DART+ South West

Technical Optioneering Report

Park West to Heuston Station

Area around Memorial Road Bridge (OBC3)

Iarnród Éireann

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Glossary of Terms

Reference	Description
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.

Reference	Description
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

Reference	Description
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

Reference	Description
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

Reference	Description
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 in the vicinity of Memorial Road Bridge (OBC3). 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, Electrical and Telecommunications
- 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 (GDA). It will provide a sustainable, electrified, reliable and more frequent rail service, improving capacity on rail corridors serving Dublin.

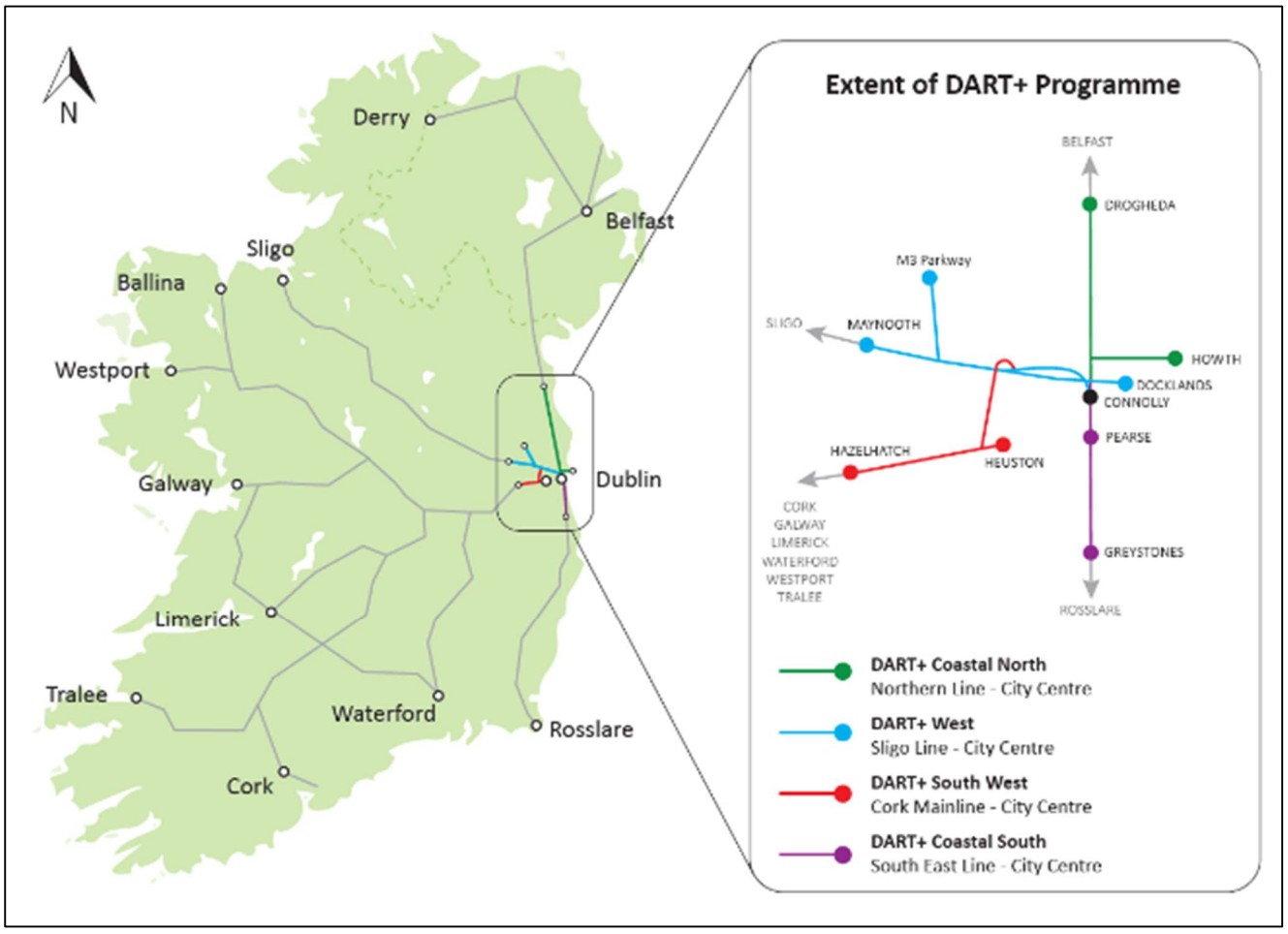

Figure 1-1 Schematic of Overall DART+ Programme

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.

The DART+ Programme also includes the 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 an electrified network, with increased passenger capacity and enhanced train service between Hazelhatch & Celbridge Station to Heuston Station (circa 16km) on the Cork Mainline, and Heuston Station to Glasnevin via Phoenix Park Tunnel Branch Line (circa 4km).

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

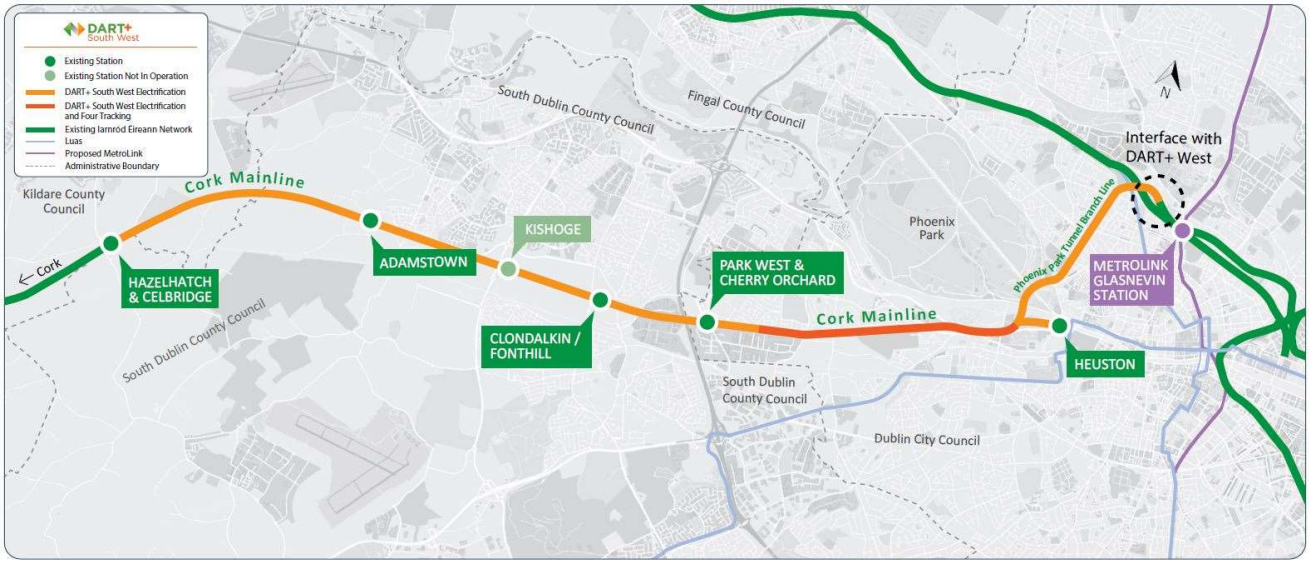

Figure 1-2 DART+ South West Route Map

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 / interventions 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)

Area Name	Sub-area Description	Extents	Main Features
Park West to Heuston Station	Area around Le Fanu 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 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
	Khyber Pass Bridge (OBC5)	Vicinity of Khyber Pass Footbridge (OBC5)	Khyber Pass Footbridge (OBC5)
	Area around Sarsfield Road Bridge (UB4)	West of Sarsfield Road Bridge (UBC4) to the West of Memorial Road Bridge (OBC3)	Sarsfield Road Bridge (UBC4)
	Area around Memorial Bridge (OBC3)	Vicinity of Memorial Road Bridge (OBC3)	Memorial Road Bridge (OBC3)
	Area around South Circular Road Junction	East of Memorial Road Bridge (OBC3) East of St John's Road Bridge (OBC0A)	South Circular Road Junction South Circular Road Bridge (OBC1) St Johns Road Bridge (OBC0A)
	Area around Heuston Station and Yard	Area at the South side of the Heuston Station Yard (non-DART+ tracks)	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 Name	Sub-area Description	Extents	Main Features
	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 (OBO8) Maynooth Line Twin Arch (OB09) Glasnevin Cemetery Road Bridge (OBO10)

2. Existing Situation

2.1. Overview

This section is 65m (approx.) in length and extends from the east side of Memorial Road Bridge (OBC3) to 50m west of Memorial Road Bridge (OBC3). The Permanent Way currently consists of 3 No. tracks. The tracks fall in level from west to east towards Heuston Station. There is currently no longitudinal drainage system installed along the Permanent Way.

Memorial Road Bridge (OBC3) is a major feature of this area; and it carries 2 No. lanes of northbound traffic over the rail corridor. There are currently no southbound lanes in Memorial Road. The junction of Memorial Road and the Chapelizod Bypass is immediately north of the bridge and it is signalised. The junction of Memorial Road and Inchicore Road is 75m (approx.) south of the bridge. Con Colbert House is located on the south-east and south-west sides of the structure. These buildings house data centres.

The rail corridor is 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 trace and earthwork cutting slopes along the north side. The south side of the rail corridor is retained with a battered masonry retaining wall. The north side of the rail corridor is formed with a cutting slope. The major infrastructure features are illustrated in **Figure 2-1** below.

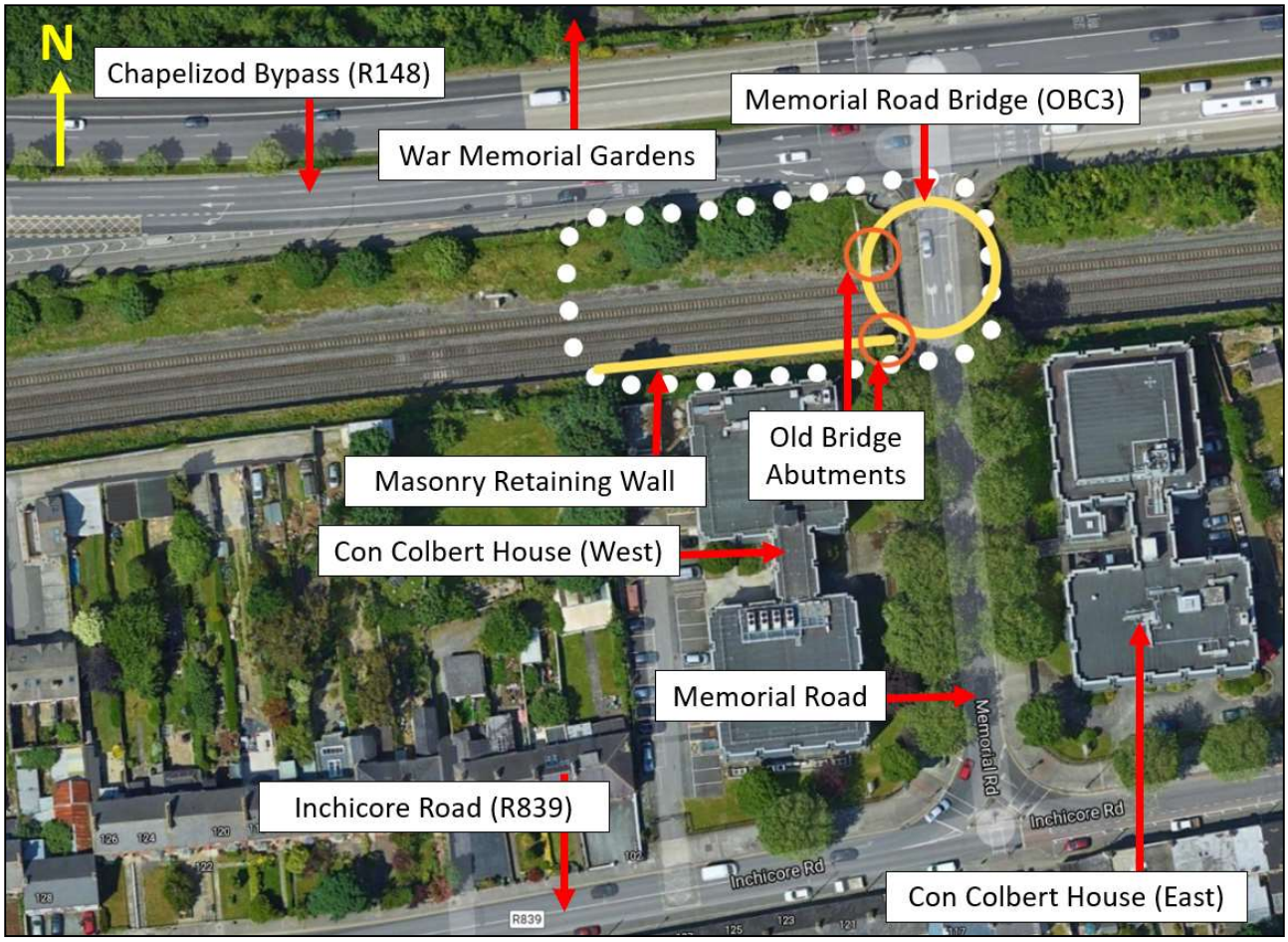

Figure 2-1 Aerial view of the area (white dotted outline)

The main Environmental features are described in **Section 2.8** below.

2.2. Challenges

The project objective is to increase the number of tracks between Park West & Cherry Orchard Station and Heuston Station to 4 No. tracks and to electrify 2 No. 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. As such, all options include widening the corridor to the north, where no such constraints exist. 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 would be placed between the existing rail line and the Chapelizod Bypass which runs parallel to the permanent way corridor.

The existing Memorial Road Bridge (OBC3) structure, which currently has 3 No. tracks beneath it, has insufficient horizontal clearance for 4 tracks. The intervention options proposed involve reconstructing the bridge with a new structure that has sufficient horizontal and vertical clearance for 4 No. tracks and overhead line electrification (OHLE).

Due to the existing road profiles and proximity of the Chapelizod Bypass on the north side of the bridge, minor 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.

2.3. Structures

Memorial Road Bridge (OBC3)

Memorial Road Bridge (OBC3) is a single span structure carrying road traffic from south to north over the rail corridor. The bridge consists of pre flexed cast iron concrete encased beams supported on reinforced concrete abutments. The clear span of the structure is 12m (approx.). The bridge carries a 6m (approx.) wide carriageway and 2 No. footways of 4m (approx.) width on both sides of the carriageway. The existing footpaths are not suitable for vehicular traffic.

There are currently 3 No. tracks beneath the existing structure. The minimum vertical clearance beneath the existing structure is 4.358m (from top of track to bridge soffit). The bridge has insufficient horizontal clearance to construct an additional 4th track and insufficient vertical clearance for OHLE.

Figure 2-2 Memorial Road Bridge (OBC3) - East Elevation

Retaining Walls

There is 1 No. Continuous existing retaining wall along the boundary of the corridor. The battered masonry retaining wall on the south side of the corridor extends along the full length of the area, except at Memorial Road Bridge (OBC3) itself. The wall is typically 3.5m (approx.) high. This increases to 4.5m high (approx.) on the south-west side of the bridge. 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.

Other Structures

There are disused masonry bridge abutments immediately adjacent to the west side of Memorial Road Bridge (OBC3), north and south. The abutments (now defunct) previously supported a steel pedestrian bridge which has been removed. Options that proposed replacing Memorial Road Bridge (OBC3) with a wider structure (to the west) would clash with these abutments.

Figure 2-3 Masonry Retaining Wall south-west side of Memorial Road Bridge (OBC3)

Figure 2-4 Disused masonry abutments to the west of Memorial Road Bridge (OBC3)

2.4. Permanent Way and Tracks

There are currently 3 No. tracks in this area. These are named from north to south as 'Up Main', 'Down Main' and 'Relief Line'. The maximum speed under Memorial Road Bridge (OBC3) in the Up direction (i.e. towards Heuston Station) is 25mph for the Up Main and Down Main and 40mph for the Relief Line. In the Down direction (to Inchicore) the maximum speed in is 40mph for all tracks. (refer to **Figure 2-5** below).

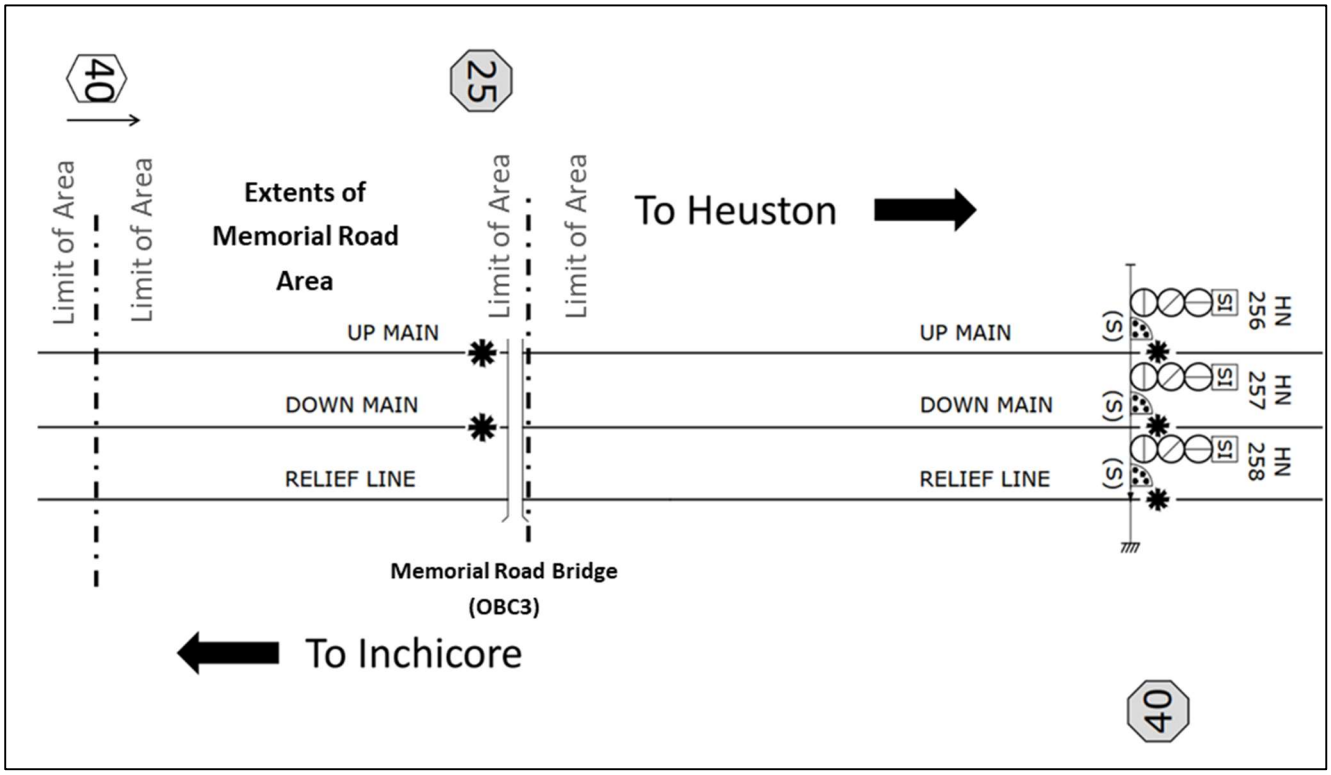

Figure 2-5 Track Layout.

As mentioned above, the tracks are in a cutting, with a retaining wall on the south side. The distance between the retaining wall and the nearest rail is 1.7m. The area is marked as a limited clearance area because position of safety cannot be ensured on this side (i.e. area unsafe for staff during normal train running). In **Figure 2-6**, the relative position of the Relief Line and the retaining wall is shown.

The distance between the tracks and the bridge abutments is substandard on both sides. In addition to the limited clearance area on the south side, there is also a limited clearance area through the bridge on the north side (refer to **Figure 2-7**).

The track gradient through the area is around 1.3%, with the gradient falling towards Heuston. The track-form is comprised of ballasted track with 54E1 rail and concrete sleepers.

There is not any track drainage element at this area. The water is freely running and naturally percolating into the soil.

Figure 2-6 Nearest rail from southern bridge abutment wall is 1.7m - Facing East

Figure 2-7 Nearest rail from northern bridge abutment wall is 1.3m - Facing West

2.5. Other Railway Facilities

There are no other facilities (such as access points) in this area.

2.6. Road Network

Memorial Road is a unidirectional 2-lane carriageway that runs perpendicular to and connects traffic from Inchicore Road (R839) to Con Colbert Road/Chapelizod Bypass (R148). Traffic enters Memorial Road from the single lane one-way Inchicore Road from the east and from a 2-lane bi-directional single carriageway from the west.

Vehicles entering Memorial Road (R839), proceed 75m (approx.) to its junction with the Con Colbert Road/Inchicore Bypass (R148) while crossing Memorial Road Bridge (OBC3). There is a single access off Memorial Road for the Con Colbert House (East) carpark, 20m from Inchicore Road.

From the nose of the 'fishtail' splitter island, at the southern end of the Memorial Road, to the kerb line on the south side of the R148 is 105m (approx.).

The lane widths on entry to Memorial Road (R839), from the south, are 3.75m (approx.). The road then tapers down to lanes width of 2.75m in an area 5m (approx.) before the southern bridge abutment. This arrangement of 2.75m lanes continues over the bridge with parapets becoming the new footpath boundary limits. The existing footpaths widths are 4.5m (approx.) on both sides of the carriageway on approach from the south of Memorial Road Bridge (OBC3). The palisade fences of Con Colbert House form the outer boundary of the footpaths.

The Memorial Road junction intersection with Con Colbert Road / Inchicore Bypass (R148) is signalised with the approach lane on the east being a dedicated right turn towards South Circular Road Junction located 560m to the east of the junction. The western approach is a dedicated left turn onto westbound carriageway of Con Colbert Road / Inchicore Bypass (R148), in the direction of the N4. Con Colbert Road / Inchicore Bypass (R148) is a 3-lane dual carriageway road, of which the outer lanes are dedicated bus lanes. The westbound and eastbound lanes carriageways are separated by a 2.5m (approx.) wide grassed median, which forms the crest of the dual carriageway. Its lanes crossfalls at 2% (1 in 50), from the median outwards (north and south), in the vicinity of Memorial Road (R839).

Memorial Road (R839), is a key transport node providing one of the limited access points across the rail corridor, connecting traffic from Inchicore (south of the rail corridor) to the R148/N4 (north of the rail corridor). In addition, is it is a highly trafficked pedestrian route providing access between Memorial Park, the Kilmainham Gaol historical sector and one of the limited safe R148 crossing points for children attending the St John of Gods (Special School); some of whom would be deemed mobility impaired.

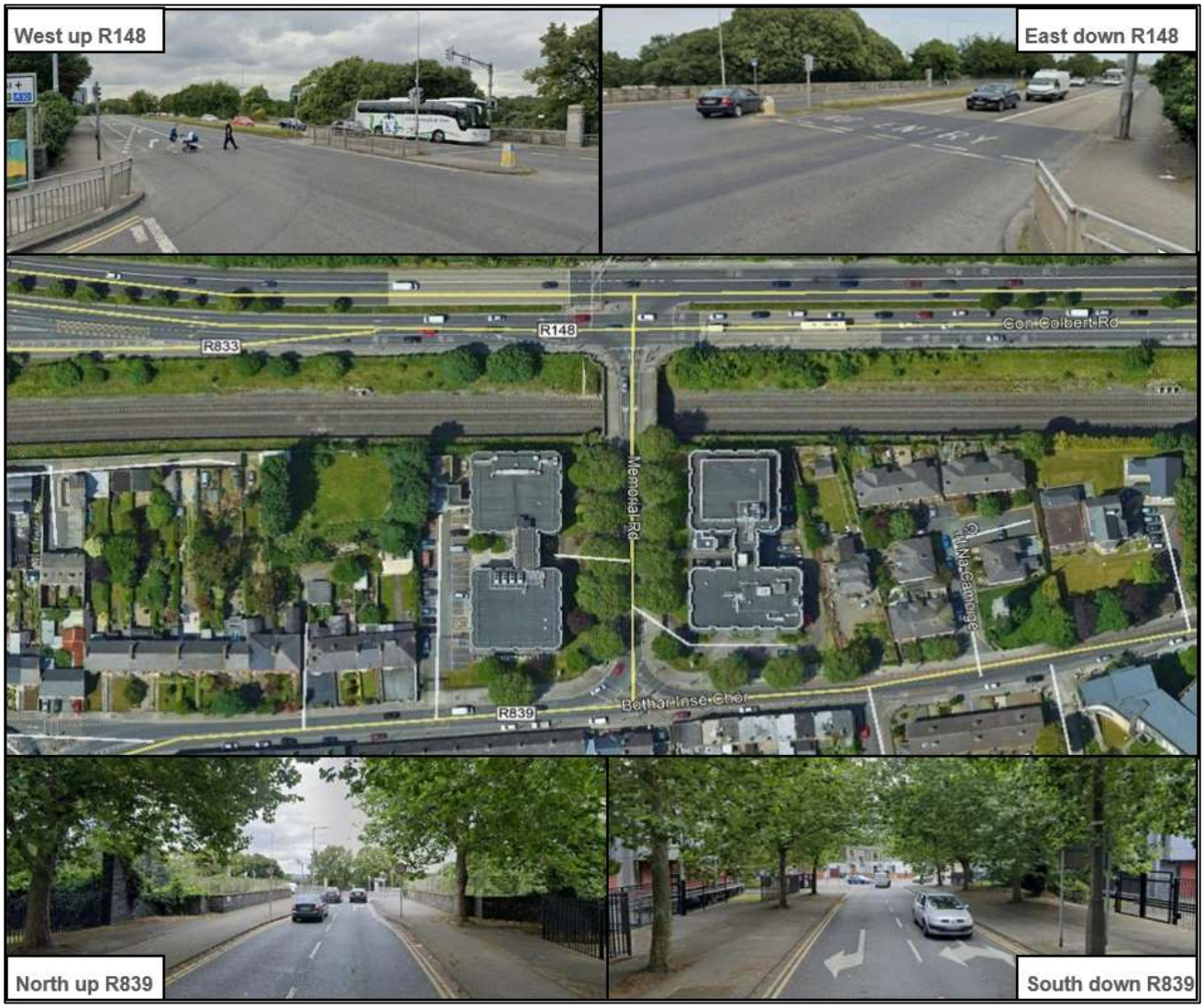

Figure 2-8 View of areas would be impacted temporarily during the construction works.

BusConnects' proposals, under both the Liffey and Lucan Schemes, cover the area around the bridge. The proposals include changing Memorial Road from a one-way system to provide bi-directional flow. This would

include a dedicated right turn slip lane being provided on the eastbound carriageway of the Chapelizod Bypass (R148) to facilitate southbound turns into Memorial Road (R839),. (Refer to **Figure 2-9** below)

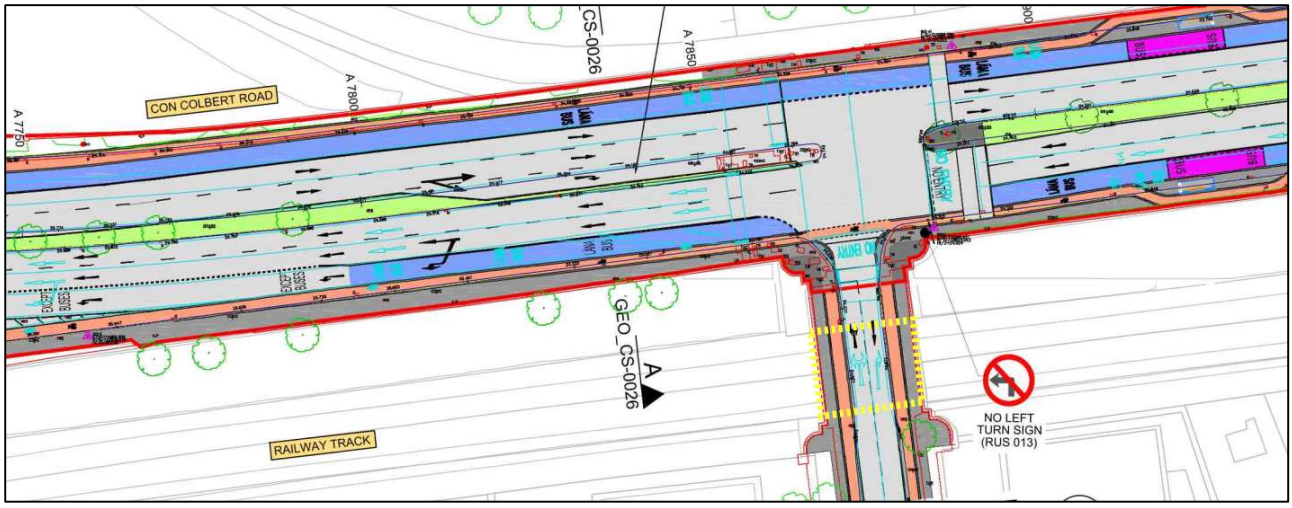

Figure 2-9 BusConnects (Interface of Lucan and Liffey Schemes)

2.7. Ground Conditions

The railway is located within a deep cutting in this area. The northern boundary cutting slope gradually increases in height from the western boundary of the area on to Memorial Road Bridge (OBC3) where it is at its highest. The southern boundary of the railway is supported by a battered masonry retaining wall. The area adjacent to the bridge generally is flat in topography, however further north, the ground slopes north towards the River Liffey.

The general superficial geology in this area is anticipated to comprise urban (made ground) deposits. It is anticipated that a layer of till will be underlying these urban deposits. Till deposits encroach into the southern boundary of the railway within the area. A pocket of gravel encroaches into the southern boundary of the railway at Woodfield Cottages (to the west of the area). Underlying the superficial deposits, bedrock deposits comprise limestone and shale.

Ground conditions in a borehole located 20m south of Memorial Road Bridge (OBC3) comprised made ground between ground level and 1.2m below ground level (bgl), at 23.17m AOD, underlain by deposits of clay and gravel to 5m bgl (19.37m AOD). Firm to stiff clay overlying the bedrock was encountered between 5m bgl (19.37m AOD) and 18.50m bgl (5.87m AOD). Bedrock was described as very strong to strong limestone with moderately strong to weak mudstone and shale. Ground water was not recorded during drilling.

Ground conditions in a borehole located 100m east of Memorial Road Bridge (OBC3) comprised made ground between ground level and 1.2m bgl (21.94m AOD) which was underlain by gravelly clay. Bedrock was encountered described as strong to moderately strong limestone with moderately strong to weak mudstone and shale. Ground water was not recorded during drilling.

2.8. Environment

Directly opposite Memorial Road and north of the rail corridor is the Con Colbert Road / Chapelizod Bypass (R148) and beyond that the War Memorial Gardens. In addition to their role as a garden of remembrance, they are also considered to have architectural heritage interest. There is a designated landscape area of note related to the War Memorial Gardens. To the south and straddling Memorial Road there are 2 No. office blocks

understood to be government data centres. West of these are residential houses and some commercial properties associated with Woodfield. These properties are within 100m of the existing rail corridor.

Refer also to **Section 4.1** (Environment).

2.9. Utilities

The existing utility networks in the area consist of varied which is typical of an urban environment such as this. Service providers with network assets in this area include the following:

- EIR
- ESB Networks
- 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 the existing streets and rail line bridge crossing. Hence, where modifications are required to the existing bridge and/or to the adjacent road network, impacts on utilities will be inevitable.

A number of services are also present at track level, crossing the railway corridor below the tracks. 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 utility providers are present and will be challenging to deal with given that only limited-service outage time (if any) will be permissible to the service and its customers. Significant forward planning and coordination will be necessary for such instances.

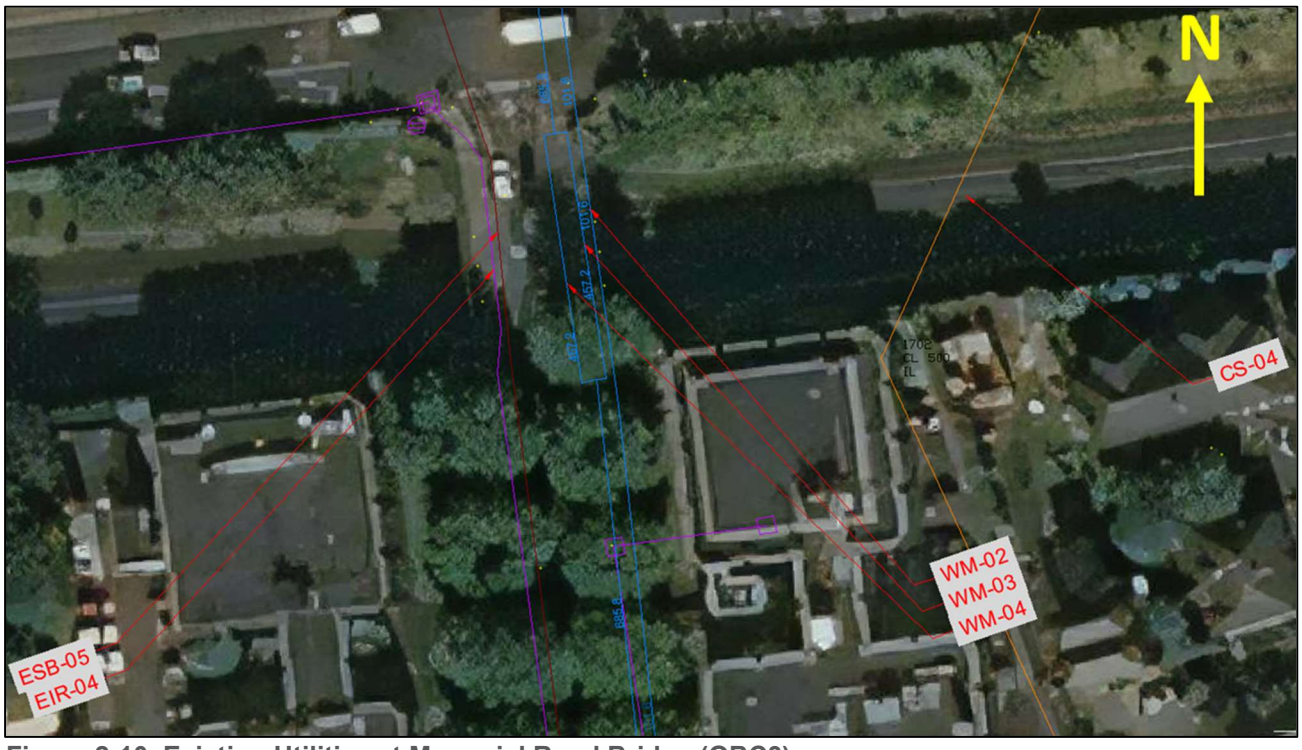

Figure 2-10 Existing Utilities at Memorial Road Bridge (OBC3)

3. Requirements

3.1. Specific Requirements

- Increase the number of tracks from 3 No. tracks to 4 No. tracks
- Electrification of 2 No. tracks for DART+ South West
- 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.

Significant 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.

3.2.1. 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.

In 4 No. 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.

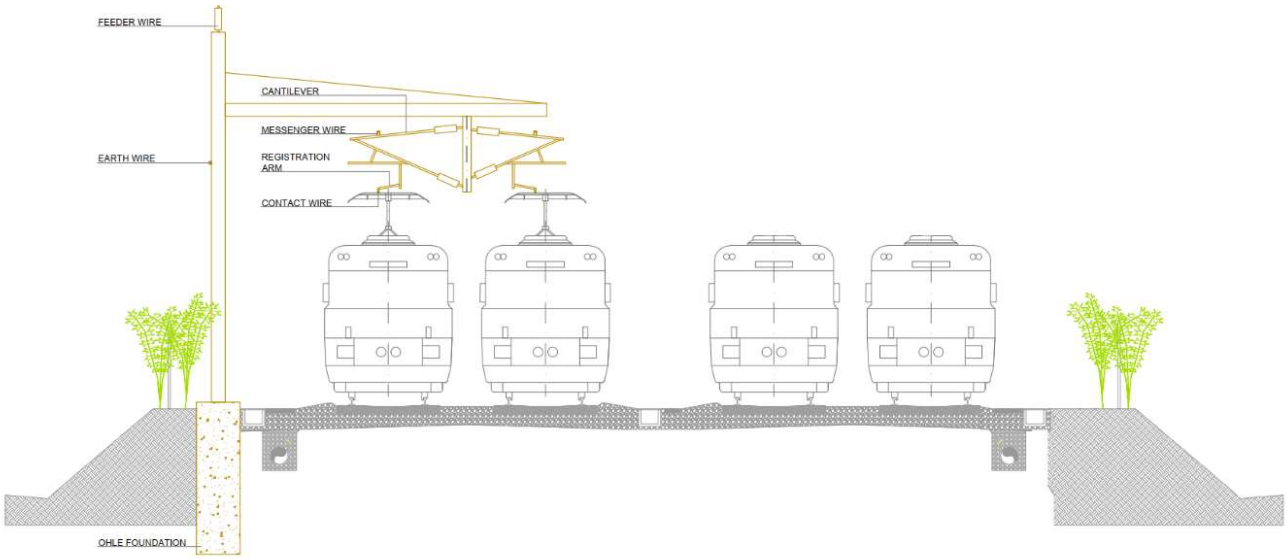

Figure 3-1 Typical OHLE arrangement in four track open route.

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.

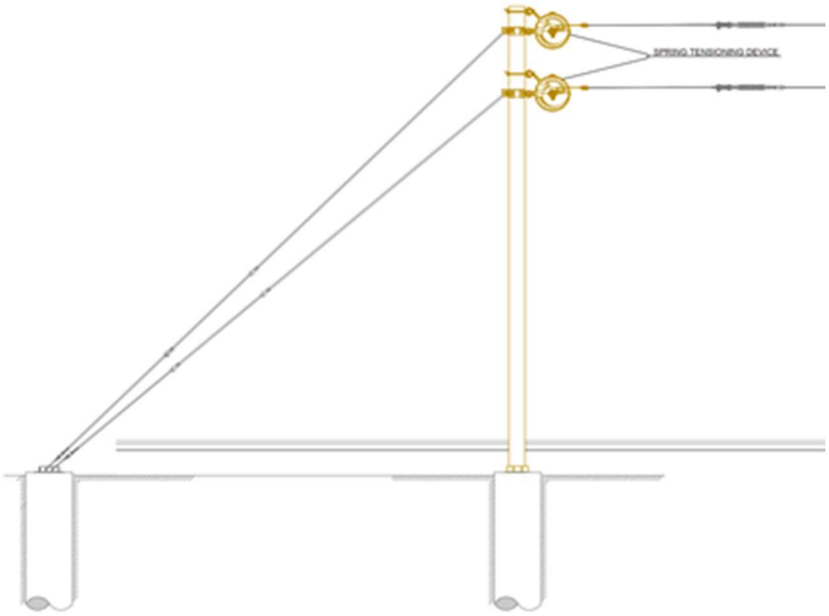

Figure 3-2 Typical anchor structure

The OHLE configuration through the overbridges for each track or civils option is being assessed using a calculator derived from the System Wide OHLE FRS, and a set of configurations agreed with Irish Rail through the Interface Coordination Document (ICD) process. This includes level and graded free running options, as well as level and graded options with elastic bridge arms fitted to the bridge.

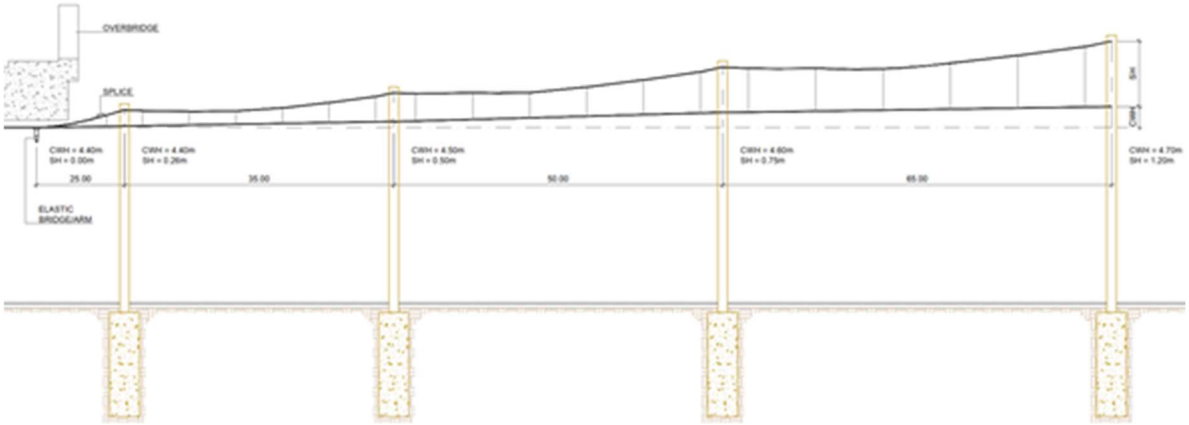

Figure 3-3 Typical arrangement on approach to a low bridge

3.2.2. 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:

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

In principle, there are no proposed substations for this area.

3.3. Design Standards

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

4. Constraints

4.1. Environment

The key constraints for this area relate to proximity to residential and commercial properties to the south west of the bridge and possibility of noise and vibration sensitive receptors associated with data centre. Visual intrusion in relation to the War Memorial Gardens is also to be considered.

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 existing vertical clearance at Memorial Road Bridge (OBC3) is also insufficient to accommodate the OHLE infrastructure required to electrify the rail line.

The Chapelizod Bypass (R148) is almost directly adjacent and parallel to the top of the cutting slope along the length of this project area. 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 is therefore required to create space for the additional track. In addition, the road falls towards Inchicore Road (R839) south of the bridge, which lengthens the tie-in chasing potential for every Option that proposes to increase the road level. Options to reconstruct the bridge at this location would likely have a severe impact on the traffic in the area.

Several key constraints are listed below which are deemed to govern the road level in support of providing OHLE clearances at bridges; as well as geometric constraints to mitigating the impact on existing roads, properties; as well as the various road user categories during the construction phase.

- The proximity of the junction of Chapelizod Bypass (R148) and Memorial Road to the existing and proposed north abutment (for bridge replacement Options) is a major constraint in terms of reconstructing Memorial Road Bridge (OBC3) to provide the clearances needed.
- The structural depth of beam/slab options (all listed in this report).
- The depth of track lowering reasonably achievable.
- TII and DMURS (Design Manual for Urban Roads and Streets) requires a maximum of 3% gradient for the first 15m of road at junctions. Limiting the ability to chase levels back to existing road levels.
- On Memorial Road, the back of footpath edge is at the top of an embankment upon which is the Con Colbert House plot boundary fences. A raising of the road would require changing the embankments within the grounds of Con Colbert House or constructing a low-level retaining wall (upstand) along the boundary.

4.3. Property

The density and proximity of the residential properties along the south side of the rail corridor is a major constraint in terms of achieving the 4-tracking requirements by adding the additional track to the south side of the corridor. Please refer to Property Boundary lines on the Bridge and Permanent Options Drawings in Appendix C.

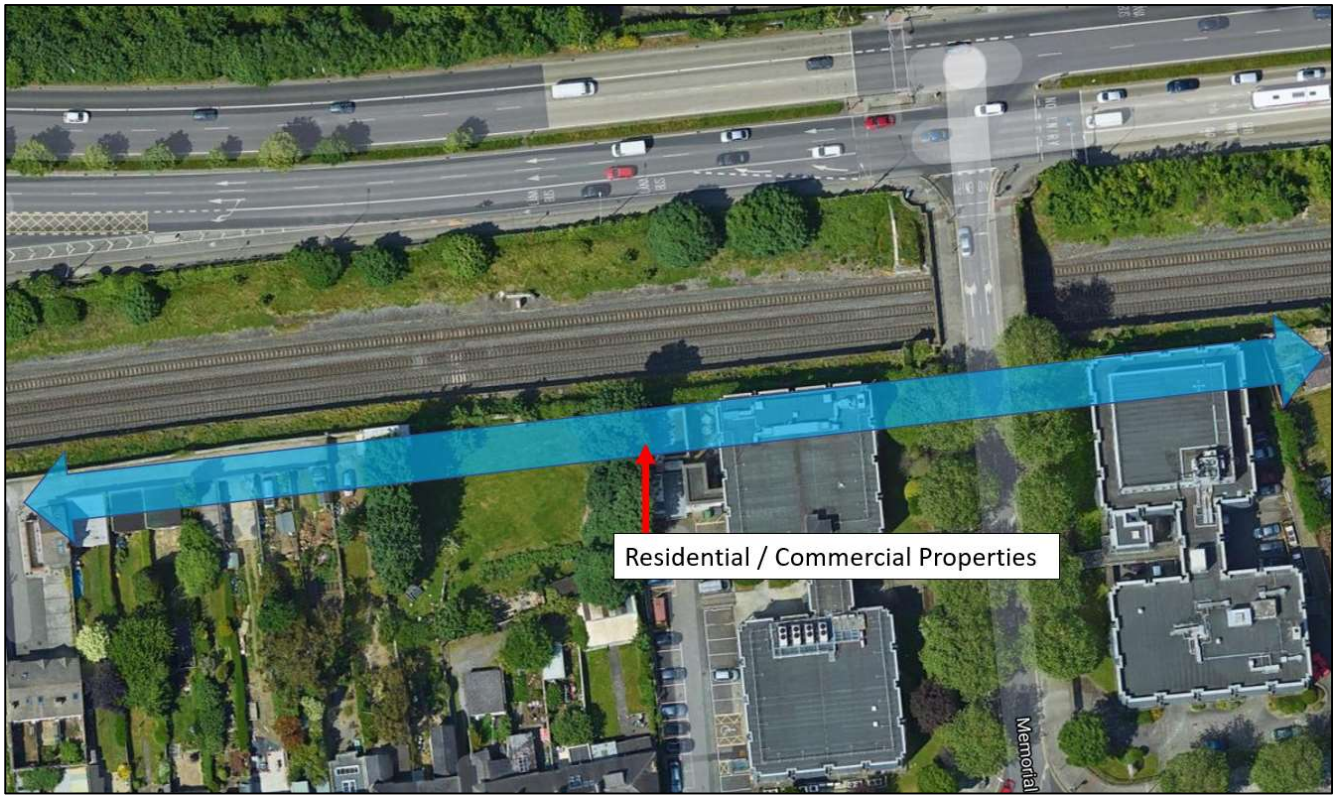

Figure 4-1 Residential and Commercial Property Locations in the area

4.4. Permanent Way

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

Table 4-1 Permanent Way Geometrical Constraints

ID	Name	Description
1	Existing width of the railway corridor	The existing width of the railway corridor is not adequate for the installation of an additional track. The corridor should be widened.
2	Existing masonry retaining wall	Any modification to the existing retaining wall on the south would potentially impact the stability of the properties along the south side of the corridor and must be carefully assessed.
2	Chapelizod Bypass	The widening of the railway corridor to the north for an additional fourth track could potentially impact the functionality of this road.
4	Safety and Maintainability	There are substandard safety clearances on the south side of the tracks to the masonry retaining wall and to the abutments of Memorial Road Bridge (OBC3). Any permanent way solution should improve the existing situation.
5	Track Alignment in area to the east and around South Circular Road	The track levels may need to be significantly modified in the section to the east, under South Circular Road Bridge (OBC1) to achieve the required vertical clearance for the OHLE equipment unless the Double Track Buried Portal Structure is used. The vertical alignment design must consider the proposals for section running under South Circular Road and into Heuston Station. The vertical alignment will be further constrained by the crossovers that are proposed on the east side of Memorial Road to provide access to Heuston station.
6	Track alignment in the area west of Memorial Road Bridge (OBC3) up to Inchicore Works	In the area, at Inchicore Works, there are two main permanent way options: widening of the railway corridor to the north or to the south. The horizontal alignment must tie-in with these designs.
7	Vertical Clearances at proposed Memorial Road Bridge (OBC3).	The proposed vertical alignment must provide adequate vertical clearances for OHLE installation through the new Memorial Road Bridge (OBC3).

The clearance requirements for the positioning of new/renewed track from property boundaries is shown in the Figure below. The space required for the installation of new property walls, OHLE masts and walkways are considered.

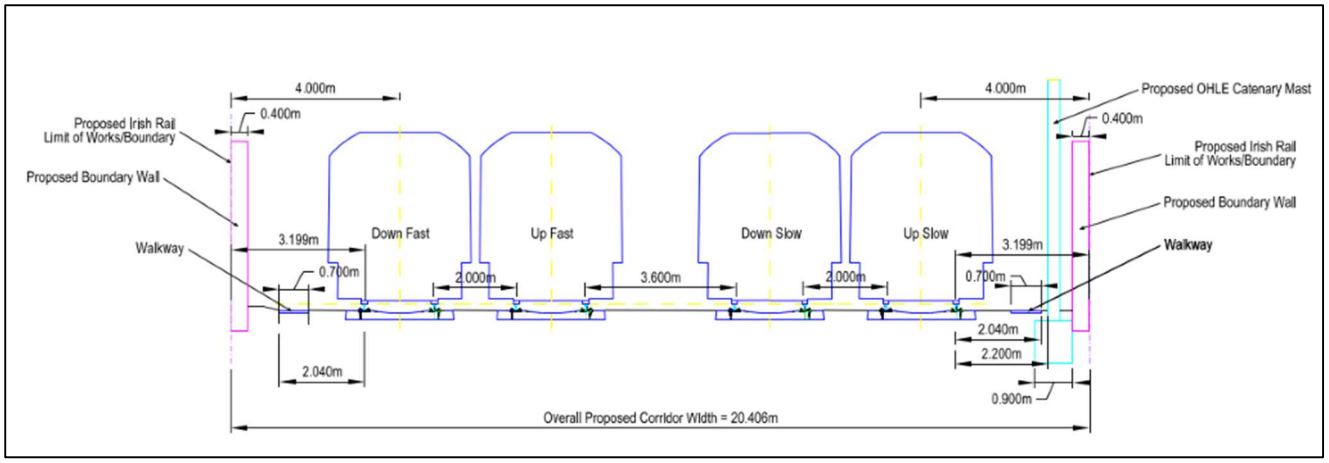

Figure 4-2 Minimum distance from property boundary to nearest track – West Facing

Dimensions in the above **Figure 4-2** may be increased due to curvature and cant effects (as per Track standard I-PWY-1101).

Figure 4-3 Rail Corridor Width

4.5. Existing Structures

The existing Memorial Road Bridge (OBC3) has insufficient horizontal clearance to accommodate an additional track beneath the structure. An initial bridge electrical clearance assessment has been carried out to determine whether an OHLE solution is possible without structural intervention or track lowering (please refer to Technical Note DP-04-23-TEN-EL-TTA-55461 appended to Technical Option Introduction Report, Appendix 3.2). The assessment found that an OHLE solution is not possible without intervention.

Proposed interventions include replacement of the road bridge with a new structure of sufficient horizontal and vertical clearance to facilitate 4-tracking and OHLE. Replacement bridge interventions consider various combinations of track lowering and increasing road levels to achieve the vertical clearance.

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 still require either track lowering, an increase to road levels or a combination of these. The track and road levels would also take account of the greater structural depth needed for an increased span (four tracks) and the horizontal clearances required from the new edge of outer rails to abutments in accordance with design standards.

Where track lowering would be required for an Option, the existing masonry retaining wall could potentially be destabilised. Options discussed below include the requirement for a stabilising intervention where required.

4.6. Geotechnical

Where significant track lowering is required, the stability of the existing retaining wall along the southern boundary could be affected.

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 may 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 in the area, particularly crossing the overbridge itself, 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 Memorial Road Bridge (OBC3). Irrespective of the option selected, the services in the existing bridge would need to be maintained or outage durations absolutely minimised.

A number of services are also present at track level, crossing the railway corridor below the tracks. Where track lowering is proposed, consideration of the impacts on these services will also be necessary.

All existing utilities pose constraints to the area-wide options. Where utility conflict arises, potential treatments are being discussed with the utility providers.

5. Options

5.1. Options Summary

The existing Memorial Road Bridge (OBC3) structure, which currently has 3 No. tracks beneath it, has insufficient horizontal clearance for 4 tracks. The existing vertical clearance beneath Memorial Road Bridge (OBC3) is also insufficient for electrification.

The potential intervention options are to either reconstruct the bridge (with sufficient clearances for 4-tracking and OHLE) with various combinations of track lowering and/or road level increases.

A total of 6 No. Options were developed for the area. Due to the limited feasibility of most Options, Drawings were not prepared for all Options 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.

Design development is by nature an iterative process; and as such the Emerging Preferred Option will be further developed and presented in greater detail at PC2.

A summary of Options is presented in the table below. A detailed description of each Option is included in **Section** Error! Reference source not found. below. Refer to **Section** Error! Reference source not found. for a description of the permanent way Options for the area (that are compatible with the bridge Options referred to in Error! Reference source not found. below).

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 4-tracking and electrification project requirements without widening the existing rail corridor or providing additional vertical and horizontal clearance at Memorial Road Bridge (OBC3).
Option 2	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by increasing the road level only.
Option 3	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by track lowering only.
Option 4	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by track lowering (50%) and increasing road levels (50%).
Option 5	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by track lowering and increasing road levels (other than a 50% split). This Option includes the original Concept Design (ARUP, 2018).
Option 6	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by increasing the road level to a point above which works would be required to the Chapelizod Bypass.

5.2. Options Description

This section describes the Options that have been considered for area. 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 for the area. To remove repetition among the Option descriptions, these issues are addressed at the end of the Options description section. Options 2 through to Option 6 propose to incorporate cycle paths in the footways. Please refer to **Section 5.4** for the Permanent Way Options.

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 Memorial Road Bridge (OBC3) would not be resolved. As such, this option would not facilitate the inclusion of the additional 4th 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 4-tracking and electrification by means of minor interventions only. A review of the area 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 proposes to achieve 4-tracking and electrification by replacing the existing Memorial Road Bridge (OBC3) with a new reinforced concrete (RC) beam-and-slab integral bridge. The proposed bridge would be 17m wide (approx.) and carry a 7.5m wide carriageway with 4.5m footpaths at each side. The bridge would have no or negligible skew.

In this option the vertical clearance requirements would be achieved by raising the road levels only, while the rail tracks would be kept at their existing levels.

Roads Analysis:

- Due to the proximity of the bridge abutment to the R148, any road raising at the bridge greater than 500mm would require the full reconstruction of the R148 dual carriageway (all lanes, as well as median and footpaths). This would also require the plot boundary walls to Memorial Park and the rail corridor to be reconstructed to retain the raised footpaths, by a level similar to that of the road raising. This road and wall reconstruction would be between 100m and 150m in length either side of the junction, but the replacement of the wall would likely be required in any event for all Options due track piling machinery access requirements. The level of road raising would also require the relaying of all utilities in the area and beyond (depending on the depth to cover requirements for each utility company).
- This would also limit the ability to carry out advance diversion works.
- The entire length of Memorial Road would need to be reconstructed with new retaining walls built along the Con Colbert House (East and West) boundaries; along with amended stairways constructed to tie-in to the building footbridge to the eastern plot and full stairway reconstruction to the western plot.

- It would also extend the level of traffic management complexity into the Con Colbert Road / Chapelizod Bypass (R148) rather than just that resulting from Memorial Road itself.
- The Lucan Bus Connects Scheme proposes amendments to the Con Colbert Road / Chapelizod Bypass (R148) along this section, it is not currently part of the scope of this project to include for reconstruction of the same.

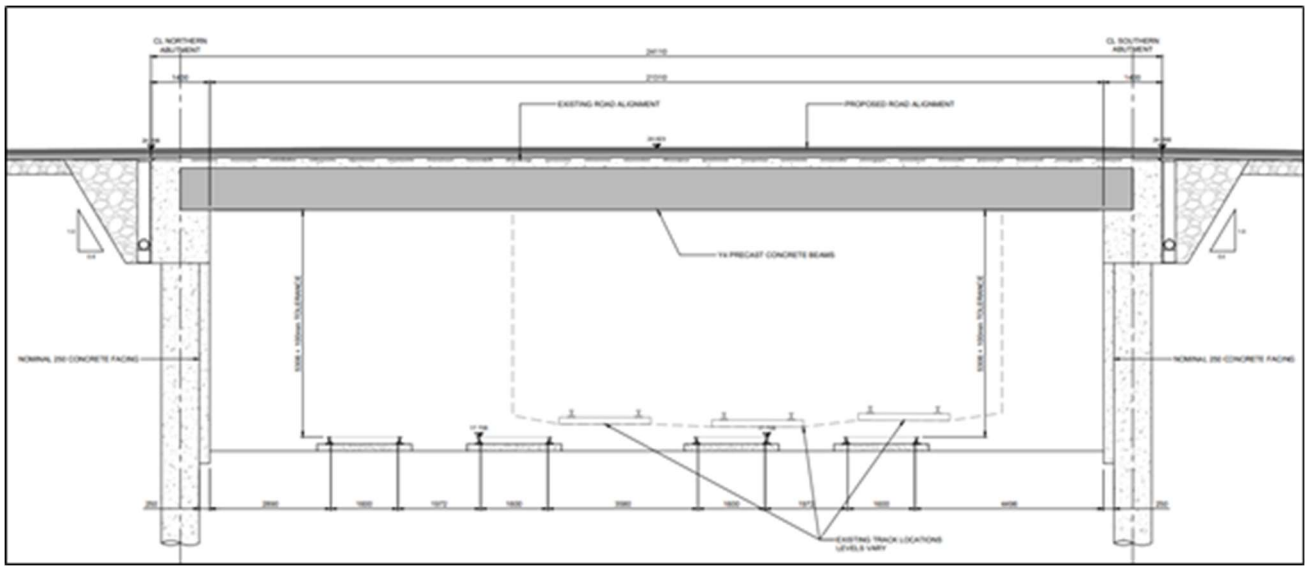

Figure 5-1 Typical longitudinal section

5.2.4. Option 3

This Option is the same as Option 2, but all the vertical clearance requirements would be achieved through track lowering, while the road levels would be kept at their existing levels.

Roads Analysis:

- As this would be an at grade reinstatement, the tie-in would likely be limited to the 7m north of the bridge, up to and including the kerb line of the Con Colbert Road / Chapelizod Bypass (R148).
- As the tie-in carriageway cross-section is wider (5.5m to 7.5m), the walls to the north at the junction would need to be reconstructed as H4A containment retaining walls transitioning into the existing rail corridor boundary wall along the Con Colbert Road / Chapelizod Bypass (R148). In addition, the bell mouth radius would be locally modified resulting in an amended footpath and kerb line (east and west of the Memorial Road intersection with the Con Colbert Road / Chapelizod Bypass (R148).
- The carriageway to the south of the bridge would need to be reconstructed for at least 15m to remove the existing taper in the kerb line and provide the revised segregated footpath/cycle track facility over the bridge.
- The Lucan Bus Connects Scheme proposes amendment to the Con Colbert Road (R148) in the area of the Memorial Road junction with Con Colbert Road / Chapelizod Bypass (R148). However it is not currently part of the scope of this project to include for reconstruction of the of any BusConnects planned works. The additional cost to reinstate the proposed Bus Connects Scheme layout, if it were programmed

for implementation in advance of DART+ South West, would not be significant. Refer to Drawing DP-04-23-DWG-CV-TTA-55276 for a high-level representation of the road reinstatement works area.

5.2.5. Option 4

This Option is similar to both Option 2 and Option 3. The Memorial Road Bridge (OBC3) is proposed to be replaced but the vertical clearance requirements would be achieved through changes to both the road and track levels. In this Option the additional vertical clearance required would be split evenly between road level increases (50%) and track lowering (50%). For example, if an adjustment of 0.7m is required to achieve the vertical clearance, the road would be raised by 0.35m and the tracks would be lowered by 0.35m.

Roads Analysis:

- The impact on roads, walls and utilities would be similar to that described for Option 3; requiring full width reconstruction of Con Colbert Road /Chapelizod Bypass (R148) but for a length of 50-75m (approx.) either side of the Junction.
- Any increase of road levels increase between 0.050m (50mm) and 0.35m (approx.) would require full reconstruction of the west bound carriageway of the Con Colbert Road /Chapelizod Bypass (R148), including footpaths and median, for approximately 110m either side of the junction. This would require commencing a super-elevation transition 100m in advance of the junction on the Con Colbert Road /Chapelizod Bypass (R148), using the median kerb as the swivel point. The resultant effect would be to a change the crossfall characteristics from 2% crossfall to the carriageway edge, to one which crossfalls from the southern carriageway edge to the central median (achieved just prior to Memorial Road junction with Con Colbert Road /Chapelizod Bypass (R148). This revised crossfall towards the median would continue 100m (approx.) to the west of the Memorial Road junction; at which point it would merge with existing super-elevation of the highway (located at the slip- lane where Con Colbert Road diverges from the Chapelizod Bypass). Tie-ins within Memorial Road would be achievable without affecting the pedestrian entrances to the 2 No. Con Colbert House buildings (east and west). Most of the mature trees could perceivably be accommodated without being removed through boxing areas around them as part of a formal landscaping scheme.

5.2.6. Option 5

This Option is similar to Option 4 such that the bridge is replaced, and the vertical clearance requirements would also be achieved through changes to road and track levels. However, with this Option the additional vertical clearance required would not be split evenly between road level increases and track lowering. It also does not limit road level to increases to a level above which would require Departures from Standards. This Option is based on the original Concept design (ARUP, 2018).

Roads Analysis:

- The Option would require a similar extent of re-construction works to the Con Colbert Road / Chapelizod Bypass (R148), as would be required for Option 4.
- The difference would be a reduction in the extent of reconstruction works required in Memorial Road (south of the bridge).

5.2.7. Option 6

This Option required that the bridge be replaced, and the vertical clearance requirements be achieved by changes to road and track levels. The additional vertical clearance required would be split between road level increases and track lowering. The road level would be increased to a level of 50mm above the existing road. This level is one that can be achieved without requiring the reconstruction of the carriageway within Con Colbert Road / Chapelizod Bypass (R148) .

Roads Analysis:

- The required road reconstruction would be similar to that of Option 3. Refer to Drawing DP-04-23-DWG-CV-TTA-55276 for a high-level representation of the road reinstatement works area. The intention would be to avoid any carriageway works to the Con Colbert Road / Chapelizod Bypass (R148), only requiring the junction 'bell-mouth' tie-in works. The tie-in between edge of bridge and the Con Colbert Road / Chapelizod Bypass (R148) would be close to the gradient limit of 3% typically accepted at junctions.
- The aim would be to limited reconstruction to within 7m of the bridge (to the north), including the kerb line of the Con Colbert Road / Chapelizod Bypass (R148) . An additional 15-20m would need to be reconstructed south of the bridge to remove the existing taper in the kerb line; and provide the revised footpath/cycle track over the bridge with its transition tie-ins to existing footpaths and kerb lines.
- The proposed new carriageway cross-section is wider (5.5m to 7.5m) across the bridge and as such will require the walls to the north of bridge to be reconstructed as H4A containment walls, transitioning into the rail corridor boundary wall that runs along Con Colbert Road / Chapelizod Bypass (R148).
- In addition, the bell-mouth radius would be locally modified due to the requirement to amend the junction bell-mouth radius. This would result in an amended footpath and kerb line, east and west of the Memorial Road junction intersection with the Con Colbert Road / Chapelizod Bypass (R148), for up to 10-15m in either direction.
- The Lucan Bus Connects Scheme proposes amendments to the Con Colbert Road / Chapelizod Bypass (R148), it is not currently part of the scope of this project to include for reconstruction of the same, unless implemented prior to DART+ South West Project.

5.3. OHLE Arrangement (All Do-Something Options)

Memorial Road Bridge (OBC3) has insufficient vertical clearance to be electrified with OHLE. Therefore Options 0 and 1 would not be feasible.

Options 1 and 2 would provide a soffit height at Memorial Road Bridge (OBC3) of 4.690m. In this configuration the OHLE would be connected to the bridge at multiple locations as it passes beneath. These connections would not be visible from road level. OHLE masts would be positioned at 20m, 55m and 105m on each side of the bridge before reverting to normal spacings.

For Options where the minimum soffit clearance of 4.866m is achievable, then OHLE configurations will use the arrangements described above, but wire heights and mast heights will be increased accordingly.

For Options where the minimum soffit clearance of 5.306m would not be achievable but a minimum contact wire height of 4.7m would be achievable, then the OHLE would pass beneath the bridge without being connected to it, and wire heights and mast heights would be increased accordingly. OHLE masts would be positioned at 20m from each side of the bridge.

5.4. Permanent Way

The differences between the Perway Options are related to the potential treatments at Inchicore (i.e. widening to the north or to the south) with minimal differences between them in this short section. In both cases, the railway corridor is widened to the north to create space for the additional track. Widening the corridor to the south is not considered feasible due to the proximity of office buildings. As such this Option has not been considered further.

The Permanent Way Options have considered a standard 10-foot dimension between the Slow and Fast lines and realignment of the existing tracks to remove areas of limited clearance to improve safety. The increment of the 10-foot dimension is an improvement to the Concept Design solution; and allows the speed limit to be increased.

The vertical alignment has been analysed and track lowering ranging from 0.7m to 0.3m is achievable. The track gradient would need to be increased from 1.3% to 1.5%. Final adjustments in the vertical level would be realised in the next stage of the design. The track lowering may require underpinned the foundation of the existing retaining wall.

For all intervention Options the track formation would be completely renewed. It is proposed that a new track drainage system would be installed and connected to a proposed attenuation facility at Heuston before discharging to the Liffey. The drainage design would be developed in the next design stage.

The concept Perway alignment has not been progressed due to the substandard 10ft dimension. As such Concept Design Options and Option 5 will not progress.

Table 5-2 Permanent Way Options

Name	Drawing Number
Permanent Way Option 1	Please refer to drawing DP-04-23-DWG-PW-TTA-55830
Permanent Way Option 2	Please refer to drawing DP-04-23-DWG-PW-TTA-55831

5.5. Geotech (All Do-Something Options)

The retaining walls required in this area, to create space in the existing cutting slope on the north side of the corridor, would be bored pile retaining walls (or similar). 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).

Note that the bridge width for all bridge replacement Options would partially clash with the disused abutments on the north-west and south-west sides of Memorial Road Bridge (OBC3). All Options propose to remove the disused abutments fully.

Where significant track lowering is required, the stability of the existing retaining wall along the southern boundary could be affected. All bridge replacement Options propose an intervention to stabilise the wall as required. 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.

5.6. Roads (All Intervention Options)

All Options will ensure vulnerable user connectivity is provided to Memorial Park. The extent of utility infrastructure relay requirements is often relative to the level of increase over the utility (subject to confirmation by specific utility companies for given locations).

All Options require the bell-mouth to be widened at the junction with the Con Colbert Road / Chapelizod Bypass (R148); as well as tie-in requiring reconstruction of road between north abutment and the Con Colbert Road / Chapelizod Bypass (R148) and south for a minimum of 15m. The extent of roadworks in a southerly direction from the bridge would be almost directly proportional to the level of bridge raising.

5.7. Cable and Containments (All Do-Something Options)

With the exception of Option 0, all Options would require the relocation of a variety of service cables, utilities and containments throughout.

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 Mainline 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 the area in the vicinity of Memorial Road Bridge (OBC3). A total of six (6 No.) 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 also poses significant constraints in terms of achieving the project requirements of providing an additional 4th track and electrifying 2 No. tracks in this area.

6.3. Preliminary Assessment (Sifting)

The table below 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)

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.
		4-tracking Park West-Heuston	FAIL. No intervention proposed. 4-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 would not be 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+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		FAIL
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.
		4-tracking Park West-Heuston	FAIL. Minor interventions only cannot achieve 4-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+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		FAIL
2	Engineering	Constructability	PASS. It would be possible to construct this option.
		Geometrical fitness for intervention	PASS. No issues.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option would achieve the electrical clearance in structures (with derogations).

Option	Requirements		Description
		Bridge Design Standards	PASS. Pass this option would achieve horizontal clearance to abutments (with derogations and derailment impact design).
		Keep current functionality of roads	FAIL. This Option would require a minimum road level increase at the bridge of 0.7m (approx.). This road level increase at Memorial Road Bridge (OBC3) would require extensive works to a significant length of the westbound carriageway of the Chapelizod Bypass which is immediately adjacent to the structure on the north side.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
3	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This Option would be difficult to construct in terms of gradient and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve the 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option would achieve the electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Pass this option would achieve horizontal clearance to abutments (with derogations and derailment impact design).
		Keep current functionality of roads	PASS. Road levels would be unchanged.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**PASS**
4	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This Option would present issues in terms of gradient and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve the 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option would achieve electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Pass this option would achieve horizontal clearance to abutments (with derogations and derailment impact design).
		Keep current functionality of roads	FAIL. This Option would require a minimum road level increase at the bridge of 0.35m (approx.). This road level increase at Memorial Road Bridge (OBC3) would require extensive works to a significant length of the westbound carriageway of the Chapelizod Bypass which is immediately adjacent to the structure on the north side.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible

Option	Requirements		Description
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
5	**Engineering**	Constructability	PASS. It would be possible to construct this option.
		Geometrical fitness for intervention	PASS. This Option would require a minimum track lowering of 0.2m.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve the 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve the electrification of DART+ tracks.
		Vertical electrical clearance in structures	FAIL. The original Concept design would provide a 4.690m vertical clearance only.
		Bridge Design Standards	FAIL. The original Concept design would provide a 4.690m vertical clearance only.
		Keep current functionality of roads	FAIL. This Option would require a minimum road level increase at the bridge of 0.4m (approx.). This road level increase at Memorial Road Bridge (OBC3) would require extensive works to a significant length of the westbound carriageway of the Chapelizod Bypass which is immediately adjacent to the structure on the north side.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
6	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This Option would be difficult to construct in terms of gradient and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve the 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option would achieve electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Pass this option would achieve horizontal clearance to abutments (with derogations and derailment impact design).
		Keep current functionality of roads	PASS. Current road functionality maintained. This Option would require a road level increase of 50mm only.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**PASS**

6.4. Preliminary Assessment Summary

A total of 7 No. Options were developed for the area around Memorial Road Bridge (OBC3). Following the assessment completed as part of the Sifting Process (as shown in the Error! Reference source not found. below), a total of two 2 No. Options were shortlisted and progressed to Stage 2 (MCA) of the assessment process.

Table 6-2 Summary of Sift Process Results

Option	Sifting Process Result
Option 0: Do Nothing	FAIL
Option 1: Do Minimum	FAIL
Option 2	FAIL
Option 3	PASS
Option 4	FAIL
Option 5	FAIL
Option 6	PASS

The following options did not meet the necessary Engineering Feasibility and Project Requirements and were not 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 4 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** - This Option seeks to achieve the 4-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 2** - This option involves the reconstruction of the Memorial Road Bridge (OBC3) with a greater span, width, and height, it would require the road level to be increased no less than 0.7m to avoid track lowering. This option was not brought forward due to the required road level increase, which would require full reconstruction of both the eastbound and westbound carriageways of the Con Colbert Road / Chapelizod Bypass (R148) for more than 100m in either direction of the junction as well as the length of memorial road, posing significant disruption during construction and greater risk due to heavy engineering works along the length of the data centres.
- **Options 4** - This option involves the reconstruction of the Memorial Road Bridge (OBC3) with a greater span, width, and height and require the road level to be increased no less than 0.35m, while also lowering the track and equivalent depth. This option was not brought forward due to the required road level increase, which would require full reconstruction of the westbound carriageway of the Con Colbert Road / Chapelizod Bypass (R148) (100m approx. in either direction of the junction); as well as a significant proportion of memorial road, posing significant disruption during construction and greater risk due to heavy engineering works along the length of the data centres.
- **Option 5** - This option involves the reconstruction of the Memorial Road Bridge (OBC3) with a greater span, width, and height and require the Con Colbert Road / Chapelizod Bypass (R148) level to be increased no less than 0.4m, while also lowering the track by at least 0.2m. This option was not brought forward as it requires a road level increase, which would require full reconstruction of the westbound carriageway of the Con Colbert Road / Chapelizod Bypass (R148), for 100m (approx.) in either direction of the junction. This would also include a significant proportion of Memorial Road, posing significant

disruption to vehicular and vulnerable users during construction. The risks associated with heavy engineering works along the length of the data centres would also be increase. In addition, the Option does not achieve the accepted OHLE minimum clearance standards.

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

Option 3 and Option 6 propose to achieve 4-tracking and electrification by replacing the existing bridge with a new beam-and-slab bridge. Vertical clearance requirements would be achieved mainly by track lowering with no or insignificant increases to road levels. The difference between the two options lies on the methodology used for adjusting the road and track levels:

- **Option 3** – This option involves the replacement of the Memorial Road Bridge (OBC3), with a greater span and width; the works would involve the entire burden of achieving OHLE clearance through track lowering; in order to limit impact on road users and adjacent land holdings. The aim being to limit impact on vehicular and vulnerable road users and adjacent land holdings. It is proposed to lower track levels by up to 1.15m to achieve a desirable OHLE contact wire clearance of 4.7m. Alternatively, reducing track lowering to 0.7m if the prior is deemed unachievable. In either case the road levels would be reinstated to their existing levels.
- **Option 6** – This option involves the replacement of the Memorial Road Bridge (OBC3), with a greater span and width; the works would involve almost the entire burden of achieving OHLE clearance through track lowering with a nominal increase to road level on. The aim being to limit impact on vehicular and vulnerable road users and adjacent land holdings. It is proposed to increase the road level to a maximum level, above which works to the Chapelizod Bypass would be required, in addition to lowering the track levels as needed to achieve the additional required vertical clearance. The road raising at the bridge would only be 50mm (approx.); thereby reducing the track lowering required under Option 3 by the equivalent depth.

After completing the Stage 1 Preliminary Assessment (Sifting) it was noted that there was a distinct choice in routing and/or spatial variation in the options for around Inchicore and South Circular Road, which would lend themselves well to the MCA process. However, in respect of this area of Memorial Road Bridge (OBC3) the spatial difference in the feasible options was much less clear. In this case, only two feasible options progressed through the Stage 1 Preliminary Assessment (Sifting) process and the differences between the options were focused on technical design matters.

Notwithstanding this, the options were reviewed by a range of specialists undertaking the Stage 2: MCA. The observations of the findings of the Stage 1 Preliminary Assessment (Sifting) for this Memorial Road Bridge (OBC3), were confirmed when the specialists could not discern a noticeable difference between the two feasible options across a wide range of sub-criteria and assessed the two options as ‘comparable / neutral’.

In order to streamline and simplify the reporting of results, it was considered appropriate at this stage (i.e., after the Stage 2: MCA process), to combine the two feasible options at this location into a single option which would be the Emerging Preferred Option. The detailed technical design differences between the options remaining a potential design iteration and /or comparator to be further explored through the future design process.

6.5. 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 (EIAR) 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 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 the Other Option
Some Comparative Disadvantage over the Other Option
Comparable to the Other Option / Neutral
Some Comparative Advantage over the Other Option
Significant Comparative Advantage over the Other Option

6.6. Multi-Criteria Analysis Summary

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

Table 6-4 MCA Summary

CAF Parameters	Option 3 Assessment	Option 6 Assessment
1. Economy	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
2. Integration	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
3. Environment	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
4. Accessibility and Social Inclusion	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
5. Safety	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
6. Physical Activity	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
Conclusion	**Comparable to the Other Option / Neutral**	**Comparable to Other Option / Neutral**

Across the CAF Parameters of Economy, Integration, Accessibility and Social inclusion, Safety and Physical Activity there was no comparative advantage or disadvantage between the two options.

In terms of the Environment, despite some advantage recorded under the landscape and visual factor for Option 3, the overall findings for the MCA for Environment are assessed as neutral. The point of difference between the options related to construction stage impacts to the road surface, including potential to impact trees which form the 'avenue vista' of the road; however, these potential impacts can be addressed through detailed construction stage planning and alone would not be reasonable to evaluate the MCA above neutral finding.

In order to streamline and simplify the reporting from the MCA results, it was considered appropriate at this stage to combine the two feasible options into a single option. The detailed design differences will remain as a potential design variation to be further explored through the future design process. Therefore, Option 3 is brought forward, with Option 6 as a design variation / comparator to be further explored through the future design process..

6.7. Emerging Preferred Option

There were significant challenges and constraints on the options available to achieve the project requirements in this area. The major ones being:

- The existing Memorial Road Bridge (OBC3).
- The masonry retaining wall to the south (within proximity of data centres and residential properties.
- The immediate proximity of Con Colbert Road/Chapelizod By-Pass (parallel to the permanent way corridor); its junction with Memorial Road being adjacent to the bridge. The junction is a key node in relieving traffic congestion in the area (Sarsfield Road to South Circular Road) and set to be even more crucial when the Bus Connects Scheme proposals are implemented.
- 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 six (6 No.) Options were initially developed for this area, following the selection process, Option 3 has been identified as the Emerging Preferred Option for this area. This Option requires the reconstruction of the existing bridge with a slightly wider cross-section and longer span and with a different beam/deck arrangement to accommodate OHLE clearances and reinstatement of utilities, and so limit negative impact on road users.

The Emerging Preferred Option widens the rail corridor to the north (adding a fourth track) and replaces the existing bridge with a longer span. In addition, the rail tracks will be lowered to facilitate the electrification infrastructure beneath the new bridge. The masonry wall on the southern side would need to be strengthened due to the lowering of the track and a new wall would be required along the northern side. TIt is envisaged that some of the works could be completed at night-time and under traffic management. It is also envisaged that a temporary pedestrian bridge would be provided, during the bridge closure phase, until such time the works area would be deemed safe again for vulnerable users. This Option would provide the optimum solution in terms of minimising traffic disruption.

The proposed new Slow tracks alignment will be provided on the northern side of the corridor, with the lowering of the track commencing east of Sarsfield Road Bridge (UBC4) to allow for the necessary OHLE clearances at Memorial Road Bridge (OBC3). The track levels of both the Slow and Fast 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 shows a track lowering of 1.15m at the western edge of structure to achieve the nominal contact wire clearance of 4.7m. Again this worth noting that this is noted as result of the constraint

imposed by the proximity to Con Colbert Road / Inchicore By-Pass (R148), as well as adjacent data centres and existing utilities. If the geotechnical investigation (coupled with drainage design development) indicate that this depth of lowering is not achievable; then a derogation will be sought for an alternative track lowering depth of no less than 0.7m to achieve the minimum acceptable OHLE contact wire clearance of 4.4m.

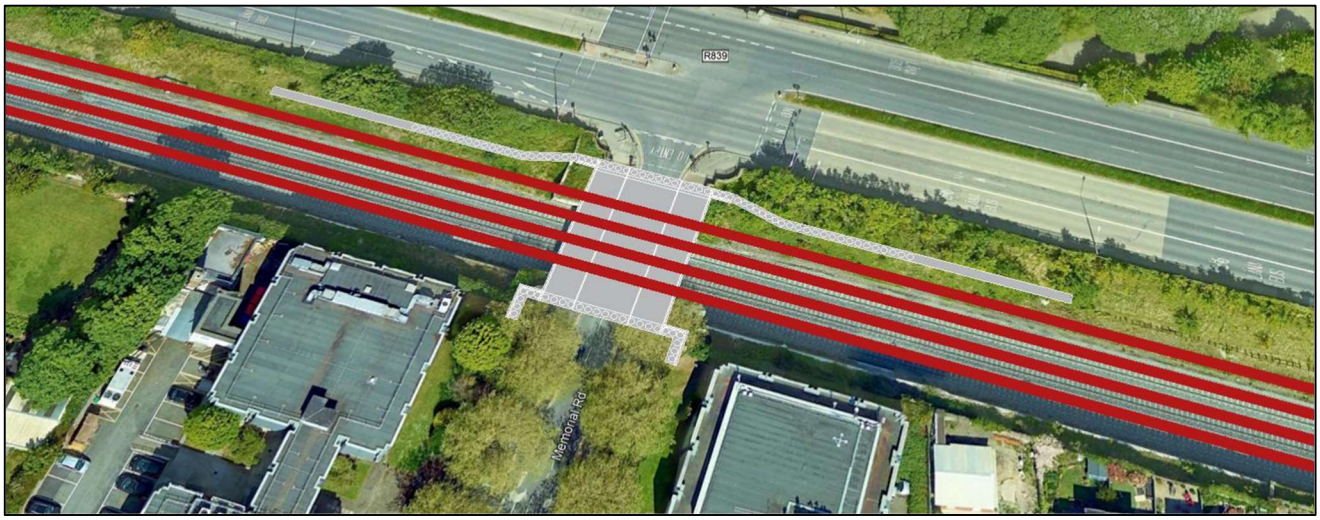

Figure 6-1 Memorial Road Bridge (OBC3) - Bridge Option 3

The Emerging Preferred Option is considered the optimum solution in terms of minimising impacts on third party property owners. Based on the level of information and design available at this time for Public Consultation No. 1, the extent of permanent works is not envisaged to interfere with third party residential or commercial property rights. There may be temporary interference of property rights during construction along the rail corridor and around the bridge works 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.

Appendix A – Sifting Process Backup

Appendix B – MCA Process Backup

Appendix C – Supporting Drawings

The following drawings accompany the Technical Report:

Bridge Drawings

DE-04-23-DWG-ST-TTA-55925

DE-04-23-DWG-ST-TTA-55926

DE-04-23-DWG-ST-TTA-55927

DE-04-23-DWG-ST-TTA-55928

Roads Drawings

DP-04-23-DWG-CV-TTA-55276

Permanent Way Drawings

DP-04-23-DWG-PW-TTA-55830

DP-04-23-DWG-PW-TTA-55831