DART+ South West

Technical Optioneering Report

Park West to Heuston Station

Area around Le Fanu Road Bridge (OBC7)

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 from the West of Cherry Orchard Footbridge (OBC8B) to the East of the proposed Le Fanu Road Bridge (OBC7). 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. It will provide a sustainable, electrified, reliable and more frequent rail service, improving capacity on rail corridors serving Dublin.

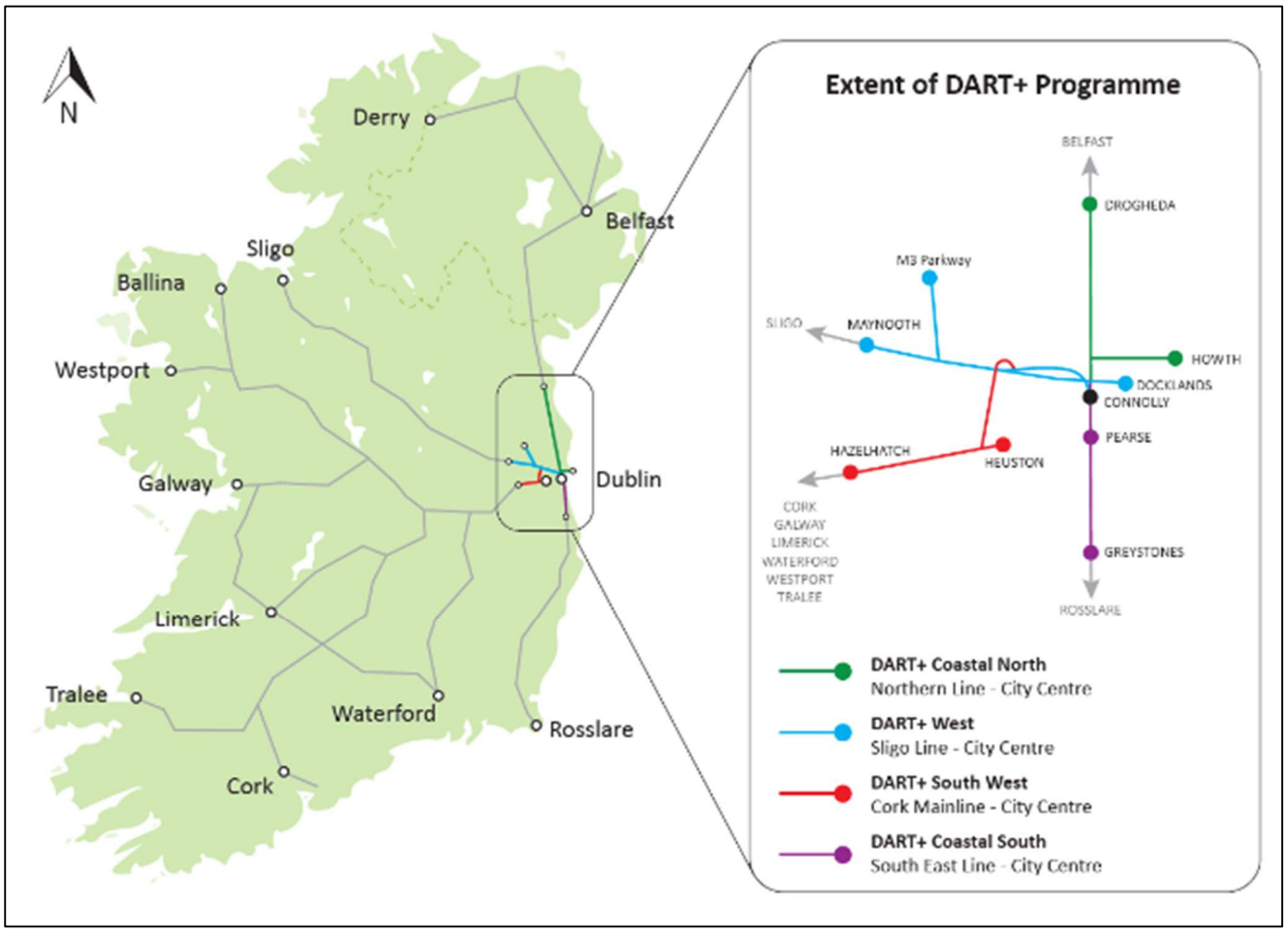

Figure 1-1 Schematic of Overall DART+ Programme

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 improved 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 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 (i.e., where four tracks reduce to two), which is currently limiting the number of train services that can operate on this route. DART+ South West will also deliver track improvements along the Phoenix Park Tunnel Branch Line, which will allow a greater number of trains to access the city centre.

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

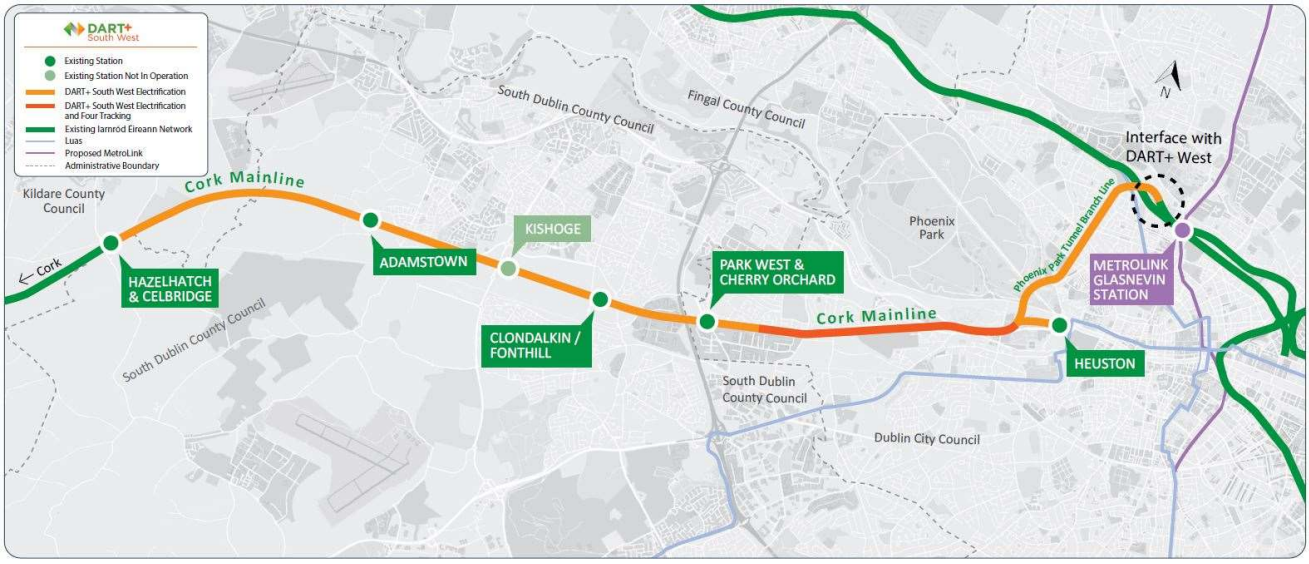

Figure 1-2 DART+ South West Route Map

1.4. Capacity increases associated with DART+ South West.

DART+ South West will improve performance and increase train and passenger capacity on the route between Hazelhatch & Celbridge Station to Heuston Station and through the Phoenix Park Tunnel Branch Line to the City Centre, covering a distance of circa 20km. It will significantly increase train capacity from the current 12 trains per hour per direction to 23 trains per hour per direction (i.e. maintain the existing 12 services, with an additional 11 train services provided by DART+ South West). This will increase passenger capacity from the current peak capacity of approximately 5,000 passengers per hour per direction to approximately 20,000 passengers per hour per direction. Upon completion of the DART+ South West Project, train services will be increased according to passenger demand.

1.5. Key infrastructural elements of DART+ South West Project

The key elements of DART+ South West include:

- Completion of four-tracking from Park West & Cherry Orchard Station to Heuston Station, extending the works completed on the route in 2009.
- Electrification of the line from Hazelhatch & Celbridge Station to Heuston Station and also from Heuston Station to Glasnevin, via the Phoenix Park Tunnel Branch Line, where it will link with proposed DART+ West.
- Undertaking improvements / 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 Station, the route also extends through the Phoenix Park Tunnel to Glasnevin. The area descriptions and extents are set out in **Table 1-1** 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 800m (approx.) long and extends from 50m west of Cherry Orchard footbridge (OBC8B) to 10m east of Le Fanu Road Bridge (OBC7). The Permanent Way currently consists of 3 No. tracks from the western boundary to 280m (approx.) west of Le Fanu Road Bridge (OBC7) where they converge to 2 No. tracks. The tracks fall in level from west to east throughout the section. There is currently no longitudinal drainage system installed along the Permanent Way.

There are 2 No. overbridges in the area. There is Le Fanu Road Bridge (OBC7), which is a single-carriageway road bridge carrying road traffic over the rail corridor in a north-south direction. Le Fanu Road Bridge (OBC7) is a major feature within the section but the area also includes Cherry Orchard Footbridge (OBC8B), which is a single-span pedestrian overbridge.

The rail corridor in is primarily in cutting (i.e. the rail level is below the surrounding ground level). The corridor is formed by earthwork cutting slopes along the north and south sides. A line of steel lattice electricity pylons run parallel to the south side of the rail corridor boundary at the top of the cutting.

The major infrastructure features are illustrated in **Figure 2-1** below.

Figure 2-1 Aerial view (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 challenges that constrain the options available to achieve the Permanent Way and Overhead Line Electrification (OHLE) project requirements. The main challenges are the narrow rail corridor in the vicinity of Le Fanu Road Bridge (OBC7), from 40m (approx.) west of the bridge as well as the geometry of bridge itself. The narrow corridor has insufficient width to provide 4-tracks, and the installation of the new tracks would require widening the corridor that is currently in a cutting, with retaining walls on either side. The existing Le Fanu Road Bridge (OBC7) structure, which currently has 2 No. tracks beneath it, has insufficient horizontal clearance for four tracks and insufficient vertical clearance for OHLE. The road level for a potentially reconstructed bridge (to provide adequate vertical and horizontal clearance) would be primarily constrained by the existing side road junctions on the north (Le Fanu Road cul-de-sac) and on the south (Kylemore Park North Road) junctions.

The cross-sectional elements of the existing approach roads (carriageway and footpaths) are not compliant with current standards for all user categories but particularly the vulnerable; namely pedestrians, cyclists, and those with disabilities. Any works would need to comply with current design standards in accommodating the needs of these user categories.

In the case of any bridge replacement, some realignment of the approach road (from the north) would be required. The road realignment and/or levels for a potentially reconstructed bridge (to provide adequate vertical and horizontal clearance) would be primarily constrained by the existing side road junctions; namely, Le Fanu Road cul-de-sac (north of the bridge) and Kylemore Park North (south of the bridge). A realignment would require a CPO of a portion of the public open space to the north of Le Fanu Road Bridge (OBC7), with a potential requirement for the same to both the Light Industrial/Commercial lands to the south.

The closure of Le Fanu Road Bridge (OBC7) for its reconstruction, along with associated road works would in the short term significantly impact traffic, causing delays as diversions are proposed to rerouted traffic over Kylemore Road Bridge.

2.3. Structures

2.3.1. Le Fanu Road Bridge (OBC7)

Le Fanu Road Bridge (OBC7), is a single span masonry arch structure carrying northbound and southbound traffic over the railway corridor along Le Fanu Road.

The bridge has a span of 9m (approx.) and a width of 7.5m (approx.). The existing structure has no footways at road level. The maximum vertical clearance beneath the existing structure is 4.452m. It is noted that this bridge is an arch structure and as such the vertical clearance varies along the span. An OHLE solution is not possible without structural intervention.

Figure 2-2 Le Fanu Road Bridge (OBC7) - west elevation

2.3.2. Cherry Orchard Footbridge (OBC8B)

Cherry Orchard Footbridge (OBC8B) is a single span steel structure. Cherry Orchard Footbridge (OBC8B) carries pedestrians and cyclists over the rail corridor and connects Cherry Orchard Avenue (north) to Lavery Avenue (south). The bridge has a span of 20m (approx.) and a width of 3m (approx.). The vertical clearance beneath the existing structure is 5.069m. The bridge currently has 4 No. tracks beneath and sufficient vertical clearance for OHLE. Consideration needs to be given to future maintenance of the steel painting system over the OLE lines.

Figure 2-3 Cherry Orchard Footbridge (OBC8B) - east elevation

2.3.3. Retaining Walls

There are 2 No. retaining structures adjacent to the south abutment of Le Fanu Road Bridge (OBC7), refer to **Figure 2-2**. On the south west side of the structure there is a 10m long (approx.) by 2m high (approx.) gabion basket and reinforced concrete (RC) retaining wall. This wall retains the cutting slope and creates space for the southern track. On the south east side of the structure there is a 10m long (approx.) by 2m high (approx.) gabion basket retaining wall. This wall retains the cutting slope and creates space for the track and a Signal structure.

There are a further 3 No. retaining walls adjacent to Cherry Orchard Footbridge (OBC8B). There is a mechanically stabilised earth (MSE) retaining wall (25m long by 3m high approx.) on the west side of the south abutment (refer to **Figure 2-5**). This wall supports the pedestrian approach ramp to the bridge. At the north abutment there are masonry retaining walls on the east side (35m long by 3m high approx.) and west side (160m long by 2m high approx.), refer to **Figure 2-4**.

An 80m long by 2m high (approx.) RC retaining wall retains back gardens of residential properties mid-way between Le Fanu Road Bridge (OBC7) and Cherry Orchard Footbridge (OBC8B), on the north side of the rail corridor.

Figure 2-4 Masonry Retaining Wall, north-west side of Cherry Orchard Footbridge (OBC8B)

Figure 2-5 MSE Retaining Wall, south-west side of Cherry Orchard Footbridge (OBC8B)

2.3.4. Minor Retaining Structures

There are several minor retaining structures along the rail corridor. Generally, their function is to retain the toe of the earth cutting slopes and provide additional room for various trackside furniture assets. The locations of these minor structures are illustrated in the Figures below.

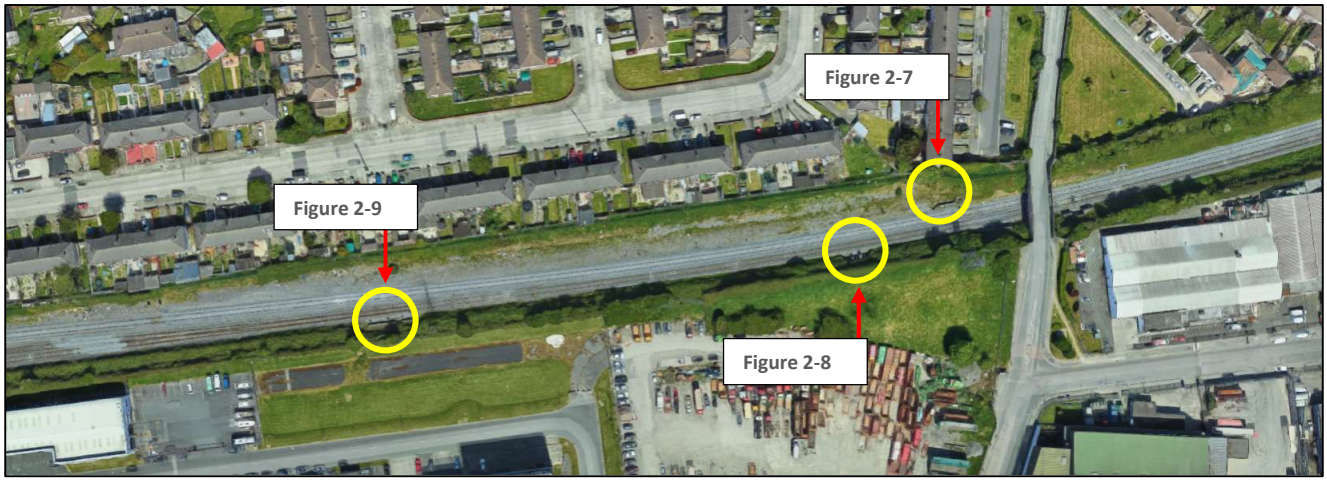

Figure 2-6 Aerial view to the east of section with minor retaining structure locations identified

Figure 2-7 Blockwork headwall east of Le Fanu Road Bridge (OBC7)

Figure 2-8 RC retaining wall east of Le Fanu Road Bridge (OBC7)

Figure 2-9 Gabion retaining wall along southern edge of cess.

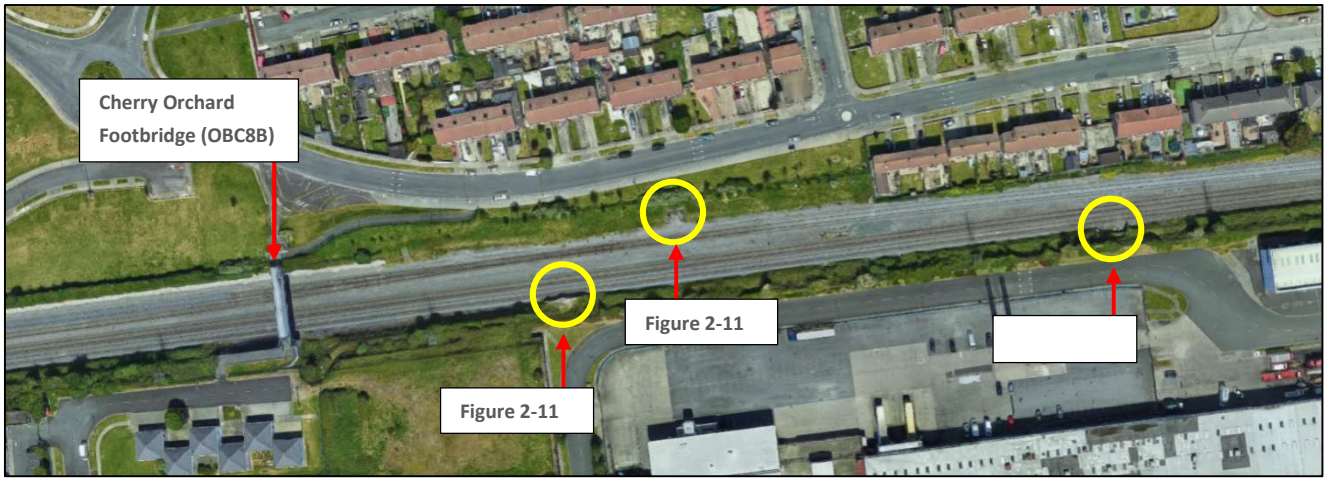

Figure 2-10 Minor retaining structure locations identified in the western half of the area.

Figure 2-11 Masonry retaining wall (possibly a partially defunct bridge abutment)

Figure 2-12 Blockwork Headwall and Fencing - Facing East

Figure 2-13 Blockwork Headwall - Facing East

2.4. Permanent Way and Tracks

The section commences at project chainage (Ch) 261+403, their exists 4-No. tracks on the approach to the area from the west (Park West). The Fast tracks are used for intercity and freight services while the outer tracks are normally used for suburban services (i.e. stopping trains). The existing track layout is represented in the **Figure 2-14** below.

The 4 No. tracks converge into 3 No. tracks at Points 802 (Ch 261+235) and again down to 2 No, tracks at Points 801 (Ch 260+845); the resulting 2 No. tracks are named as Up Main and Down Main. The maximum speed through the area is 90mph. The rail corridor is relatively wide to the west of Le Fanu Road Bridge (OBC7). The 2 No. tracks continue beneath Le Fanu Road Bridge (OBC7). The lateral clearance from the nearest rail to the existing abutment is 1.6m (approx.) and as such there is insufficient room to install a continuous walkway.

The existing track gradient from west to east (i.e. towards Kylemore Road) is at a gradient of 0.90% (approx.). The track is a ballast track with concrete monobloc sleepers and 54E1 rails. The turnouts are on concrete bearers.

Figure 2-14 Cherry Orchard Footbridge (OBC8B) and Points 802 on right (Facing West)

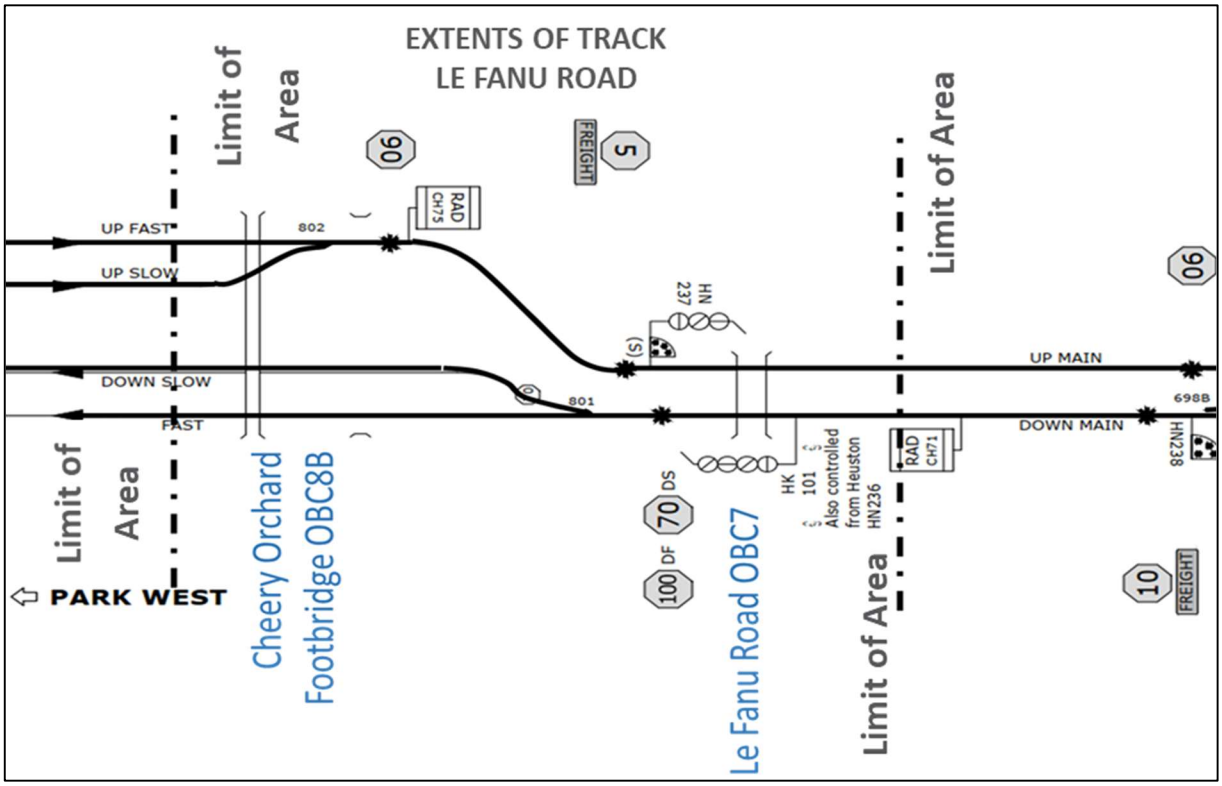

Figure 2-15 Track diagram showing the area

2.5. Other Railway Facilities

There is a track access point south of the northern pedestrian approach ramp to Cherry Orchard Footbridge (OBC8B). A set of steel access stairs traverses the cutting slope on the north side of the rail corridor. This access point is to facilitate access for Iarnród Éireann (IÉ) inspection and maintenance staff.

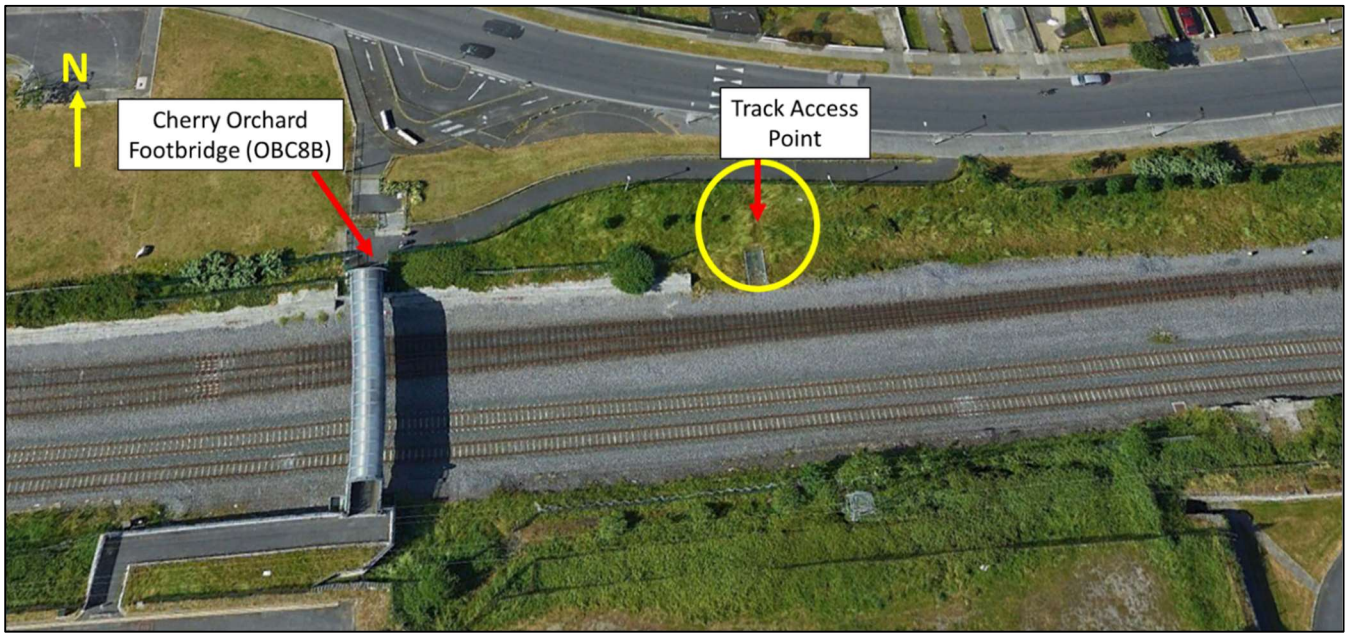

Figure 2-16 Track access point on the east side of Cherry Orchard Footbridge (OBC8B)

2.6. Road Network

Le Fanu Road, in the immediate project area between the unsignalised Kylemore Park North and the Le Fanu Road (cul-de-sac) junctions, comprises a single carriageway road. The lane widths are variable as they taper on both approaches to its crossing over the existing rail corridor at Le Fanu Road Bridge (OBC7). The cross-sectional elements include a raised footpath on the eastern approaches to the bridge; with the local raised and paved footpath area between the bridge and the plot access to the vacant industrial site, south of Le Fanu Road Bridge (OBC7). This raised area has no connectivity over the bridge or past the vacant plot access but does have a semi formalised crossing point at Kylemore Park North or formal crossing meet footpaths along the eastern carriageway edge. Pedestrians and vehicle movements are neither segregated nor defined over the existing bridge; with both pedestrians and vehicles partially unsighted by those approaching from the north.

Traffic data received from DCC indicates that Le Fanu Road shares similar heavy traffic volumes to that of Kylemore Road in the peak hour (both directions) but less than 50% (approx.) of Kylemore Road volumes over the course of a whole day. The existing 'hump-back´ road at Le Fanu Road Bridge (OBC7) is on a skew to the normal direction of the approach roads; this skew exacerbates the traffic delays experienced at peak times and has a resultant safety impact on vehicular and vulnerable users (referred to previously).

The road layer and earthworks for the approaches are contained by retaining wall structures that currently maximise public open space to the northeast of the bridge. The walls also provide space for an existing 'hammerhead' cul-de-sac for the residential service road to north-west of the bridge; as well as providing a limited open space buffer between Le Fanu road and this same service road.

The boundary detail to the south west of the Le Fanu Road Bridge (OBC7) is galvanised metal palisade fencing with gated access to the vacant industrial land (opposite Kylemore Park North junction), refer to **Figure 2-17** below.

Figure 2-17 Industrial land boundary Fence, south west of Le Fanu Road Bridge (OBC7)

2.7. Ground Conditions

Topographically the ground slopes gently from west to east with the railway in cutting throughout.

The general superficial geology in this area is anticipated to comprise till overlying bedrock (limestone and shale). At Le Fanu Road Bridge (OBC7), according to publicly available information (Geological Survey Ireland), the northern abutment is shown to be underlain by till overlying bedrock; however, the southern abutment is shown to the underlain by urban (made ground) and is likely to be overlying till and bedrock. Urban (made ground) deposits lie to the south immediately outside the southern rail corridor boundary.

Ground investigation information at 30m west of Le Fanu Road Bridge (OBC7), adjacent to the rail line, shows that superficial deposits consist of ballast (described as clayey gravel) and is underlain by sandy clay. Bedrock was encountered at a relatively shallow depth of 3m below track level. Bedrock was recorded as strong limestone with local strata of weak to strong calcareous mudstone. Groundwater strikes were encountered at 1m bgl rising to 0.60m bgl (below track level), and 2.9m bgl rising to 2.2m bgl (below track level).

To the south of Le Fanu Road Bridge (OBC7), 2 No. boreholes indicate that the southern side of the railway comprises possible fill, underlain by clay with the exploratory holes terminating in clayey gravels at 7.3m bgl (39.10m AOD) and 7.20m bgl (39.21m AOD). Another borehole recorded possible fill (made ground) underlain by clay and was terminated at 6.75m bgl (39.19m AOD) at an obstruction. No groundwater strikes were recorded within the ground investigation undertaken on the southern side of the railway.

At Cherry Orchard Footbridge (OBC8B), publicly available information indicates the depth to bedrock to be greater than 6.0m bgl.

2.8. Environment

The key environmental constraints in the zone relate to the proximity of residential and commercial properties to the rail corridor. On the north side of the existing corridor, there are significant residential properties along Le Fanu Drive, Cloverhill Road and Cherry Orchard Avenue. The area to the south of the corridor is predominantly commercial/industrial and includes the IPCC licensed facility at Thornton's Recycling. There are limited biodiversity features identified in the area; however, evidence of invasive plant species has been noted in the vicinity of Inchicore Works, and it is likely more may be found with detailed surveying.

To the northwest of Le Fanu Road Bridge (OBC7) is Le Fanu Park (also referred to as the Lawns open space) which includes a designation in the DCC development plan to preserve, provide and improve recreational amenity and open space/green networks. Three RMP sites are recorded in the southeast corner of green space. These are associated with the St. Lawrence's Church (DU018-031003) and Graveyard (DU018031004). The park also hosts the site of a former castle on the summit of a natural ridge in the park directly adjacent at the west to the church and graveyard.

The railway line itself is the subject of several Dublin City Industrial Heritage Records associated with the Phoenix Park Tunnel Branch Line including Le Fanu Road Bridge (OBC7). The bridge itself is not designated as an RPS or NIAH feature.

2.9. Utilities

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

- EIR

- ESB Networks
- Dublin City Council Road Drainage (Storm Water Sewers)
- Dublin City Council / Irish Water (Foul Water Sewers)
- Dublin City Council / Irish Water (Water Supply)
- Dublin City Council Public Lighting

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

A number of services (ESB cables & a Foul Water Sewer) cross the railway corridor below the tracks. Where track lowering is proposed, consideration of the impacts on these services will also be necessary.

Significant utilities (ESB cables & a Foul Water Sewer) are also located in parallel to the railway along both the northern and southern boundaries. In terms of proposals to widen the railway corridor, an examination of the impacts on these services will be required.

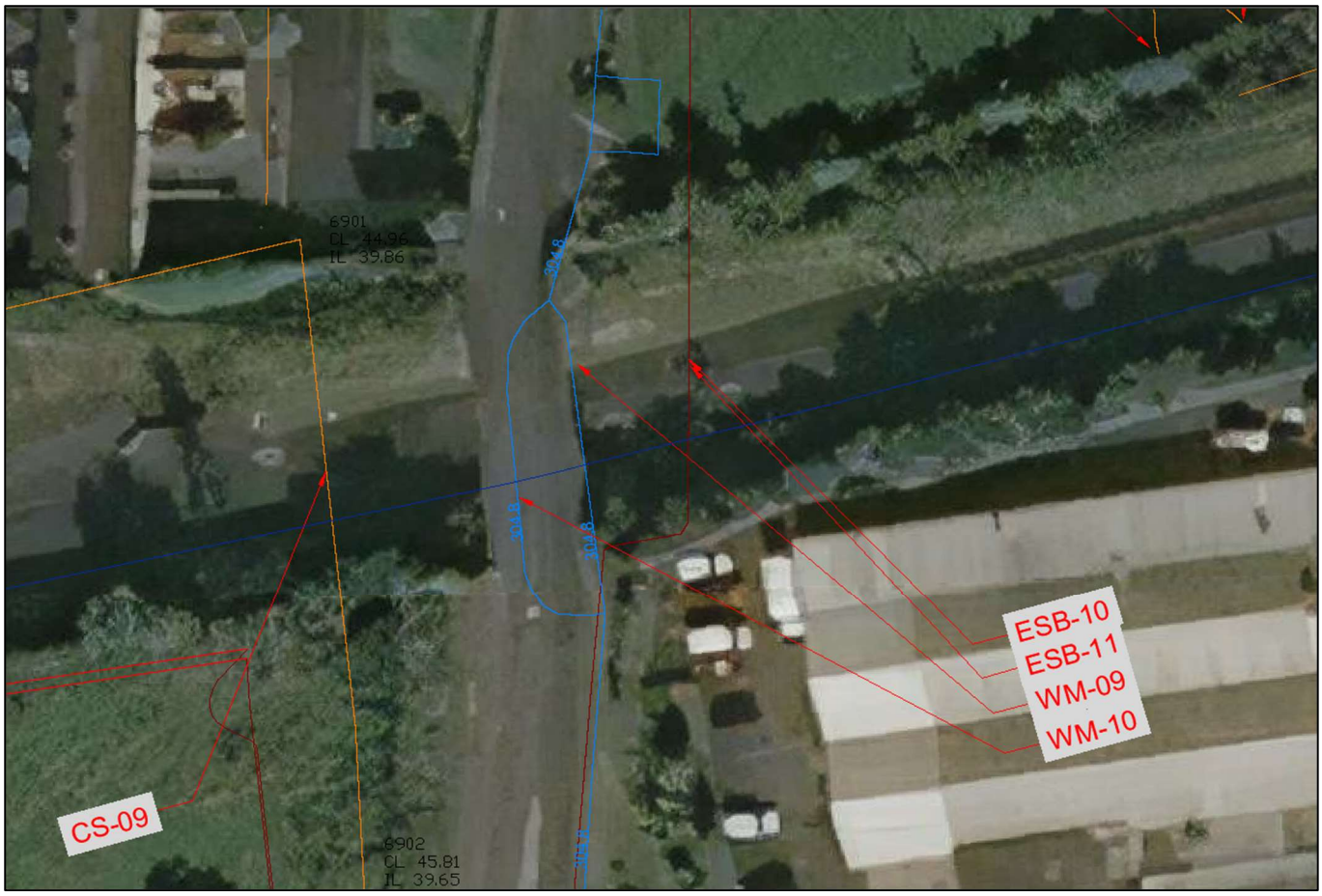

Figure 2-18 Existing utilities crossing the rail corridor at Le Fanu Road Bridge (OBC7)

3. Requirements

3.1. Specific Requirements

- Increase the number of tracks from 2 No. tracks to 4 No. tracks.
- Electrification of 2 No. tracks for the DART+ South West (this Project).
- 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.

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.

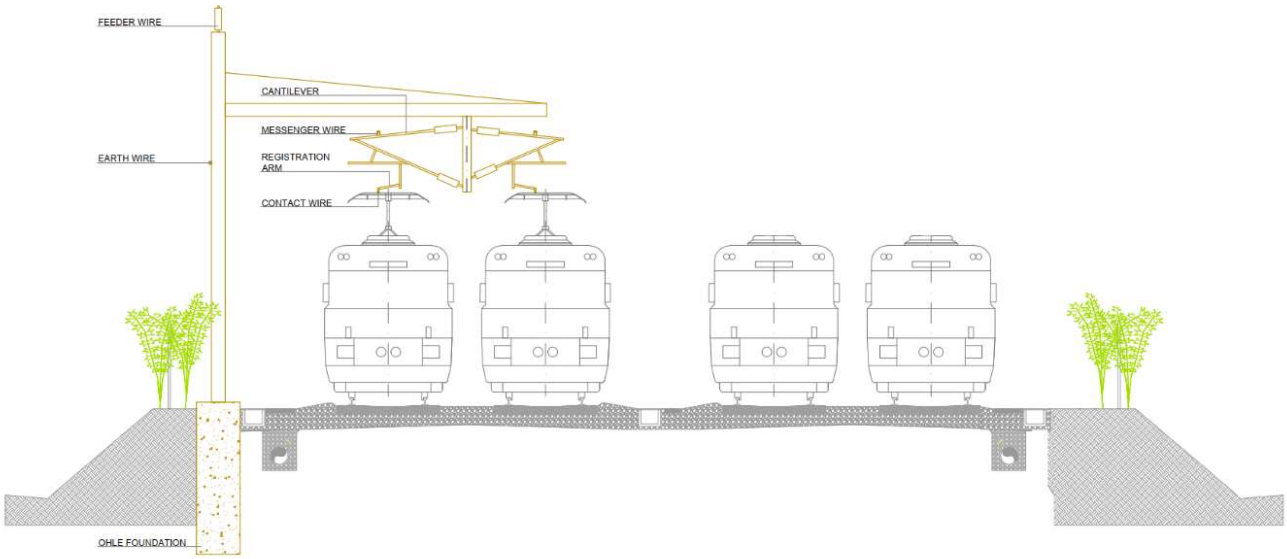

Figure 3-1 Typical OHLE arrangement in four track open route.

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.

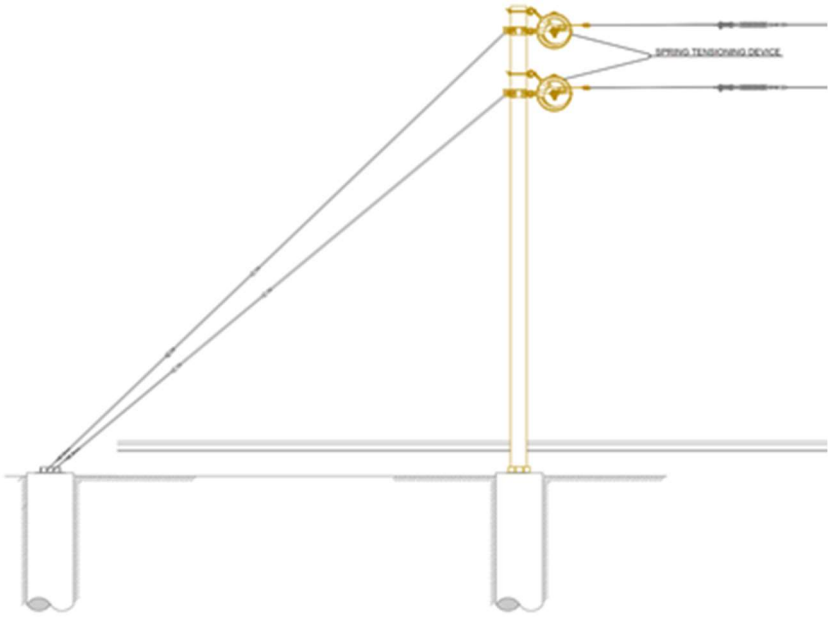

Figure 3-2 Typical anchor structure

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.

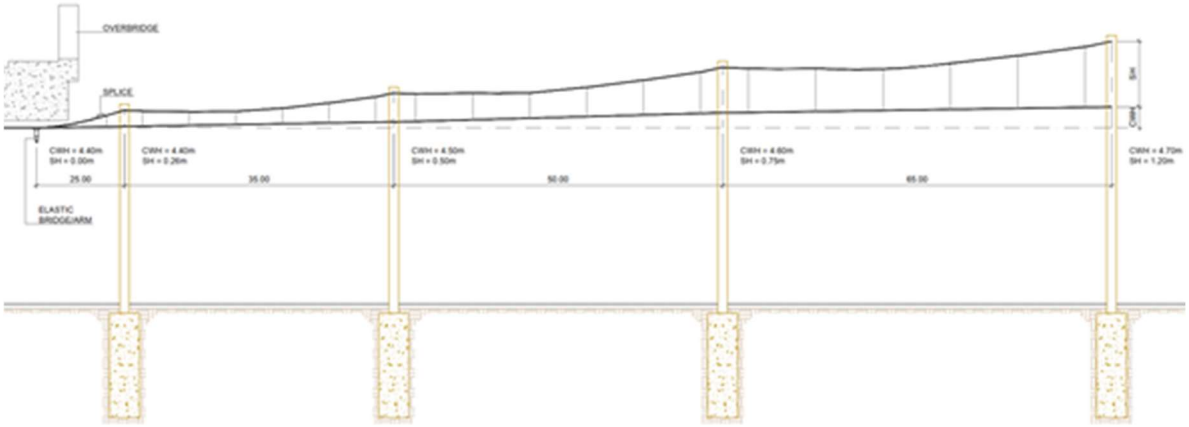

Figure 3-3 Typical arrangement on approach to a low bridge

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

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 environmental constraints relate to the proximity of residential properties to the north and commercial properties to the south of the corridor. Please refer to **Section 2.8** for further indication of the environmental constraints.

4.2. Roads

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

Several key constraints listed below are deemed to govern the road level changes required 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 and beyond.

- The structural depth of beam/slab options.
- The depth of feasible track lowering owing to the need to tie-in to the Inchicore Works track layouts, as well the potential geological substrate and ground water levels; to be confirmed with new GI.
- The National Cycleway Manual requires a maximum of 5% gradients for cycleways; restricting how rapidly one can chase levels back to existing road levels.
- TII and DMURS requires a maximum of 3% gradient for the first 15m of roads, at junctions. This potentially extends the impact up branch roads by limiting the ability to chase levels back to existing road levels and avoid impact on plot accesses.
- TII and DMURS stopping site distance compliance requiring the removal of the skew to align bridge with the alignment of the approach roads.
- The proximity of plot boundaries to the carriageway edge (particularly residential), limits design adaptability while still providing the ability to tie into existing driveways.
- Provision of a carriageway with 3.5m lane widths, as well as footpaths & cycleways either side of the carriageway. These carriageway cross-sectional elements widths along with normalising the bridge skew limits the variability of the realignment options for Le Fanu Road (north of the bridge).

4.3. Property

The density and proximity of the residential properties along the north side of the rail corridor between Cherry Orchard Footbridge (OBC8B) and Kylemore Road Bridge (OBC5A) is a major constraint in terms of achieving the project requirements. Extending the rail corridor to the south is not considered to be a feasible option. Please refer to Property Boundary lines on the Bridge and Permanent Way Options drawings in Appendix C.

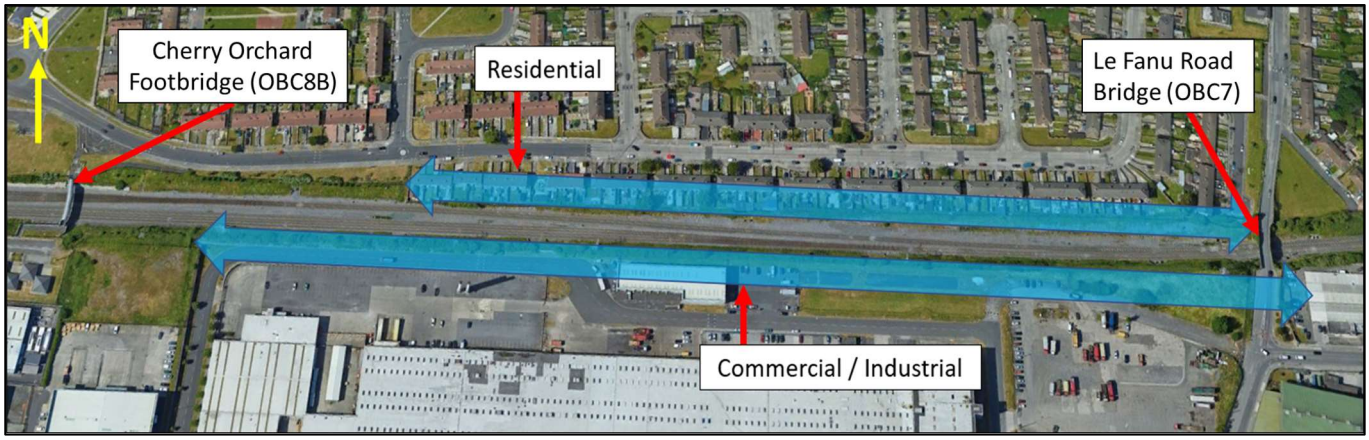

Figure 4-1 Residential and Commercial Property Locations

4.4. Permanent Way

The vertical and horizontal track 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 Fast and Slow track alignment	The proposed track alignment needs to take account of the existing track horizontal and vertical alignment so that the track renewal extents required are minimised.
2	Cherry Orchard footbridge (OBC8B)	The lateral and vertical clearance must be compliant with the current IÉ standards and the requirements for the electrification of the Slow tracks
2	Property boundary	The proximity of residential and commercial/industrial properties on the north and south side of the rail corridor is a constraint to widening.
4	Position of Pylons on the South of the corridor	Pylons support high-voltage transmission lines along the south side of the existing rail corridor. The pylons are relatively close to the southern track.
5	Kylemore Road Bridge (OBC5A)	Kylemore Road Bridge (OBC5A) will have an impact on the horizontal and vertical alignment in the area around Le Fanu Road Bridge (OBC7) and vice versa.
6	Le Fanu Road	The new level of the Le Fanu Road would determine the soffit level of a reconstructed OBC7. The vertical alignment must allow for the required vertical clearance for the installation of OHLE equipment and the required levels and gradients associated with the track layout through Kylemore Road Bridge (OBC5A)

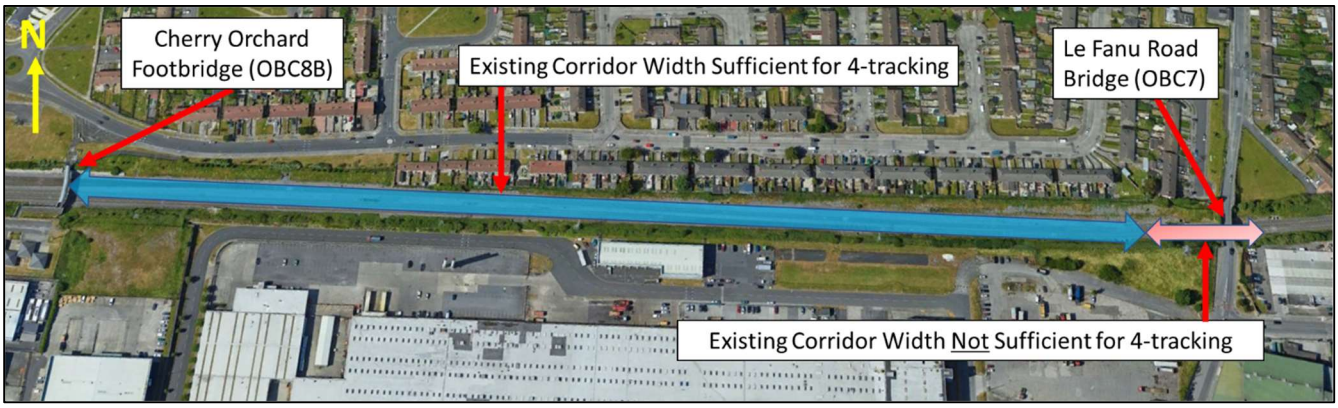

Figure 4-2 Rail Corridor Width

The main constraint to selecting a horizontal Permanent Way alignment through the area is the available width within the corridor. Additional constraints are the proximity and density of the private Residential and Commercial properties to the north and south side of the corridor, respectively.

Figure 4-3 High voltage transmission lines along south of rail corridor (Facing East)

4.5. Existing Structures

The existing Le Fanu Road Bridge (OBC7) has insufficient horizontal clearance to accommodate 2 No. additional tracks. An initial bridge electrical clearance assessment has been carried out to determine whether an OHLE solution is possible without structural intervention or track lowering. The assessment found that no OHLE solution is possible without intervention.

Proposed interventions include replacement of the road bridge with a new structure of sufficient horizontal and vertical clearance to facilitate four-tracking and OHLE; replacing the bridge with a pedestrian bridge only or creating an opening through the side (wingwalls) of the structure to create space for additional tracks. Replacement bridge interventions consider various combinations of track lowering and increasing road levels to achieve 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.

No intervention is required at Cherry Orchard Footbridge (OBC8B) to achieve four-tracking and electrification.

4.6. Geotechnical

Shallow bedrock close to the existing permanent way formation-level may be present. Appropriate groundwater management/drainage design may be required should the upcoming detailed ground investigation encounter groundwater at similar depth.

At Cherry Orchard Footbridge (OBC8B), bedrock is indicated to be more than 5m bgl. To the east of Cherry Orchard Footbridge (OBC8B), the existing four-tracking narrows to three tracks then down to a two-track arrangement towards Le Fanu Road Bridge (OBC7). Where the tracks begin to narrow at the residential properties, there is not the available width to accommodate four tracks within the existing railway corridor. Therefore, existing retaining walls (gabions, as well as masonry and concrete retaining walls) will be removed from this point onwards to east. New retaining walls will be required to provide the necessary horizontal width for the railway.

4.7. Existing Utilities

The variety of utilities will be constraints during both the design and construction phases. As such, their treatment in the temporary and permanent situations has been carefully considered during the development of options.

Services crossing the rail corridor via the existing Le Fanu Road Bridge (OBC7) are not expected to pose any particular difficulty and may be easily managed. However, over services cross under the tracks at various locations throughout the study area. Where track lowering is necessary, the impacts on these services will need to be carefully examined. It is noted that significant infrastructure links in relation to gravity storm and foul sewers are present.

In addition, significant ESB and foul sewer network assets are present in parallel to the railway alignment on the southern and northern boundaries, respectively. These may be impacted where corridor widening is required.

In summary, all existing utilities pose constraints to the options. Where they conflict with bridge and permanent way options, their potential treatment is being discussed with the utility providers.

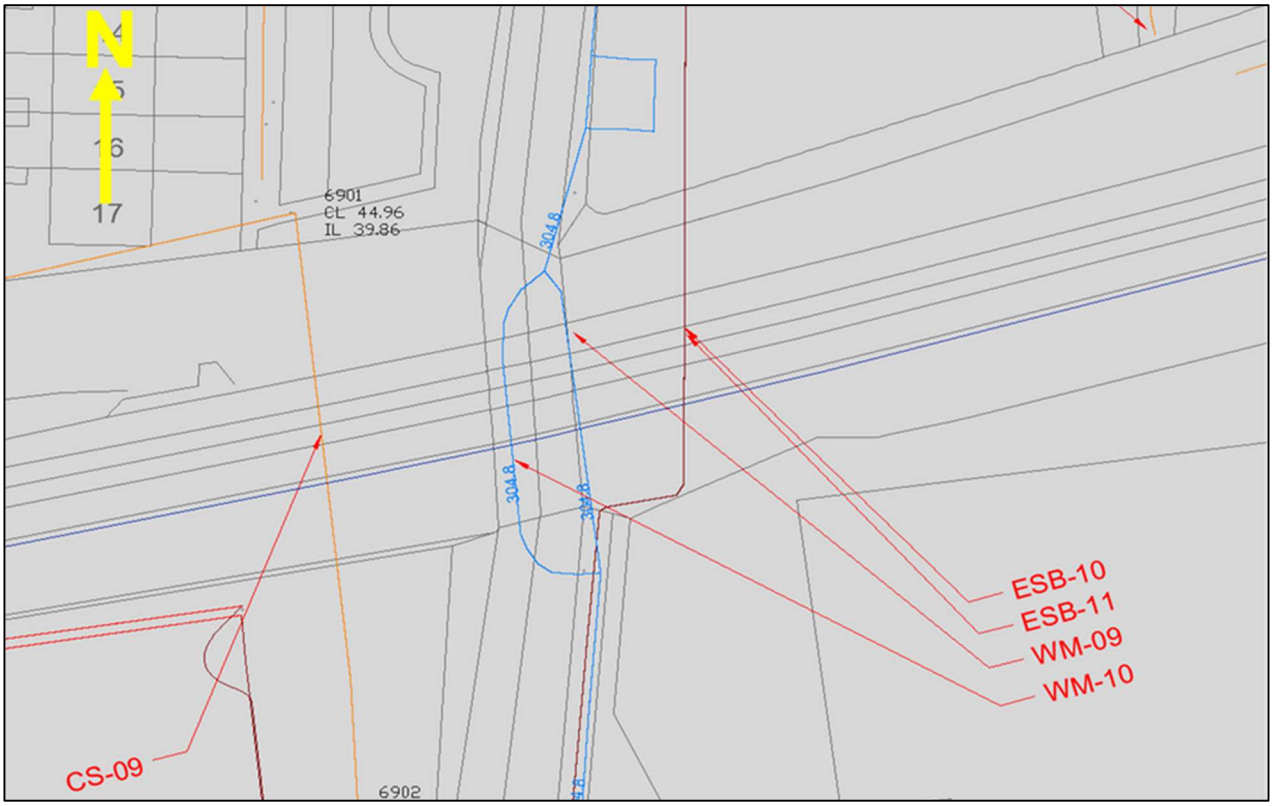

Figure 4-4 Existing Utilities at Le Fanu Road Bridge (OBC7)

5. Options

5.1. Options Summary

The existing Le Fanu Road Bridge (OBC7)structure, which currently has 2 No. tracks beneath it, has insufficient horizontal clearance for 4 No. tracks. The existing vertical clearance beneath the bridge is also insufficient for electrification.

The potential intervention options are to either reconstruct the bridge (with sufficient clearances for four-tracking and OHLE) with various combinations of track lowering and/or road level increases or to retain the existing structure (2 No. tracks) and create openings through the existing bridge wingwalls for the additional tracks. The maximum limits for road raising as well as track lowering were initially considered to be 0.9m (Approx.) in either direction. The road raising limit being set by using a combination of compliant road design standards as well as endeavouring to avoid permanent impacts to 3rd party properties. Whereas the track lowering limit is based on the depth to ground water, track drainage and rail scheme interfaces with track through Kylemore Road Bridge (OBC5A) and the Inchicore Yard. A further limitation to this track lowering limit that could result in reduction a further reduction of this limit would be its constructability as well as the potential effects on operations.

An option to replace the road bridge with a pedestrian bridge only has also been considered permanent way Options comprise realignments to provide standard clearances, both vertically and horizontally for single and 2-span bridge replacement options.

A total of 9 No. Options were initially developed for review. The Options include a 'Do-Nothing' Option and a 'Do-Minimum' Option. All Options, from Option 3 through to Option 9 (except Option 8), refer to requirements for a road bridge replacement and as such the same horizontal road realignment is proposed for these options; whereas Option 8 refers to replacement with only a pedestrian/cyclist bridge. The alignment includes for compliant cross-sectional and profile design elements for vehicular and vulnerable road users (see the **Constraints Section** for details). The realignment and raising of the road would require the demolition of the existing retaining walls, along with the CPO of a linear portion of public open space to the north of the railway corridor to accommodate the road realignment.

- 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	Description
Option 1: Do Minimum	This option endeavours to achieve the four-tracking and electrification project requirements without widening the existing rail corridor or providing additional vertical and horizontal clearances at Le Fanu Road Bridge (OBC7).
Option 2	This option proposes to make openings in the sides of the existing structure, through the wingwalls, to provide space for additional tracks without replacing the existing bridge.
Option 3	This Option proposes to replace the existing bridge with a new road bridge that would have sufficient vertical and horizontal clearances. The vertical clearance requirements would be achieved by **increasing the road levels, only**.
Option 4	This Option proposes to replace the existing bridge with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by **track lowering, only**.
Option 5	This Option proposes to replace the existing bridge 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 the road would require Departures from Standards and track lowering.
Option 6	This Option proposes to replace the existing bridge with a new road bridge that would have sufficient vertical and horizontal clearances. The vertical clearance requirements would be achieved by **sharing the level increase at the bridge between track lowering (50%) and road raising (50%).**
Option 7	This Option is similar to Option 6, however the vertical clearance requirements would be achieved through **a combination of track lowering and road raising, that is not shared evenly; where the apportionment between the limits of both has yet to be determined.**
Option 8	This Option proposes to remove the road bridge and replace it with a pedestrian and cycle friendly bridge with sufficient vertical and horizontal clearance to facilitate four-tracking and OHLE.
Option 9	This Option proposes to replace the existing bridge with a new road bridge in the form of a truss which endeavours to minimise the road level increase required. The clearance requirements would be achieved by **sharing the level increase at the bridge between track lowering and road raising; where the apportionment between the limits of both has yet to be determined.**

5.2. Options Description

This section describes the Options that have been considered. With the exception of Option 0 (Do-Nothing) and Option 1 (Do-Minimum), there are some design disciplines that have technical features that are common to all Options (e.g. OHLE and Cable & Containment). Similarly, there are technical aspects that have been considered but are determined to have no (or insignificant) bearing on the development or selection of Options. To remove repetition among the Option descriptions, these issues are addressed at the end of the Option description section. Option 3-9 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 Le Fanu Road Bridge (OBC7) would not be resolved. As such, this option would not facilitate the inclusion of the additional 2 No. tracks nor the installation of an OHLE system. The project requirements would not be achieved.

5.2.2. Option 1: Do-Minimum

This Option seeks to achieve the four-tracking and electrification by means other than bridge reconstruction with the works contained primarily within IÉ property boundary.. A review of the constraints has concluded that there are no minor interventions that by themselves alone could achieve the project requirements.

5.2.3. Option 2

The existing main span has insufficient vertical clearance for OHLE; consequently Option 2 proposes to create openings in the sides of the existing Le Fanu Road Bridge (OBC7) structure to create space for 2 No. additional tracks (1 No. on each side of the existing tracks). New buried portal structures would be constructed on the north and south approach embankments. The existing bridge would become a 3-span structure. Four tracks would be laid in this area doubling the existing 2 No. tracks at Le Fanu Road overbridge. The 2 No. central tracks would follow the existing alignment with and 1 No. new track on either side would go through the structure openings.

The new openings would require additional vertical clearance relative to the existing tracks to provide the additional headroom required for the OHLE equipment. The track lowering would also take account of the depth of the roof slabs for the new portals. Retaining walls would be required between the 2 No. additional tracks (and the 2 No. existing tracks to maintain the difference in levels required.

However, the wing wall to the north and south approach embankments are not of sufficient length to achieve the geometrical requirements of this Option. New retaining walls would be required to remove the existing cutting slopes on the approach and departures from the existing bridge. The new retaining walls would require 4.5m clearance to the edge of the new outer rail locations (or 2.5m derogated with a derailment impact loading design). There is not sufficient room to achieve the derogated clearance requirement given the existing structure dimensions. With this solution the lateral clearance to the existing bridge abutment would not be compliant with the IÉ standards (i.e. 2.5m to the abutments).

Figure 5-1 Le Fanu Road Bridge (OBC7) wingwall, south-west

Figure 5-2 Le Fanu Road Bridge (OBC7) wingwall, north-west

5.2.4. Option 3

This Option proposes to achieve four-tracking and electrification by replacing the existing bridge with a new beam-and-slab bridge. The proposed bridge would be 14.2 m in width and carry a 6.5 m wide carriageway with 3.5 m footpaths at each side. The bridge would be at a skew angle of 18 degrees (approx.).

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. To achieve a minimum acceptable contact wire height clearance, the road level at the bridge would need to be raised a minimum of 1.6m (approx.).

The existing bridge would be replaced with a new bridge with the superstructure constructed with precast prestressed concrete beams and an in-situ concrete deck slab. The horizontal clearance to both abutments and pier would be a minimum of 2.5m, and therefore the abutments and the pier would be designed for derailment impact loading.

Both single and two span bridges were considered to understand the impact that bridge span and depth of superstructure would have on the rail, road and OHLE alignments; with the two-span bridge being the worst case in terms of span length (23.1m) while the single span would be shorter (at 21.6m) but requires a greater depth of superstructure.

Roads Analysis:

- Due to regulatory design constraints on gradients governing the ability to chase back and tie into the existing road closer to the bridge, the impact of this level of road raising would be substantial in terms road works impact on adjacent lands. The extent of land impact could potentially be curtailed during the design development stage through the use of retaining walls instead of embankments.
- The road would, for the most part, have to be fully reconstructed without the opportunity for phasing works down the middle. For road raising less than 0.9m; the extent of full layer works construction could

potentially be limited to an area between Le Fanu Cul-de-Sac & Kylemore Park North junctions, with only minor works in the junctions themselves.

- However, for this option to achieve a minimum acceptable contact wire height clearance would require the works to extend down the cul-de-sac, as well as require full reconstruction of the Le Fanu Cull-de-Sac & Kylemore Park North junctions instead of a localised overlay anticipated with some other options. Even with the use of retaining walls the minimum impact to the properties north of the cul-de-sac would be:
    - the loss of internal driveway/parking to several residential properties
    - requiring steps down from a new elevated footpath to enter the plot
    - work to the utility connections of each plot. (A partial CPO of the property would make no difference to potential impact of this level increase).

Utilities Analysis:

- Any impact on roads typically would affect the utilities under the roads or adjacent footpaths/verges. There are several critical utilities (namely Water and Gas and Fibre Optics) that will require extended lengths of infrastructure relays to reach compliance with the individual utility company standards. Road junctions are typically where utilities branch off from mainlines; and correspondingly would be affected further down the connecting roads the higher the road is raised at the bridge.

Permanent Way analysis:

- Four tracks would be installed throughout. The new tracks would tie-in to the existing 4 No. tracks in close proximity to Cherry Orchard footbridge (OBC8B). To the east the tracks would tie-in to the new track alignment that is proposed for the area between Le Fanu Road and Kylemore Road bridges. The vertical level would follow the existing track levels in this Option.

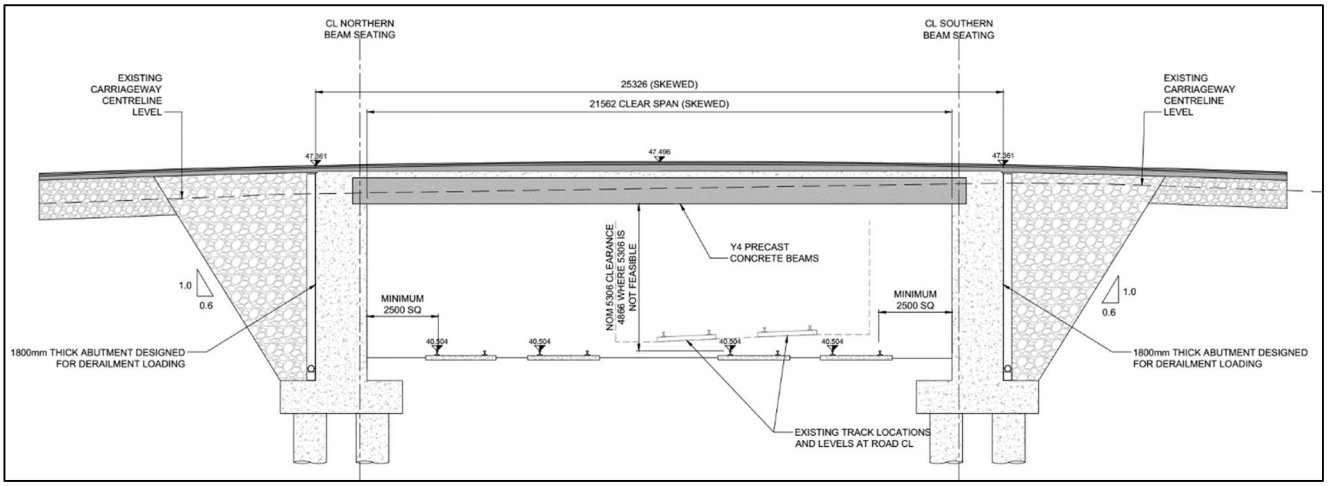

Figure 5-3 Typical Single Span Longtudinal Section

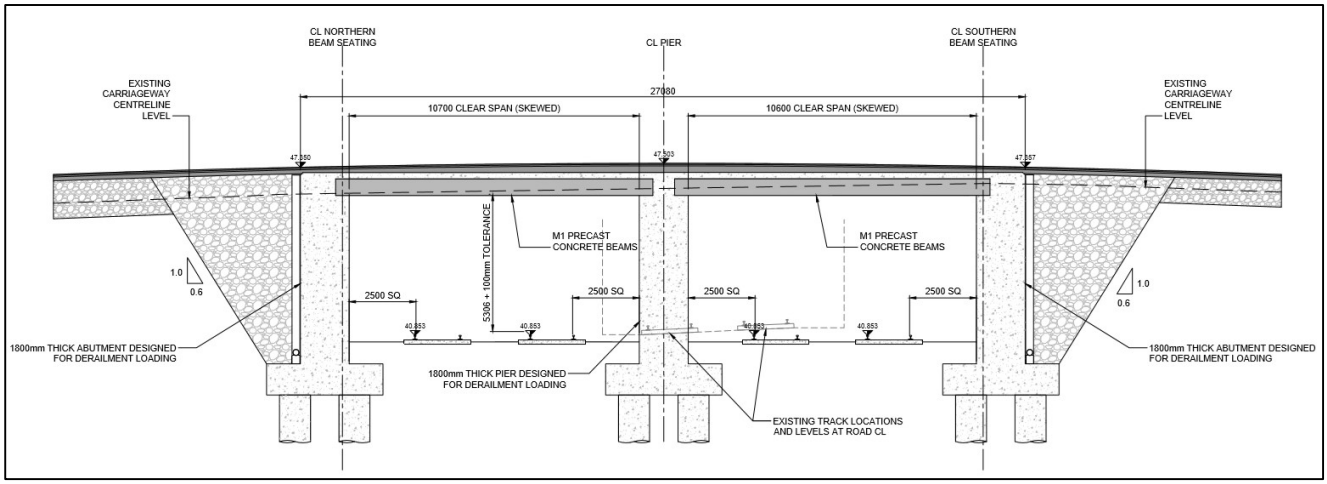

Figure 5-4 Typical two-span longitudinal section

5.2.5. Option 4

With this Option all the vertical clearance requirements would be achieved by track lowering while the road levels would be kept at their existing levels. Note that the existing bridge is an arch structure with a hump-back vertical road profile. The replacement bridge would have a flat deck and be of similar construction to Option 3.

Roads Analysis:

- Even though the bridge replacement level would result in road levels similar to that of the existing road levels, they would nevertheless not be the same for the following reasons:
    - The span of the bride would be longer than the existing, resulting in these existing roads levels being required closer to the junctions to the north and south of the bridge.
    - In addition, the removal of the skew and the reinstatement of a carriageway with compliant cross-sectional elements would require the full reconstruction of the road with road edge containment and encroachment into the public open space in particular to the north of the bridge.
- However, impact on residential plots when compared to Options 3 is eliminated. The public open space and roads would still be impacted because of the removal of the skew in the road alignment as well as the inclusion of the additional compliant cross-sectional elements for vulnerable users (combined footpath/cycletrack).

Permanent Way Analysis:

- If it were possible to achieve the track lowering levels required, then the four new tracks would be installed and tie-in to the existing 4 No. tracks in close proximity to Cherry Orchard Footbridge (OBC8B). To the east the tracks would tie-in to the new track alignment that is proposed for the area between Le Fanu Road and Kylemore Road bridges. To achieve the minimum contact wire clearance of 4.4m would require a minimum track lowering of 1.15m and potentially up to 1.95m subject to design development. Such levels of track lowering are not deemed feasible to achieve the interface tie-in with adjacent track alignments of the scheme.

5.2.6. Option 5

This Option is considers the same structural configurations as used in Options 3 &4, but the vertical clearance requirements would be achieved through a combination of track lowering and increases to road levels. The vertical clearance requirements would be achieved by increasing the road level to a point above which Departures from Standards would be required in order to still tie into the existing road while at the same time avoid permanent impact on private property driveway accesses. The This vertical increase to road level is governed by the maximum gradient allowable by the National Cycling Manual and the constraints posed by the existing side road junctions on the north side (Le Fanu Road cul-de-sac) and south side (Kylemore Park North) of the bridge, to which limited works would be proposed.

The existing bridge would be replaced with either single or two- span bridge. The superstructure would be constructed with precast prestressed and an in-situ concrete slab. The span and beam type selection also impact the level to which roads need be raised or track lowered to achieve the minimum acceptable contact wire height.

The horizontal clearance to both abutments would be a minimum of 2.5m, and therefore the abutments would need to be designed for derailment impact loading.

Roads Analysis:

- The maximum road raising level limit of 0.9m would result in limiting impact on private residential properties to footpath works and possibly nominal tie-in works to their existing driveways.
- In the main the road would have to be fully reconstructed without the opportunity for phasing works down the middle. Refer to drawing, DP-04-23-DWG-CV-TTA-60271 for the profile associated with Options 5 & 6.
- The extent of road works at the junctions of Kylemore Park North/Le Fanu roads and the Cul-de-sac with Le Fanu Road will only be fully determined by PC2.

Permanent Way Analysis:

- Four tracks would be installed throughout. The new tracks would tie-in to the existing 4 No. tracks in close proximity to Cherry Orchard Footbridge (OBC8B). To the east, the tracks would tie-in to the new track alignment that is proposed for the area between Le Fanu Road and Kylemore Road bridges. The maximum track lowering limit in order to tie-in the track configurations at Kylemore Road Bridge (OBC5A) and Inchicore Yard is 0.9m. While a minimum of 0.5m track lowering will be required to achieve the minimum contact wire clearance of 4.4m.

5.2.7. Option 6

This option is similar to Option 5 such that the bridge would be replaced, and the vertical clearance requirements would be achieved by changes to road and track levels. With this Option the additional vertical clearance required, to achieve the minimum acceptable contact wire height, would be split evenly between road level increases (50%) and track lowering (50%). For example, if an adjustment of 0.7m would be required to achieve the vertical clearance, the road would be raised by 0.35m and the tracks would be lowered by 0.35m. The same limit of 0.9m for both track lowering and road raising at Le Fanu Road Bridge (OBC7) would apply to Option. The purpose of the 50/50 was to have a clear proposal that shared the level change burden equally between IE and external parties. Option 6 is essentially a defined ratio sub-set of Option 5. As with Option 5 the superstructure would be constructed with precast prestressed concrete beams and an in-situ concrete slab.

Roads Analysis:

- As noted above, Option 6 is essentially a defined ratio sub-set of Option 5. Refer to drawing, DP-04-23-DWG-CV-TTA-60271 for the profile associated with Options 5 & 6.
- Le Fanu Road would in the main have to be fully reconstructed between Kylemore Park North and the Le Fanu Cul-De-Sac without the opportunity for phasing works down the middle due to the realignment requirements to the north and provision of the compliant footpath and cycleway cross-sectional elements throughout. However road raising requirements would be limited 0.9m and potentially reduced to 0.5m; and subject to further design development, the latter will be confirmed by PC2.

Permanent Way Analysis:

- Four tracks would be installed throughout. The new tracks would tie-in to the existing 4 No. tracks in close proximity to Cherry Orchard Footbridge (OBC8B). To the east, the tracks would tie-in to the new track alignment that is proposed for the area between Le Fanu Road and Kylemore Road bridges. The track lowering requirements would be limited 0.9m and potentially reduced to 0.6m; and subject to further design development, the latter will be confirmed by PC2.

5.2.8. Option 7

This Option proposes a specific track level provided from a historical concept design for a single span bridge. The option would require the bridge to be replaced with that similar to Option 6, with vertical clearance requirements achieved by providing changes to road and track levels. The horizontal clearance to both abutments is 2.5m min, and therefore the abutments would need to be designed for derailment impact loading. The superstructure would be constructed with precast prestressed concrete beams and an in-situ concrete slab.

Roads Analysis:

- The impact on existing roads and adjacent properties would be similar to Option 6; namely, limited impact on adjacent private property, removal of the skew and bringing into compliance the vertical and horizontal alignment design.

Permanent Way Analysis:

- If it were possible to achieve the track lowering levels required, then the four new tracks would be installed and tie-in to the existing 4 No. tracks in close proximity to Cherry Orchard Footbridge (OBC8B). To the east the tracks would tie-in to the new track alignment that is proposed for the area between Le Fanu Road and Kylemore Road. To achieve the minimum contact wire clearance of 4.4m would require the minimum track lowering of 1.43m. Such levels of track lowering are not deemed feasible for rail tie-ins to adjacent sections of the scheme.

5.2.9. Option 8

This Option proposes that the existing Le Fanu Road Bridge (OBC7) would be replaced with a new footbridge, for pedestrians and cyclists only. The existing bridge would be replaced with a single-span footbridge of of 21.6m (approx.) clear span. The horizontal clearance to both abutments would be a minimum of 2.5m, and therefore the abutments would be designed for derailment impact loading. The superstructure would be constructed with precast concrete beams.

Roads Analysis:

- The options to tie-in the pedestrian/cyclist bridge into the existing road infrastructure would be almost limitless and a least cost solution. It would result in the road closure on both sides of the tracks with the approach road being used develop ramps to achieve the necessary bridge clearance height.
- In spite of the perceived benefits to vulnerable users; the current traffic volumes at peak time along Le Fanu Road, already indicates a stressed road network. This Option consequently would not be feasible.

Utilities Analysis:

- Several critical utility infrastructure networks currently cross over the existing bridge and these would require a new permanent utility crossing bridge; or an integrated structure accommodating both the vulnerable user categories, as well as utilities.

Permanent Way Analysis:

- Four tracks would be installed throughout. The new tracks would tie-in to the existing 4 No. tracks in close proximity to Cherry Orchard Footbridge (OBC8B). To the east the tracks would tie-in to the new track alignment that is proposed for the area between Le Fanu Road and Kylemore Road bridges. The vertical level would ideally follow the existing track levels, in this Option, because the road bridge would no longer be the constraint in achieving the required clearances.

5.2.10. Option 9

This Option proposes to replace the existing bridge with a new single-span steel truss bridge of 23.4m clear span (approx.). The proposed bridge would have a width of 14.2m and support a 6.5m wide carriageway with 3.5m wide footways at each side. The horizontal clearance to both abutments would be a minimum of 2.5 m, and therefore the abutments would need to be designed for derailment impact loading.

However, a new steel structure would require 2m of clearance above the new overhead lines (to allow for future maintenance of the paint system over the OLE lines) and as such the clearance requirements are increased when compared to RC bridge options. The extent to which track lowering, as well as road raising would be required is 0.8m (approx.) greater than the 0.9m design limit currently presented for Le Fanu Road Bridge (OBC7). In addition a change of greater than 3m would be required if one of road or rail were to be changed without affecting the other.

5.3. OHLE Arrangement (All Do-Something Options)

For the Cherry Orchard Footbridge (OBC8B), the bridge is sufficiently low in its existing configuration that the OHLE will need to be fitted as it passes through, but the bridge itself cannot accommodate fitment. It will be wired using a fitted arrangement with elastic bridge arms and a contact wire height of 4.4m, with an OHLE mast placed directly next to the bridge to support the OHLE. A minimum normal clearance has been achieved. The steel structure of the bridge needs to be bonded based on bonding strategy. No track lowering or structural interventions required.

The Le Fanu Road Bridge (OBC7) is an overbridge that does not have sufficient clearance to be electrified with OHLE. Therefore, Options 0 and 1 are not feasible.

For Options that could only achieve a bridge soffit clearance to track of 4.866m, the OHLE would need to be connected to the bridge soffit at one location per track electrified track. These connections would not be visible from road level. OHLE masts are expected to be positioned 20m, 55m and 105m (approx.) from each edge of the bridge before reverting to normal spacings.

For Options that could only achieve a desirable bridge soffit clearance to track of 5.306m, the OHLE would pass through the bridge without being connected to it; the OHLE masts will be positioned away from the bridge, and wire heights and mast heights would be increased accordingly.

For Options where the minimum soffit clearance of 4.866 is achievable the OHLE configuration would be a graded contact wire, twin contact equipment (zero system height). OHLE through the bridge would be fitted, with elastic bridge arms supported from the bridge at single locations in the middle of the bridge deck. Electrical clearances will be 100mm static, and 50mm passing. Allowance would be made for 25mm of upward track movement. OHLE masts are expected to be positioned around 20m, 55m and 105m from each edge of the bridge before reverting to normal spacings.

For Options where the minimum soffit clearance of 5.306 would not be achievable but a minimum contact wire height of 4.7m could be achieved then the OHLE configuration would be wired using a free-running arrangement and so grading would be required. Electrical clearances would be 150mm static and 100mm passing, and allowance made for 100mm of upward track movement. A reduced system height would be required with 100mm minimum dropper length, and catenary would be substituted through the bridge span. OHLE masts are expected to be positioned around 25m from each outer edge of the bridge. Routing of parallel feeders would be dependent on the development of the system design, but it would either be an aerial insulated conductor or a ground-level insulated cable in a trough route.

For Option 9, the OHLE would use the same arrangements as described above, without being connected to the bridge, but catenary wire would be used through the bridge, and the wire heights and mast heights would be increased accordingly.

5.4. Permanent Way

A single Permanent Way option has been developed, with the optimum horizontal footprint to achieve the project requirement of spacing the tracks such that the interval between the pair of Slow lines on the north side and the Fast lines on the south could, in future, accommodate the construction of Kylemore Road Station. This passive provision would enable an island platform in the wide-way (ten-foot) between the Slow and Fast lines, with an additional single facing platform to the north and south extremities – servicing the Up Slow and Down Fast lines respectively. This design option complies with IÉ design standards and fulfils the speed requirements of 160km/h on the Fast lines and 110km/h on the Slow lines.

Vertically, the track alignment achieves the necessary lowering required to ensure electrical clearance at the overline structures, Kylemore Road Bridge (OBC5A) and Le Fanu Road Bridge (OBC7) respectively, with all lines on a gradient of 0.7% in this vicinity, slightly flatter than the existing 0.9%.

Table 5-2 Permanent Way Options

ID	Name	Description
Perway Option 1 ~~2~~	Three Platform Configuration for potential future Kylemore Road Station (passive provision for platforms)	The horizontal track alignment would be compatible with the passive provision required for a possible alternative platform configuration for potential future Kylemore Road Station. This Perway Option is compatible with a single span bridge reconstruction Options at Le Fanu Road Bridge (OBC7). Also, with the necessary alignment alteration, a central pier could be added. The original concept design vertical profile shows a track lowering though Le Fanu Road Bridge (OBC7) of ~~0.5m~~ 0.7m (approx.). The vertical alignment can be adjusted to comply with the required vertical clearances for electrification.

5.5. Geotech (All Do-Something Options)

All Options (excluding Option 0 and 1) propose four-tracking and electrification interventions and will require detailed geotechnical design for the following elements:

- Earthworks and track bed formation design for new tracks
- Overhead Line Equipment foundation (preliminary) design

Track lowering is proposed for Options 4 through to Option 7, as well as Option 9. Track bed design to facilitate track lowering would be required for these options. Bedrock has been indicated at a depth of 1.5m or 38.36m AOD (approx.). Options that propose significant track lowering close to anticipated bedrock levels are less desirable Options. Where insufficient clearance to bedrock is present for traditional track bed formation, a slab track may be required. The latter would result in further design complexity and cost to avoid line speed reductions, increased noise disturbance and accommodate slab track drainage.

Any new bridge or existing bridge modifications will also require detailed geotechnical design. The proposed structural elements that fall into this category include:

- New bridge abutment piles and/or bridge wingwall modifications.
- New retaining wall designs along the northern and southern boundary of the railway. The retaining walls will be required to provide the necessary horizontal width for the four-tracking. The cutting height (south) or wall height (north) would be 3m (approx.) increasing to 6m towards Le Fanu Road Bridge (OBC7). The retaining wall heights at Le Fanu Road Bridge (OBC7) would be 7m to 9m in height where the greatest level of track lowering is required. Bored pile walls are considered as suitable at this stage of design development.
- To the east and west of Le Fanu Road Bridge (OBC7), track lowering, and new permanent way alignment may require steepening of the existing earthwork profiles to allow for the new proposed permanent way level tie-ins beyond the locations of bored pile walls.

Figure 5-5 Indicative extent of retaining walls required within IE property

- Existing nearby walls, buildings, structures and earthworks may require vibration monitoring during any nearby piling works for new structures to ensure no structural damage or instability is caused.

5.6. Roads (All Intervention Options)

The constraints, as listed in the **Section** Error! Reference source not found. of this report, were used in assessing the impact of Options 3 through to Option 9. Refer to drawing DP-04-23-DWG-CV-TTA-60270 for a comparative

representation of impact in plan and profile based on increasing the road levels to achieve an acceptable contact wire clearance for a number of scenarios represented by the Options. Drawing DP-04-23-DWG-CV-TTA-60271 serves to indicatively represent the area that could potentially be impacted by the Emerging Preferred Option road interventions.

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

With the exception of Option 0, all the other Options will require the relocation of a variety of service cables, utilities and containments throughout. The existing maintenance access point east of Cherry Orchard Footbridge (OBC8B) will be maintained.

5.8. Drainage

The track formation must be completely renewed in this area, so the installation of a new drainage system is desirable. The track gradient is falling towards Inchicore and where a possible the outfall will consider discharging into the existing culvert that crosses the tracks at Sarsfield Road.

The potential exists for an alternative outfall location into a surface water pipe crossing the corridor, east of Cherry Orchard Footbridge (OBC8B). The discharge of the track drainage system into this surface water system, if required, would need to be attenuated. The requirement for and suitability of the alternative outfall and associated attenuation system will be confirmed through the design development by PC2.

Figure 5-6 Potential location of Attenuation tank within IÉ boundary.

5.9. Substations

To facilitate the introduction of the new OHLE scheme across the DART+ network, a power supply study was carried out by the DART+ West MDC. Following review of this report there is a requirement to provide 6 new substations at the following locations:

- Islandbridge

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

Also, any decision on preferred location will only be provisional until the availability of ESB supplies and the route for incoming cables is established.

The required footprint for the substation sites has been determined and based on information in the ESB Construction Standard and the DART+ Traction Power Functional Requirements the nominal land-take requirement is estimated to be 20m by 50m for the substation building and compound (including ESB substation requirements directly adjoining). The shape of the available land and its relationship to the vehicle access point will also need to be considered.

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 rail line operating in a pre-defined corridor, the options to accommodate the necessary works at some locations along the route are limited due to spatial constraints.

6.2. Stage 1 Preliminary Assessment (Sifting)

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

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

The area under consideration covers approximately 800m and extends from 50m west of the Cherry Orchard Footbridge (OBC8B) to the east of the Le Fanu Road Bridge (OBC7). A total of 9 No. Options were initially developed for this area and concept design iterations were analysed and taken into consideration as part of the initial assessment process.

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 but in a manner to minimise impact on both the private residential and commercial properties located on the northern & southern side of the existing rail corridor, respectively. Existing structures in this area were analysed to determine if they could accommodate the additional tracks and installation of the new Overhead Line Electrification (OHLE) system. The existing road network poses significant constraints in terms of achieving the project requirements of providing an additional 1 No. to 2 No. tracks, as well as 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 Sifting Process

Option	Requirements		Description
0	Engineering	Constructability	Not applicable. No intervention proposed.
		Geometrical fitness for intervention	Not applicable. No intervention proposed.
		Safety	Not applicable. No intervention proposed.
		four-tracking Park West-Heuston	FAIL. No intervention proposed. four-tracking is not achieved.
		Electrification of DART+ tracks	FAIL. No intervention proposed. Electrification of the DART+ tracks not achieved.
		Vertical electrical clearance in structures	FAIL. No intervention proposed. Vertical electrical at structures not achieved.
		Bridge Design Standards	Not applicable. No intervention proposed.
		Keep current functionality of roads	PASS. No intervention proposed.
	Economy	Compatible with the investment guidelines and programme for DART+	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.
		four-tracking Park West-Heuston	FAIL. Minor interventions only cannot achieve four-tracking.
		Electrification of DART+ tracks	FAIL. Minor interventions only cannot achieve electrification of the DART+ tracks.
		Vertical electrical clearance in structures	FAIL. Minor interventions only cannot achieve vertical electrical clearance requirements at structures.
		Bridge Design Standards	PASS. Minor interventions to the rail corridor in accordance with standards are possible.
		Keep current functionality of roads	PASS. Minor interventions to rail corridor that do not affect road functionality are possible.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No Impact
	SHORTLISTED FOR STAGE 2 MCA		FAIL
2	Engineering	Constructability	FAIL. This option is not feasible due to the geometry of the existing structure and design standard requirements.
		Geometrical fitness for intervention	FAIL. This option does not permit a feasible Perway design in accordance with design standards.
		Safety	FAIL. Minimum requirements for (derogated) horizontal clearances to structures would not be achieved.
		four-tracking Park West-Heuston	PASS. This option would achieve four-tracking (but is not constructible).
		Electrification of DART+ tracks	PASS. This option would achieve electrification of DART+ tracks (but is not constructible).

Option	Requirements		Description
		Vertical electrical clearance in structures	PASS. This option would achieve electrical clearance in structures (but is not constructible).
		Bridge Design Standards	FAIL. Option would not be in accordance with design standards.
		Keep current functionality of roads	PASS. Current road functionality maintained.
	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. No issues.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Pass with derogations to horizontal clearance to abutments (and pier).
		Keep current functionality of roads	FAIL. This Option would require a minimum road level increase at the bridge of 1.1m. This road level increase at OBC7 would require extensive works to the junctions on the north and south side. The vertical profile of the road would not be in accordance with design standards. The vertical gradients would not be in accordance with the National Cycle Manual. The road embankment on the north side would block entrances to residences north of the cul-de-sac. It is not compatible with existing geometry at private entrances.
	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**
4	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	FAIL. This Option would require a minimum track lowering of 1.1m. This level of track lowering is not feasible at Le Fanu Road.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. Current road functionality maintained.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No Impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**

Option	Requirements		Description
5	Engineering	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This Option would require a minimum track lowering of 0.2m.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. This Option would require a maximum road level increase of 0.90m at the bridge. It would require extensive works but is considered feasible.
	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	Engineering	Constructability	PASS. This Option would be difficult to construct in terms of gradient and longitudinal drainage, but it is considered feasible.
		Geometrical fitness for intervention	PASS. This Option would require a minimum track lowering of 0.6m.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. Current road functionality maintained. This Option would require a road level increase of 0.9m.
	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**
7	Engineering	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	FAIL. This would require a minimum track lowering of 1.4m. This level of track lowering is not feasible at Le Fanu Road.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. This would require a minimum road level increase of 0.8m.
	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**
8	**Engineering**	Constructability	PASS. No issues.
		Geometrical fitness for intervention	PASS. No issues.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures.
		Bridge Design Standards	PASS. Option is in accordance with standards.
		Keep current functionality of roads	FAIL. Road functionality is not maintained.
	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**
9	**Engineering**	Constructability	PASS.
		Geometrical fitness for intervention	FAIL. This Option would require a minimum track lowering of 1.73m. This level of track lowering is not feasible at Le Fanu Road.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures.
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	FAIL. This option would require a minimum road level increase of 1.73m. This is not feasible at Le Fanu Road and would not maintain the functionality of existing road.
	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**

6.4. Preliminary Assessment Summary

A total of 9 No. Options were developed for the area from Cherry Orchard Footbridge (OBC8B) to the east of Le Fanu Road Bridge (OBC7). Following the assessment completed as part of the Sifting Process (as shown in the **Table 6-2** below), a total of 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	Sifting Process Result
Option 2	FAIL
Option 3	FAIL
Option 4	FAIL
Option 5	PASS
Option 6	PASS
Option 7	FAIL
Option 8	FAIL
Option 9	FAIL

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 four tracks or the installation of the OHLE system. The project requirements would not be achieved as such this option was not brought forward.
- **Option 1** - This Option seeks to achieve the four-tracking and electrification by means of minor interventions only. A review of the constraints has concluded that there are no minor interventions that by themselves alone could achieve the project requirements.
- **Option 2** - proposes creating openings in the sides of the existing Le Fanu Road Bridge (OBC7) structure to create space for 2 No. additional tracks (1 No. on each side of the existing tracks). New buried portal structures would be constructed on the north and south approach embankments. The existing bridge would become a 3-span structure. Track clearance requirements for OHLE preclude this from being feasible; resulting anyway in the full reconstruction of the central bridge area to achieve OHLE clearances due to track lowering constraints and worsening the impact on properties either side of the bridge due to the addition track widening.
- **Option 3** - proposes to achieve four-tracking and electrification by replacing the existing bridge with a new beam-and-slab bridge. The proposed bridge would be 14.2 m in width and carry a 6.5 m wide carriageway with 3.5 m footpaths at each side. The bridge would be at a skew angle of 18 degrees (approx.). This option considered all the clearance being achieved through road raising of 1.966m. This would have resulted in the loss of driveway access for up to 20 properties north of the Perway corridor and the commercial/industrial units to the south of the tracks (adjacent to junction with Kylemore Park North). In addition, all these plot boundary walls would revert to retaining walls.
- **Option 4** - This Option is the same as Option 3 but all the vertical clearance requirements would be achieved by track lowering while the road levels would be kept at their existing levels.
- **Option 7** - is similar to Option 6 such that the bridge is replaced, and the vertical clearance requirements would be achieved by changes to road and track levels. In this Option the additional vertical clearance required is split between road level increases and track lowering but not evenly. Unfortunately, the track lowering was in the order of 1.4m which was deemed unachievable based track gradients required to tie-into the Inchicore works.
- **Option 8** - proposes that the existing Le Fanu Road Bridge (OBC7) would be replaced with a new footbridge, for pedestrians and cyclists only. This was a 'blue sky' proposal prior to receiving traffic data for the area. During a stakeholder consultation meeting held with Dublin City Council (DCC), DCC officials that traffic count data would confirm that the permanent closure of Le Fanu Road Bridge (OBC07) to vehicular traffic would not be feasible. TTAJV were able to validate the DCC assumptions, after it was

provided with BusConnects traffic count and loop data for a number of junctions pertinent to DART+ South West project.

- **Option 9** – proposes to replace the existing bridge with a new truss bridge. The proposed bridge would have a width of 14.2m and support a 6.5m wide carriageway with 3.5m wide footways at each side. It is envisaged that this form of structure would 'do the work' above road level. However, a new steel structure would require 2m of clearance above the new overhead lines and as such the clearance requirements are increased compared to RC bridge options. The road level increasing and/or track lowering requirements for all manner of permutations were not considered feasible considering the previous assertions for other options.

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

Option 5 and Option 6 propose to achieve four-tracking and electrification by replacing the existing bridge with a new beam-and-slab bridge. Vertical clearance requirements would be achieved by a combination of track lowering and increases to road levels. The difference between the two options lies on the methodology used for adjusting the road and track levels:

- **Option 5** – This option involves the reconstruction of the Le Fanu Road Bridge (OBC7), replacing it with a larger span and higher structure and removing the skew. This option proposes increasing the road level at the bridge to a limit (0.9m), above which road Departures from Standards would be required in order to tie back into the existing road early enough in order to limit permanent impact on private properties. An additional requirement would be to lower the track levels as needed to achieve the additional required vertical clearance. The removal of the skew also results in the requirement to realign the approach roads and in so doing necessitates that the new alignment include compliant cross-sectional elements for vulnerable user groups (pedestrians, cyclists etc.).
- **Option 6** – This option involves the reconstruction of the Le Fanu Road Bridge (OBC7), replacing it with a larger span and higher structure and removing the skew. This option proposes splitting the required level changes 50/50 between track lowering and road raising to achieve the required OHLE clearances.

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 Le Fanu Road Bridge (OBC7) 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 Le Fanu Road Bridge (OBC7), 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 B.

Table 6-4 MCA summary

CAF Parameters	Option 5 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**

Option 5 is identified as the Emerging Preferred Option, while Option 6 remains a potential design iteration of Option 5. Drawings DE-04-23-DWG-ENG-ST-TTA-60915 to 60918 identify the representative bridge for Option 5.

Economy:

In terms of the Economic criteria, there is no comparative advantage or disadvantage between both options.
.***In terms of Economy, both options are identified as comparative.***

Integration:

In terms of the Integration criteria, there is no comparative advantage or disadvantage between both options. Neither Option 5 nor 6 allow for phased construction to allow for uninterrupted use of the bridges; and both would require temporary traffic diversions resulting from the need to close bridge and immediate approach roads.
In terms of Integration, both options are identified as comparative.

Environment:

In terms of the Environmental criteria, there is no comparative advantage or disadvantage between both options.
In terms of Environment, both options are identified as comparative.

Accessibility and Social Inclusion:

In terms of Accessibility and Social Inclusion, there is no comparative advantage or disadvantage between the options.
In terms of Accessibility and Social Inclusion, both options are identified as comparative.

Safety:

In terms of Safety, there is no distinct comparative advantage or disadvantage between both options with both providing an improved road user journey (greater sight distances), reduction in the 'humpback' experience, and provision of a combined footpath/cycletrack on both sides of the road (segregated from the vehicular lanes).
In terms of Safety, both options are identified as comparative.

Physical Activity:

In terms of Physical Activity, there is no comparative advantage or disadvantage between both options.
In terms of Physical Activity, both options are identified as comparative.

6.7. Emerging Preferred Option

There were significant challenges and constraints on the options available to achieve the project requirements in this area. Primarily these were the existing junctions and plot accesses located close to the Le Fanu Road Bridge (OBC7), both to the north and south of the bridge. 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.

The existing skew of the bridge is problematic from a safety and traffic flow perspective. As the bridge would need to be reconstructed anyway, the realignment of the same as well as the widening of the approaches to improve the flow and safety will benefit all users. Reinstating a bridge by providing for the additional road cross-sectional elements to current standards was deemed desirable.

The Emerging Preferred Option involves the reconstruction of the Le Fanu Road Bridge (OBC7), replacing it with a larger span and higher structure to facilitate the additional width required for the additional tracks and removing the skew. To overcome the lack of height available for the electrification infrastructure, the road level will be raised in combination with lowering the rail track. Retaining walls are required to the north and south of the corridor adjacent to the new bridge to allow the widening of the corridor while minimising the impact on the adjacent

properties. The raising of the road level will also mean that retaining walls will be required along the road to the north of the railway.

The proposed replacement bridge will be a modern structure that will segregate vulnerable users from vehicular traffic as well as remove of the skew which currently provides restrictive sightline, both will provide a significant improvement on the existing situation. In terms of utility diversions there is no substantial difference between this emerging preferred option and the other options owing to the nature of the road widening and raising that will occur to improve the geometrics and provide the necessary OHLE clearances.

Signalling, Telecommunications and Low Voltage cable containments would be moved to new positions. OHLE masts would be installed along the north side of the rail corridor. OHLE equipment would be fitted to the new OBC7 to allow for continuous electrification through the structure.

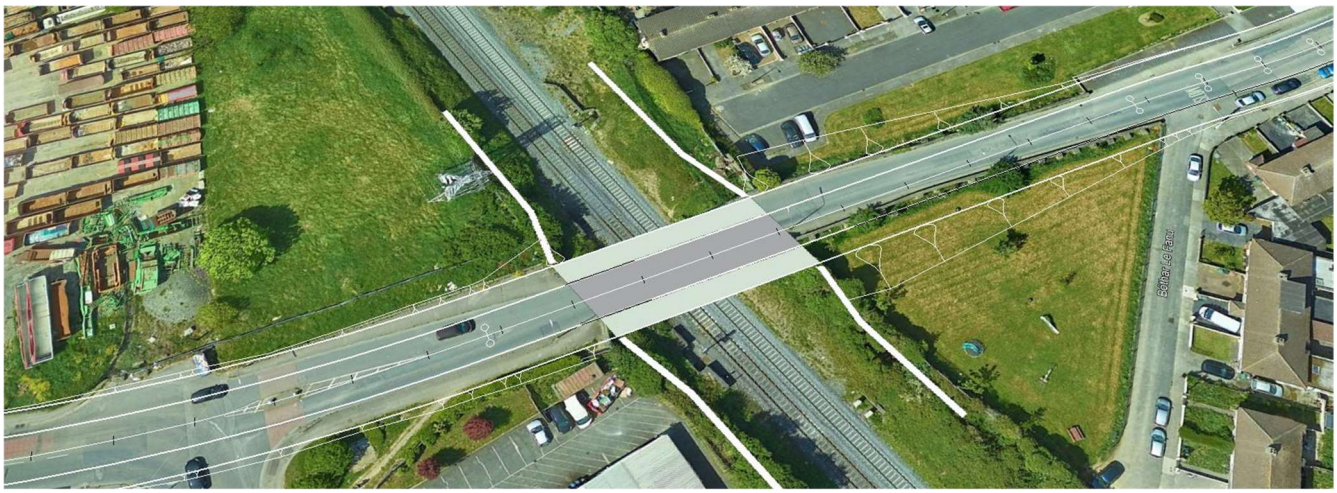

Figure 6-1 Emerging Preferred Option - Indicative Road Embankments of Option 5

The opportunities for allowing uninterrupted flow of public vehicular access over the bridge during construction of the bridge and approach roads is not possible or at best limited. The entire bridge and its approaches require closure to raise the road and reconstruct the new bridge. This Option would provide the optimum solution in terms of minimising traffic disruption. The aim would be to formally divert traffic to Le Fanu Road Bridge (OBC7) via Kylemore Park North (northbound) and via Kylemore Avenue and Ballyfermot Roads (southbound), LDVs and HGVs respectively for the latter, in order to cross over the rail corridor during the intervention.

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 for this area:

Bridge Drawings

DE-04-23-DWG-ENG-ST-TTA-60915

DE-04-23-DWG-ENG-ST-TTA-60916

DE-04-23-DWG-ENG-ST-TTA-60917

DE-04-23-DWG-ENG-ST-TTA-60918

Roads Drawings

DP-04-23-DWG-CV-TTA-60270

DP-04-23-DWG-CV-TTA-60271

Permanent Way Drawings

DP-04-23-DWG-PW-TTA-60750