DART+ South West

Technical Optioneering Report

Park West to Heuston Station

Area around Khyber Pass Footbridge (OBC5)

Iarnród Éireann

Contents

Tables

Figures

Glossary of Terms

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

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

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

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

1. Introduction

1.1. Purpose of Report

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

This report provides the technical assessment of the area around Khyber Pass Footbridge (OBC5). This report presents the approach to option development, options assessment, and options selection. This optioneering process incorporates assessment by the following Design Workstreams and specialist Project Teams:

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

The report provides:

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

1.2. DART+ Programme Overview

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

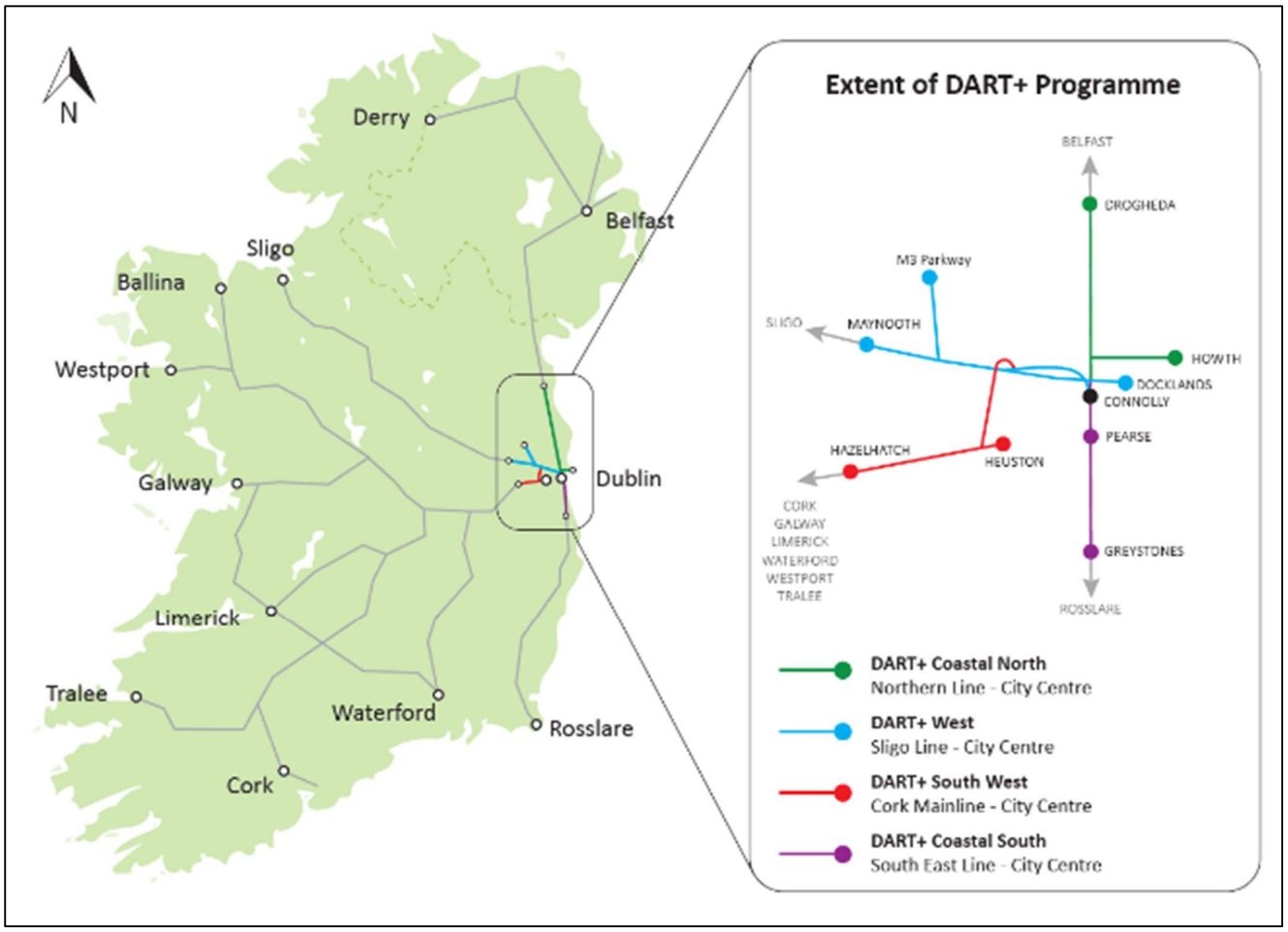

Figure 1-1 DART+ Programme

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

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

- DART+ Fleet – purchase of new electrified fleet to serve new and existing routes.

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

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

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

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

1.3. DART+ South West Project

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

DART+ South West will complete four tracking between Park West & Cherry Orchard Station and Heuston Station, in addition to re-signalling and electrification of the entire route. The completion of the four tracking will remove a significant existing constraint on the line (i.e., where four tracks reduce to two), which is currently limiting the number of train services that can operate on this route. DART+ South West will also deliver track improvements along the Phoenix Park Tunnel Branch Line, which will allow a greater number of trains to access the city centre.

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

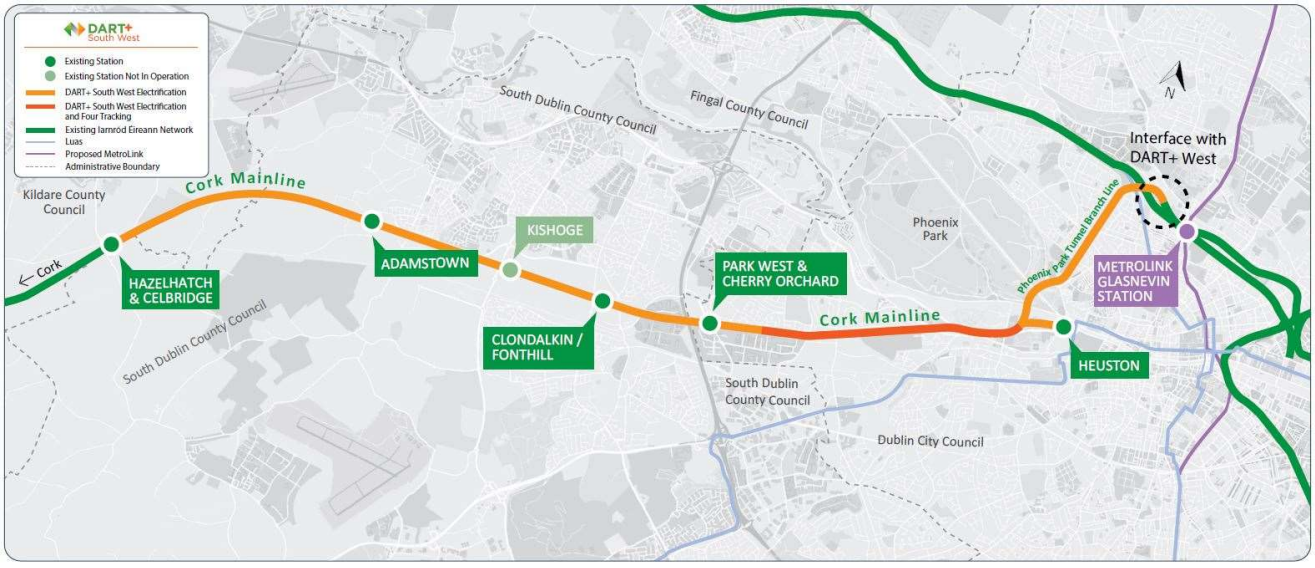

Figure 1-2 DART+ South West Route Map

1.4. Capacity Increases Associated with DART+ South West

The operating capacity of services in the Heuston area is currently constrained by railway infrastructure limitations and the ability of Heuston Station to accommodate terminating trains. Iarnród Éireann operates at a maximum capacity of 10 inbound trains in the AM peak hour (08:00hrs-09:00hrs) and 10 outbound trains in the PM peak hour (17:00hrs-18:00hrs). This provides a peak capacity of approximately 3,750 passengers per hour per direction during the AM and PM peak hours; operating inbound and outbound, respectively. DART+ South West aims to 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.

DART+ South West will significantly increase train capacity from the current 10 trains per hour per direction to 21 trains per hour per direction (i.e. maintain the existing 10 services, with an additional 11 train services provided by DART+ South West). This will increase passenger capacity from the current peak capacity of approximately 3,750 passengers per hour per direction to approximately 17,000 passengers per hour per direction. Upon completion of the DART+ South West Project, train services will be increased according passenger demand. 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 Infrastructure Elements of DART+ South West

The key elements of DART+ South West include:

- Completion of four-tracking from Park West & Cherry Orchard Station to Heuston Station, extending the works completed on the route in 2009.
- Electrification of the line from Hazelhatch & Celbridge Station to Heuston Station and also from Heuston Station to Glasnevin, via the Phoenix Park Tunnel Branch Line, where it will link with proposed DART+ West.
- Undertaking improvements / reconstructions of bridges to achieve vertical and horizontal clearances.
- Remove rail constraints along the Phoenix Park Tunnel Branch Line.
- Feasibility report and concept design for a potential new Heuston West Station.
- The ‘Emerging Preferred Option’ will be compatible with the future stations at Kylemore and Cabra, although the construction of these stations is not part of the DART+ South West Project.

1.6. Route Description

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

Table 1-1 Route Breakdown

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

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

2. Existing Situation

2.1. Overview

This report focusses on a localised area that covers the existing Khyber Pass Footbridge (OBC5) . The Permanent Way in this area currently consists of 3 No. tracks. The rail is at grade and approximately the same level as the surrounding ground. There is a masonry boundary wall along the north side of the rail corridor at this location.

The major infrastructure features of the area are illustrated in **Figure 2-1**.

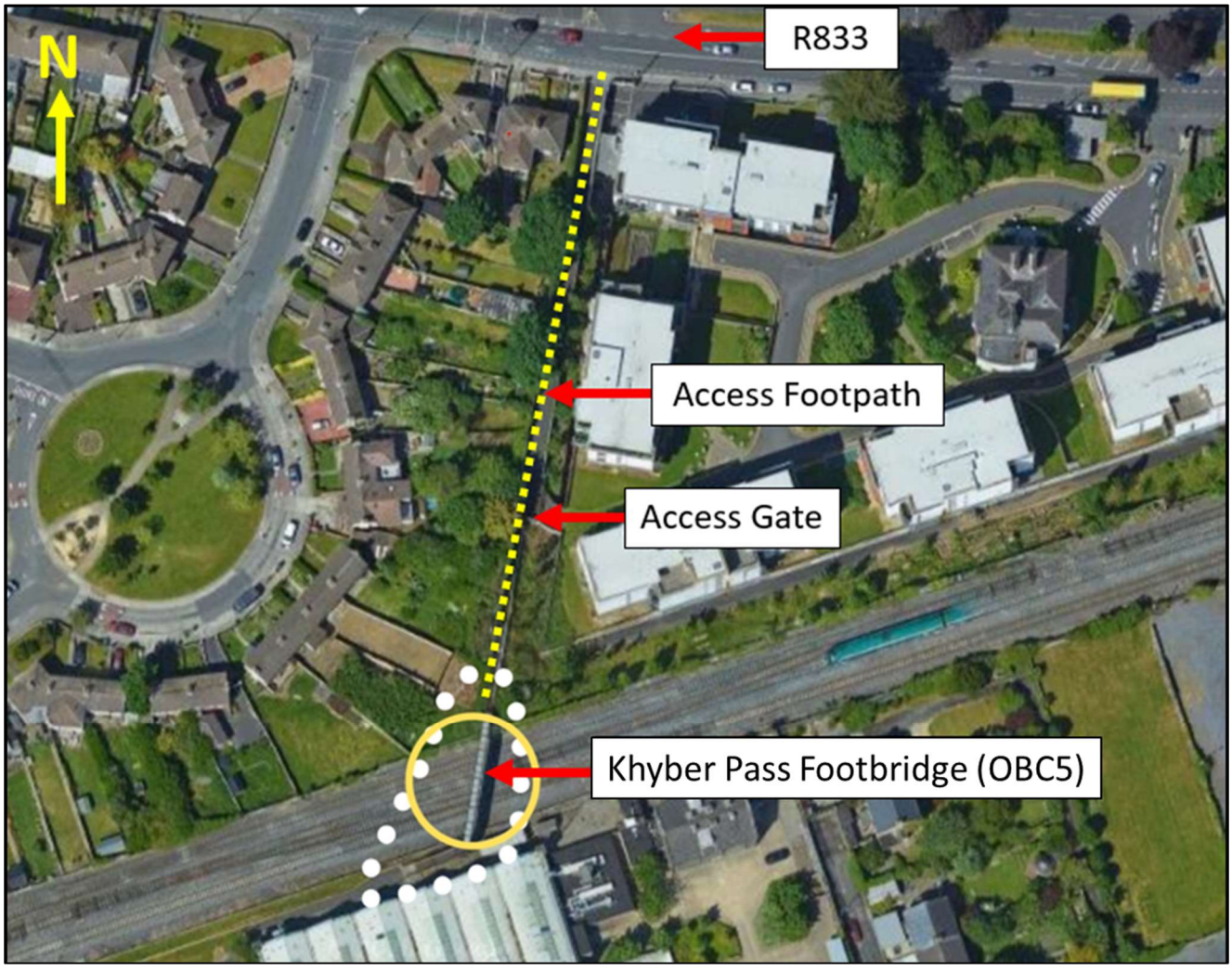

Figure 2-1 Area covered under this Technical Optioneering Report (white dotted outline)

The main Environmental features of this area are described in **Section 2.6**.

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. of tracks and to electrify 2 No. northern tracks from Hazelhatch Station to Glasnevin Junction.

The challenge in this area is the constraint that is posed by the existing Khyber Pass Footbridge (OBC5) structure. It has insufficient horizontal clearance to facilitate 4 No. tracks to Iarnród Éireann (IÉ) design standards without a structural intervention.

Options for the Khyber Pass Footbridge (OBC5) include reconstruction of the bridge with a new bridge that would have sufficient vertical and horizontal clearance to meet the requirements for 4-tracking and electrification; retention of the existing bridge and installation of derailment protection blocks to protect the abutments; or its permanent removal and implementation of an alternative (existing) pedestrian access route via Sarsfield Road and Inchicore Terrace North.

2.3. Structures

Khyber Pass Footbridge (OBC5)

The Khyber Pass Footbridge (OBC5) is an existing pedestrian overbridge at the Inchicore Works. The steel structure was manufactured and installed by Iarnród Éireann in the early ’00s. The bridge crosses the existing tracks at a high skew. The structure has a vertical clearance of approximately 5.2m above existing rail levels and a span of approximately 24m.

The single-span structure is supported on steel abutment supports and shallow foundations. The existing north and south abutments have horizontal clearances greater than 4.5m from the nearest rail (derailment clearance requirement). The north abutment is positioned outside the north CIE boundary wall (i.e. to the north of the boundary wall). The south abutment is located on the north side of the Iarnród Éireann Infrastructure building.

The internal width of the structure is 1.1m. A stairway on the north and south sides of the bridge facilitates access to deck level for the users. The edge of stairways incorporates a bicycle ledge that allows users to more easily manoeuvre bicycles to and from deck level. The bridge deck is fully enclosed. The height of the enclosed deck is 2.7m.

Access to the R833 road on the north side is secured by means of a keypad locked steel access gate. The bridge is exclusively for use by Iarnród Éireann staff and does not form part of a public footway.

Figure 2-2 Khyber Pass Footbridge (OBC5), west elevation

Figure 2-3 North boundary wall

2.4. Permanent Way and Tracks

Currently at Khyber Pass Footbridge (OBC5) there are 3 No. tracks beneath the bridge, they are named from north to south: Up Main, Down Main and Relief Line. The connection to the Inchicore Works depot, where the

Relief Line becomes the Long Siding is 180m to the west. At the bridge there are several crossovers to provide access to the depots from the three main lines.

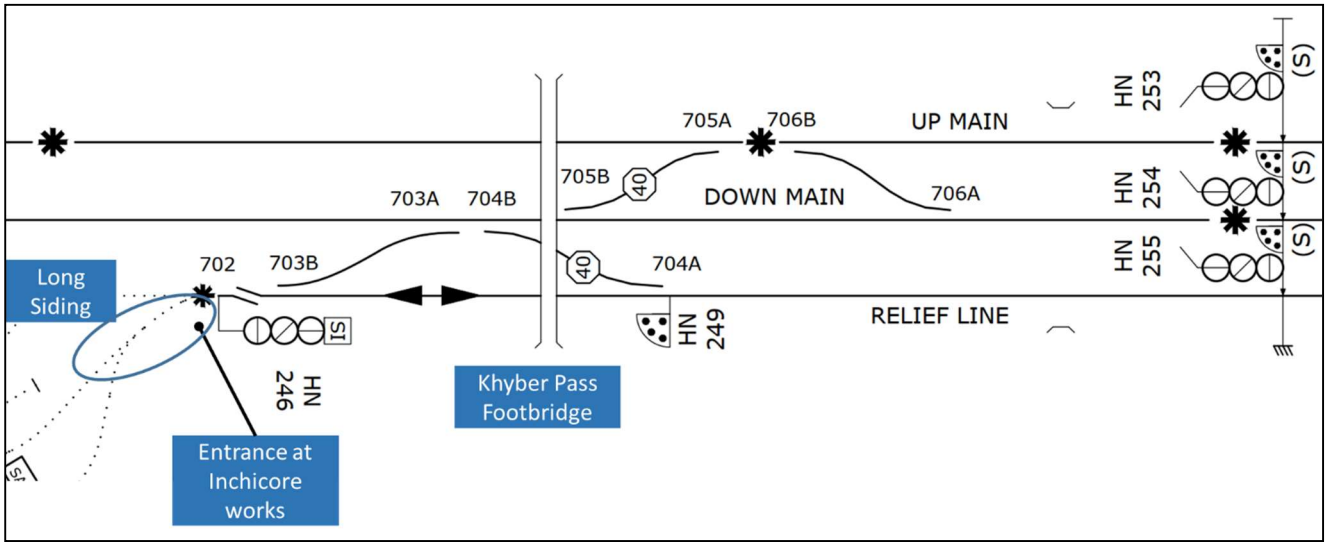

Figure 2-4 Track layout in the vicinity of Khyber Pass Footbridge (OBC5)

Please refer to Annex 3.6 for a detailed description of the existing Permanent Way in the wider area.

2.5. Topography and Ground Conditions

Topographically the ground slopes gently towards the River Liffey east to west and the railway is at grade at Khyber Pass Footbridge (OBC5).

The general superficial geology in this area is anticipated to comprise till overlying bedrock (limestone and shale). A previous ground investigation completed 70m west of Khyber Pass Footbridge (OBC5) recorded a thin layer of topsoil overlying made ground to depth of 1.40m below ground level (bgl) (28.24m AOD). This was described as slag and stony clay. The made ground was underlain by very soft to soft clay becoming stiff to very stiff with depth. The borehole was terminated at 9.50m bgl (20.14m AOD). Water strikes recorded as seepage during drilling were noted at 0.70m bgl and 5.30m bgl.

The borehole was re-drilled from ground level using rotary coring techniques. The ground conditions recorded were clayey gravel and gravelly clay between ground level and 8.50m bgl (21.14m AOD). There was no recovery of this material. Firm clay was recorded from 8.50m bgl (21.14m AOD) overlying a thin layer of limestone gravel. Rock comprising strong to very strong limestone and moderately weak mudstone and shale was encountered at 10.50m bgl (19.14m AOD).

2.6. Environment

The Khyber Pass Footbridge (OBC5) is not a protected or a listed structure. There are a number of NIAH south of the bridge associated with the main works including an office and a workshop directly south. To the east of the bridge is the Seven Oaks Apartment complex which is adjacent to the rail corridor. An RPS listed building (house) is located within the development. The Liffey Gael GAA Club grounds are located to the north of the footbridge. To the west there is significant residential development associated with Landan Road.

Refer to **Section 4.1** for further details.

2.7. Utilities

The only services that cross beneath the Khyber Pass Footbridge (OBC5) are IÉ owned services that run along the rail corridor. There are no other services that are above, below or in close proximity to the bridge. Please refer to Annex 3.6 for details of IÉ owned services adjacent to the bridge within the rail corridor.

3. Project Requirements

3.1. Area-Specific Requirements

The specific project requirements for this area are:

- Increase number of tracks from 3 No. tracks to 4 No tracks.
- Electrification of 2 No. tracks for DART+
- Provide vertical electrical clearance through existing structures or amend or reconstruct structures to provide the required clearance.
- Keep current functionality of footbridge
- Replacement bridge options to be ambulant disabled accessible and incorporate a bicycle ledge

3.2. Systems Infrastructure and Integration

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

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

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

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

3.3. Electrification System

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

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

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

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

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

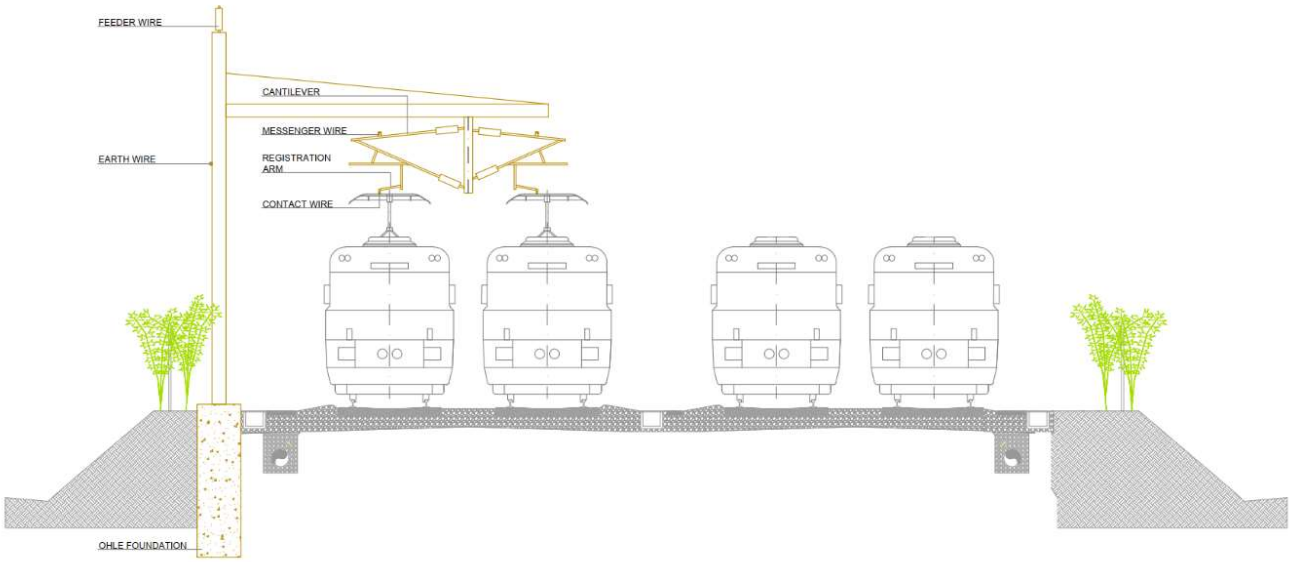

Figure 3-1 Typical OHLE arrangement in four track open route

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

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

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

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

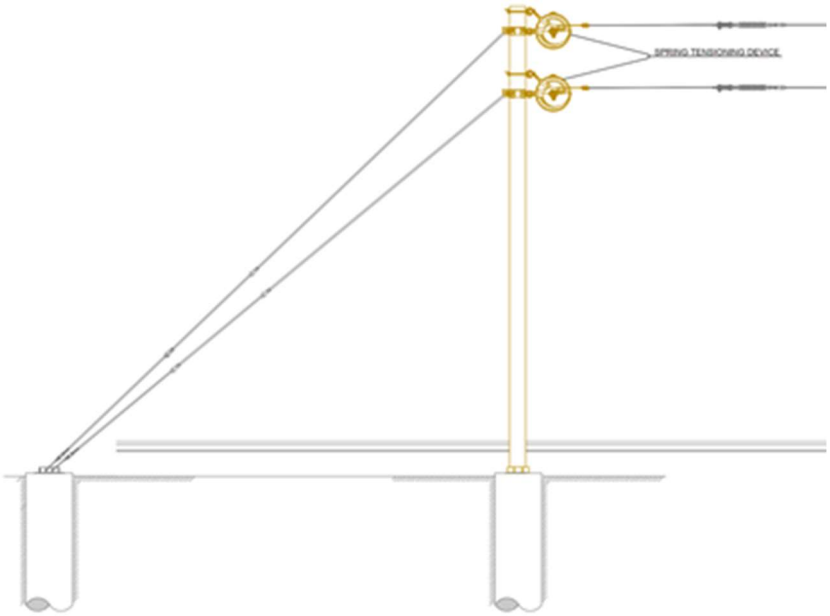

Figure 3-2 Typical anchor structure

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

3.4. Substations

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

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

3.5. Design Standards

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

4. Constraints

4.1. Environment

East of the main Inchicore works there is a lane that provides access to a private footbridge over the rail line into the CIE Works site, this is known as the Khyber Pass Footbridge (OBC5). The bridge is not a protected structure.

There are a number of NIAH south of the bridge associated with the main works, including an office and a workshop directly south. To the east of the bridge is the Seven Oaks Apartment complex which is adjacent to the rail corridor. An RPS listed building [house] is located within the development. The Liffey Gael GAA Club grounds are located to the north of the footbridge. To the west there is significant residential development associated with Landen Road.

The key environmental constraints in the area therefore include the residential development at the east end of Landen Road and the Seven Oaks Apartments and the NIAH features associated with the railway works.

Please refer to the Annex 3.6 for a description of the environmental constraints in the wider area.

4.2. Property

The existing Khyber Pass Footbridge (OBC5) is fully within IÉ lands. Options that propose a replacement bridge would be constrained by the narrow pedestrian walkway on the north side of the structure. A replacement structure designed to ambulant disabled standards would require a minimum width of 2m (i.e. more than the existing width). The lands to the east and west of the north access steps are not in IÉ ownership.

The building on the south side of the bridge poses a geometric constraint for replace bridge options with increased span lengths. Replacement bridge options with higher deck levels would require longer stairs in plan.

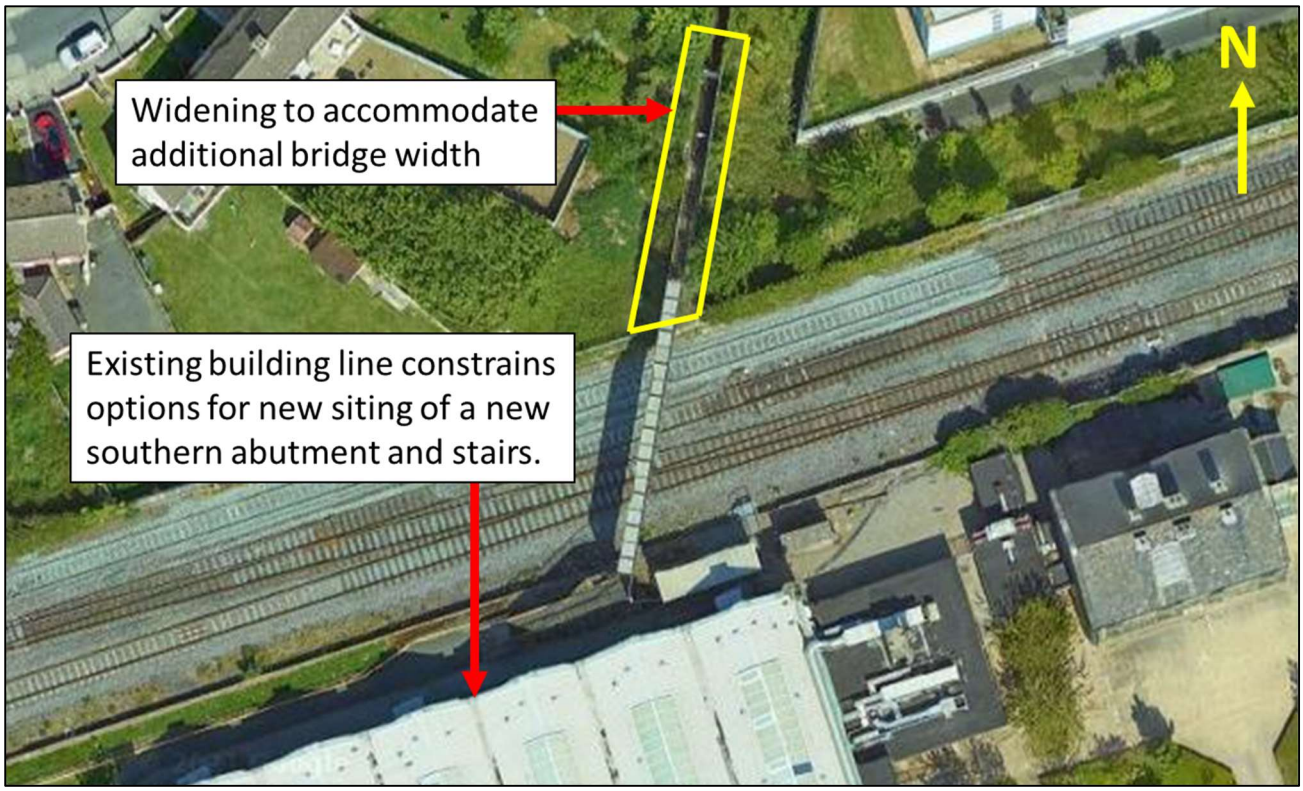

Figure 4-1 Existing pathway not sufficiently wide to provide ambulant disabled access

Figure 4-2 Land to the west (LHS) and east (RHS) of the existing north access steps

4.3. Permanent Way

The main constraints at the area of the Khyber Pass Footbridge (OBC5) are related to the resulting railway corridor width after the installation of the four-tracking. On the north the wall of the back gardens of private properties and in the south the Track & Signal HQ building. Also, it is worth mentioning that the alignment is widely constrained by the solutions chosen in the wider area around Inchicore Works.

Refer to Annex 3.6 for a description of the Permanent Way constraints in the wider area.

4.4. Existing Structures

The span and clearance of the existing Khyber Pass Footbridge (OBC5) presents a challenge in terms of achieving the project requirements of four-tracking and electrification.

There is insufficient horizontal clearance to install 4 No. tracks beneath the structure without an intervention. This is primarily due to the current location of the abutments relative to feasible Permanent Way design Options and also that the reduced horizontal clearance to the supports would not be in accordance with bridge design standards (even when derogated).

An initial bridge electrical clearance assessment has been carried out to determine whether an Overhead Line Equipment (OHLE) solution is possible without structural or track intervention. The assessment found that minimum normal clearance can be achieved with a 4.7m contact wire height with no structural or track intervention required. The skew of the bridge presents a constraint in terms of positioning OHLE masts on either side (i.e., the bridge would be crossing the OLE above each track at unequal distances from the support gantries on either side).

4.5. Geotechnical

No onerous ground or groundwater conditions are anticipated in this area based on the existing information. Shallow bedrock close to the existing permanent way formation level may be present.

Widening proposals are constrained to the south by the existing 0.5m high retaining wall on the southern boundary of the railway and the approximately 1m to 2m high masonry boundary wall to the north of the railway. New retaining walls will be required to provide the necessary horizontal width for the railway.

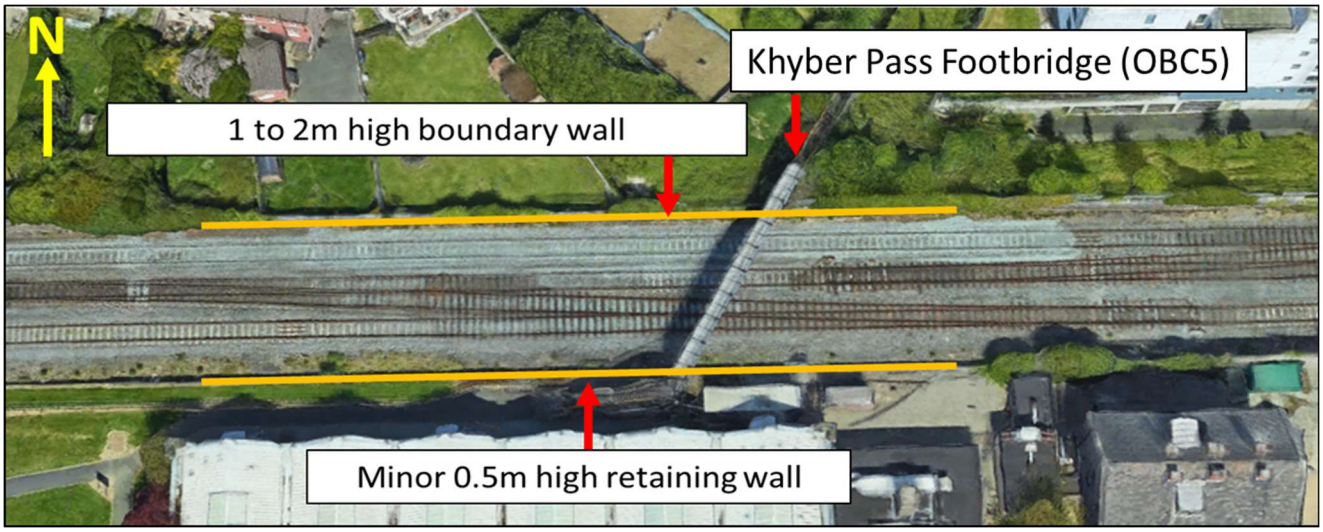

Figure 4-3 Boundary wall constraints

4.6. Existing Utilities

The only services that cross beneath the Khyber Pass Footbridge (OBC5) are IÉ owned services that run along the rail corridor. There are no other services that are above, below or in close proximity to the bridge. Please refer to Annex 3.6 for details of IÉ owned services adjacent to the bridge within the rail corridor.

5. Options

5.1. Options Summary

The existing Khyber Pass Footbridge (OBC5) structure, which currently has 3 No. tracks beneath it, has insufficient horizontal clearance to safely accommodate 4 No. tracks.

The potential intervention options for the Khyber Pass Footbridge (OBC5) include reconstruction of the bridge with a new bridge that would have sufficient vertical and horizontal clearance to meet the requirements for four-tracking and electrification, retention of the existing bridge and installation of derailment protection blocks to protect the abutments; or its permanent removal and implementation of an alternative (existing) pedestrian access route via Sarsfield Road and Inchicore Terrace North.

A total of 4 No. 'Options' have been developed. The Options include a 'Do-Nothing' Option and a 'Do-Minimum' Option.

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

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

Table 5-1 Options summary

Option	Description
Option 0: Do Nothing	The existing infrastructure remains unchanged. There are no interventions.
Option 1: Do Minimum	This option endeavours to achieve the 4-tracking and electrification project requirements with the least amount of work to the Khyber Pass Footbridge (OBC5) structure itself.
Option 2	This option proposes to remove the Khyber Pass Footbridge (OBC5) permanently and implement the use of an alternative (existing) pedestrian access route.
Option 3	This option proposes to replace the existing Khyber Pass Footbridge (OBC5) with a new bridge that has increased horizontal and vertical clearance.

5.2. Options Description

This section describes the Options that have been considered. With the exception of Option 0 (Do-Nothing) and Option 1 (Do-Minimum), there are some design disciplines that have technical features that are common to all Options (e.g. OHLE and Geotechnical). These disciplines are addressed at the end of the Option description section.

5.2.1. Option 0: Do-Nothing

The Do-Nothing Option proposes no changes to the existing Khyber Pass Footbridge (OBC5) or rail infrastructure. The horizontal and vertical constraints at the bridge would not be resolved. This option would not facilitate neither the inclusion of the additional 4th track nor the installation of an OHLE system. The project requirements would not be achieved.

5.2.2. Option 1: Do-Minimum

This option seeks to achieve the four-tracking and electrification through interventions that would retain the existing Khyber Pass Footbridge (OBC5) structure in its current form. Under this option, four-tracking and electrification would be implemented. The newly placed tracks would be located within less than 4.5m from the existing footbridge supports. As such, derailment protection walls would be constructed in front of the existing bridge supports to withstand derailment impact forces. However, the horizontal clearance to the derailment protection walls would be less than the 2.5m required by standards. The preliminary design indicates that the derailment protection walls would need to be 23.5m long x 1.5m wide x 2.5m high on 1.2m diameter piles at 2.5m centres. The bridge, which is steel, would require insulating for compatibility with the electrification system.

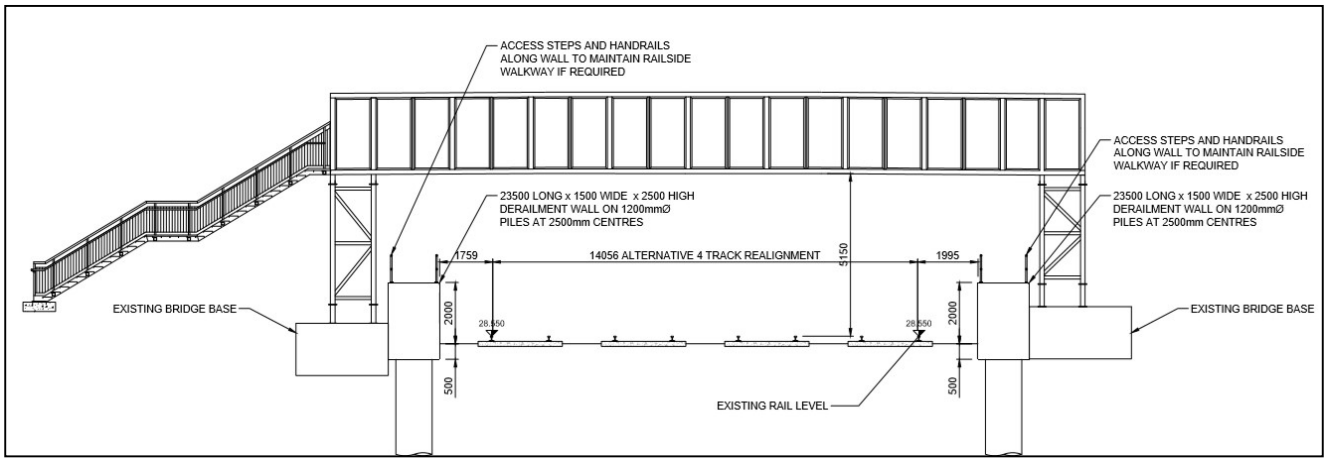

Figure 5-1 Option 1 - Bridge retained with derailment blocks installed to front of supports

5.2.3. Option 2

This option would require significant intervention. The existing Khyber Pass Footbridge (OBC5) would be removed permanently and not replaced. An alternative (existing) pedestrian access route via the R833, Sarsfield Road and Inchicore Terrace North would be implemented. Electrification and 4-tracking would be achieved. The length of the alternative route (shown in **Figure 5-2**) is 1.2 km (10-15 min walking time approximately). Dublin Bus stop (2643) is located on Sarsfield Road at the entrance to Inchicore Terrace North. The distance between stop 2643 and the south side of the existing footbridge is 700m (8 mins walking time approximately). This option would not meet the current requirement to maintain the functionality of the existing footbridge.

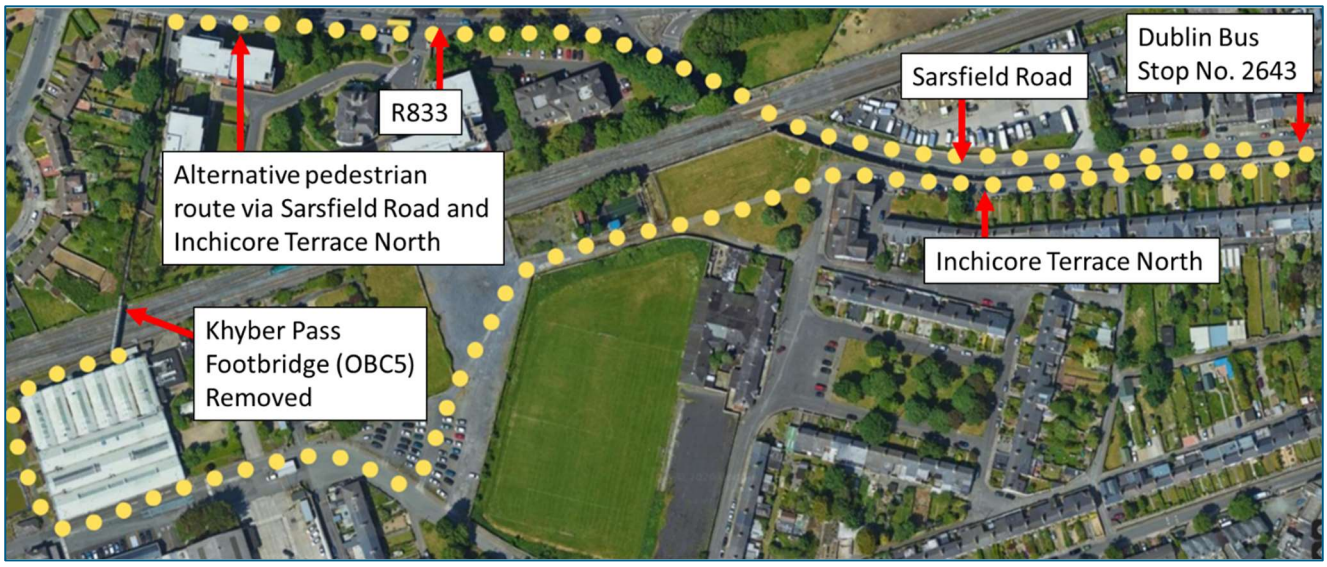

Figure 5-2 Option 2 - Alternative pedestrian and cycle route

5.2.4. Option 3

This option proposes to replace the existing Khyber Pass Footbridge (OBC5) structure. The existing bridge would be replaced with a new structure that has adequate vertical clearance to achieve the required contact wire height and OHLE clearance and a span that facilitates a minimum horizontal clearance to abutments of 4.5m. The additional vertical clearance is to accommodate the constraint posed by the skew of the bridge to the OHLE system. The superstructure would be formed using Y8 beams and an RC deck. The bridge would be enclosed. The bridge stairs would be designed to ambulant disabled standards. The stairs would incorporate a bicycle ramp ledge (similar to the existing structure). This option is compatible with Perway Option 4 and can be adjusted for compatibility with Perway Option 3. The available space at the south side of the structure is geometrically constrained in Perway Option 4. Where stairs are positioned within 4.5m (horizontally from the edge of the nearest rail), they will be dethatched and not integral with the main structure and supports. An existing spiral staircase fire escape to the building on the south side of the bridge would be removed and replaced with a stair connection to a landing platform on the southern staircase. Please refer to drawings DE-04-23-DWG-ST-TTA-55990, DE-04-23-DWG-ST-TTA-55991 and DE-04-23-DWG-ST-TTA-55992. An underpass beneath the new tracks may be also be considered as an alternative solution.

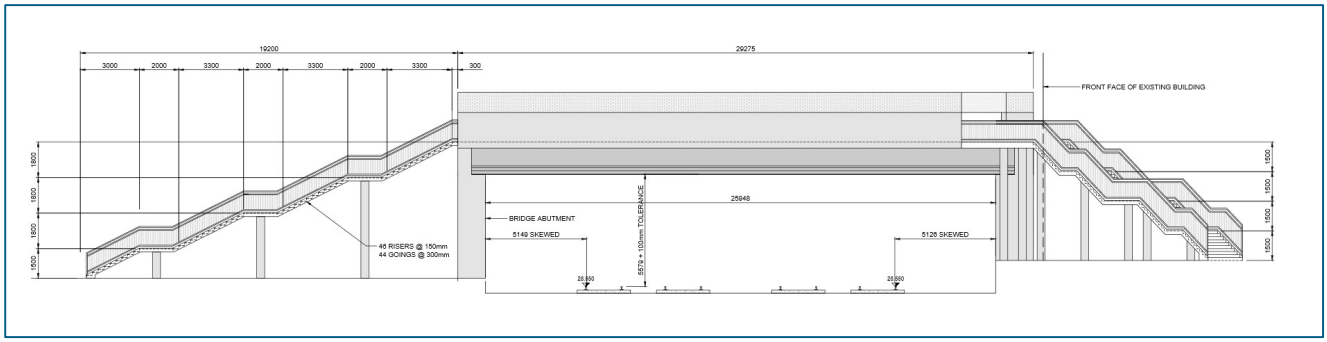

Figure 5-3 Option 3 - Bridge replacement, west elevation

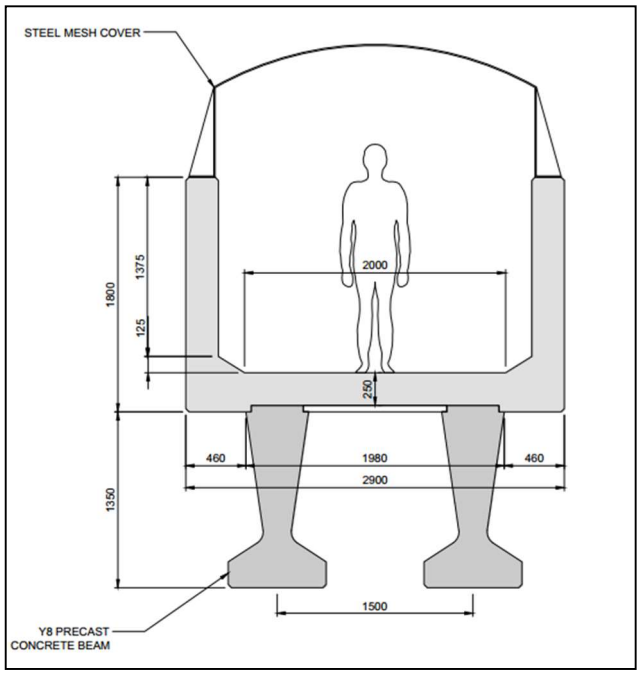

Figure 5-4 Option 3 - Bridge replacement, cross section

5.3. OHLE Arrangement

Khyber Pass Footbridge (OBC5) is sufficiently high that it can be electrified without any track lowering or structure interventions.

Option 1 (i.e., 'Retain Bridge') provide a soffit height of 5.207m. In this configuration, the OHLE would pass under the bridge without being connected to it. OHLE masts are expected to be positioned around 20m from each outer edge of the bridge. An electrical clearance of 150mm static and 100mm passing would be achieved with a 4.7m contact wire height. The OHLE configuration would be wired using a free-running arrangement. No vertical wire-level grading is required.

For Option 2, the bridge is permanently removed, and so the OHLE would run through this area with nominal contact wire and system height.

Option 3 provides a soffit height of 5.579m. In this configuration, the OHLE would use the arrangements described above for Option 1, but the catenary wire heights and mast heights would be increased accordingly.

5.4. Permanent Way

The track alignment through Khyber Pass Footbridge (OBC5) is linked to the permanent way solutions in the wider area. At this particular location there are two main alternatives:

- Area around Inchicore Works Option 3: The rail corridor is widened to the north.
- Area around Inchicore Works Option 4; The rail corridor is widened to the south.

The differences in plan are related to a different position of around 3m in the north-south direction between the alternatives.

Crossovers need to be installed under the footbridge to maintain the functionality of the depot.

The Emerging Preferred Option for the Area around Inchicore Works is Option 4 (fully described in Annex 3.6), as it as it minimizes impacts on third party property owners whilst still fulfilling the project requirements – i.e. electrification of the Slow lines and maintaining the operational functionality of the Inchicore Works and sidings.

5.5. Geotechnical

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

- Earthworks (embankment steepening or widening) and trackbed formation design for new tracks.
- Overhead Line Equipment foundation (preliminary) design.

The geotechnical design will also be required for:

- Derailment blocks (Option 1 only).
- Bridge foundation design.
- Potential replacement of northern boundary wall (1m to 2m in height) and replacement of southern boundary minor retaining walls (Options 1, 2 and 3). Replacement of the concrete walls is considered to be suitable at this stage of development. intervention on the masonry wall only locally if/where required.

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.

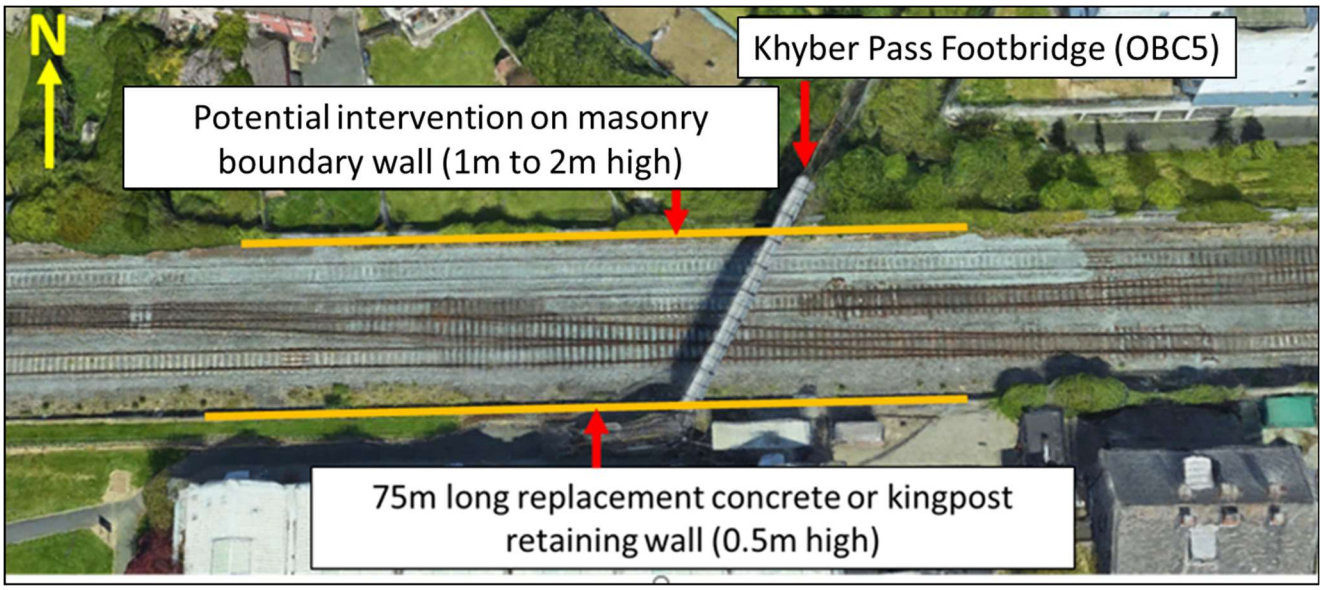

Figure 5-5 Replacement walls locations

6. Options Selection Process

6.1. Options Selection Process

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

The Option Selection Process involves a three-stage approach as summarised below:

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

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

6.2. Stage 1 Preliminary Assessment (Sifting)

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

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

The area under consideration specifically focuses on the four-tracking area and the clearances of the Khyber Pass Footbridge (OBC5). A total of four options were initially developed for this area. These ranged from a 'Do-Nothing' Option, 'Do-Minimum' Option to a range of 'Do-Something' Options. Each of the options was assessed to determine if they were feasible and met the Project Objectives / Requirements.

The 'Do-Something' Options in this area involve the replacement of the current bridge, or the removal of the bridge and use an alternative pedestrian / cycle route.

6.2.1. Preliminary Assessment (Sifting)

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

Table 6-1 Preliminary Assessment (Sifting) Findings

Option	Requirements		Description
0	Engineering	Constructability	Not applicable. No intervention proposed.
		Geometrical fitness for intervention	Not applicable. No intervention proposed.
		Safety	Not applicable. No intervention proposed.
		4-tracking Park West-Heuston	FAIL. No intervention proposed. 4-tracking is not achieved.
		Electrification of DART+ tracks	FAIL. No intervention proposed. Electrification of the DART+ tracks not achieved.
		Vertical electrical clearance in structures	PASS. Existing structure has vertical clearance for OHLE.
		Bridge Design Standards	Not applicable. No intervention proposed.
		Keep current functionality of footbridge	PASS. The existing footbridge is retained.
		Ambulant Disabled & Bicycle Ledge	PASS. No intervention proposed therefore not applicable.
	Economy		Compatible with investment guidelines & DART+ programme
	Environment		No impact on Environmental sites of National of International significance.
	SIFTING OUTCOME		**FAIL. Do not progress to Stage 2 Assessment**
1	Engineering	Constructability	PASS. This option is considered feasible.
		Geometrical fitness for intervention	PASS. This option is considered feasible.
		Safety	FAIL. Horizontal clearance to derailment protection walls is <2m therefore less than the 2.5m required by standards.
		4-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. Existing structure has vertical clearance for OHLE.
		Bridge Design Standards	FAIL. Horizontal clearance to derailment protection walls is <2m therefore less than the 2.5m required by standards.
		Keep current functionality of footbridge	PASS. The existing footbridge is retained.
		Ambulant Disabled & Bicycle Ledge	PASS. No intervention proposed therefore not applicable.
	Economy		Compatible with the investment guidelines and programme for DART+
	Environment		No impact on Environmental sites of National of International significance.
	SIFTING OUTCOME		**FAIL. Do not progress to Stage 2 Assessment**
2	Engineering	Constructability	PASS. This option is considered feasible.
		Geometrical fitness for intervention	PASS. This option is considered feasible.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. Bridge is permanently removed.
		Bridge Design Standards	PASS. Bridge is permanently removed.
		Keep current functionality of footbridge	FAIL. Bridge is permanently removed.
		Ambulant Disabled & Bicycle Ledge	PASS. Not applicable as bridge is permanently removed.
	Economy		Compatible with the investment guidelines and programme for DART+

Option	Requirements		Description
		Environment	No impact on Environmental sites of National of International significance.
		SIFTING OUTCOME	FAIL. Do not progress to Stage 2 Assessment
3	Engineering	Constructability	PASS. This option is considered feasible.
		Geometrical fitness for intervention	PASS. This option is considered feasible.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option achieves the 4 tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance at structures
		Bridge Design Standards	PASS. Option is in accordance with standards.
		Keep current functionality of footbridge	PASS. Footbridge functionality is maintained.
		Ambulant Disabled & Bicycle Ledge	PASS. Ambulant disabled access and bicycle ledge would be provided.
		Economy	Compatible with the investment guidelines and programme for DART+
		Environment	No impact on Environmental sites of National of International significance.
		SIFTING OUTCOME	PASS. Proceed to Stage 2 Assessment

6.2.2. Summary of the Preliminary Assessment (Sifting)

Following the assessment completed as part of the sifting process, only one Option has passed the assessment criteria. **Table 6-2** provides a summary of the sifting process results.

Table 6-2 Summary of Sift Process Results

Main Option	Sifting Process Result
Option 0: Do Nothing	FAIL
Option 1: Do Minimum	FAIL
Option 2	FAIL
Option 3	PASS

In terms of the Economy, all options are compatible with the investment guidelines and programme for DART+.

The sifting process noted no environmental issues at this stage which would discount any option solely on environment criteria i.e. no impact on Environmental Sites of National or International significance.

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

- **Option 0:** The Do-Nothing Option proposes no changes to the existing infrastructure, as such, this option would not facilitate the inclusion of the required four tracks or the installation of the OHLE equipment. This option will not achieve the project requirements or objectives and therefore will not be carried forward to the next stage of assessment.
- **Option 1:** The Do-Minimum Option seeks to achieve the four-tracking and electrification by means of minor interventions only, i.e. with the least amount of work to the structure itself. The addition of the fourth track would result in insufficient horizontal clearance between the tracks. Provision of derailment

protection walls would be located within the 2.5m clearance required by standards. The minor interventions would not be sufficient to meet required bridge design and railway safety standards and therefore this option does not pass the preliminary assessment.

- **Option 2:** This option seeks to permanently remove the bridge and provide an alternative route for pedestrian and cycle access to Inchicore Works. By removing the bridge, the key objective of maintaining the functionality of the structure is not met. As this option does not meet the project requirements it does not pass the preliminary assessment.

Only **Option 3** meets the necessary Engineering Feasibility and Project Requirements through the provision of a replacement bridge structure to achieve the required increase in horizontal and vertical clearance.

6.3. Stage 2 Detailed Assessment (MCA Process)

As only a single option has been identified as feasible, this option becomes the Emerging Preferred Option and there is no requirement to continue with a detailed assessment (MCA).

6.4. Emerging Preferred Option

The Emerging Preferred Option involves the reconstruction of the Khyber Pass Footbridge (OBC5) with a new bridge that would have sufficient vertical and horizontal clearance to meet the requirements for four-tracking and electrification.

The existing bridge would be replaced with a new structure that has adequate vertical clearance to achieve the required contact wire height and OHLE clearance and a span that facilitates a minimum horizontal clearance to abutments of 4.5m.

The superstructure would be formed using Y8 beams and an RC deck. The bridge would be enclosed and the bridge stairs would be designed to ambulant disabled standards. The stairs would also incorporate a bicycle ramp ledge.

It is noted that Permanent Way Option 4 for the area around Inchicore Works (which is the Emerging Preferred Option for the area) is compatible with this Emerging Preferred Option for Khyber Pass Footbridge (OBC5). Since the rail corridor is widened to the south, the available space at the south side of the structure is geometrically constrained in Perway Option 4. However, where stairs are positioned within 4.5m (horizontally from the edge of nearest rail), they will be detached and not integral with the main structure and supports.

An existing spiral staircase fire escape to the adjacent building on the south side of the bridge would be removed and replaced with a stair connection to a landing platform on the southern staircase.

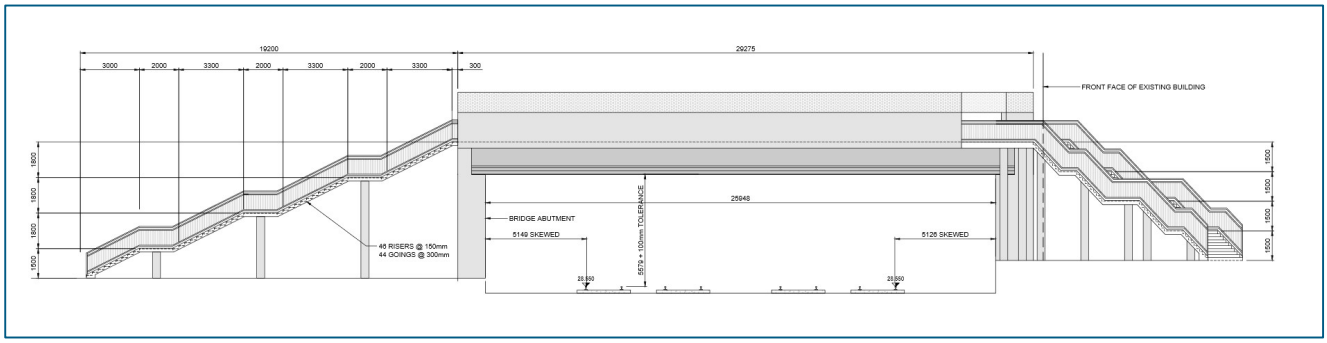

Figure 6-1 Emerging Preferred Option - Bridge replacement, west elevation

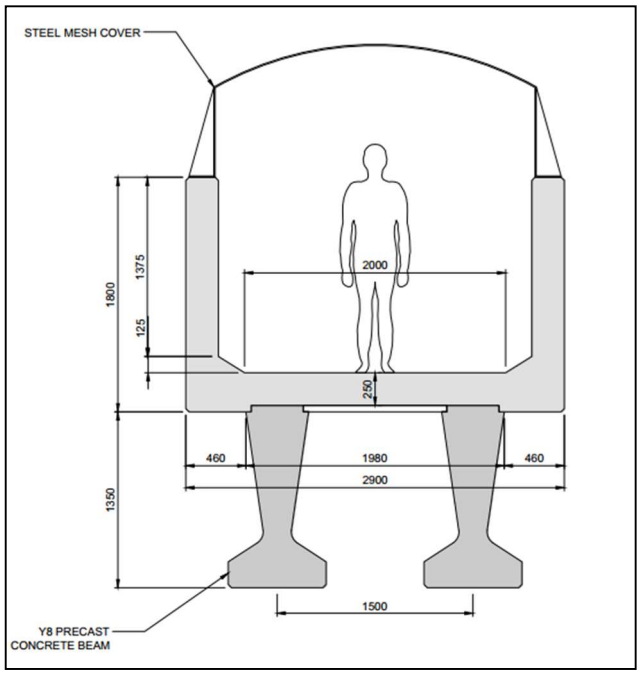

Figure 6-2 Emerging Preferred Option - Bridge replacement, cross section

Appendix A - Sifting Process Backup

Appendix B - Drawings

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

Bridge Drawings

DP-04-23-DWG-ST-TTA-55990

DP-04-23-DWG-ST-TTA-55991

DP-04-23-DWG-ST-TTA-55992