to identify an overall spatial envelope for each option identifying the likely extent of permanent and temporary works required. The spatial envelope and GIS software was used to run queries in relation to environmental and other data sets to assist the specialists in undertaking the Stage 2:

Multi-Criteria Analysis (MCA) (also refer to Technical Appendices Volume 2.1 'Environmental Constraints Reporting' for details of the constraints datasets used).

Due to the complexity of the junction at South Circular Road Bridge (OBC1), assessments were carried out to determine the impact of the various options on the road network, during the construction phase and also the longer term impacts of the proposed solution. This section of the rail corridor is also critical from a rail operations perspective as it is the gateway to Heuston Station, as such all options had to be assessed to determine any potential impacts on rail operations.

Preliminary cost estimates were prepared for each of the Options, incorporating the construction costs and potential land acquisition costs.

The MCA Process involved assessing the performance of each option against relevant quantitative and qualitative indicators, the assessment was carried out at dedicated MCA workshops by a multi-disciplinary team including commercial, technical, safety and environmental specialists.

Presented in a matrix format, each specialist included a commentary of his/her analysis for each option. They then compared the options relative to each other based on whether an option had a 'some' or 'significant' advantage or disadvantage over other options or whether all options were 'comparable / neutral'. This basis of comparison is consistent with the NTA Guidelines which use the following five-point ranking scale when comparing options against each other for comparative analysis.

Table 6-3 Comparison Criteria

Comparison Criteria Legend
Significant Comparative Disadvantage over Other Options
Some Comparative Disadvantage over Other Options
Comparable to Other Options / Neutral
Some Comparative Advantage over Other Options
Significant Comparative Advantage over Other Options

6.4 Multi-Criteria Analysis Summary

Table 6-4 shows the summary findings of the comparative assessment undertaken during the Stage 2 MCA, the detailed matrix is provided in **Appendix B**.

Table 6-4 MCA Summary

CAF Parameters	Option 2	Option 4	Option 6	Option 7	Option 8
1. Economy	Some Comparative Disadvantage over Other Options	Some Comparative Disadvantage over Other Options	Significant Comparative Advantage over Other Options	Some Comparative Disadvantage over Other Options	Significant Comparative Disadvantage over Other Options
2. Integration	Some Comparative Disadvantage over Other Options	Some Comparative Advantage over Other Options	Some Comparative Advantage over Other Options	Some Comparative Disadvantage over Other Options	Some Comparative Advantage over Other Options
3. Environment	Some Comparative Disadvantage over Other Options	Some Comparative Disadvantage over Other Options	Some Comparative Advantage over Other Options	Some Comparative Disadvantage over Other Options	Some Comparative Disadvantage over Other Options
4. Accessibility and Social	Some Comparative Advantage over Other Options	Some Comparative Advantage over Other Options	Some Comparative Disadvantage over Other Options	Some Comparative Advantage over Other Options	Some Comparative Advantage over Other Options
5. Safety	Some Comparative Disadvantage over Other Options	Some Comparative Disadvantage over Other Options	Some Comparative Advantage over Other Options	Some Comparative Disadvantage over Other Options	Some Comparative Advantage over Other Options
6. Physical Activity	Comparable to Other Options / Neutral	Comparable to Other Options / Neutral	Comparable to Other Options / Neutral	Comparable to Other Options / Neutral	Comparable to Other Options / Neutral
Conclusion			Preferred Option		

Option 6 is identified as the preferred option or solution, the basis for this, is as follows:

Economy:

Option 6 is the least expensive option having regard to land take, traffic disruption (temporary works) and capital costs of the works. Option 8 is the most expensive because of extent of capital works and potential for greater traffic disruption.

Option 6 is the only option that leaves the Intercity and Regional Rail service tracks approximately at the same level as they have today. This negates the need to implement a substantial track lowering in these tracks to accommodate a new electrification driven by the DART tracks, which in this case run under a new separate structure, thus avoiding the significant works required to the wall in response to lowering the track.

Neither Option 2 nor 7 allow for phased construction (requiring the removal of the entire bridge) and this would result in significant disruption and diversions (and associated costs) during construction for users immediately around the junction, business in the area (in particular Inchicore) but also strategically in the context of the wider transport network. While the other options (Option 4, 6 and 8) allow for phased construction maintaining local and strategic access, Option 6 allows for phasing in localised areas, allowing traffic to continue throughout the construction period with local diversions. Having regard to the importance of the South Circular Road Junction for local and strategic access to economic activities Option 6 is preferred because the nature of the proposed works can facilitate shorter traffic disruption / diversions than other options.

In terms of Economy, Option 6 is the preferred option.

Integration:

Neither Option 2 nor 7 allow for phased construction (requiring the removal of the entire bridge) and this would result in significant local and strategic accessibility issues from disruption and diversions to the local and wider strategic road network. While the other options (Option 4, 6 and 8) allow for phased construction maintaining local and strategic access, Option 6 allows for phasing in localised areas, allowing traffic to continue throughout construction with local diversions. Having regard to the importance of the South Circular Road Junction for local and strategic accessibility Option 6 is preferred from a constructability perspective.

However, there are some comparative advantages of the over-widened structures of Options 2, 4, 7 and 8 where there is greater potential for enhanced junction geometry in the long term.

Railway services would be significantly affected by the need to lower the existing tracks to achieve OHLE clearances, a feature of all options except option 6. Option 6, however, does necessitate the construction of a retaining wall between the existing and the new tracks from South Circular Road junction to Memorial Road.

In terms of Integration, Options 4, 6 and 8 are comparable with some comparative advantage over the other options considered.

Environment:

In terms of the Environmental criteria, Option 6 was found to have 'Some Comparative Advantage' over the other options, in terms of minimising the potential effect on: Air and Climate (less effect on traffic during construction); Landscape and Visual; Cultural Heritage and Architectural Heritage; and Agricultural and non-agricultural land use factors. Option 6 has less effect on the housing to the southwest of South Circular Road Bridge (OBC1).

In terms of Environment, Option 6 is the preferred option.

Accessibility and Social Inclusion

In terms of Accessibility and Social Inclusion, while there is no comparative advantage or disadvantage between options 2, 4, 7 and 8, in service it is considered that Option 6 would not have the same degree of flexibility or marginally less available space to provide facilities for road users. Hence, Option 6 was found to have 'Some Comparative Disadvantage over Other Options'.

In terms of Accessibility and Social Inclusion all options are identified as comparable with Option 6 scoring Some Comparative Disadvantage.

Safety

In terms of Safety, Options 6 and 8 are identified as having 'Some Comparative Advantage' over Options 2, 4 and 7.

This relates to a combination of risks associated with steep gradients, requirements to underpin walls and whether construction can be phased to provide sufficient space to accommodate vulnerable road users.

In terms of safety Options 6 and 8 are identified as having 'Some Comparative Advantage' over other options.

Physical Activity

In terms of Physical Activity, there is no comparative advantage or disadvantage between all the options.

In terms of Physical Activity all options are identified as comparable.

6.5 Emerging Preferred Option

There were significant challenges and constraints on the options available to achieve the project requirements in this area. Two major road overbridges, South Circular Road Bridge (OBC1) and St. Johns Road Bridge (OBC0A), carry road traffic across the rail line. This intersection is one of the busiest in Dublin and is highly congested during peak travel times. The rail corridor is primarily in cutting, the rail level is below the surrounding ground level, which imposed further constraints in terms of the track requirements.

A total of nine Options were initially developed for this area, following the selection process, Option 6 has been identified as the Emerging Preferred Option. This Option retains the existing South Circular Road Bridge (OBC1).

A new 'cut and cover' buried portal structure would be constructed on the north side of the existing bridge. The buried portal would provide space for two electrified tracks. The existing South Circular Road Bridge (OBC1) would facilitate two non-electrified tracks, therefore would not require any major modifications.

It is envisaged that construction works could be completed in phases, some of the works could be completed at night-time and under traffic management. This Option provides the optimum solution in terms of minimising traffic disruption.

The two Slow tracks will be realigned towards the north to pass through the new cut and cover structure and, after this, through the north span of St John's Road Bridge (OBC0A). The track level of the Slow tracks will be significantly lower than the existing rail levels to achieve the required vertical clearance for the electrification along the new structure. The proposed vertical profile suggests that track lowering of up to 3m at the west entrance of the proposed cut and cover structure, which may be necessary to achieve the standard vertical clearance of 5.3m. This is due to the low level required for the buried portal soffit, which would be constrained by existing road levels, existing utilities and the vertical clearance requirements for new structures.

In terms of permanent way, this option enables the existing tracks under South Circular Road Bridge (OBC1) to be realigned to provide standard lateral clearances. However, slightly increased vertical gradients would be utilised for the new DART+ South West tracks.

This option is the most favourable in terms of utility diversions. The sequencing of the buried portal construction would allow utilities to be diverted across the top of the roof slab to temporary and permanent locations as required and with relatively little disruption compared to other options.

Signalling, Telecommunications and Low Voltage cable containments would be moved to new positions. OHLE masts would be installed along the north side of the rail corridor. OHLE equipment would be fitted to the new cut and cover buried portal and to St John's Road Bridge (OBC0A) to allow for continuous electrification through the structures. The existing portal gantries would be removed.

There may be temporary interference of property rights during construction; however technical and construction related solutions will seek to minimise these. Construction requirements (including potential temporary interference of property rights) and methodologies will be presented at Public Consultation No. 2.

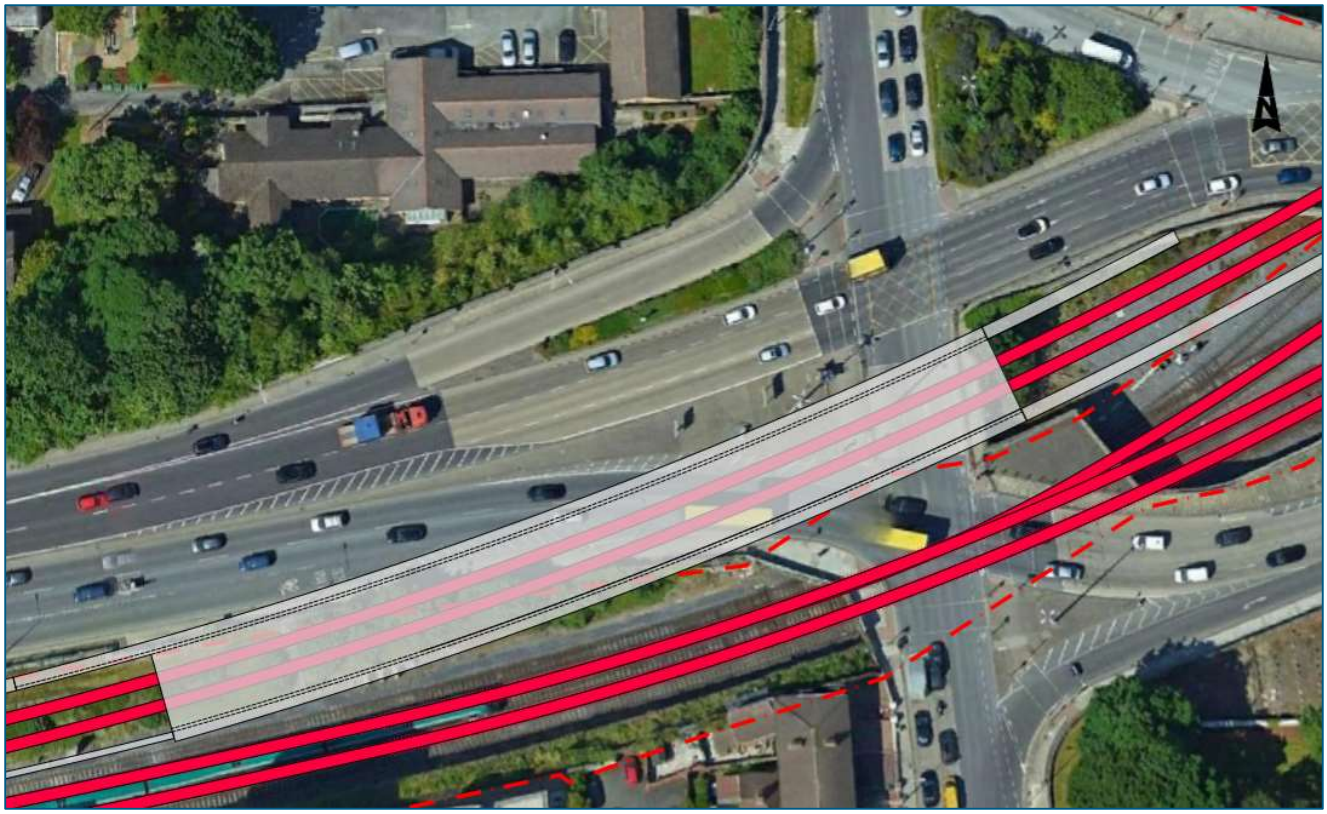

Figure 6-1 Emerging Preferred Option, general arrangement

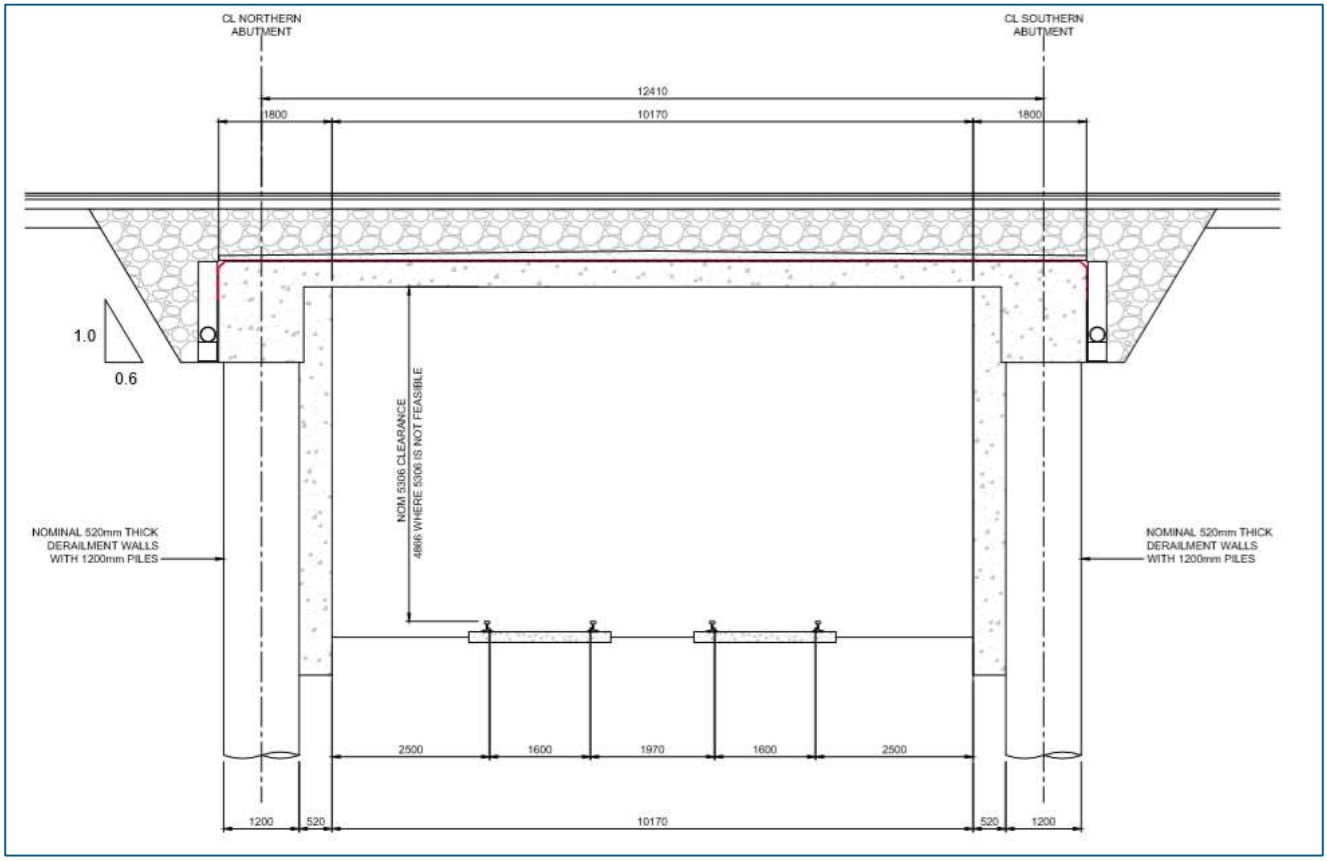

Figure 6-2 Emerging Preferred Option, typical cross section

Appendix A - Sifting Process Backup

Appendix B - MCA Process Backup

Appendix C - Supporting Drawings

The following drawings accompany the Technical Optioneering Report for this area:

Bridge Drawings

DE-04-23-DWG-ST-TTA-55885

DE-04-23-DWG-ST-TTA-55886

DE-04-23-DWG-ST-TTA-55887

DE-04-23-DWG-ST-TTA-55888

DE-04-23-DWG-ST-TTA-55889

DE-04-23-DWG-ST-TTA-55890

DE-04-23-DWG-ST-TTA-55891

DE-04-23-DWG-ST-TTA-55892

DE-04-23-DWG-ST-TTA-55893

Traffic Drawings

DP-04-23-DWG-TF-TTA-56285

DP-04-23-DWG-TF-TTA-56286

DP-04-23-DWG-TF-TTA-56123

Permanent Way Drawings

DP-04-23-DWG-PW-TTA-55747

DP-04-23-DWG-PW-TTA-55748

DP-04-23-DWG-PW-TTA-55751

DP-04-23-DWG-PW-TTA-55752

DP-04-23-DWG-PW-TTA-55753