DART+ South West

Volume 3B – Technical Optioneering Report – Park West to Le Fanu Road Bridge

Iarnród Éireann

November 2021

Contents

Tables

Figures

Glossary of Terms

Reference	Description
ABP	An Bord Pleanála
ACA	Architectural Conservation Area
AOD	Above Ordnance Datum
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
CIÉ	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
CSS	Construction Support Site, Interchangeable with Construction Compound

Reference	Description
CTC	Central Traffic Control
Cutting	A railway in cutting means the rail level is below the surrounding ground level.
D&B	Design & Build (contractor)
DART	Dublin Area Rapid Transit (IÉ's Electrified Network)
DART+	DART Expansion Programme
DeBo	Designated Body
DC	Direct Current, 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

Reference	Description
HAZID	Hazard Identification
Horizontal Clearance	The horizontal distance between a bridge support and the nearest railway track is referred to as horizontal clearance. Bridge supports include abutments (at the ends of the bridge) and piers (at intermediate locations).
HV	High Voltage
IA	Independent Assessor
IÉ	Iarnród Éireann
IM	Infrastructure Manager (IÉ)
IMSAP	Infrastructure Manager Safety Approval Panel
Insulators	Components that separate electricity live parts of the OHLE from other structural elements and the earth. Traditionally ceramic, today they are often synthetic materials.
KCC	Kildare County Council
Lateral Clearance	Clearances between trains and structures.
LCA	Landscape Character Area
Mast	Trackside column, normally steel that supports the OHLE.
MCA	Multi-criteria Analysis
MDC	Multi-disciplinary Consultant
MEP	Mechanical electrical and plumbing
MFD	Major Feeding Diagram
MMDC	Maynooth Multi-disciplinary Consultant
MV	Medium Voltage
NDC	National Biodiversity Data Centre
NIAH	National Inventory of Architectural Heritage
NoBo	Notified Body
NTA	National Transport Authority
OHLE	Overhead Line Equipment
Overbridge (OB)	A bridge that allows traffic to pass over a road, river, railway etc.
P&C	Points and Crossings
Pantograph	The device on top of the train that collects electric current from the contact wire to power the train.

Reference	Description
PC	Public Consultation
Permanent Way	A term used to describe the track or railway corridor and includes all ancillary installations such as rails, sleepers, ballast as well as lineside retaining walls, fencing and signage.
POAP	Plan-On-A-Page, high-level emerging programme
PPT	Phoenix Park Tunnel
PRS	Project Requirement Specification
PSCS	Project Supervisor Construction Stage
PSDP	Project Supervisor Design Process
PSP	Primary Supply Points
QA/QC	Quality Assurance/Quality Control
RAM	Reliability, Availability, Maintainability
RC	Reinforced Concrete
Re-signalling	Re-signalling of train lines will regulate the sage movement of trains and increase the capacity of train services along the route.
RMP	Record of Monuments and Places
RO	Railway Order
RPS	Record of Protected Structures
RSC-G	Railway Safety Commission Guideline
RU	Railway Undertaking (IÉ)
SAM	Safety Assurance Manager
SAP	Safety Approval Panel
SDCC	South Dublin County Council
SDZ	Strategic Development Zone
SET	Signalling, Electrical and Telecommunications
Sidings	A siding is a short stretch of railway track used to store rolling stock or enable trains on the same line to pass
SMR	Sites and Monuments Records
SMS	IÉ Safety Management System
STC	Single Track Cantilever

Reference	Description
TII	Transport Infrastructure Ireland
TMS	Train Management System
TPH	Trains per Hour
TPHPD	Trains per Hour per Direction
TPS	Train Protection System
Track Alignment	Refers to the direction and position given to the centre line of the railway track on the ground in the horizontal and vertical planes. Horizontal alignment means the direction of the railway track in the plan including the straight path and the curves it follows.
TSI	Technical Specifications for Interoperability
TSS	Train Service Specification
TTAJV	TYPSA, TUC RAIL and ATKINS Design Joint Venture (also referred to as TTA)
TTC	Two Track Cantilever
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 Option Selection Report to inform Public Consultation No. 2 (PC2). This report shows the options considered as part of the project development and why the 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 (OHLE)
- Environment
- Highways
- Geotechnical
- Construction Compounds

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 leading to the identification of the Preferred Option, including the Sifting process and the Multi-Criteria Analysis process.
- A summary of the feedback received from the first public consultation which was held in May and June 2021.
- An update on the design development.
- An overview of the proposed construction methodology and requirements in terms of construction compounds.

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.

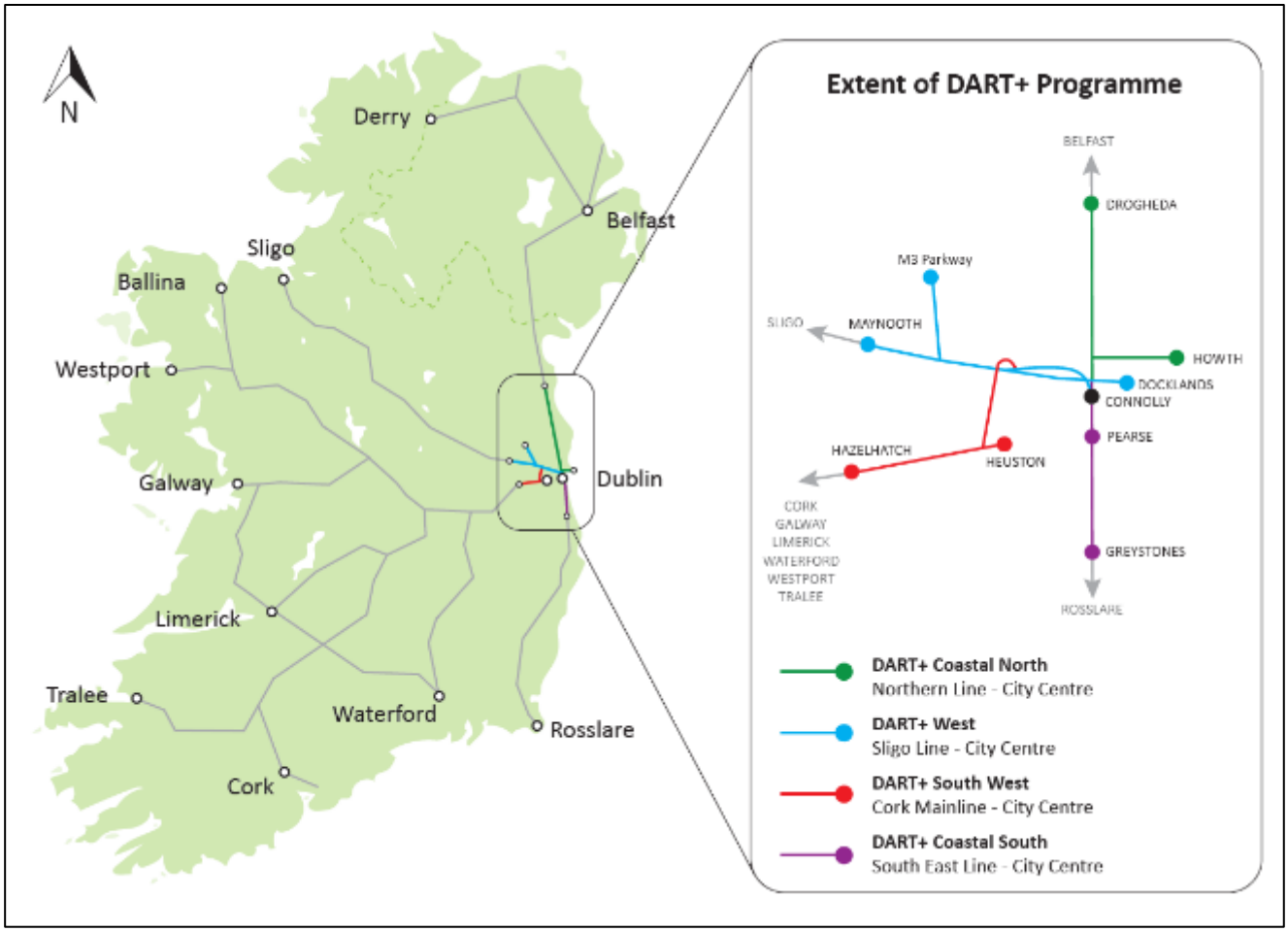


Figure 1-1 Schematic of Overall DART+ Programme

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 and Heuston Station and also circa 4km between Heuston Station and Glasnevin Junction, 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 2021-2030 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.

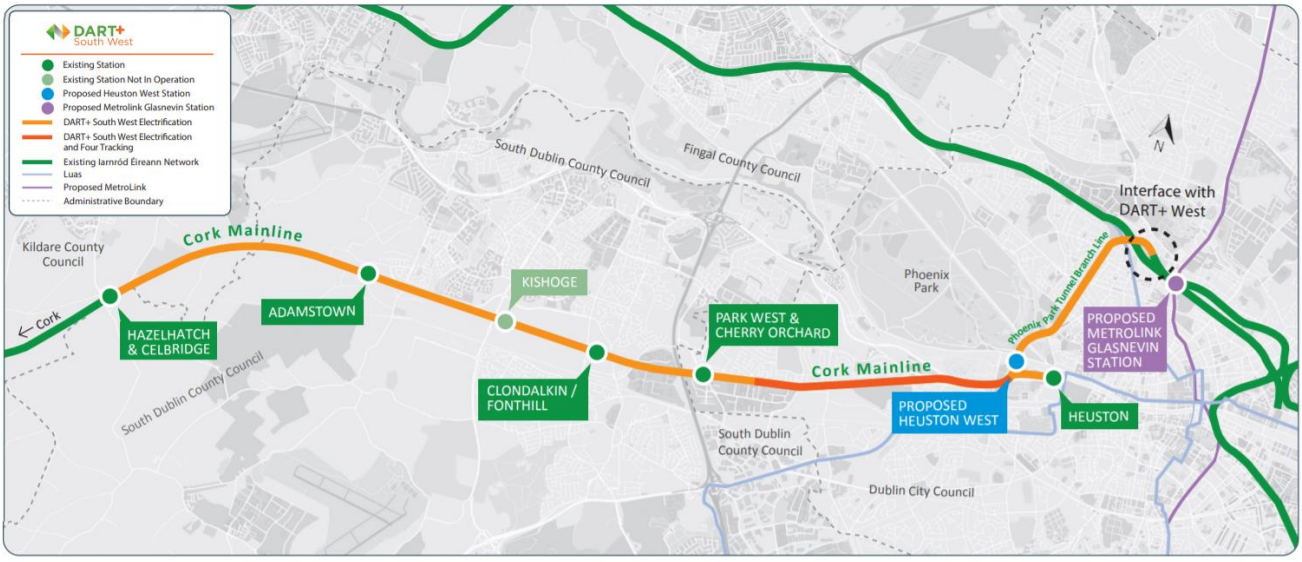


Figure 1-2 DART+ South West Route Map

1.4. Capacity Improvements 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 Junction, via the Phoenix Park Tunnel Branch Line, where it will link with the proposed DART+ West.
- Undertaking improvements / interventions of bridges to achieve vertical and horizontal clearances.
- Remove rail constraints along the Phoenix Park Tunnel Branch Line.
- Delivery of a new Heuston West Station

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

1.6. Route Description

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

Table 1-1 Route Breakdown

Area Name	Sub-area Description	Extents	Main Features
Hazelhatch to Park West	Area from Hazelhatch to Park West (Volume 3A)	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
Park West to Heuston Station	Area from Park West to Le Fanu (Volume 3B)	West of Cherry Orchard Footbridge (OBC8B) to the East of the proposed Le Fanu Road Bridge (OBC7)	Cherry Orchard Footbridge (OBC8B) Le Fanu Road Bridge (OBC7)
	Area from Le Fanu to Kylemore (Volume 3C)	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 Name	Sub-area Description	Extents	Main Features
	Area from Kylemore to Sarsfield (Volume 3D)	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 Footbridge (OBC5)
	Area from Sarsfield to Memorial (Volume 3E)	West of Sarsfield Road Bridge (UBC4) to the West of Memorial Road Bridge (OBC3)	Sarsfield Road Bridge (UBC4)
	Memorial Road (Volume 3F)	Area around Memorial Road Bridge	Memorial Road Bridge (OBC3)
	Area from Memorial Road to South Circular Road Junction (Volume 3G)	East of Memorial Road Bridge (OBC3) to 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 (Volume 3H)	Area at the South side of the Heuston Station Yard (non-DART+ tracks)	Heuston Station Sidings around Heuston Station
Heuston West Station	New Heuston West Station (Volume 3I)	Area to the West of Heuston Station, adjacent to Liffey Bridge (UBO1)	Heuston West Station
St John's Road Bridge (Islandbridge) to Glasnevin Junction	East of St John's Road Bridge (OBC0A) (Islandbridge) to North of Phoenix Park Tunnel (Volume 3J)	East of St John's Road Bridge (OBC0A) (Islandbridge) to North of Phoenix Park Tunnel	Liffey Bridge (UBO1). Conyngham Road Bridge (OBO2) Phoenix Park Tunnel
St John's Road Bridge to Glasnevin Junction	North of the Phoenix Park Tunnel to Glasnevin Junction (Volume 3K)	North 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)

Area Name	Sub-area Description	Extents	Main Features
			Royal Canal and LUAS Twin Arches (OBO8) Maynooth Line Twin Arch (OBO9) Glasnevin Cemetery Road Bridge (OBO10)

1.7. Stakeholder Feedback

A large volume of stakeholder submissions were received during the six week public consultation period, which ran from 12th May 2021 to 23rd June 2021, an additional week was provided, extending the consultation period until 30th June 2021. All submissions received either via email, post, telephone, or through the online feedback form, were analysed and recorded by the project team on a dedicated consultation database. Each individual submission was analysed to identify the themes that were raised by the respondent and each submission was classified according to the themes raised. All feedback provided, was then anonymised before being analysed under each of the themes. In addition, further engagement with relevant local authorities and prescribed stakeholders has been ongoing. Engagement with potentially affected landowners has also taken place since the commencement of PC1..

All submissions received as part of the first round of public consultation have fed into the design process and the selection of the Preferred Option. The project team has analysed the submissions and considered all relevant information in re-evaluation and further development of design options leading to the selection of the Preferred Option.

With regard to the segment of the railway line between Park West and Le Fanu the majority of submissions were based on issues regarding Le Fanu Bridge.

Stakeholder feedback noted using large amounts of concrete is not visually appealing and will result in the removal of green spaces and trees around the Le Fanu bridge area. It was specifically stated that pre-casting concrete may be cheaper and suitable for motorways but should be reconsidered for residential areas. Submissions also had specific queries on how much space was required for the bridge improvements and if the bridge would move closer to the homes in the area.

Stakeholders also expressed concerns about on the retaining embankments to support bridge abutments encrocahing on open space and conttibuting to anti-social behaviour and asked the designers and engineers to reconsider the impact of the bridge development on the surrounding area not solely on the bridge.

Stakeholder submissions stated the bottle neck of trains that currently exists near Cherry Orchard as the lines are shared with intercity services. It was further noted that this issue should be resolved and suggested that four tracking all the way to Heuston Station may help relieve the pressure around the area. Completion of four-tracking from Park West & Cherry Orchard Station to Heuston Station is a core objective of DART + South West.

A number of submissions noted the development of new stations between Cherry Orchard and Glasnevin should be considered as part of this project.

Further details of the Stakeholder Feedback are captured in the **Public Consultation No. 1: Findings Report, Volume 4**.

Similarly, all feedback received on the Preferred Option at Public Consultation No.2 will feed into the development of the preliminary design, Railway Order and Environmental Impact Assessment Report (EIAR).

2. Existing Situation

2.1. Overview

This section extends from east of Park West & Cherry Orchard Station to 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**.

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.

The requirement to provide Construction compounds along the project limits represents a challenge given the urban environment along the route. The urban environment and the requirement to minimise disruption to rail services also results in challenges in terms of the proposed construction methodologies.

2.3. Structures

2.3.1. 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 4.988m, according to latest topography survey measurement. 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 2-2 Cherry Orchard Footbridge (OBC8B) - east elevation

2.3.2. 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 2-3 Le Fanu Road Bridge (OBC7) - west elevation

2.3.3. Retaining Walls

There are 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.**

There are further 2 No. retaining structures adjacent to the south abutment of Le Fanu Road Bridge (OBC7), refer to **Figure 2-4.** 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.

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.

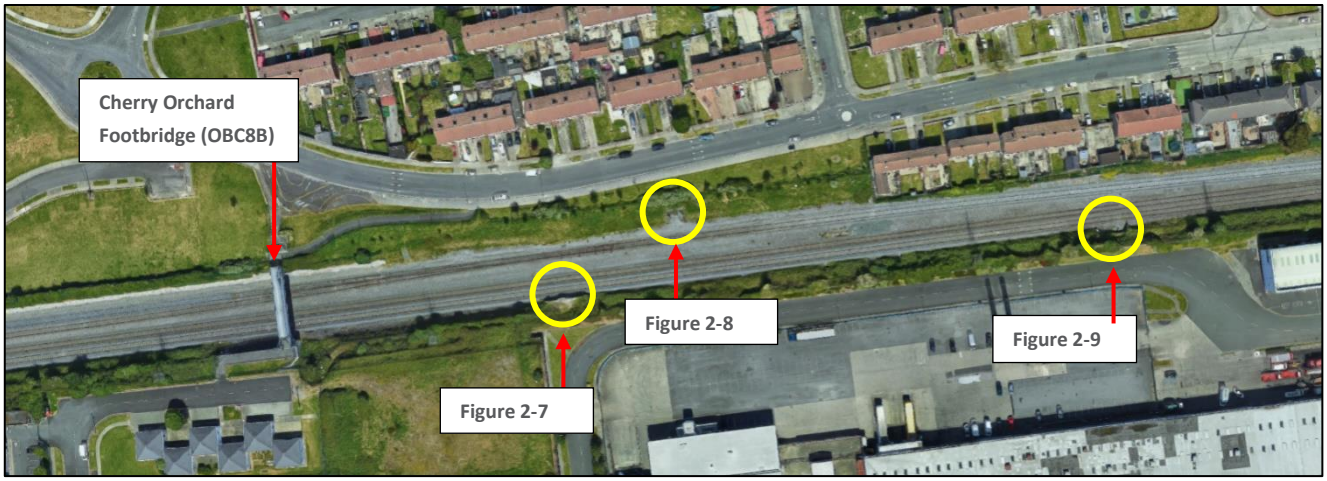


Figure 2-6 Minor retaining structure locations identified in the western half of the area.

Figure 2-7 Masonry retaining wall (possibly a partially defunct bridge abutment)

Figure 2-8 Blockwork Headwall and Fencing - Facing East

Figure 2-9 Blockwork Headwall - Facing East

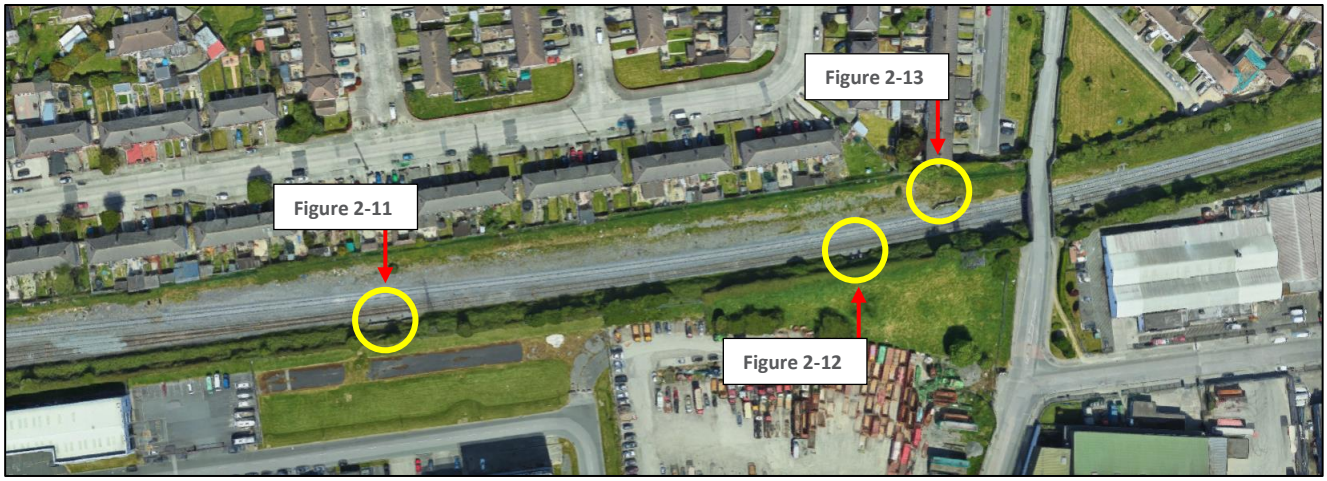


Figure 2-10 Aerial view to the east of section with minor retaining structure locations identified

Figure 2-11 Gabion retaining wall along southern edge of cess.

Figure 2-12 RC retaining wall east of Le Fanu Road Bridge (OBC7)

Figure 2-13 Blockwork headwall east of Le Fanu Road Bridge (OBC7)

2.4. Permanent Way and Tracks

The section commences to the east of Park West & Cherry Orchard Station, comprising 4 tracks. The 2 outer Fast tracks are used for intercity and freight services while the 2 inner Slow tracks are normally used for suburban services (i.e. stopping trains). The existing track layout is represented in **Figure 2-14** showing the area below.

The 4 No. tracks converge into 3 No. tracks at Points 802 and again down to 2 No. tracks at Points 801; all to the west of Le Fanu Road Bridge (OBC7). The resulting 2 No. tracks are named as Up Main and Down Main. The maximum speed through the area is 90mph (145kph). 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 (approximately) and as such there is insufficient room to install a continuous walkway or provide a position of safety.

The existing track gradient from west to east (i.e. towards Kylemore Road) is at a gradient of 0.90% (approximately). The track is a ballast track with concrete monobloc sleepers and 54E1 rails. The turnouts are on concrete bearers, as illustrated in the figure below.

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

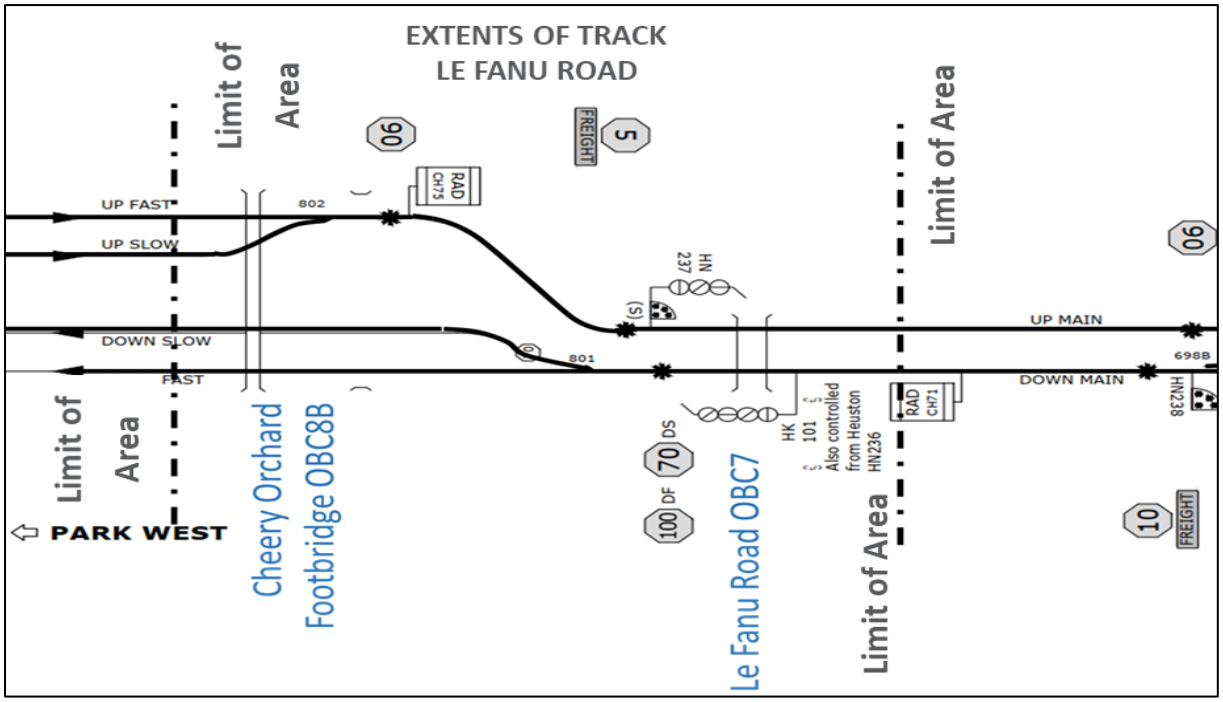


Figure 2-15 Track diagram showing the area

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.

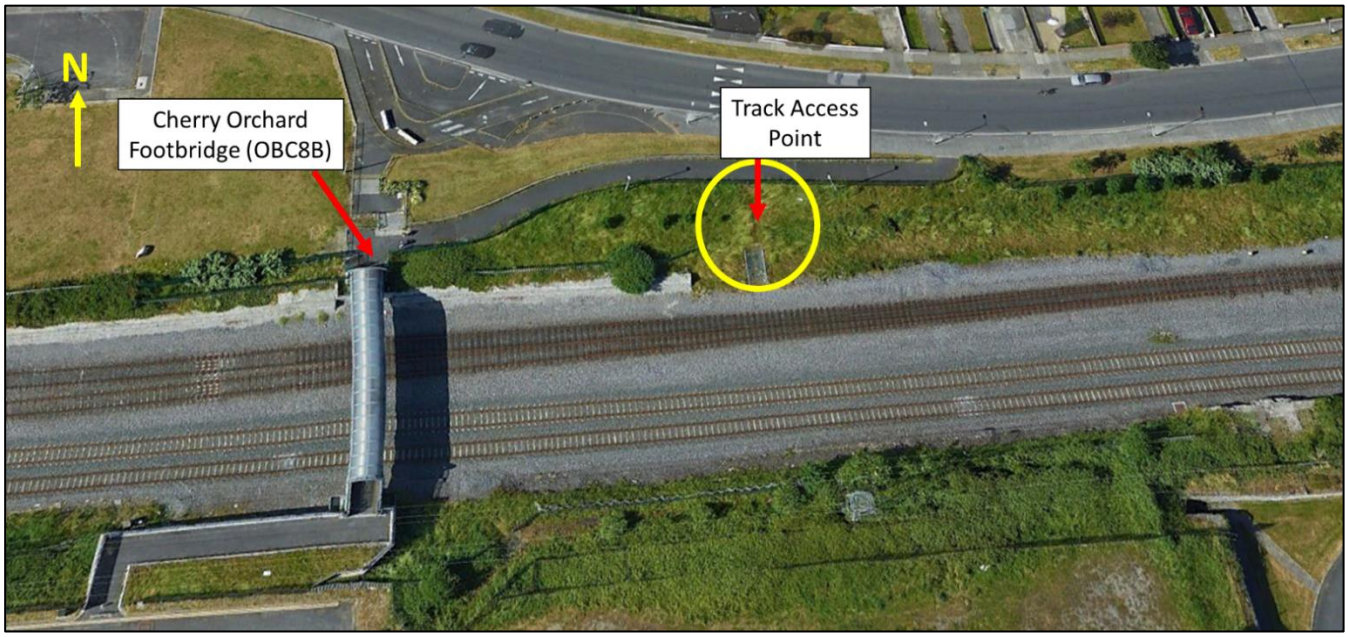


Figure 2-16 Track access point on the east side of Cherry Orchard Footbridge (OBC8B)

2.6. Road Network

Le Fanu Road, between the unsignalised Kylemore Park North and the Le Fanu Road (cul-de-sac) junctions, comprises a two-lane single carriageway road. The lane widths are variable as they taper on both approaches to its crossing of 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 half 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**.

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

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.

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).

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.

A Ground Investigation is currently ongoing to verify the ground conditions outlined above which is based on historical investigations.

2.8. Environment

The key environmental constraints relate to the proximity of residential and commercial properties to the rail corridor. The area to the south of the corridor is predominantly commercial/industrial and includes the IPCC licensed facility at Thornton's Recycling. On the north side of the existing corridor, there are significant residential properties along Le Fanu Drive, Cloverhill Road and Cherry Orchard Avenue. There are limited biodiversity features identified in the area; however, evidence of invasive alien 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 Record of Monuments and Places (RMP) sites are recorded in the southeast corner of the 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 on the DCC Record of Protected Structures (RPS) or listed on the National Inventory of Architectural Heritage (NIAH)

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 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.

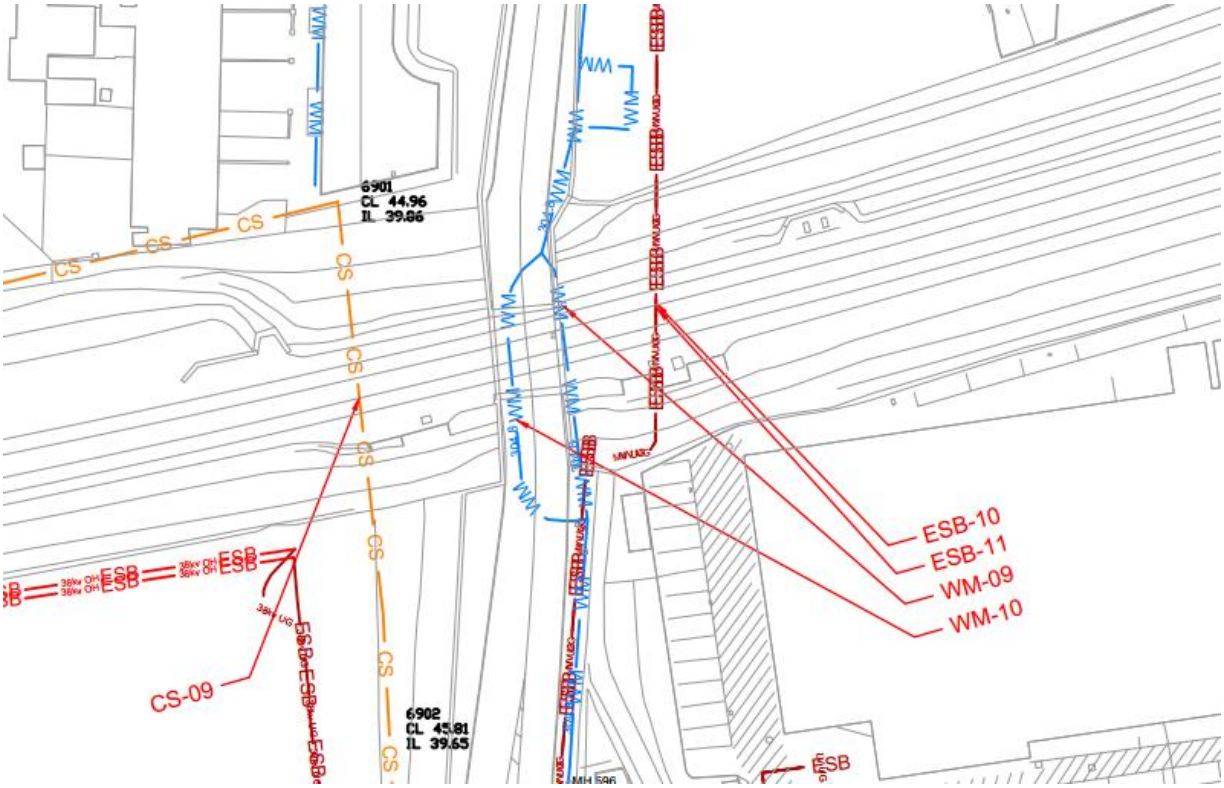


Figure 2-18 Existing utilities crossing the rail corridor at Le Fanu Road Bridge (OBC7)

3. Project Requirements

3.1. Area - Specific Requirements

In addition to the general feasibility requirements of constructability, general fitness for intervention and safety, the specific requirements for this area are:

- 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 and services/utilities (electricity, gas, water, etc.).
- A single span bridge is to be considered as the preferred option; (multi-span bridges are typically a requirement at stations or for complex track arrangements).

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. It is proposed 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 equipment rooms, including Relocatable Equipment Buildings (REB) 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+ Programme will adopt a 1,500V DC (Direct Current) OHLE system to provide electrical power to the network’s new electric train fleet.

OHLE diagrams in this report are for visual information only. Construction details will be determined during Detail Design, which will be developed at later stages of the project, which will be developed at later stages of the project.

The OHLE concept comprises a simple (2-wire) auto-tensioned system, supported on galvanised steel support structures. See **Figure 3-1** for a typical OHLE arrangement in four track open route.

In the four track areas, Two Track Cantilevers (TTCs) will generally be placed on the north side of the line, to support OHLE on the northern two tracks. The project aims to achieve a minimum contact wire height of 4.4m

throughout to ensure compliance with the relevant design standards, localised special conditions may be required.

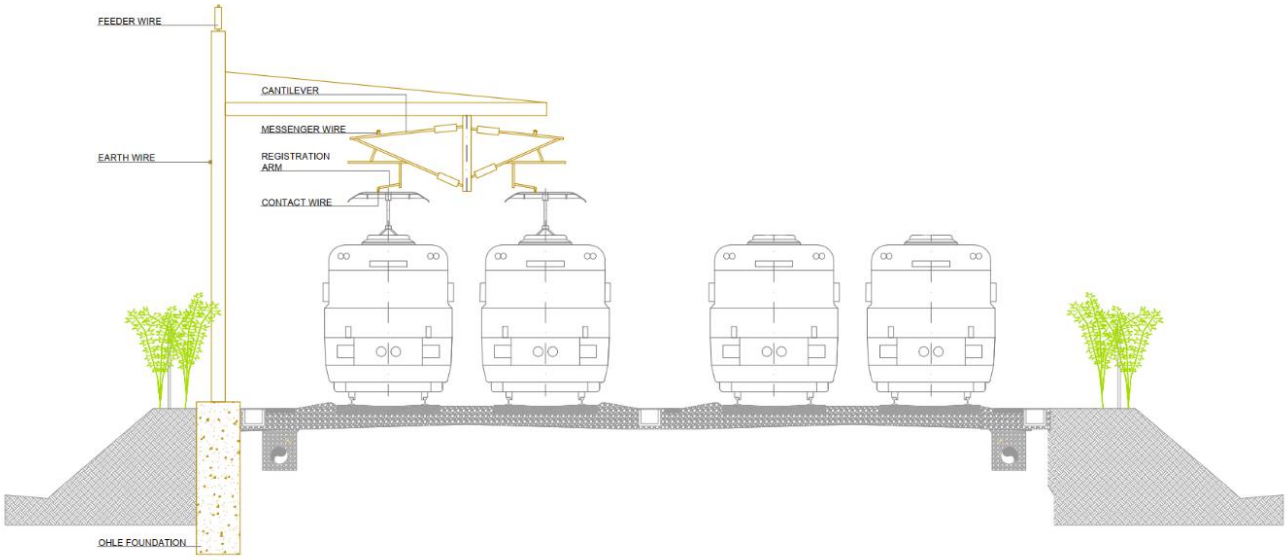


Figure 3-1 Typical OHLE arrangement in four track open route – Facing East.

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. 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. See **Figure 3-2** for a typical anchor structure.

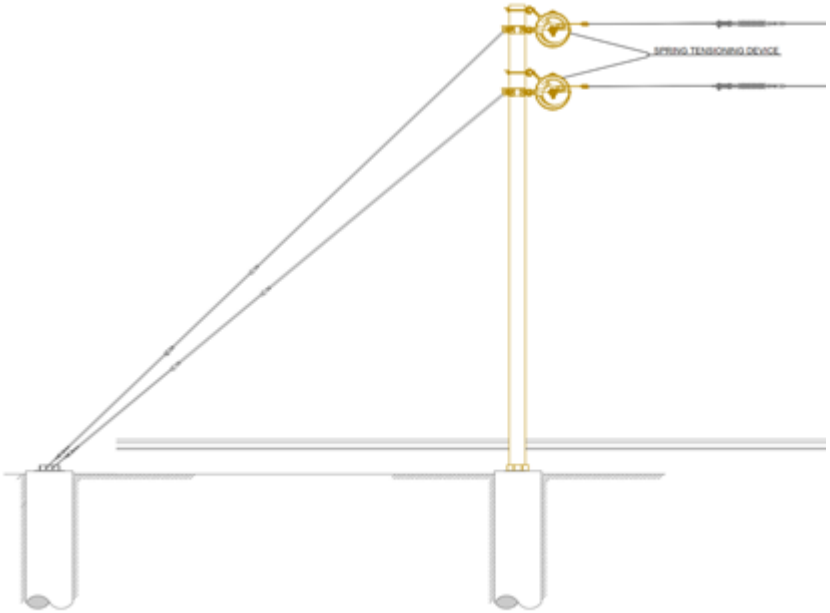


Figure 3-2 Typical anchor structure

The OHLE configuration through the overbridges for each track have been assessed using a clearance assessment tool derived from the System Wide Functional Requirement Specification (FRS) relating to Overhead Line Equipment (OHLE) and a set of configurations agreed with Irish Rail Signalling and Electrification Department 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. See Figure 3-3 for a typical arrangement on approach to a low bridge.

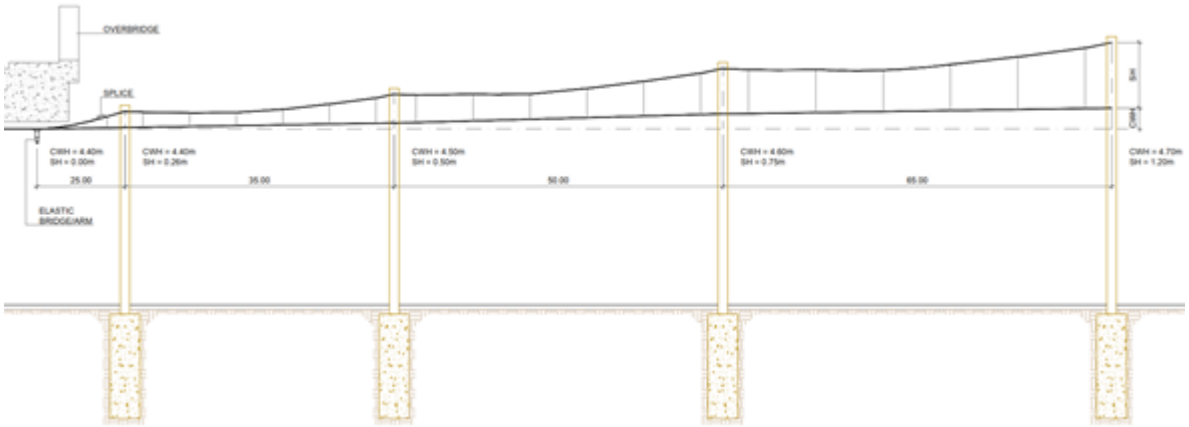


Figure 3-3 Typical arrangement on approach to a low bridge

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 six new substations on the DART+ South West scheme, but none of them fall within this section of the route.

3.3. Design Standards

The project design is governed by various technical and safety guidelines, which include European, National and Iarnród Éireann internal standards and specifications.

Compliance with these standards will be ensured via internal and external technical and safety assurance processes throughout the delivery and commission stages of the project.

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. Further desk and field survey work has been undertaken to inform the environmental constraints identified in **Section 2.8 Environment** and the feedback from PC1 has been reviewed. Together that information has improved the understanding of the environmental constraints in the study area. Details of the further desk and field survey work and stakeholder feedback from PC1 is outlined below.

Ecological field surveys of the route have been carried out to establish the baseline ecological conditions. Surveys for mammals (badger, bats), amphibians, invasive alien species, birds and terrestrial and freshwater habitats have been carried out to date.

In relation to Built Heritage, a comprehensive desktop assessment of built heritage assets within 50m either side of the railway centreline has been undertaken by a Heritage Specialist. This assessment confirmed the designated status of the features of heritage interest due to their Protected Structure status and/or inclusion in the NIAH record, and/or inclusion in the Industrial Heritage Record. A meeting with Dublin City Council noted the bridge in the context of local built heritage examples. In addition, DCC noted that a new City Development Plan for 2022-2028 is being prepared. The new City Development Plan for 2022-2028 may contain modifications (additions/deletions) to the Record of Protected Structures (RPS). A structure must be listed on the planning authority's RPS to qualify for protected status under the Planning and Development Act 2000 (as amended). The RPS will be monitored on an on-going basis by the Heritage Specialist.

A flood Risk Assessment (FRA) is currently under preparation. The FRA will be completed in accordance with "The Planning System and Flood Risk Management – Guidelines for Planning Authorities" (DOEHLG, 2009). Detailed mitigation measures will be specified in the final FRA and will inform the EIAR which will be submitted to An Bord Pleanála for Railway Order approval.

Stakeholder feedback from PC1 has noted a local community feature of importance in the area - the "Tree of Hope" planted in the green space at Le Fanu Drive.

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 2 No. 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 based on the new bridge span.
- 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.

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 the Bridge and Permanent Way Options drawings in **Appendix C Supporting Drawings**.

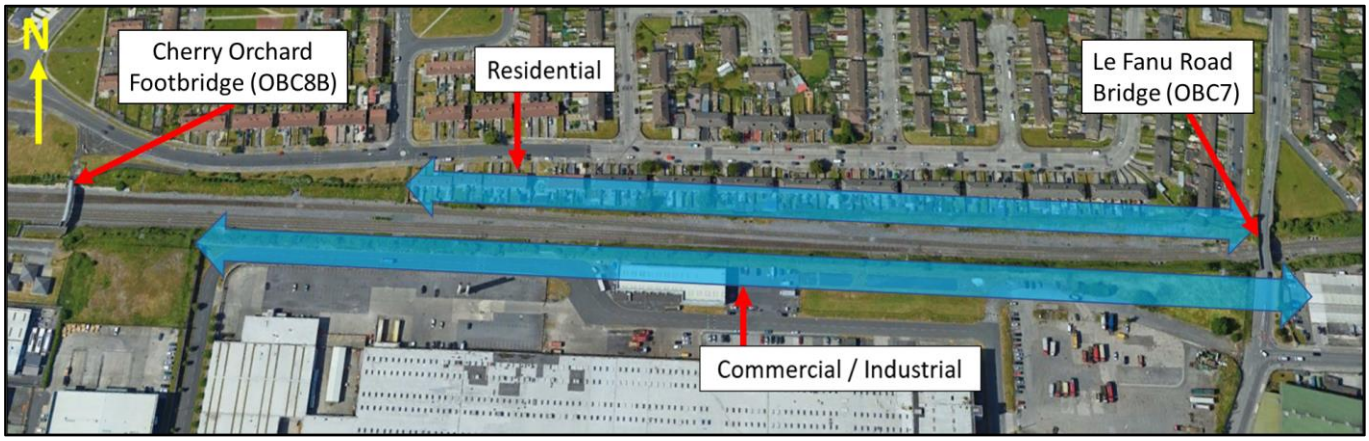


Figure 4-1 Residential and Commercial Property Locations

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

ID	Name	Description
		clearance for the installation of OHLE equipment and the required levels and gradients associated with the track layout through Kylemore Road Bridge (OBC5A)

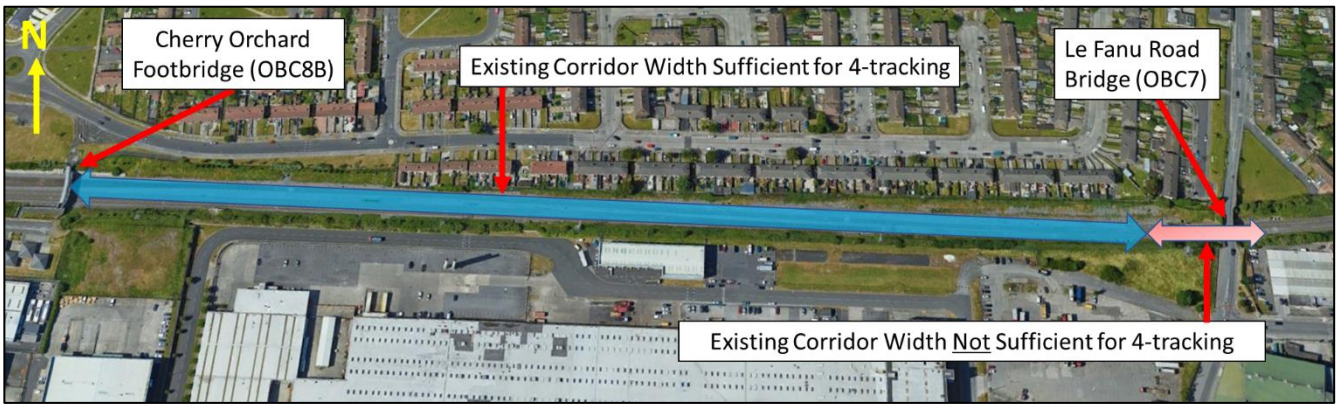


Figure 4-2 Rail Corridor Width

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

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

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.

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.

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. However, other 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.

Using sewer record data and results from the latest permanent way track lowering calculations, a diversion will be required for the foul sewer (CS-09) that crosses the tracks west of OBC7. There will not be adequate space to both lower the tracks and retain the existing arrangement. The sewer also runs parallel to the tracks on the northern bank before crossing the tracks, meaning the diversion is also likely to affect this portion of the sewer. The extent of the diversion is yet to be determined. Depending on the extents, subject to design development, there may be a requirement for land aqcuisition or an easement south of the tracks.

There is a twin circuit 38kV overhead ESB power line that is parallel to the tracks on the southern bank. The foul sewer is in close proximity to a pylon supporting the power line. As such, it has been advised by ESB that any works required to divert the foul sewer may undermine the structural integrity of the pylon. Additional adjacent pylons supporting the same line have been identified to be in close proximity to track widening and subsequent trench walls. Hence, a section of the 38kV line may need to be diverted in order to facilitate the foul sewer diversion and track widening requirement. Discussions are ongoing with ESB and other relevent stakeholders in the area to discuss this matter.

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.

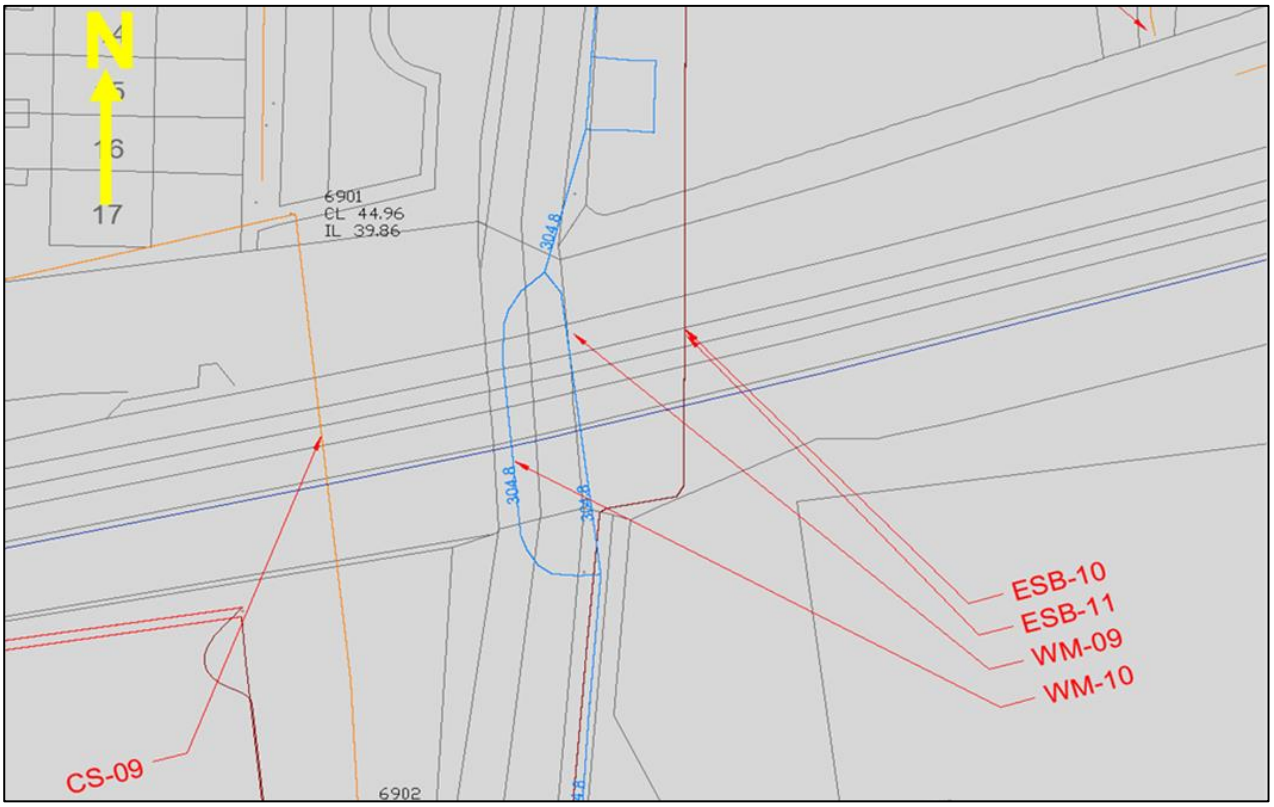


Figure 4-4 Existing Utilities at Le Fanu Road Bridge (OBC7)

5. Options

This section presents the options associated with the following elements on the Park West to Le Fanu Road Section:

- Civil and OHLE infrastructure solutions
- Construction Compounds locations

5.1. Civil and OHLE Options

5.1.1. Le Fanu Road Bridge (OBC7)

Cherry Orchard Footbridge (OBC8B) currently has 4 No. tracks beneath and sufficient vertical clearance for OHLE; optioneering therefore focuses on the railway corridor west of the footbridge and the existing Le Fanu Road Bridge (OBC7) structure, which currently has 2 No. tracks beneath it, and 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 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 the area and presented at PC1. 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.

A summary of Options presented at PC1 as part of the Emerging Preferred Option Selection process is presented in the **Table 5-1**. Refer to **Section 5.1.3 Permanent Way** for a description of the permanent way Options for the area (that are compatible with the bridge Options referred to in **Table 5-1**.

Table 5-1 Options Summary

Option	Description
Option 0: Do Nothing	The existing infrastructure remains unchanged. There are no interventions.
Option 1: Do Minimum	This option endeavours to achieve the four-tracking and electrification project requirements without widening the existing rail corridor or providing additional vertical and horizontal 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.**

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 from **Section 5.1.2** to **Section 5.1.7**.

5.1.1.1. 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.

5.1.1.2. 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.

5.1.1.3. 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

5.1.1.4. 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.

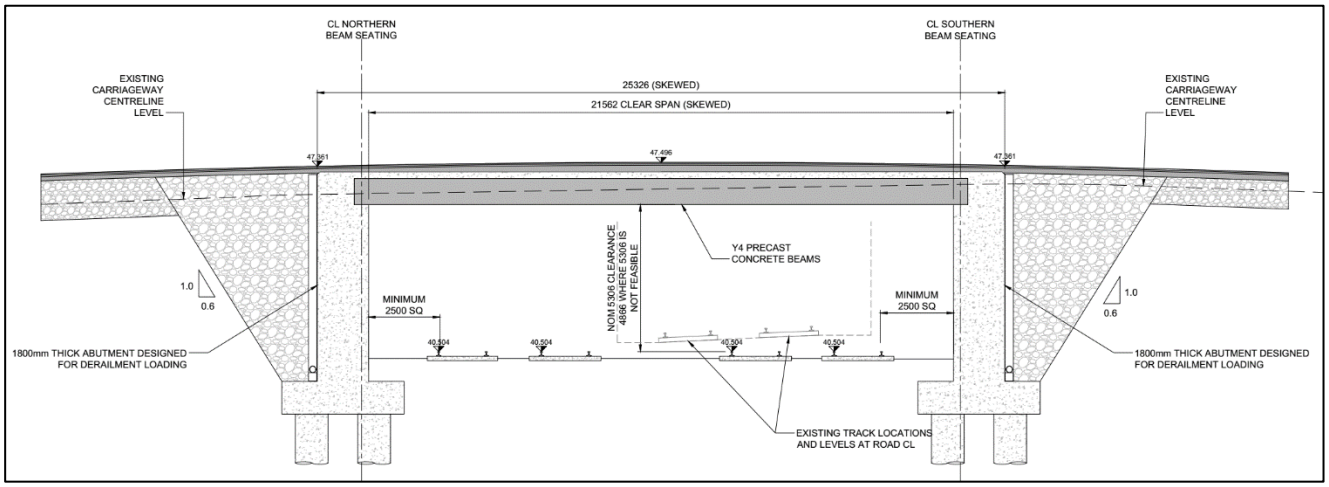


Figure 5-3 Typical Single Span Longitudinal Section – Facing East

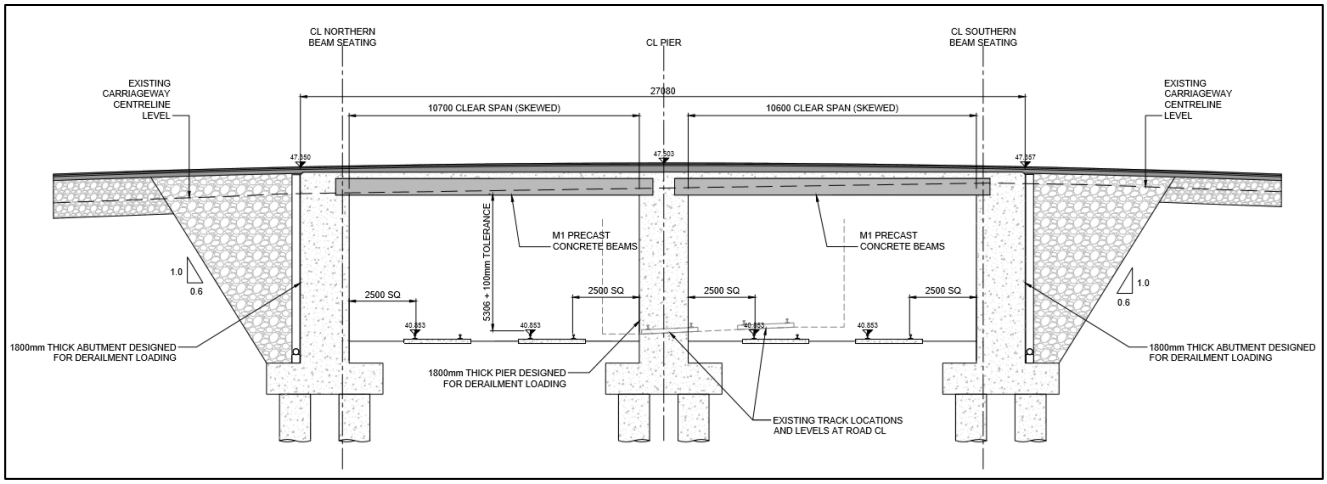


Figure 5-4 Typical two-span longitudinal section – Facing East

5.1.1.5. 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/cycle track).

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.

5.1.1.6. Option 5

This Option 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. This vertical increase to road level is governed by the maximum gradient allowable in 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 beams and an in-situ concrete slab. The span and beam type selection also impacts 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 the impact on private residential properties; to footpath works and possibly nominal tie-in works to their existing driveways.
- Due to the proposed bridge and road level increase and the northern approach road geometry, there would be no opportunity for phasing the road closure and works to limit the duration of road closure.
- The extent of road works at the junctions of Kylemore Park North/Le Fanu roads and the Cul-de-sac with Le Fanu Road are outlined in more detail in Section 8.

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.

5.1.1.7. 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:

- 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.

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 subject to further design development.

5.1.1.8. 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.

5.1.1.9. 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 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.

5.1.1.10 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.

5.1.2. 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. The aim is to provide compliant design with 4.4m contact wire height and 4.91m rail to soffit clearance, the OHLE fitting arrangement will be dependent on the final vertical clearance achieved under the bridge.

5.1.3. 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. As a future station at Kylemore would be situated directly to the east of Le Fanu Road Bridge (OBC7), it has a direct influence on the track alignment in this section. 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 (100mph) on the Fast lines and 110km/h (70mph) 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 0.6% in this vicinity, slightly flatter than the existing 0.9%.

Table 5-2 Permanent Way Options

ID	Name	Description
Per way 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 Per way 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 0.7m (approx.). The vertical alignment can be adjusted to comply with the required vertical clearances for electrification.

5.1.4. 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 with ground anchors 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.

5.1.5. Roads (All Intervention Options)

The constraints, as listed in **Section 4 Constraints** were used in assessing the impact of Options 3 through to Option 9. Drawing DP-04-23-DWG-CV-TTA-61511 serves to indicatively represent the area that could potentially be impacted by the Preferred Option road interventions.

5.1.6. 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 as well as new containment routes to accommodate all new railway systems cabling throughout. These will be migrated in accordingly at each stage of construction. The existing maintenance access point east of Cherry Orchard Footbridge (OBC8B) will be maintained.

5.1.7. Drainage

The track formation must be completely renewed in this area, so the installation of a new drainage system is required. 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, will need to be attenuated.

5.2. Construction Compounds

Four construction compounds are required within the limits of the corridor between Park West to Le Fanu Road Bridge:

- Friel Avenue
- Cherry Orchard Avenue
- Le Fanu Bridge
- Main Contractor Offices & Compound

5.2.1. Friel Avenue

A small construction compound is required on the south side of the rail corridor to facilitate access and transfer of materials and plant for the construction of the new retaining wall on the south side of the corridor west of Le Fanu bridge.

The works in this area include the excavation and widening of the rail corridor and to facilitate this work, a suitable construction compound is required for materials processing and to provide the necessary support infrastructure.

Access is proposed via Friel Avenue, with the proposed site located in a green area with direct access to the rail corridor. See **Figure 5-7** and **Figure 5-8** for the site location and an indicative site layout respectively. There is 2-3m difference in level between the track and the land above, with access from track proposed to the North west of the plot but ths acces route will be modified as construction of the retaining walls progresses.

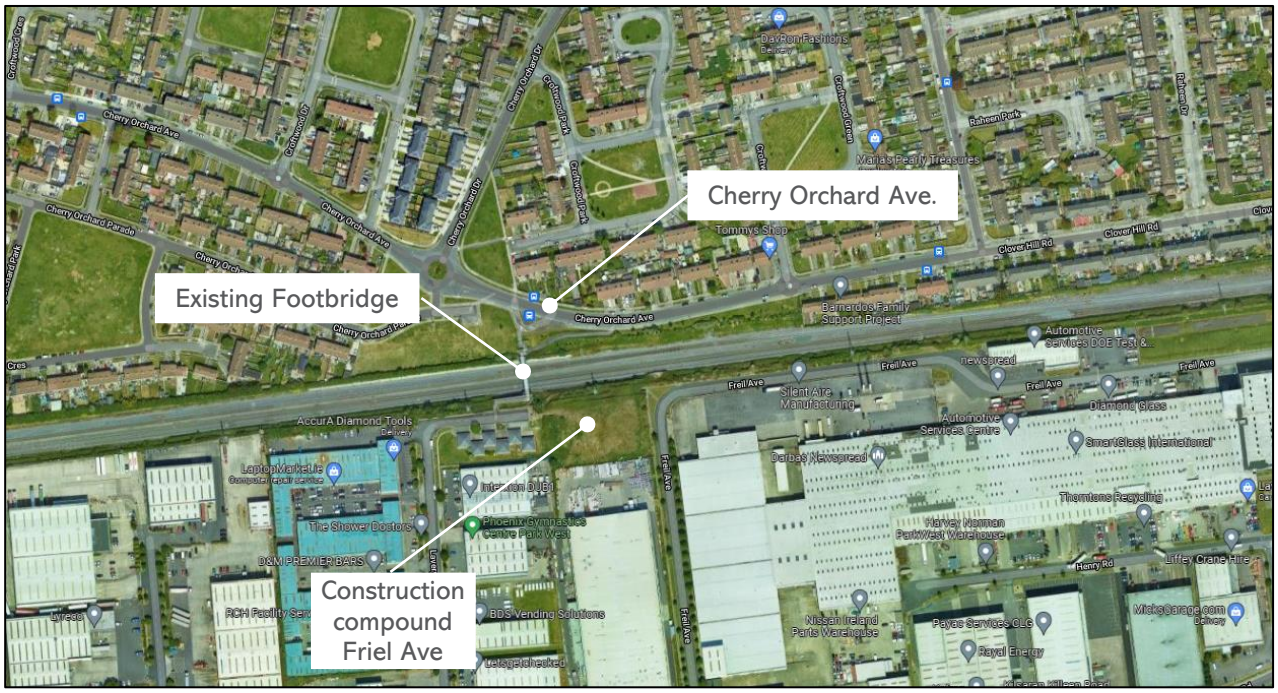


Figure 5-6 Proposed Construction Compound - Friel Avenue Site Location

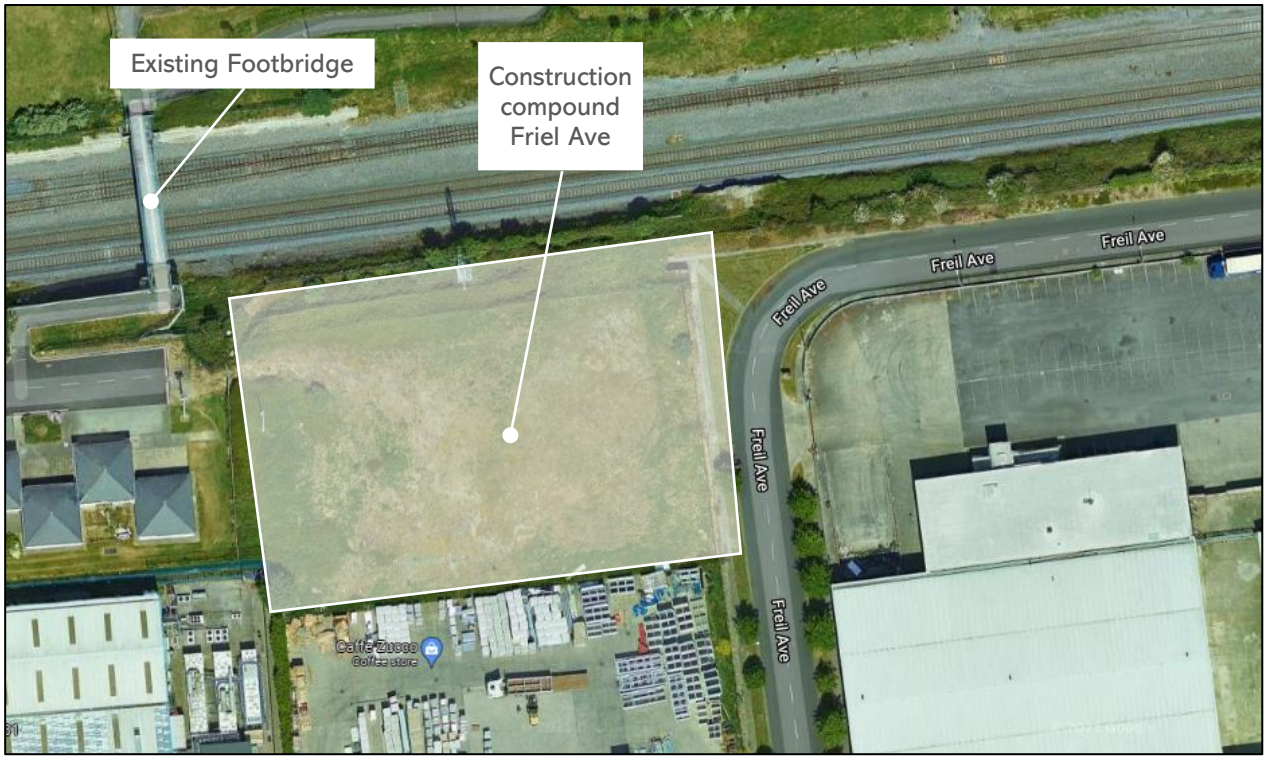


Figure 5-7 Proposed Construction Compound - Friel Ave Indicative Site Layout

The site is located on green space, adjacent to the rail line and Friel Ave. The site is privately owned commercial property and would need to be temporarily acquired for the duration of the works. Other options along the southern rail boundary were not considered due to the narrow space available between railway corridor and existing infrastructure/buildings and due to the location of the proposed works. Constructing a compound to the right of Friel avenue on the existing privately owned car park may be possible but the requirement to cross Friel Avenue to transport plant and materials would be a significant inconvenience to construction/the landowner. The site will be reinstated following completion of the works.

5.2.2. Cherry Orchard Avenue

A small construction compound is required on the northside of the rail corridor to facilitate access and transfer of materials and plant for the construction of the new retaining wall on the north side of the corridor west of Le Fanu bridge.

Works in this area include the excavation and widening of the rail corridor and to facilitate this work, a suitable construction compound is required for materials processing and to provide the necessary support infrastructure on the northern side of the railway.

Access is via Cherry Orchard Avenue, Le Fanu Road, Kylemore Road to the Chapelizod Bypass. The proposed site is currently a green area with direct access to the rail corridor. The site is owned by DCC and would need to be temporarily acquired for the duration of the works. A site west of the existing footbridge was not considered as the proposed retaining wall is highest near the proposed site location, which requires good access via a construction compound to remove the necessary spoil and material arising from the wall installation.

Figure 5-8 Proposed Construction Compound - Cherry Orchard Ave Site Location

Figure 5-9 Proposed Construction compound - Cherry Orchard Ave Indicative Site Layout

5.2.3. Le Fanu Bridge

There is a requirement for construction compounds at each corner of Le Fanu road bridge to facilitate the bridge reconstruction works and also to provide access to the rail corridor for construction of the new retaining wall structures.

In the Northeast corner, there is a triangular green space, and this area is required to facilitate the reconstruction works to the bridge and also the construction of the northern retaining wall between Le Fanu and Kylemore bridges. In the Northwest corner there is a green area that will be required to facilitate access from the haul road between Le Fanu and the Cherry Orchard Avenue compound.

To the Southeast, a small access point and transfer area is required to facilitate construction of the walls from Le Fanu to Kylemore on the southern side. This site is located in the car park of a commercial unit and would require temporary land acquisition. There would be a potential impact on the operations of the business for the duration of the works.

Access to the southwest corner of Le Fanu bridge is required to facilitate bridge reconstruction works, the construction of the new retaining wall structures

The existing 110kv ESB electricity pylon to the south west of Le Fanu bridge will need to be removed and the existing supply cables diverted to facilitate track widening works.

Access to the construction compounds is via Le Fanu Road, New Nangor Road, Naas Road to the M50.

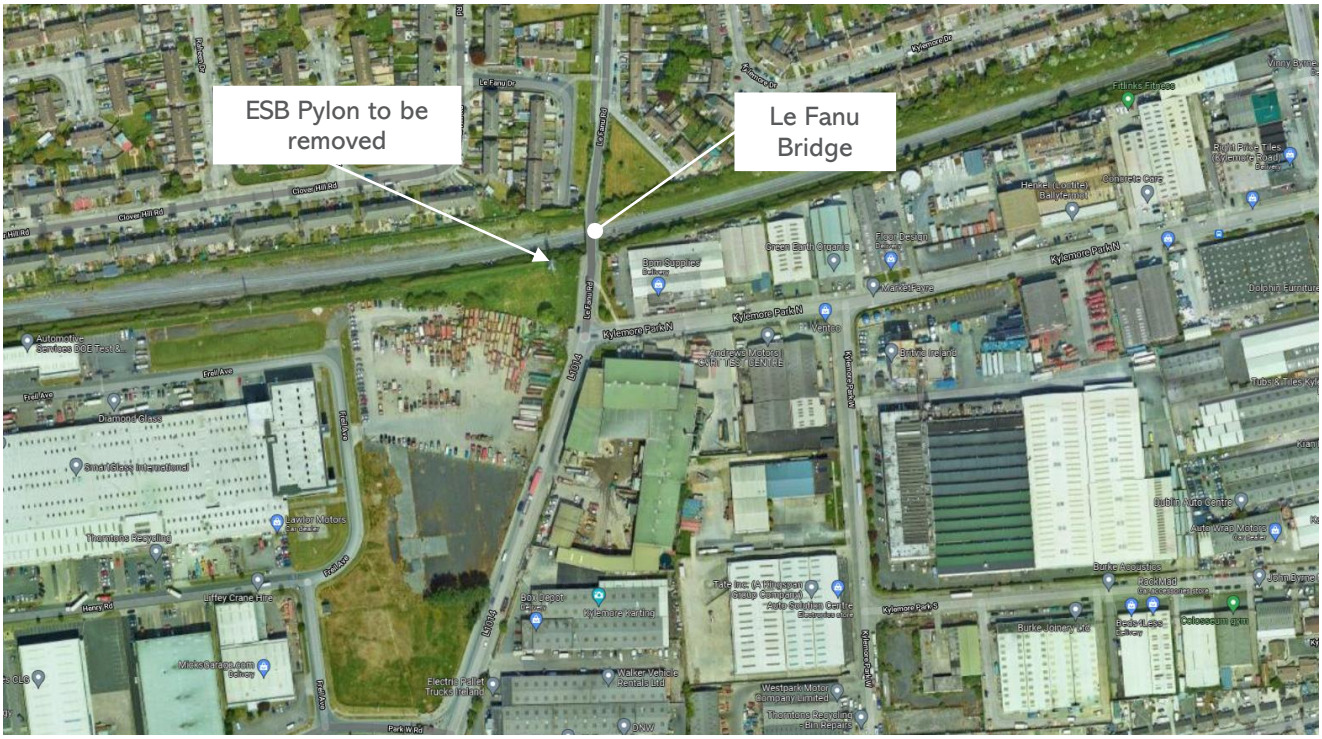


Figure 5-10 Le Fanu Bridge Site Location

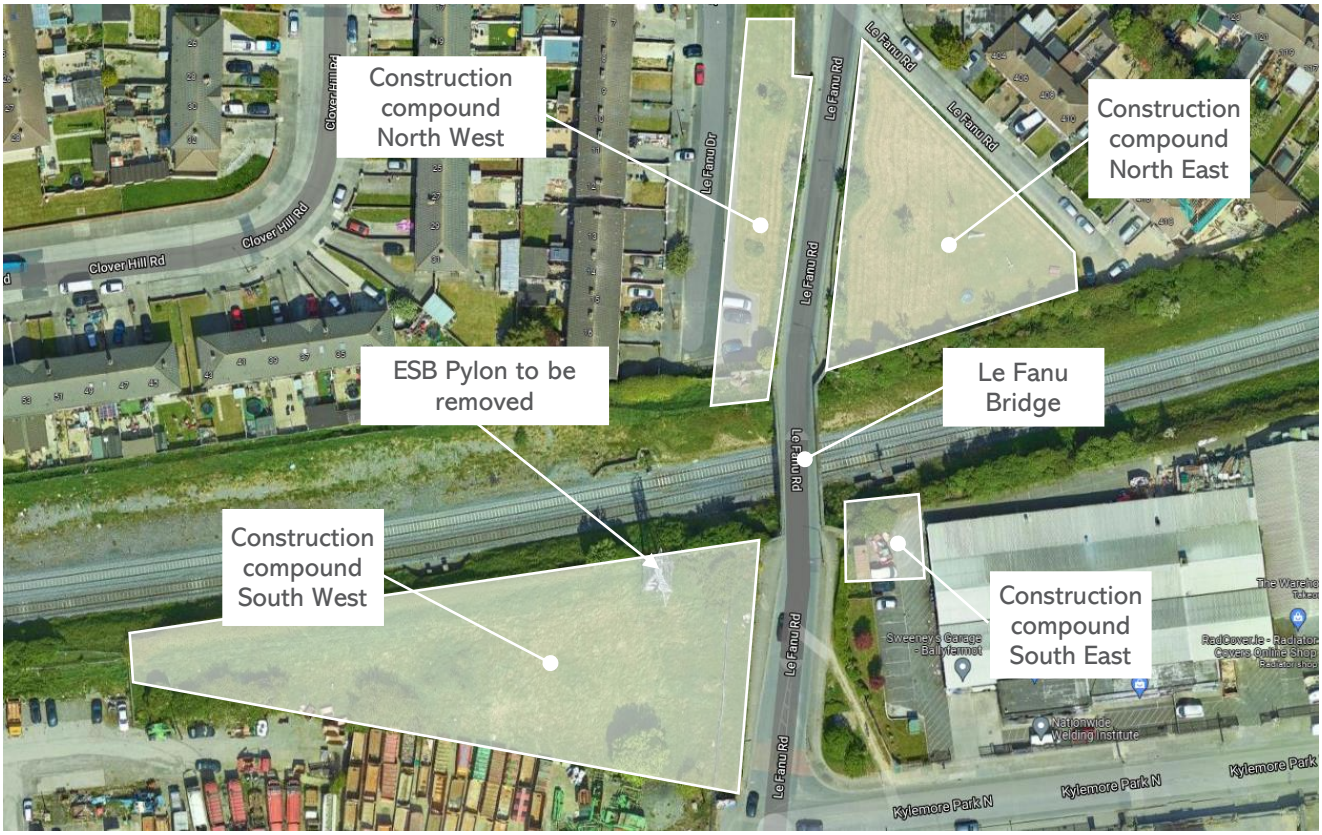


Figure 5-11 Le Fanu Bridge Construction Compounds

5.2.4. Main Contractors Office & Compound

It is proposed to locate the contractor's main construction compound and project management office in this area. The site will need to accommodate offices for the contractor and client teams, storage facilities, recycling facilities, parking for cars and plant and potentially fabrication areas. It is a prerequisite that the compound is located close to and ideally with direct access to the work site. The site must be fully serviced with electricity, water, sewerage and telecoms and must have good access to the public road network.

3 No. options were considered for the location of the main construction compound to the southwest of Le Fanu bridge. The options are shown in Figure 5-12.

Figure 5-12 Le Fanu Bridge and Main Contractor Offices Options

Option 1 is located on private land, it is a hardstanding area, currently used for truck parking. The current access is via Friel Avenue. There is also an old access point from Killeen road which is currently blocked off. Option 1 is the closet of the 3 options to the work site. This option would require temporary land acquisition and temporary relocation of the existing truck parking to an alternative location, potentially south to the hardstanding area immediately adjacent to the site.

Option 2 is also located on private land, it is also a hardstanding area, currently vacant. The site is accessed via Friel avenue. It is further from the work site than Option 1 making material and equipment movement more difficult with potential safety implications associated with moving bulky construction materials and equipment along a public road.

Option 3 is located on a green area to the front of Mitsubishi Fuso on Friel avenue, the area is adjacent to the track, but the site is small with insufficient space to accommodate the construction compound facilities, as such it has been ruled out.

6. Options Selection Process

6.1. Options Selection Process Summary

A clearly defined appraisal methodology has been used in the selection of the 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 two-stage approach (if / as appropriate):

- Stage 1 Preliminary Assessment (Sifting)
- Stage 2 Multi Criteria Analysis (MCA)

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, a number of discrete elements extend beyond the boundary of the existing railway. The optioneering process has focused on these elements for which alternative options manifest, options which are markedly different from one another, and which have varied impact on the local environment. Examples of such include four tracking, bridge replacements, and options for the location of substations and construction compounds.

The above selection process has been used to asess the options associated with the following elements on the section between Park West and Le Fanu Road Bridge:

- Civil and OHLE Infrastructure
- Construction Support Sites

6.1.1. 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.

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 for selecting the Preferred Option for the Project, 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. Where the sifting results in only one feasible option, a multi-criteria analysis (MCA) is not required for that one option.

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.

6.1.2. Stage 2 Multi Criteria Analysis (MCA)

Stage 2 of the optioneering process comprises a detailed multi-disciplinary comparative analysis of the feasible options that passed through Stage 1: Preliminary Assessment (Sifting).

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). These parameters were split into a number of sub-criteria considered relevant to the DART+ South West Project.

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 a Preferred Option.

Relevant considerations include:

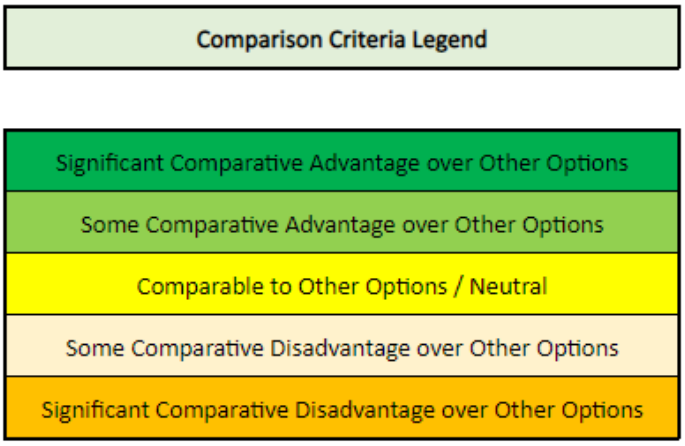
- This is a comparative analysis between the various options, not an impact assessment of each option. The impact from the Emerging Preferred Option will be assessed in the environmental impact assessment report (EIAR) in the next phase of the development.
- Not all sub-criteria and qualitative and/or 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 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.

The MCA Process involved assessing the performance of each option against relevant quantitative and qualitative indicators, the assessment was carried out 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 6-1 Comparison Criteria



6.2. Civil and OHLE Option Selection

6.2.1. Stage 1 Sifting

Table 6-2 provides details of the assessment undertaken as part of the Stage 1 Preliminary Assessment (Sifting) Process, used in the selection of the Preferred Option for Civil and OHLE for the corridor between Park West and Le Fanu Road Bridge. Options which were assessed as feasible and fulfilled the project requirements were brought forward to Stage 2 MCA for a more detailed assessment.

Table 6-2 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.

Option	Requirements		Description
		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).
		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.

Option	Requirements		Description
	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**
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).

Option	Requirements		Description
		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
	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.

Option	Requirements		Description
		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**

A total of 9 No. Options were developed for the area from west of 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 6-3)**, a total of 2 No. Options were shortlisted and progressed to Stage 2 (MCA) of the assessment process.

Table 6-3 Summary of Sift Process Results

Main Option	Result	Brought forward to MCA
Option 0: 'Do Nothing'	Fail	No
Option 1: Do Minimum	Fail	No
Option 2	Fail	No
Option 3	Fail	No
Option 4	Fail	No
Option 5	PASS	Yes
Option 6	PASS	Yes
Option 7	Fail	No
Option 8	Fail	No
Option 9	Fail	No

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 similar to 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. DART+ South West Design Team 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 Le Fanu Road Bridge (OBC7) 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.). Note, Cherry Orchard Footbridge (OBC8B) is not impacted by any of the options and no works are proposed to the bridge.
- **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. Note, Cherry Orchard Footbridge (OBC8B) is not impacted by any of the options and no works are proposed to the bridge.

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.

6.2.2. Multi Criteria Analysis

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

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 Preferred Option, while Option 6 remains a potential design iteration of 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.***

The two 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 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.

6.2.3. Civil and OHLE 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 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 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 will be installed along the north side of the rail corridor. OHLE equipment will be fitted to the new Le Fanu Road Bridge (OBC7) to allow for continuous electrification through the structure.

Figure 6-6-1 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.

6.3. Construction Compounds

6.3.1. Friel Avenue

Access is required for localised retaining wall works along the southern boundary of the railway and the proposed location for the construction compounds is required to facilitate this work. As no other suitable alternative locations were identified in the area, the selected construction compound location did not require optioneering.

6.3.2. Cherry Orchard Avenue

Access is required for the construction of a new retaining wall along the northern boundary of the railway west of Le Fanu bridge and, the proposed location for the construction compounds is required to facilitate this work. As no other suitable alternative locations in the area, the selected construction compound location did not require optioneering and location of the construction compounds came down to the most suitable area along this section of the rail corridor.

6.3.3. Le Fanu Bridge

Localised access is required for the bridge reconstruction, 4 discrete compounds are located at each corner of the bridge are required to facilitate this work. As no other suitable alternative locations in the area were identified for construction compounds, optioneering was not required.

6.3.4. Le Fanu Bridge Main Contractor Offices

3 No. options were considered for the location of the main construction compound to the southwest of Le Fanu bridge. The site will need to accommodate offices for the contractor and client teams, storage facilities, recycling facilities, parking for cars and plant and potentially fabrication areas. It is a prerequisite that the compound is located close to and ideally with direct access to the work site. The site must be fully serviced with electricity, water, sewerage, and telecoms and must have good access to the public road network.

Three Options excluding the 'Do Nothing' option have been identified for the area. **Table 6-5** provides details of the assessment undertaken as part of the Stage 1 Preliminary Assessment (Sifting) Process, used in the selection of the Preferred Option the Main Contractor Offices at Le Fanu Road Bridge.

Table 6-5 Preliminary Assessment Sifting

Option	Requirements		Description
0	Engineering	Constructability	Not applicable. No intervention proposed
		Safety	Not applicable. No intervention proposed.
		Proximity to the Railway Line	Not applicable. No intervention proposed
		Vehicular Access	Not applicable. No intervention proposed
		Direct access to the work site	Not applicable. No intervention proposed
		Site size requirements	Not applicable. 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 – site would provide direct access to the bridge works, direct access to the rail corridor.
		Safety	Pass – site located adjacent to the proposed works
		Proximity to the Railway Line	Pass – closest of the 3 options to the rail corridor and work sites
		Vehicular Access	Pass – direct access via Friel Avenue. There is also an old access point from Killeen road which is currently blocked off
		Direct access to the work site	Pass
		Site size requirements	Pass
	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
2	Engineering	Constructability	Pass
		Safety	Fail – plant and materials would need to be transferred from the compound along Friel ave to get to the work site.
		Proximity to the Railway Line	Fail – no direct access
		Vehicular Access	Pass – via Friel avenue
		Direct access to the work site	Fail – no direct access
		Site size requirements	Pass
	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**
3	**Engineering**	Constructability	Pass – site would provide direct access to the bridge works, direct access to the rail corridor.
		Safety	Pass – site located adjacent to the proposed works.
		Proximity to the Railway Line	Pass – site is located adjacent to the rail corridor
		Vehicular Access	Pass – via Friel avenue
		Direct access to the work site	Pass – not as close as Option 1 to the bridge works, but adjacent to the rail corridor
		Site size requirements	Fail – site is limited in size, parking belonging to a business unit is located immediately to the west.
	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**

Table 6-6 Summary of Sifting Process Results

Main Option	Result	Brought forward to MCA
Option 0: 'Do Nothing'	Fail	No
Option 1:	Pass	Yes
Option 2	Fail	No
Option 3	Fail	No

Option 0, 2 and 3 fail to meet the necessary Engineering Feasibility and Project Requirements for the main contractor office and compound area (highlighted in grey).

Options 1 meets the necessary Engineering Feasibility and Project Requirements for the main contractor office and compound area and is the Preferred Option. Stage 2 (highlighted in Green): MCA is not necessary.

6.3.5. Construction Compounds Preferred Locations

Four construction compounds are required in section between Park West and Le Fanu Road Bridge, the proposed locations are shown on Fig 6-2:

- Friel Avenue
- Cherry Orchard Avenue
- Le Fanu Bridge
- Main Contractor Offices & Compound

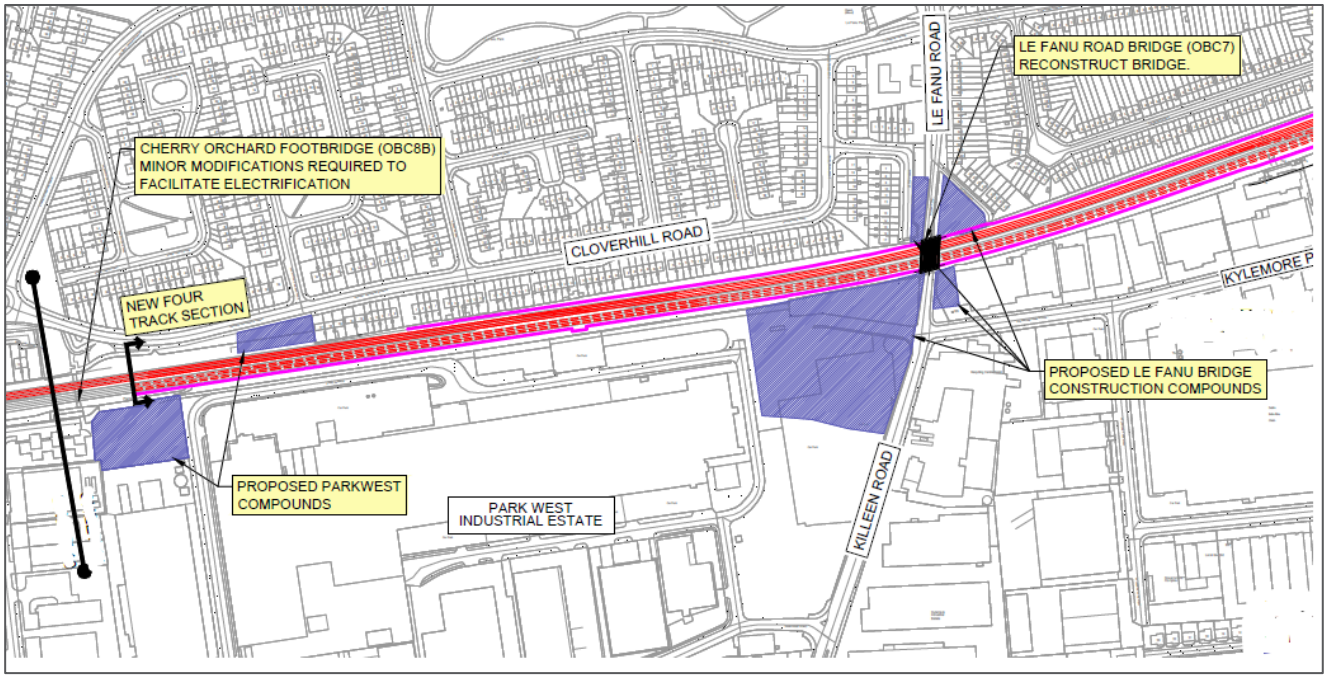


Figure 6-2 Proposed Construction Compounds Locations

7. Preferred Option Design Development

7.1. Review of Preferred Option

The baseline information or outcomes of design development since PC1 (inclusive of stakeholder input) have not materially impacted the optioneering and MCA outcomes that resulted in the selection of Option 5 as the Preferred Option for the Civil and OHLE infrastructure at the Park West to Le Fanu Road Bridge Corridor.

The structural design requirements as clarified in **Section 3 Project Requirements** did however serve to further constrain the variability within Option 5 design development; a key consideration being to limit permanent impact on 3rd party landowners, in addition accommodating the complexity of railway infrastructure elements and alignment requirements between Cherry Orchard Footbridge and Inchicore Yard while track lowering as much as possible.

The Option 5 has nevertheless been validated and it design progressed as the Preferred Option.

7.2. Review of Stakeholder Feedback

The intention is to reinstate the stone masonry walls and parapets with similar aesthetic materials in keeping with the existing visual character of the approach walls. Where feasible; first preference will be given to recycling of the existing masonry stone. However, where the walls can't be retained or stone not being considered feasible for use because of the higher category of safety containment required for new schemes; then in such cases masonry looking concrete finishes or masonry cladding will be considered. (Refer to Section 7.3 for examples of some finishes in use).

The northern approach road, on the residential side of the rail corridor, is proposed to widen predominantly towards the park rather to limit the impact on the residential plots to the west

The current proposal considers providing embankments rather than replacing the retaining walls with higher walls (bearing in mind the proposed bridge deck is 800mm (approx.). The use of embankments will have a greening effect and has the potential to reduce acts of graffiti on what would otherwise be an even higher wall than the current one.

The embankments would however reduce the park's flatter spaces by encroaching a distance of 12m (approx.) to the south (at the bridge abutment) and 2m to the north (at the cul-de-sac junction). This will require the reinstating of existing trees affected and/or equivalent planting of new trees of similar maturity. A large proportion of the park area would be required for the road, bridge and railway construction activities but as it is acknowledged to be a local public amenity area, it would be reinstated with this sensitivity in mind.

As already noted in **Section 1.7** the current bottlenecking at Cherry Orchard will be removed with the implementation of the 4-tracking of DART+ SW project.

No stations are proposed for development in this specific section of the project from Cherry Orchard Footbridge (OBC8B) to Le Fanu Road Bridge (OBC7) under the current scope of the DART+ SW project.

7.3. Design Development

The following sub-sections provide greater clarity on the development of the design towards the preferred option, this section includes the following:

1. Structures
2. Permanent Way
3. Signalling, Electrical and Telecommunications (SET)
4. Roads
5. Drainage

7.3.1. Structures

7.3.1.1. Bridges

As noted earlier in the report, electrifying the route requires the installation of overhead electrical lines along the railway. The lines pass under existing bridges. In many instances the existing bridges are too low to accommodate the overhead lines at their normal heights and special measures are warranted to facilitate the electrification. In relation to Le Fanu Road Bridge (OBC7), a total of nine (9 No.) Options were initially developed, following the selection process, Option 5 was identified as the Preferred Option for this area. This Option requires the reconstruction of the existing bridge with a slightly wider cross-section and longer span and with a different beam/deck arrangement to the existing humpback arch structure to accommodate OHLE clearances and reinstatement of utilities. Please refer to **Appendix C Supporting Drawings** for drawings of Le Fanu bridge.

The requirement for a single span also resulted in the depth of beam increasing; however, the associated impact on road and/or track was offset by the reduction in clearance requirement.

In addition, the rail tracks would be lowered to facilitate the electrification infrastructure beneath the new bridge. See **Figure 7-1** and **Figure 7-2** for a general arrangement of the bridge and the deck longitudinal section.

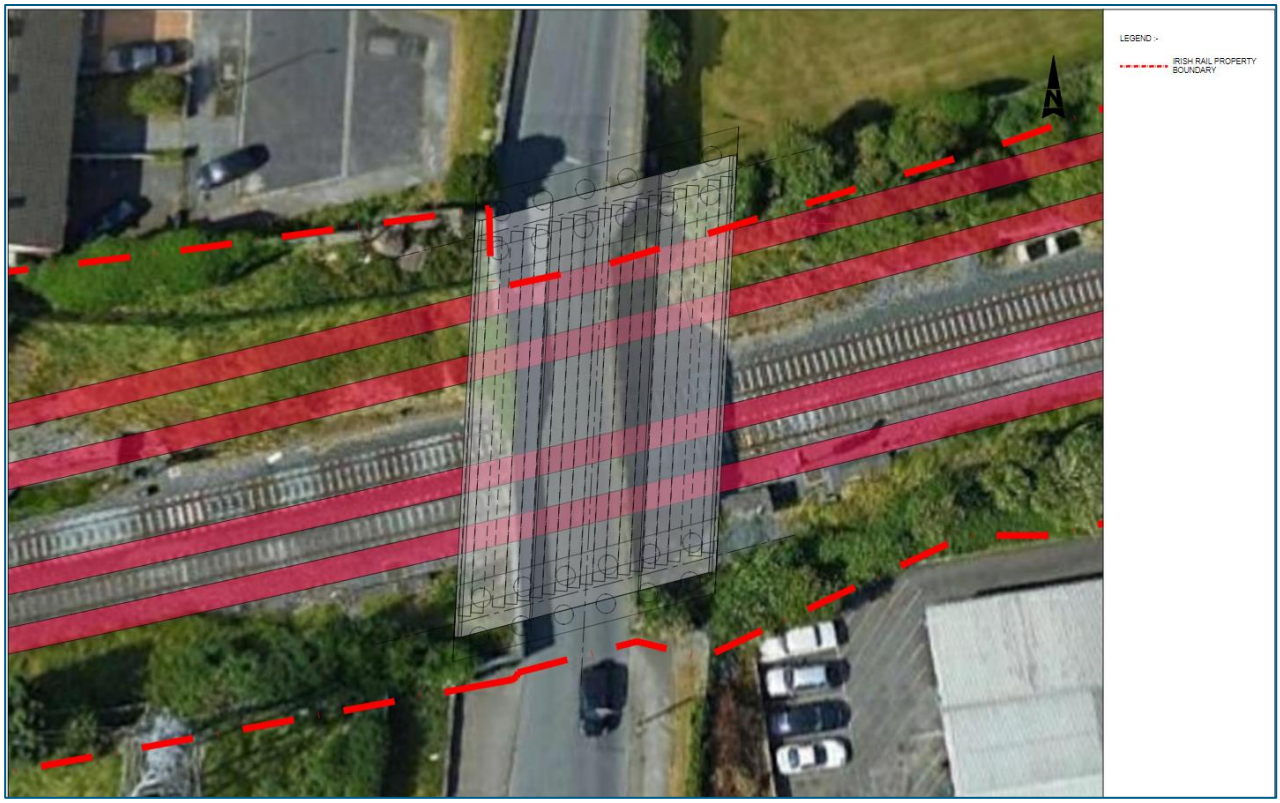


Figure 7-1 Le Fanu Road Bridge (OBC7) General Arrangement

Design development has focused on providing a bridge structure that facilitates (as a minimum) removal of the skew in the road and accommodating a revised carriageway width that incorporates footpath and cycle facilities that currently do not exist over the structure. Summary of the proposed bridge details:

- Proposed Bridge Type = Prestressed Beams and In-situ Deck seated with Abutments supported on a Pile foundation.
- Proposed Bridge Span (incl. Abutment Length) = 25.83m
- Proposed Bridge Width (incl. Parapets) = 16.0m
    - An additional buffer width has been provided on both sides of the bridge adjacent to parapets for H4A containment termination terminals, as well as for future space proofing of the structure.
- Proposed Bridge Slab Depth = 0.25m
- Proposed Bridge Beam Depth = 1.0m
- Proposed Parapet = H4A containment walls 1.8m higher than adjacent footpath
- Proposed Utility Space Proofing = include duct and pipe containment for the reinstatement of the watermain and fibre optics and ESB cables in deck or between the beams, subject to the preference of the utility company at detailed design stage.

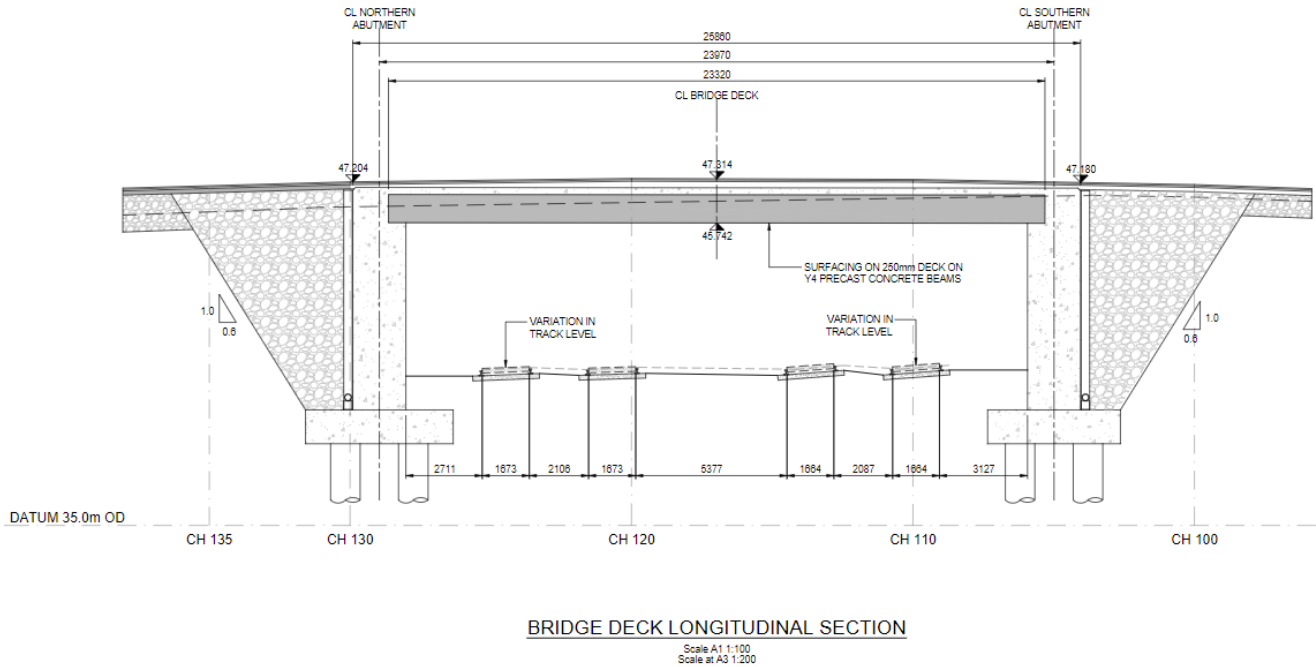


Figure 7-2 Le Fanu Road Bridge (OBC7) Bridge Deck Longitudinal Section - Facing East

The current bridge structure and approach road barriers have historical and aesthetic appeal being of a masonry stone finish. There are currently a number of options being evaluated for parapets and approach road containment walls for the new bridges. The main criteria for the parapet is that they achieve an overall height of 1,8m above deck level. The options under consideration include full height precast reinforced concrete parapets, full height steel parapets, and 1200m high RC parapets with perforated or glazed sections to the remaining 600mm to achieve the min height requirement. All parapets will have a H4a containment level. More information on parapets and approach on road containment walls will be available at Railway Order stage.

As the aesthetic is an important factor a number of finishes are being considered for the precast concrete options. These include introducing patterned concrete formers to replicate the existing masonry parapets currently in place, see **Figure 7-3**. There a many different finishes available to use and the panels can be coloured. See below some examples.

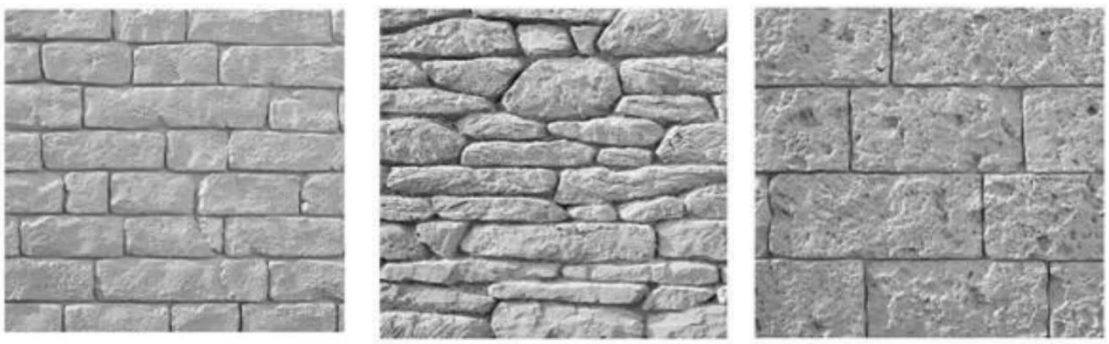


Figure 7-3 Examples of Architectural Concrete Finishes and/or Limestone Cladding

Other options are to fully clad the precast panels with masonry cladding to match the exiting parapets, see **Figure 7-4**, or to retain and repurpose the existing masonry in the parapets to be used as cladding to the new precast parapets. Other options being considered take into account landscape and visual considerations where a desire has been expressed to retain views of the Dublin mountain skyline from some of the structures.

Figure 7-4 Precast panels fully cladded with masonry

7.3.1.2. Retaining Walls

The over steepened nature of the existing cutting slopes, proximity of the adjacent domestic properties and height of the cutting slope to be retained, necessitates a piled wall solution with the inclusion of soil nails or ground anchors, and cantilever walls along both the north and south sides of the rail corridor west of Le Fanu Bridge.

To facilitate the widening along the northern and southern perimeters to form the northern (slow) and southern (fast) track cess edges and retain the slopes of the cutting, the retaining wall height (above track cess level) will vary between 3 and 6m, rising to 9m along this section and bored secant pile wall and cantilever wall solutions will be adopted for this section of retaining wall. Examples of a typical section of the wall and finished walls are shown in **Figure 7-5**, **Figure 7-6** and **Figure 7-7**.

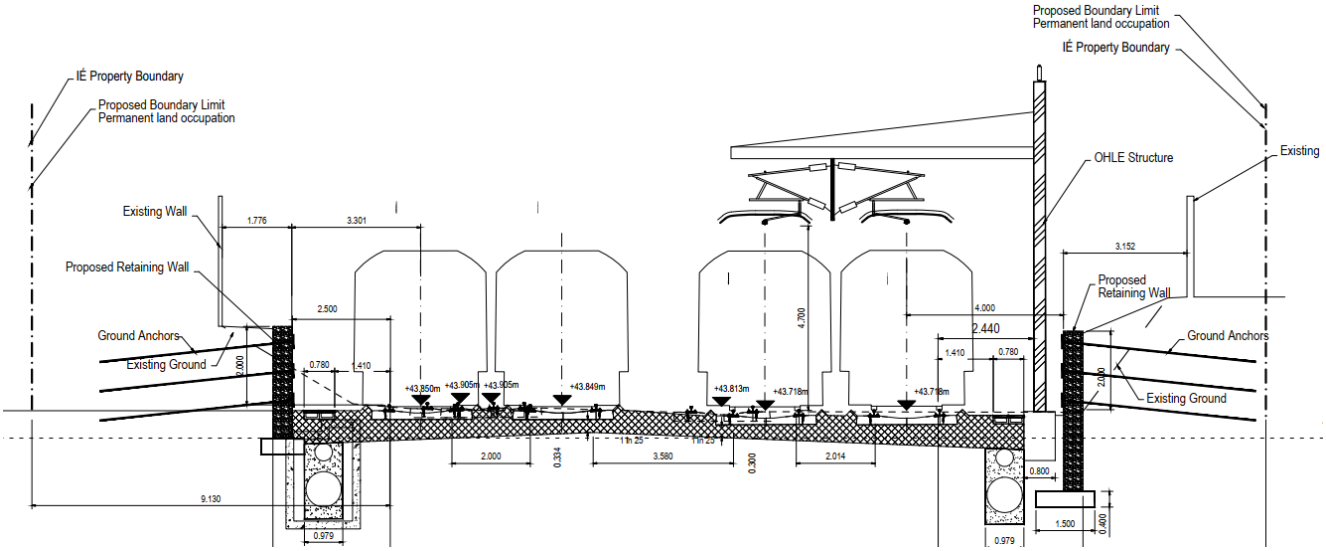


Figure 7-5 Cantilever Retaining Wall & Ground Anchors – Facing West

Figure 7-6 Example of a Secant Wall

Figure 7-7 Examples of Retaining Walls

7.3.1.3. Signalling Cantilevers

Where possible, signalling infrastructure will be located within IE existing land; however, in areas where the track encroaches into adjacent land, then consideration will be given to nominal additional land take for signalling structure access. Where space for foundations in the cess is not available, consideration will be given to integrating the signalling cantilevers into the retaining wall structural design locally.

Access to the top of man access cantilevers will be from steps within the cess unless local access from IE land is safer and operationally more efficient.

7.3.2. Track Bed Design

Track lowering up to 0.9 m is proposed to achieve vertical clearances and therefore a new track bed design is required along this section. Bedrock has been indicated west of Le Fanu near elevation 36 m AOD, and to facilitate the track lowering, the new track bed formation shall be constructed consisting of subgrade, sub ballast and ballast.

7.3.3. Permanent Way

The existing 4-track layout converges to 2No. tracks at approximate 350m to the east of Cherry Orchard footbridge – the proposed layout realigns these 2No. tracks on the south side of the rail corridor to become the Fast lines. The 2No. new tracks – the Slow lines – will be situated on the north side of the corridor as shown in the **Figure 7-8**.

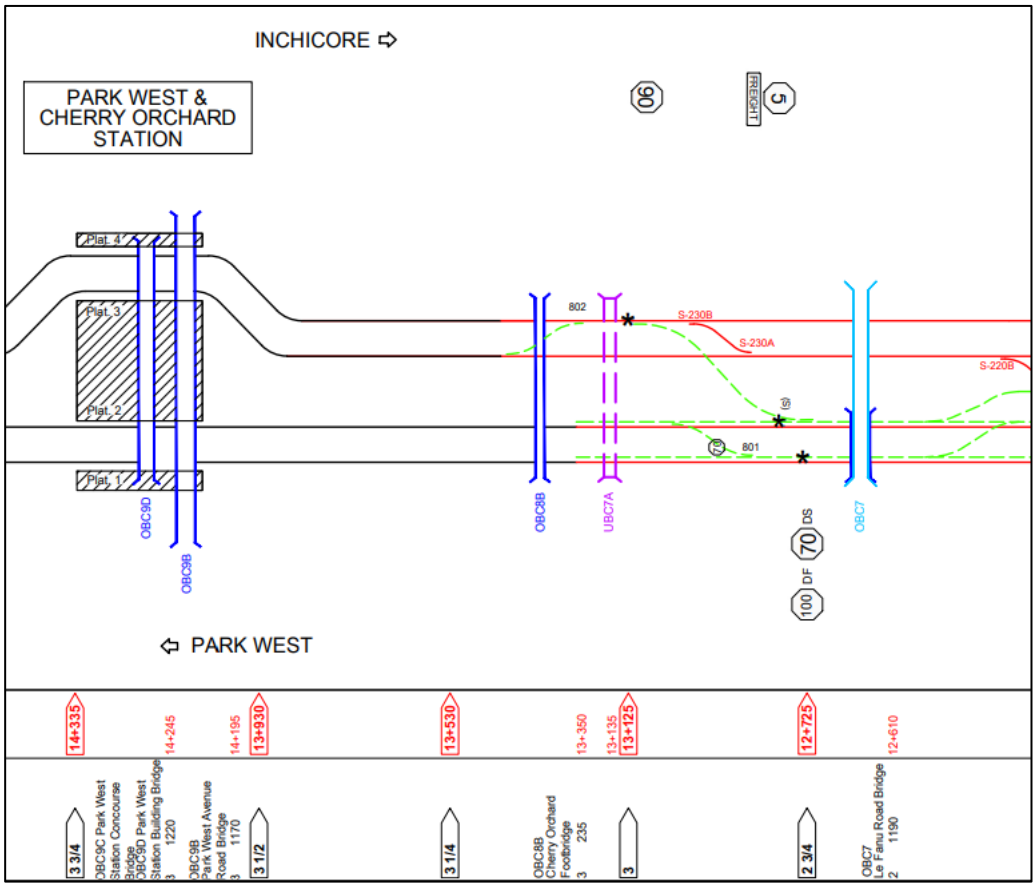


Figure 7-8 Park West & Cherry Orchard Station to Le Fanu Road Bridge (OBC7) – Track Plan Layout

(new tracks = red, removed tracks = dashed green, structures = blue)

For Cherry Orchard Footbridge (OBC8B), near the beginning of the section, the Slow tracks are subject to minor realignment where the new tracks tie-in to the existing tracks. This includes track lifts up to a maximum of 80mm with resultant soffit clearance of 4.91m that enables the OHLE solution of 4.4m contact wire height. The Fast tracks are not subject to any realignment here.

Heading east, the Slow and Fast tracks are co-planar (at the same level and gradient) through this section, in order to accommodate the crossover between the Slow lines to the west of Le Fanu Road Bridge (OBC7) and facilitate a level bridge deck across the new span perpendicular to the tracks. The magnitude of the track lowers at Le Fanu Road Bridge (OBC7) is 0.9m at the eastern parapet; this is in order to achieve the minimum acceptable contact wire height of 4.4m for the slow tracks.

The maximum gradient through the section is 1.200%, for all tracks, to the west of Le Fanu Road Bridge (OBC7).

The existing line speeds of 160km/h (100mph) on the Fast lines and 110km/h (70mph) on the Slow lines has been maintained.

Retaining walls are required to both the north and south sides of the rail corridor as the 4-track corridor enters cutting, as shown in **Figure 7-9**.

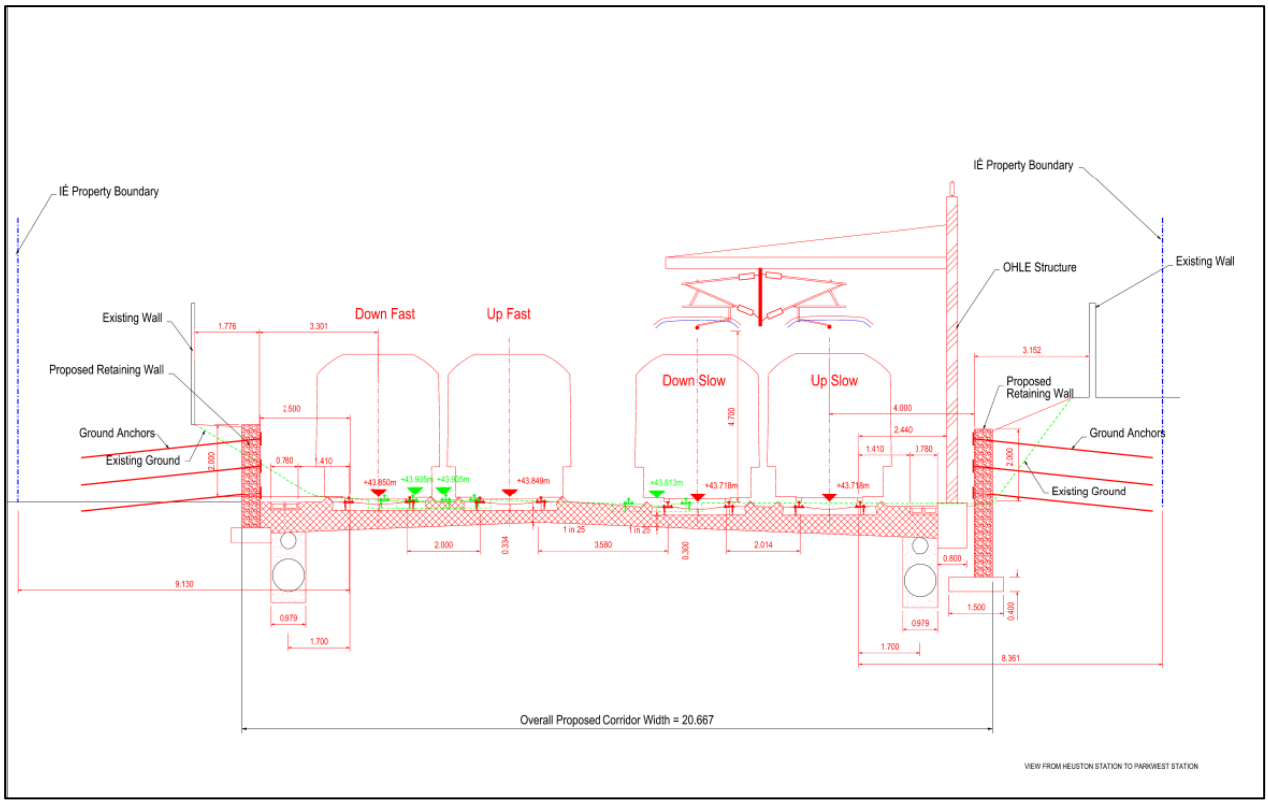


Figure 7-9 Typical Cross Section looking West at approx. 400m to the east of Cherry Orchard Footbridge

7.3.4. Signalling, Electrical and Telecommunications (SET)

This section provides detail on the proposed SET equipment and components which will be distributed along this section of the railway. More information on the typical SET equipment is included in the **Technical Options Report Volume 2**.

7.3.4.1. Signalling

The signalling system is used to safely control and monitor train movement on the Irish Rail network. The system comprises a network of sensors, controls, signs and lights. It also includes localised control cabinets and cabins.

A Signalling scheme plan has been developed for the entire route, the section pertaining to this area is detailed in **Figure 7-10**. The scheme plan shows the number and type of signals that will be allocated on this section of the route and the points and crossings that they interface with. The following details the physical signalling infrastructure that will be installed.

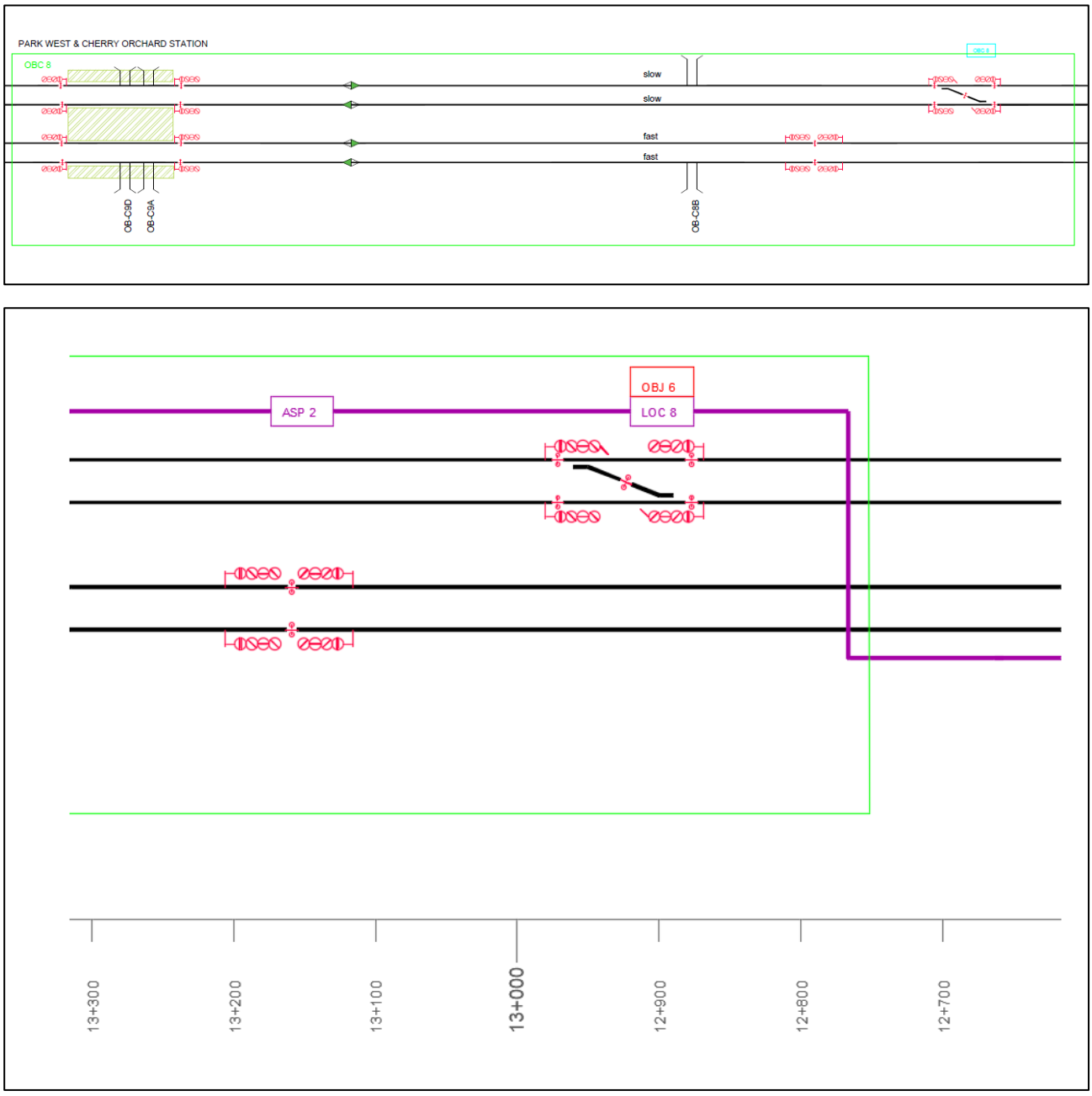


Figure 7-10 Signalling Scheme Plan (Park West – Le Fanu Bridge)

Legend:

- Purple line: 650 V line
- Purple square: LV cabinet
- Orange square: OBJ cabinet (signalling)
- Green square: OBJ influence area
- Black lines: Tracks
- Red: Signals

The physical signalling infrastructure has been developed and is indicated in **Figure 7-11**. This figure shows an Object Controller Cabinet (blue box) and a Location Case (black box). All equipment is expected to be located within the existing IE land boundary to minimise the impact to the public.

Infrastructure highlighted in **Figure 7-11** and **Figure 7-12** as follows:

- Blue box – Object Controller Cabinet
- Red box: - LV equipment

Figure 7-11 Signalling Infrastructure (Approx. 450m east of Footbridge Cherry Orchard)

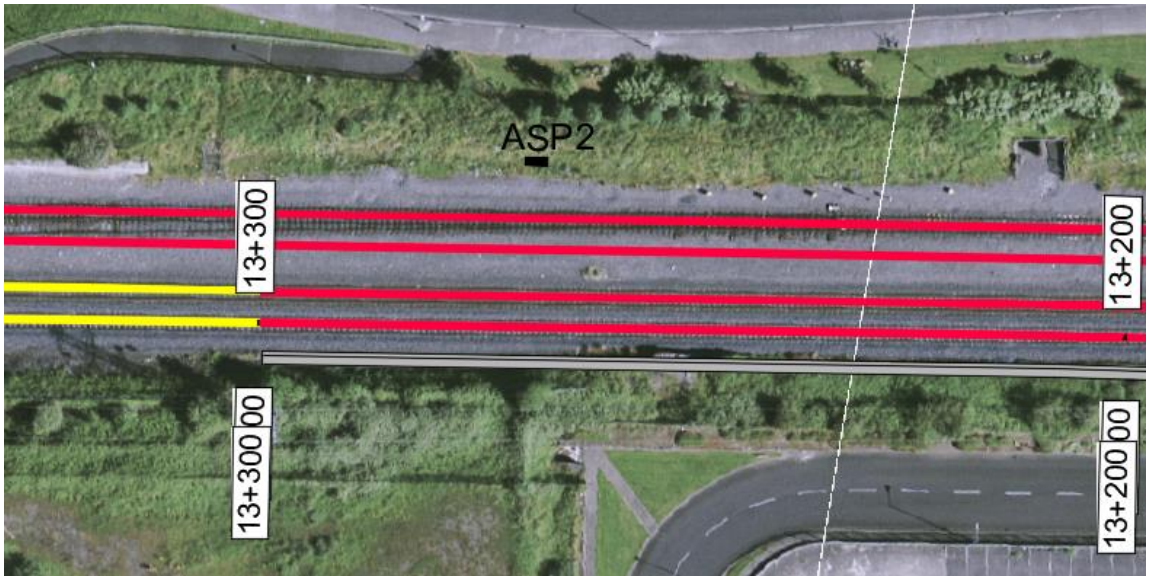


Figure 7-12 Signalling (Approx. 50m east of Footbridge Cherry Orchard)

- Black box – Auxiliary Supply Power

7.3.4.2. Signalling Post

There are currently no proposed signalling cantilevers or gantries in this section and trackside signals would be located on signal posts adjacent to trackside. A typical signal post is shown in **Figure 7-13.**

Figure 7-13 Typical Signalling Post

7.3.4.3. Object Controller Cabinet (OBJ)

In the railway system, the movement of the train is controlled by an interlocking system. Such an interlocking system consists of different parts. From a logical perspective, there is a central device (computer) that controls

and senses the condition of important equipment such as switches, signals, track circuits, etc. This equipment is collectively referred to as an object or rail side object. The equipment that handles the interface between the central device and the object is referred to as an object controller. A typical Object Controller Cabinet is shown in **Figure 7-14e 7-14**.

Figure 7-14 Typical Object Controller Cabinet (OBJ)

7.3.4.4. Location Case

Location Cases (Locs) accommodate railway signalling equipment to detect the location of trains, control the trackside signals and switch the points. They link the physical asset to the control equipment within. Additionally, they are used to accommodate the required power distribution to the signalling equipment. A typical Location Case is in **Figure 7-15**.

Figure 7-15 Typical Location Cases

7.3.4.5. Cable Containment

A cable containment strategy has been progressed and following review of several alternatives such as traditional concrete troughing and direct burying cable routes and secure anti-slip walkways (see **Figure 7-16**), with ladder rack being used on the tunnel walls. Secure troughing occupies the same footprint as concrete troughing but is of lighter more manageable construction. As this trunking also acts as a designated non-slip walkway it will help to mitigate space constraint issues along the route as well as minimise the aesthetic impact to the public. It also has the added advantage that it provides security of cabling from theft and damage as well as providing easy maintenance going forward.

Figure 7-16 Containment walkway

Cable containment route will run adjacent to the track in accordance with standard railway practice and will cross under the track where required using under track crossings (UTX) and secure turning chamber. Type of containment at each stage of the track will be shown at the permanent way cross section drawings. See **Appendix C Drawings** .

7.3.4.6. Telecommunications

No new TER is needed in this section

7.3.4.7. Electrification

In Park West to Le Fanu Road Bridge section, in the 4 track area, the electrification equipment will be supported by TTC structures and STC structures where the OHLE to be terminated with an anchor arrangement when required in limited space, as detailed in **Section 3.2.1. Figure 7-17** shows an example OHLE TTC arrangement in a four track open route

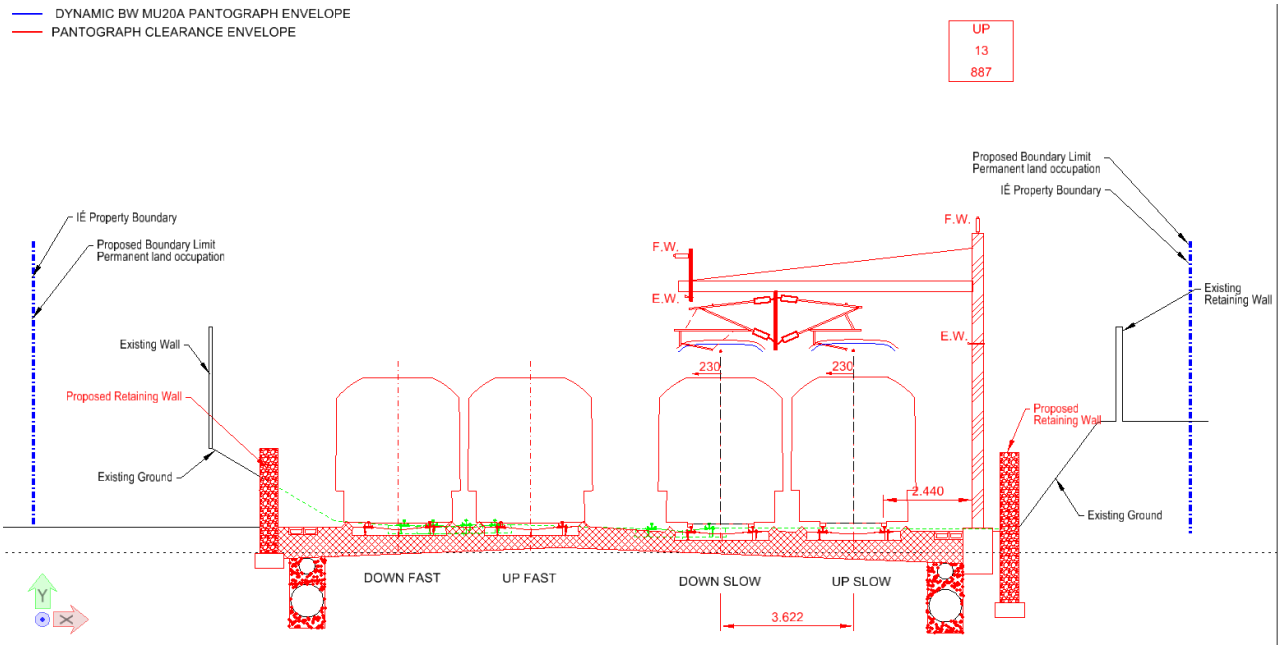


Figure 7-17 Example OHLE TTC arrangement in a four-track open route – Facing West

Le Fanu Road Bridge (OBC7) will be designed to provide a minimum soffit height of 4.91m. In this configuration the OHLE will be graded down with a minimum contact wire height of 4.4m through the bridge under all conditions. OHLE through the bridge will be fitted, with elastic bridge arms supported from the bridge at a single location in the middle of the bridge due to its length. Electrical clearance from the live OHLE to the bridge will be 100mm static and 80mm dynamic. These connections would not be visible from road level.

For Cherry Orchard Footbridge (OBC8B), the bridge is sufficiently low in its existing configuration that the OHLE can be fitted as it passes through, but the bridge is narrow. Therefore, the OHLE is supported either side of the bridge on the standalone masts with elastic bridge arms with a contact wire height of 4.61m with 4.4m minimum contact wire height under all conditions. Electrical clearance from the live OHLE to the bridge will be 100mm static and 180mm dynamic.

Typically, OHLE masts would be positioned between 20m and 40m on each side of the bridge before reverting to normal spacings. The contact wire will be graded up. **Figure 7-18** shows an example of a cross section for fitted OHLE system in the four-tracking area.

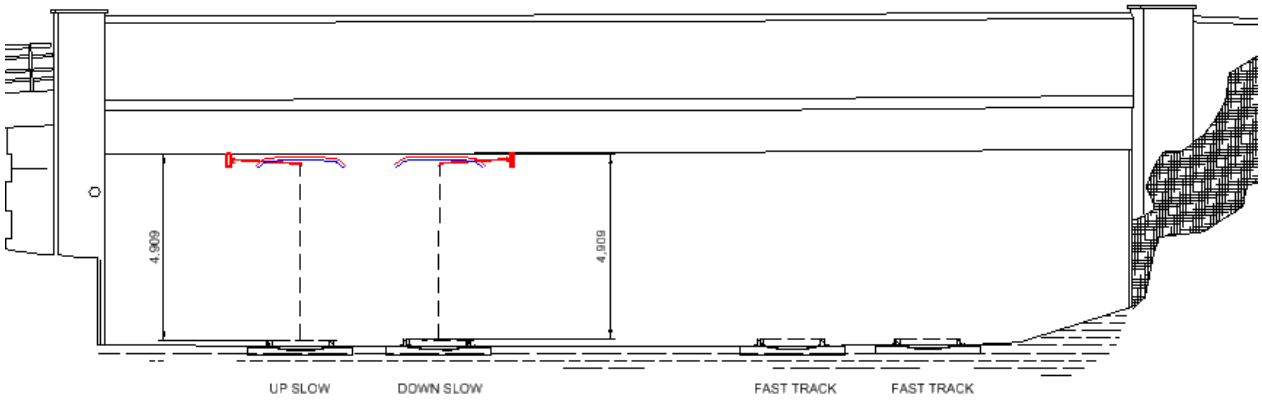


Figure 7-18 Example cross section for fitted OHLE system in four tracking area – Facing East

7.3.5. Roads

The brief remains to provide a footpath width that would be compliant with current Design Manual for Roads (2011); as well as a cycle lane/track width that is compliant with the National Cycle Manual (2013).

Figure 7-19 shows the roadway plan and profile at Le Fanu Road over the area reinstated to accommodate the bridge raising.

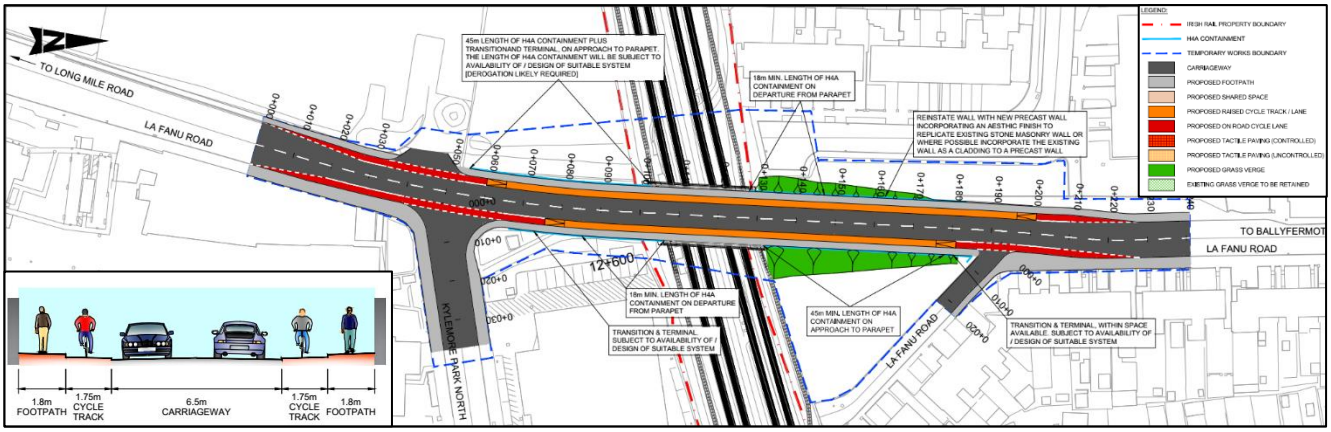


Figure 7-19 Le Fanu Road - Plan and Section

Further considerations as the design progresses through to detailed design will be the potential formalising of crossing points in the vicinity of Kylemore Park North (to the south) and Le Fanu Cul-de Sac (to the north).

Careful attention has been made to balance the provision of off-road segregated cycle tracks while providing unhindered access to existing properties. Where the geometry of the road and junctions dictate, the cycle tracks revert to on-road cycle lanes but still independent of the vehicular lane.

The carriageway lane widths would be increased to 3.25m over the bridge, in localised sections of the short length on approach roads, it would result in a decrease from existing lane widths; only because of the variable widths that currently exist across the reconstruction length. The proposed reduction in lane widths serves a threefold purpose:

- primarily to provide the space for segregation of vulnerable users from road traffic.
- secondary to this is to provide uniformity of cross-section through the new section.
- In addition it is desired to facilitate reduce speeds reductions having introduced a new layout that is vulnerable user-friendly and at a transition between residential and industrial districts (also earmarked as an area of interest for urban regeneration).

The proposed footpath and cycle track arrangement, for both sides of the road over the bridge, and on all departures and approaches to the bridge would include:

- 1.75m wide cycle track segregated from the carriageway with a 50mm kerb height
- 1.8m wide footpath with 75mm kerb height to the cycle track adjacent; separating it from the cycle track
- At the bridge the footpath will have an additional buffer strip to the parapet face for potential fixings.
- Appropriate drop kerbs and tactile paving will be provided for vulnerable users at crossing points.

The previous pedestrian crossing of Le Fanu Road, between Kylemore Park North and the bridge is not proposed to be replaced due to the space constraints on the road corridor. However, a replacement crossing is proposed immediately to the south of Kylemore Park North where the road corridor widens at boundary of its interface with the current proposed reinstatement works area.

7.3.6. Drainage Requirements

7.3.6.1. Road Drainage

The road drainage would be reinstated with typical pipe and gulley collection system, with gullies located similarly to the current drainage layout. Additional gullies would however be provided to account for the nominal widening of the road corridor. All low points would typically be reinstated with a double gulley configuration to provide a level of mitigation against the potential for blockages.

The short section of road 60-80m north of the crest of the road, at the bridge, is proposed to drain into an engineered infiltration trench/bed located in the public open space to the east of Le Fanu road. The details of the infiltration bed and associated planting will be agreed at the detailed design stage to include appropriate sustainable planting for this public amenity area.

This infiltration bed will serve to:

- Reduce runoff into the existing combined sewer gravity system located in the area. All such systems tend to be overloaded owing to the increased runoff over time.
- Provide an enhanced level of natural treatment of aromatic hydrocarbons associated with road runoff as well as attenuate fine particular matter that normally enters the closed gravity systems.
- Provide a more direct source of water for the planting and trees that would be relocated and reinstated as part of the road widening.

7.3.6.2. Track Drainage

The proposed drainage system includes filter drains to collect runoff waters from the ballast and surrounding areas, and carrier pipes to convey collected runoffs to the proposed attenuation structure and discharge point, located west of Inchicore Depot. The proposed filter drains discharge into the collector pipes through manholes, which are to be spaced between 30 to 50 metres.

The drainage network for this track section consists of two main branches running parallel to the track beneath the ballast layer. No track drainage attenuation structures are proposed in this section between Park West and Le Fanu; as the retention tank and outfall point for the network draining this track length are located in the Inchicore Yard lands.

8. Construction

This section of the report sets out the approach in relation to the construction methodology for the works based on the preferred option in the area between Park West Station and Le Fanu Road Bridge (OBC7).

The section of the railway corridor has to be widened from Cherry Orchard Footbridge to Le Fanu Road Bridge (OBC7) to accommodate the additional 2No. tracks for the new DART+ service. In addition, the 2No. northern tracks through this area (Slow Tracks) will be electrified. The cross section varies through this area but is predominantly in cutting, with property boundaries close to the top of the cut slopes. The widening operation is further complicated by the need to lower the tracks through this area so that roads that cross the corridor at Le Fanu Road Bridge (OBC7) and Kylemore Road Bridge (OBC5A) to an extent they create a create significant permanent impact on local properties and road infrastructure, as well as being cognisant of the temporary impact being that of a long duration for both bridges combined.

8.1. Retaining Structures

To achieve the widened cross section, to limit the impact of the construction works on adjacent properties and to reduce land acquisition, it is proposed to construct walls along each side of the corridor where there is a level difference between the tracks and the adjacent land.

Several different wall types are proposed depending on the height of the retained soil, the soil conditions and the proximity of buildings to the corridor.

8.1.1. Secant piled walls and contiguous bored piled walls

Secant and contiguous bored piled walls are constructed using a top down method i.e. they are constructed through the soil and then the soil in front of the walls is removed. Large piling rigs are required to core large diameter holes through the soil using augers through soil and corers through rock. Once the soil is removed a reinforcement cage is lowered into the holes and concrete is poured. New piles are added to the side of the first to create a wall. Secant pile walls have continuous piles interconnected with each other and contiguous piles have gaps between the piles and are infilled between to create continuous support.

The boring of the piles, the removal of spoil, the supply of reinforcement cages and concrete to and from the wall position is a significant operation requiring large piling equipment, cranes, dump trucks, and large concrete and rebar supply and dump vehicles. These operations require good access and egress, a stable operational platform and significant working space.

8.1.2. Cantilever Retaining Walls

Cantilever walls can be constructed by locally steepening the cut slopes. This will create the space for cast in place or precast construction. The working sites will require access for relatively heavy plant (small cranes, concrete trucks, dump trucks etc) and it is anticipated that this will be done by means of a bench at base of the slope or using possessions of the railway to create access via temporary haul roads. Cantilever walls can be cast in situ or precast with precast being preferred on time-critical sites so as the rail environment.

8.1.3. Soil Nailing

Soil nailing is a top down walling method. From the top, soil is excavated over a short height. The surface of the excavation can be spray concreted with steel mesh placed in position if required. When the concrete has cured sufficiently, long steel rods are driven into the retained soil and stressed to give the wall global stability and strength. The area beneath the constructed section of wall can then be excavated and the process repeated until the entire height is complete.

The main advantage of soil nailing is that relative to other options it has less impact on the properties in terms of noise and disruption. It also does not need so much large plant to install the wall and is therefore considered safer to the railway operation.

The main disadvantage of this method is that vertical walls cannot generally be created so more land take is required to form the wall. Also, the nails are required to extend several metres past the face of the wall and may encroach into property outside of the ownership of Irish Rail. In this case a wayleave or other ownership mechanism may be required under certain properties.

8.1.4. Le Fanu - Embankments and Retaining Walls

It is proposed that a bored secant pile wall solution will be adopted for the section of retaining wall immediately west of Le Fanu along the perimeters to form the northern and southern tracks cess edge. The retaining walls vary between 3 to 6m in height and will be constructed utilising access from track side within Irish Rail lands.

To minimise the pile size and associated lateral movement of the upper portion of the walls and to maintain the integrity of the infrastructure beyond the crest of the retained slope, the retaining walls along this section shall be anchored using soil nails extending into the existing slope substratum on both the northern and southern side of the rail corridor. The length of the soil nails/ground anchors will vary based on the height of the cutting slope to be retained and are anticipated to be approximately 10 m in length.

The soil nails/ground anchors will be installed utilising access from track side within Irish Rail lands.

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

Cantilever walls are proposed at the wall locations travelling west of the secant pile wall towards Park West. The cantilever walls will typically range from 0.5 to 2.5 m in height and will be constructed utilising access from track side within Irish Rail lands.

8.2. Bridges

The Le Fanu Road Bridge (OBC7) is required to be reconstructed to enable a greater span over the railway, with the number of tracks going from 2No. to 4No. under the bridge.

The preferred option assumes that Le Fanu Road Bridge (OBC7) will have to be closed to allow construction of the new bridge, approach roads and associated advanced work to facilitate the same. A temporary footbridge will also be needed for the construction of the works. As a result of the full closure, a temporary vulnerable user bridge would be provided in advance of said works to provide an uninterrupted direct access (at this location) between the residential area to the north and the industrial area to the south of the bridge (Pedestrians, Cyclists and Wheel). Refer to Section 8.6 – Temporary Traffic Management. The same temporary bridge will include utility diversions.

The Le Fanu Road Bridge (OBC7) will be constructed in advance of Kylemore Road Bridge (OBC5A) Le Fanu Road itself will also be closed to allow construction of the new bridge.

Both abutments are currently assumed to be piled foundations, an alternative method may be proposed by the construction contractor; or amended during detail design. Works will focus on the north side first; the proposed northern abutment wall is suffiently distant from existing tracks to pile in advance of the bridge demolition and adjacent to public open space available for access (the public open space is intended for temporary occupation and reinstatement as part of this project, see Section 8.5- Construction Compounds). Following demolition, the southern abutment walls will be constructed in a safe zone. Beams, slab and parapets will then be placed during nightime possessions to limit impact on rail operations.

Following demolition of the existing bridge, lowering of the slow tracks zone and finishing the abutment seating construction works to both north and south abutments, abutting precast concrete beams will be placed using a cranes located each side of the bridge. A deck slab will be poured over the beams and at the end diaphragms to tie the walls into the deck. Craning of precast beams would also be undertaken under a track possession, but deck slab and diaphragm stitches could possibly be done during live operations.

8.3. Permanent Way

Track lowering will be required as a result of the preferred option through this area to facilitate the provision of four tracking and electrification. Works will comprise:

- Diversion or closure of the operational track, utilities and ancillary infrastructure
- Where excavations are significant, support of adjacent operational track
- Excavation of track bed
- Excavation of sub strata
- Replacement of utilities and ancillary infrastructure
- Construction of new track bed

Due to the proximity of the proposed southern retaining walls to the existing track between Cherry Orchard Footbridge (OBC8B) and Le Fanu Road Bridge (OBC7), it is probable that a few staging phases between OBC8B and Inchicore Yard may be required to facilitate construction. First priority will be to provide the proposed new Slow Tracks to the north and consequently therefore the northern retaining wall in advance to facilitate the same.

8.4. OHLE Infrastructure

Structures will be required at a maximum spacing of 60m along the track to support the catenary cables. The support structures are generally supported from one side of the track (cantilever) or from both sides (portal) depending on the permanent way layout. Where there are adjacent walls the support structure can be fixed to the walls negating the need for vertical supports (stanchions).

Support structures will be either founded by means of piles or spread foundations, depending on soil conditions or the contractor's preferred methodology.

It is envisaged that the OHLE will be constructed in safe zones adjacent to the live railway or in night-time possessions. The phasing of the works will endeavour to keep a minimum of 2No. working railway tracks through the Cork line. it is envisaged that a safe zone will be possible for construction in this area.

8.5. Construction Compounds

Works on this linear scheme will require construction compounds at specific locations. The sites will need to accommodate offices for the contractor and client teams, storage facilities, recycling facilities, parking for cars and plant and potentially fabrication areas. It is a prerequisite that the construction compounds are located close to and ideally with direct access to the site. The sites must be fully serviced with electricity, water, sewerage and telecoms and must have good access to the public road.

The construction compounds are required at specific construction sub-sites and also distributed along the scheme by geographical features. For example, compounds will be required at each of the bridge reconstruction locations as well as for material processing and storage of construction components. The construction compounds will be used to support earthworks, ecological clearances, enabling works, site clearance, utility diversions work, civil works, the demolition of bridges, OHLE, track installation, signalling and telecoms equipment and all ancillary works.

Layouts have been developed for each compound, but final layouts will be developed by the contractors at construction stage. Fencing and in some cases screening along with topsoil bunds where topsoil has been removed may be required for each construction compound. Noise screening and temporary guide rail fencing may be required at access locations to the railway corridor. Security fencing will be required for security purposes of both the workforce and the public. Gated access to the site and compounds will be required to check vehicles and personnel arriving on site are permitted to gain access. An access road will also be required from each compound to the site and also joining up to the public road. These access roads will be the main route for vehicles entering the site, including deliveries and arrival and departure of the workforce.

The construction compounds will be located such that they require minimal modification, if any, over the duration of the construction programme. The compound will consist of areas of hardstanding for vehicles and materials and therefore the water runoff with be managed and treated as required.

Construction compounds will need to accommodate offices for the contractor and client teams, storage facilities, recycling facilities, parking for cars and plant and potentially fabrication areas. It is a requirement that the construction compounds are located close to and ideally with direct access to the various work sites and have good access to the public roads network.

Some construction compounds are required at very specific geographic locations, in close proximity to specific work elements, for example, construction compounds will be required at each of the bridge reconstruction locations.

A number of geographic locations have been identified as construction compounds along the route to support the project construction; four compounds are required in the vicinity of Park West and Le Fanu Bridge:

- Friel Avenue
- Cherry Orchard Avenue
- Le Fanu Bridge
- Main Contractor Offices & Compound

Section 5 Options outlines the preferred locations for the three construction compounds required for this area; **Section 6 Options Selection Process** provides a detail of the option selection methodology. **Figure 8-1** illustrates the preferred option indicative site layout for these construction compounds.

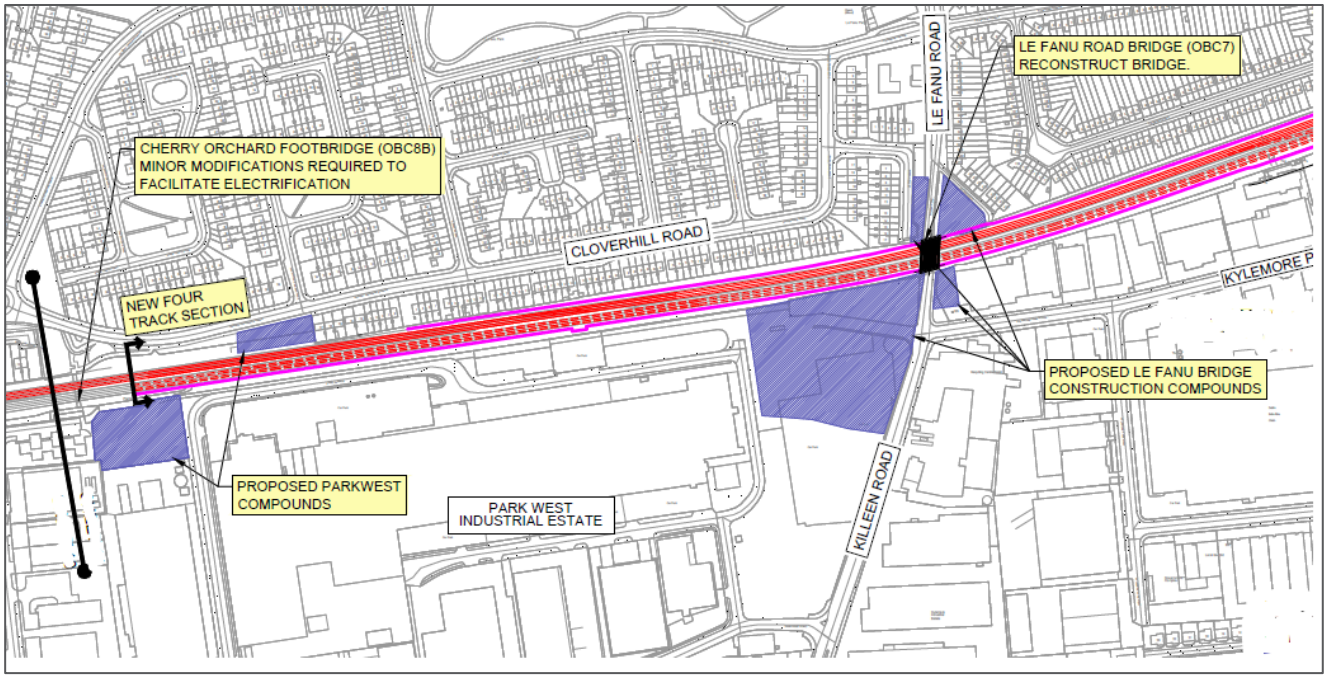


Figure 8-1 Proposed Construction Compound Locations

8.6. Temporary Traffic Management

8.6.1. Le Fanu Road Closure

Le Fanu Road Bridge (OBC7) reconstruction will require a full closure of the existing bridge on Le Fanu Road. A temporary pedestrian bridge is to be provided on the western side of the Le Fanu Rd bridge. This will cater for all pedestrian movements across the rail line during the construction period.

The option of providing a temporary road bridge was investigated but the impact on all the 3rd party landowners north of the track (located in the service) would block vehicular access to these properties for the full extent of the Le Fanu Road Bridge (OBC7) reconstruction period, as well as a period for the advance temporary utility diversions. The clearance requirements to existing running rails dictating the level of a temporary bridge along with a very long span, resulting in a proposed road/ramp extending 40-50m into the service road before being able to link back with Le Fanu Road near the Le Fanu Road (cul-de-sac).

The southbound and northbound traffic is anticipated to be distributed onto the surrounding network via the Kylemore Road bridge. Heavy Vehicles (HVs) will be restricted from using Kylemore Ave and will be required to travel via Ballyfermot Rd instead. The proposed diversion routes for light traffic are shown in Figure 8-3 while heavy traffic diversion routes are shown in Figure 8-4.

To cater for the additional traffic volumes, it is anticipated that temporary traffic signals will be required at the following existing priority junctions:

- Kylemore Rd & Kylemore Ave; and
- Kylemore Park Rd & Le Fanu Rd.

Temporary traffic signal locations are shown in Figure 8-5.

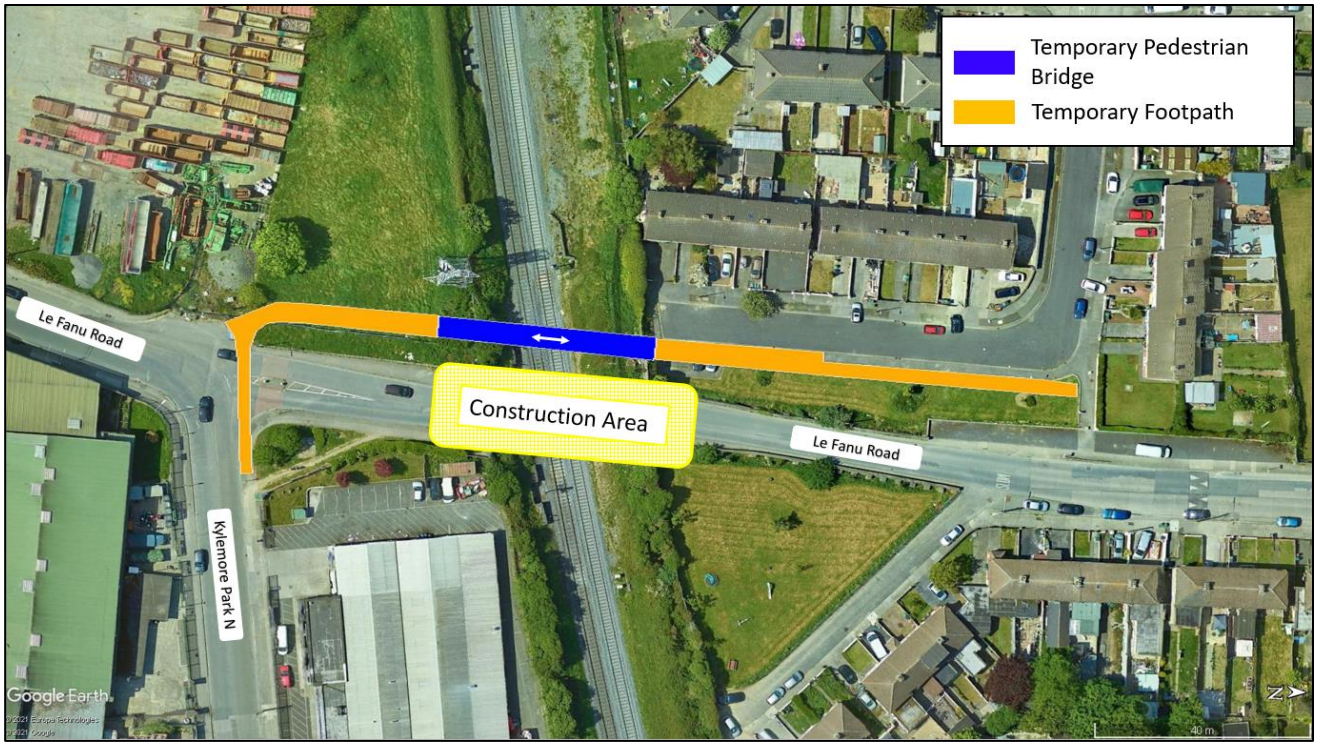


Figure 8-2 - Le Fanu Rd Full Closure – Mitigation Measures

Figure 8-3 – Le Fanu Road Traffic Diversions – Light Vehicles

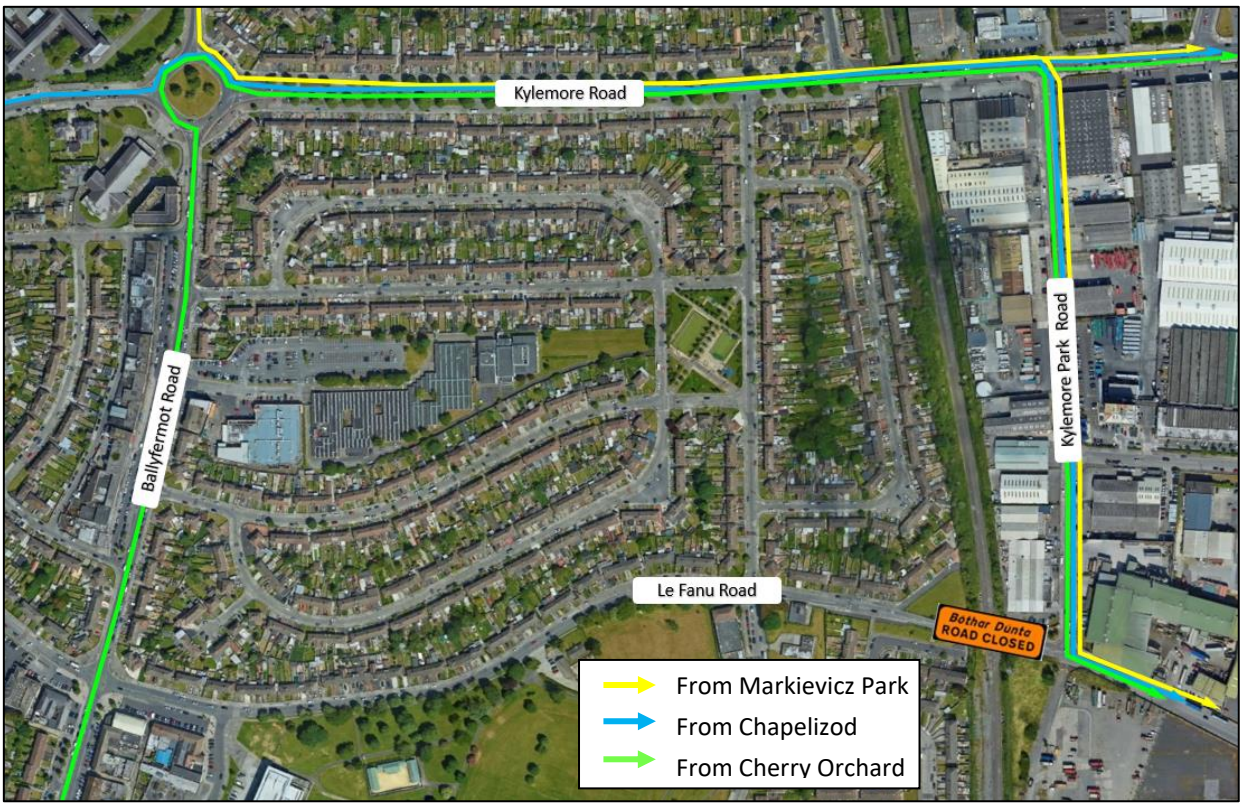


Figure 8-4 - Kylemore Southbound Traffic Diversions – Heavy Vehicles

Figure 8-5 - Temporary Traffic Signal Locations

Owing to the lengthy duration of this closure, vehicular users are anticipated to experience initial congestion at the start of the closure, followed by a gradual decrease in total vehicle volumes and congestion.

Overall pedestrian and cycling connectivity are expected to be maintained throughout the closure period and, as a result, it is expected to maintain a high level of service. Pedestrian facilities are expected to be provided on the western side of the construction area via a single temporary bridge.

No bus routes are known to utilise Le Fanu Road and will therefore not require any diversions.

8.7. Restrictions

There are restrictions associated with working on or adjacent to the live railway line. Irish Rail will mandate a safe system of work which will invariably include barriers between the live tracks and the working area or full possession of the railway (no trains running).

Every attempt will be made to control materials delivery times to outside peak traffic hours; particularly for construction HGV's known to restrict natural flow of traffic. In addition, where possible long duration night works will be limited in residential areas unless appropriate noise mitigation can be provided.

A full methodology of the setup and construction methods will need to be sympathetic to both the railway operations, as well as residents and/or employers in the area. The methodologies will be fully reviewed by the Irish Rail team before the works are given approval to proceed (taking account of all stakeholder concerns from the public consultation phases as well as planning compliance criteria stipulated in the Railway Order).

Appendix A – Sifting Process Backup

A1. Sifting Process Backup - Le Fanu Road Bridge

A2. Sifting Process Backup – Main Contractors Office & Compound

Appendix B – MCA Process Backup

B1. MCA Process Backup – Civil and OHLE

Appendix C – Supporting Drawings

The following drawings accompany the Technical Report for this area:

Bridge Drawings

DE-04-23-DWG-ST-TTA-62130: Le Fanu Road Bridge (OBC7) – General Arrangement

DE-04-23-DWG-ST-TTA-62131: Le Fanu Road Bridge (OBC7) – Bridge Deck Plan

DE-04-23-DWG-ST-TTA-62132: Le Fanu Road Bridge (OBC7) – Bridge Deck Longitudinal Section

DE-04-23-DWG-ST-TTA-62133: Le Fanu Road Bridge (OBC7) – Bridge Deck Cross Section

Roads Drawings

DP-04-23-DWG-CV-TTA-61511: Le Fanu Road Bridge (OBC7) Road – Plan and Profile

Permanent Way Drawings

DP-04-23-DWG-PW-TTA-61990: Kylemore Road Bridge (OBC5A) and Le Fanu Road Bridge (OBC7) Road – Track Plan Layout

DP-04-23-DWG-PW-TTA-61992: Kylemore Road Bridge (OBC5A) and Le Fanu Road Bridge (OBC7) Road – Cross Section at Ch 12+898