DART+ South West

Technical Optioneering Report

East of St John's Road Bridge to Glasnevin Junction

Area from east of Phoenix Park Tunnel to Glasnevin Junction

Iarnród Éireann

Contents

Tables

Figures

Glossary of Terms

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

Reference	Description
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

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

1. Introduction

1.1. Purpose of the Report

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

This report provides the technical assessment of the area between east of Phoenix Park Tunnel and Glasnevin Junction. 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 (OHLE)
- 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.

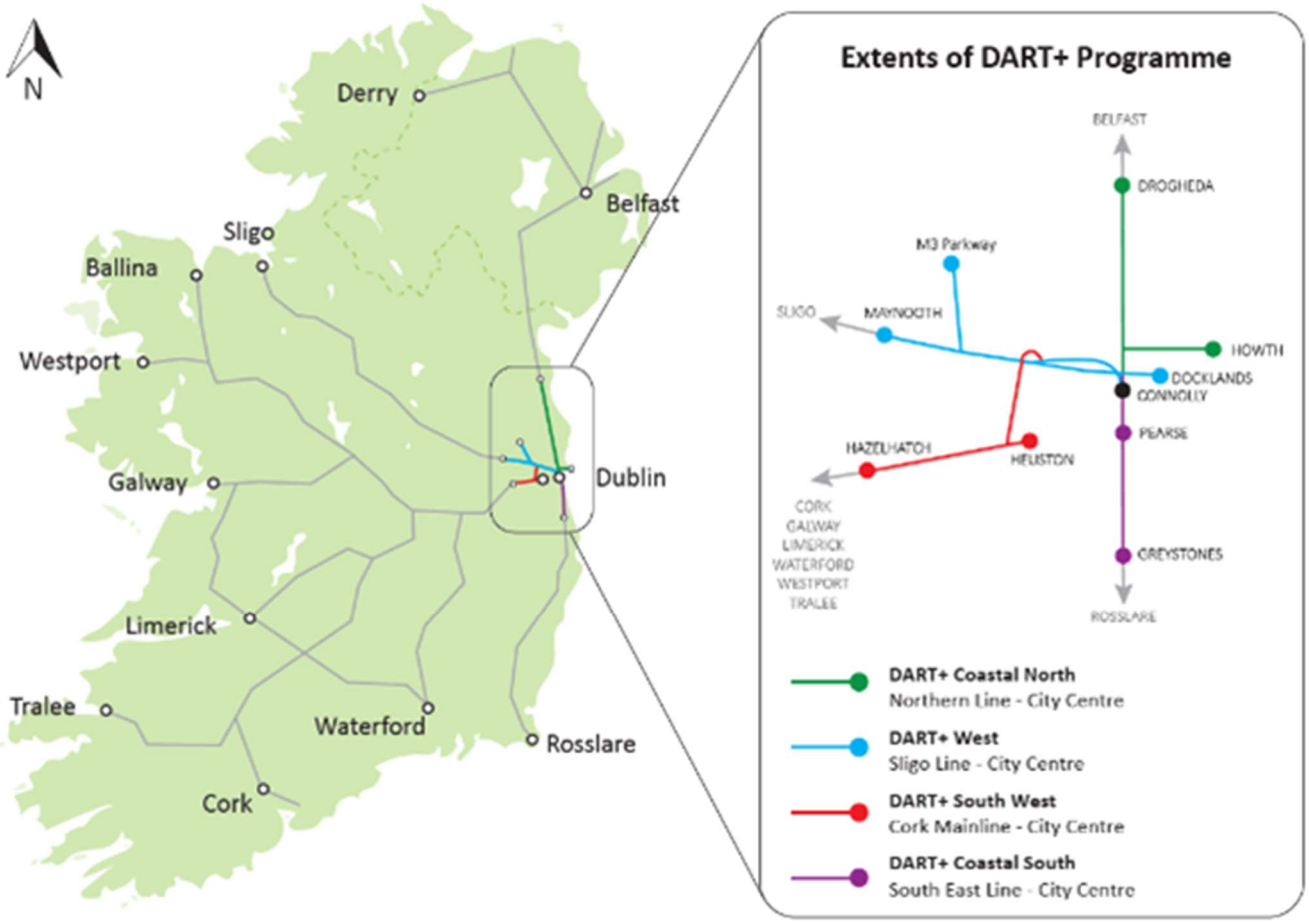


Figure 1-1 Dart+ Programme

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 also has 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 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 Overview

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

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

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

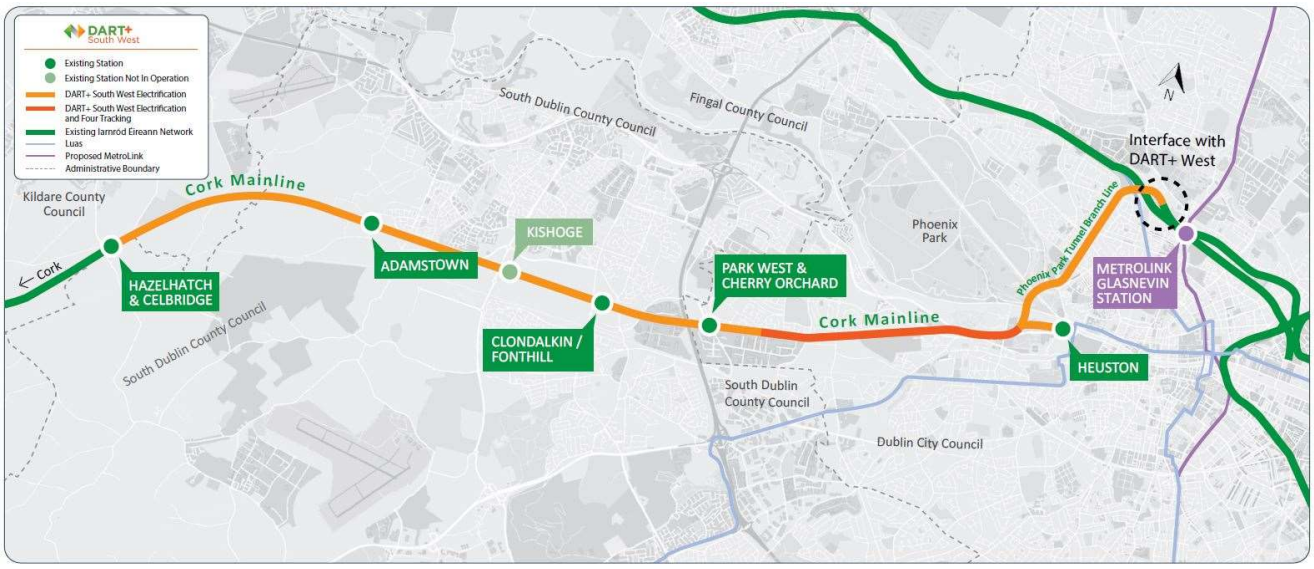


Figure 1-2 DART+ South West Route Map

1.4. Capacity Increases Associated with DART+ South West

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

1.5. Key Infrastructure Elements of DART+ South West

The key elements of DART+ South West are as follows:

- 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.
- 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 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 Bridge (OBC7)	West of Cherry Orchard Footbridge (OBC8B) to the East of the proposed Le Fanu Road Bridge (OBC7)	Le Fanu Road Bridge (OBC7)
	Area around Kylemore Bridge (OBC5A)	East of the proposed Le Fanu Road Bridge (OBC7) to the East of IE700B (i.e. the points for the Inchicore headshunt turnout)	Kylemore Road Bridge (OBC5A)
	Area around Inchicore Works	East of IE700B (i.e. the points for the Inchicore headshunt turnout to the west of Sarsfield Road Bridge (UBC4)	Inchicore Works Depot
	Khyber Pass Bridge (OBC5)	Vicinity of Khyber Pass Footbridge (OBC5)	Khyber Pass Footbridge (OBC5)
	Area around Sarsfield Road Bridge (UB4)	West of Sarsfield Road Bridge (UBC4) to the West of Memorial Road Bridge (OBC3)	Sarsfield Road Bridge (UBC4)
	Area around Memorial Bridge (OBC3)	Vicinity of Memorial Road Bridge (OBC3)	Memorial Road Bridge (OBC3)
	Area around South Circular Road Junction	East of Memorial Road Bridge (OBC3) East of St John's Road Bridge (OBC0A)	South Circular Road Junction South Circular Road Bridge (OBC1) St Johns Road Bridge (OBC0A)
	Area around Heuston Station and Yard	Area at Heuston Station Yard, including all platforms and sidings	Heuston Station Sidings around Heuston Station
St John's Road Bridge to Glasnevin Junction	Area from East of St John's Road Bridge (OBC0A) to East of Phoenix Park Tunnel	East of St John's Road Bridge (OBC0A) to East of Phoenix Park Tunnel	Potential New Heuston West Station Liffey Bridge (UBO1).

			Conyngham Road Bridge (OBO2) Phoenix Park Tunnel
	Area from Phoenix Park Tunnel to Glasnevin Junction	East of Phoenix Park Tunnel to South of Glasnevin Junction	McKee Barracks Bridge (OBO3) Blackhorse Avenue Bridge (OBO4) Old Cabra Road Bridge (OBO5) Cabra Road Bridge (OBO6) Fassaugh Avenue Bridge (OBO7) Royal Canal and LUAS Twin Arches (OBO8) Maynooth Line Twin Arch (OB09) Glasnevin Cemetery Road Bridge (OBO10)

2. Existing Situation

2.1. Overview

This part of the scheme connects the Dublin-Cork line with the Maynooth line and extends from the Phoenix Park Tunnel in the south to Glasnevin Junction in the north. The rail corridor is primarily in cutting (i.e. the rail level is below the surrounding ground level), the corridor is formed mainly by earth embankments, the track passes under 8 no. overbridges and over 1 no. culvert. The northern boundary of this section of the line is approx. 10m east of Glasnevin Cemetery Road Bridge (OBO10), after this point the line extends to join the Maynooth Line and the interface with the DART+ West project.

The general view of the area is shown in Figure 2-1

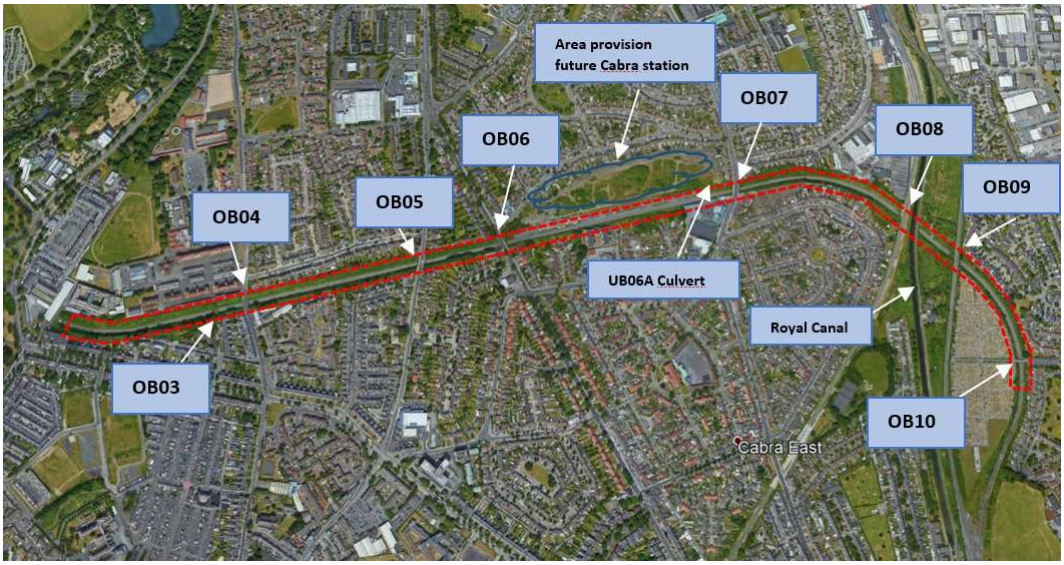


Figure 2-1 General View

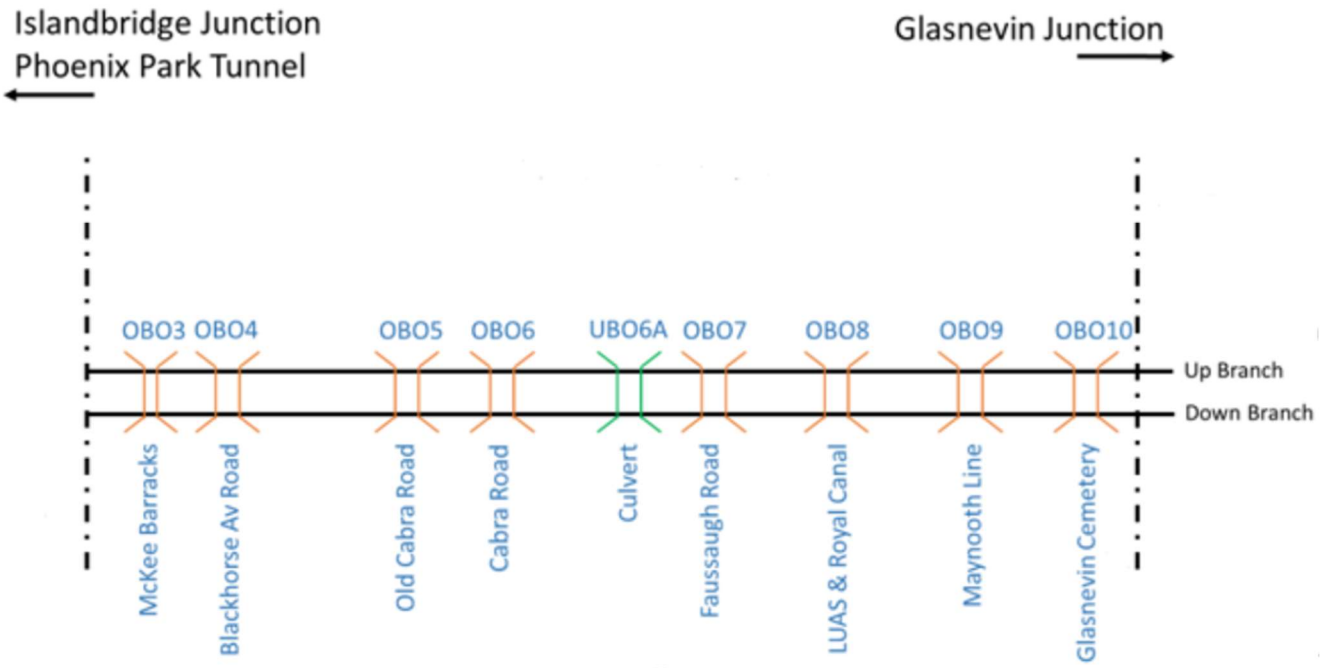


Figure 2-2 Existing Track Layout

2.2. Challenges

North of the Phoenix Park Tunnel, the main constraint to the electrification requirements of the Project is the low clearances of existing overbridges in the area (including service bridges), namely: McKee Barracks Bridge (OBO3), Blackhorse Avenue Road Bridge (OBO4), Old Cabra Road Bridge (OBO5), Cabra Road Bridge (OBO6), Fassaugh Road Bridge (OBO7), Royal Canal and LUAS Twin Arch (OBO8), the Maynooth Line Twin Arch (OBO9) and Glasnevin Cemetery Road Bridge (OBO10).

DART + South West is currently undertaking surveys and analysis along this section, including within the tunnel, to understand the current characteristics and constraints.

Figure 2-3 View from the east, of Royal Canal and LUAS Twin Arch Bridge (OBO8).

In terms of the vertical alignment in this section, there is a low point between Royal Canal and LUAS Twin Arch Bridge (OBO8) and the Maynooth Line Twin Arch Bridge (OBO9) (refer to Figure 2-4). This has caused some flooding issues in the past. In recent years, a pumping station and an infiltration tank has been installed as part of stabilisation works carried out in the cutting west of Royal Canal and LUAS Twin Arch Bridge (OBO8). The pumping station drains the excess water from the cutting located immediately to the west of Royal Canal and LUAS Twin Arch Bridge (OBO8), as per Figure 2-16). This facility directs the inflows to the attenuation tank located to the northwest.

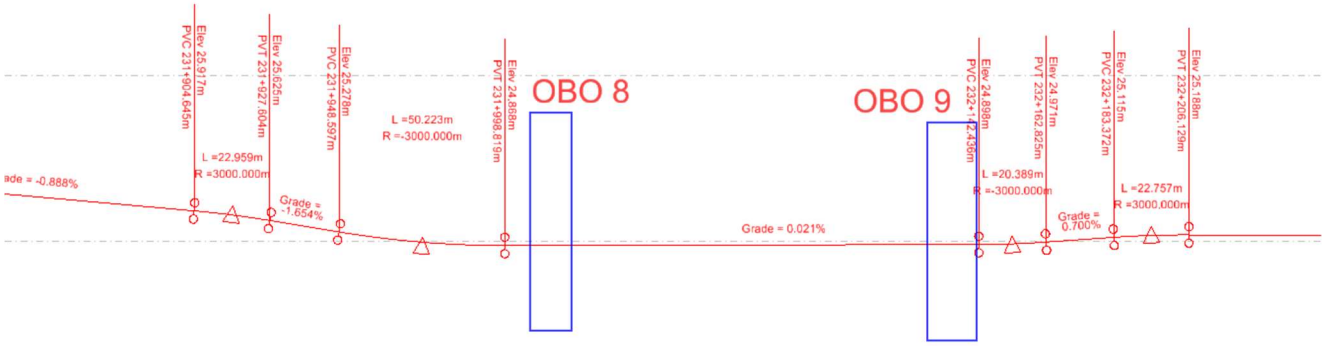


Figure 2-4 Longitudinal profile between Royal Canal and LUAS Twin Arch Bridge (OBO8) and Maynooth Line Twin Arch Bridge (OBO9).

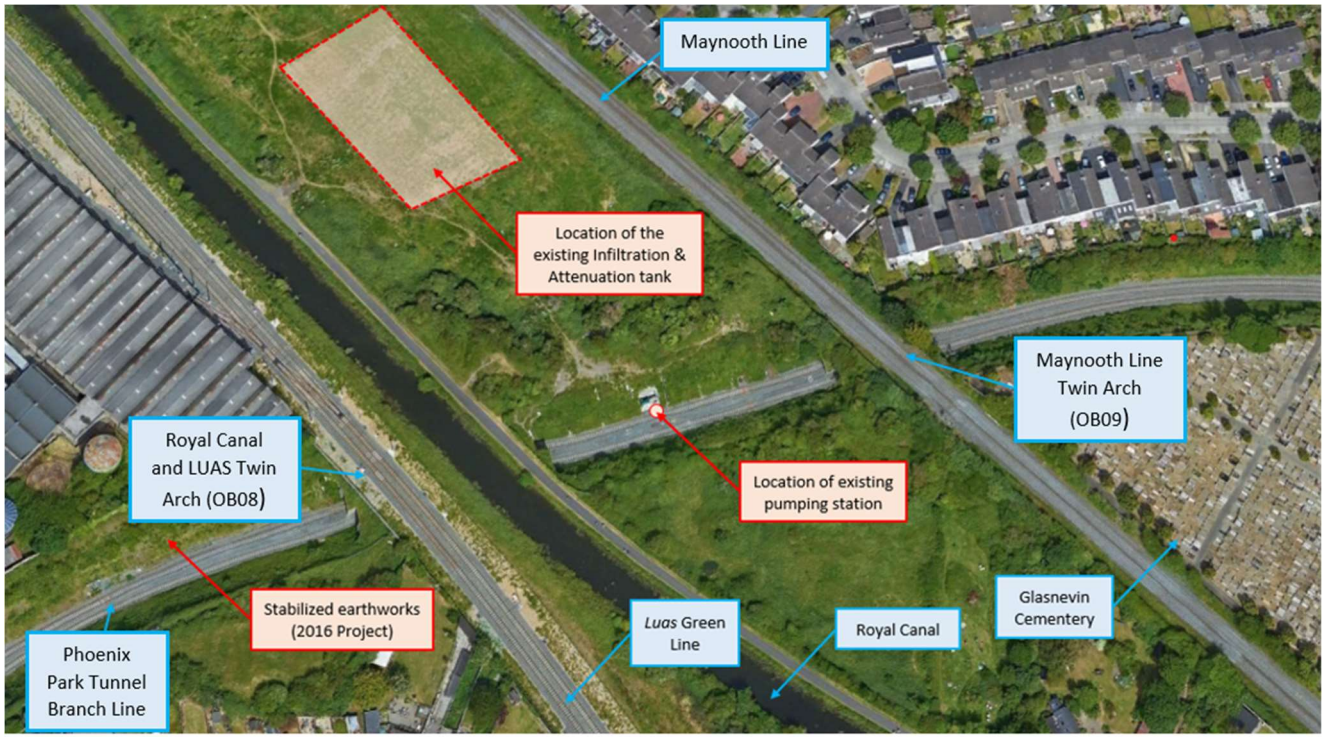


Figure 2-5 Location of drainage challenges.

2.3. Permanent Way and Tracks

This section starts to the east of Phoenix Park Tunnel, and the railway features a double track section. The horizontal alignment is straight from the tunnel up to Fassaugh Avenue Bridge (OBO7) before the track alignment crosses under the LUAS Green Line and Royal Canal Twin Arch Bridge (OBO8) and Maynooth Line Twin Arch Bridge (OBO9) to connect with the Maynooth Line at Glasnevin Junction. The vertical alignment features a high point between Cabra Road Bridge (OBO6) and Fassaugh Avenue Bridge (OBO7). The gradient falls towards the Phoenix Park Tunnel in this section and is up to 1.15% between the tunnel and Cabra Road Bridge (OBO6). The gradient reduces from Cabra Road Bridge (OBO6) to Glasnevin featuring a low point between OBO8 and Maynooth Line Twin Arch Bridge (OBO9). Between Cabra Road Bridge (OBO6) and Fassaugh Avenue Bridge (OBO7) the area levels off near where Cabra Sidings were located (Figure 2-6).

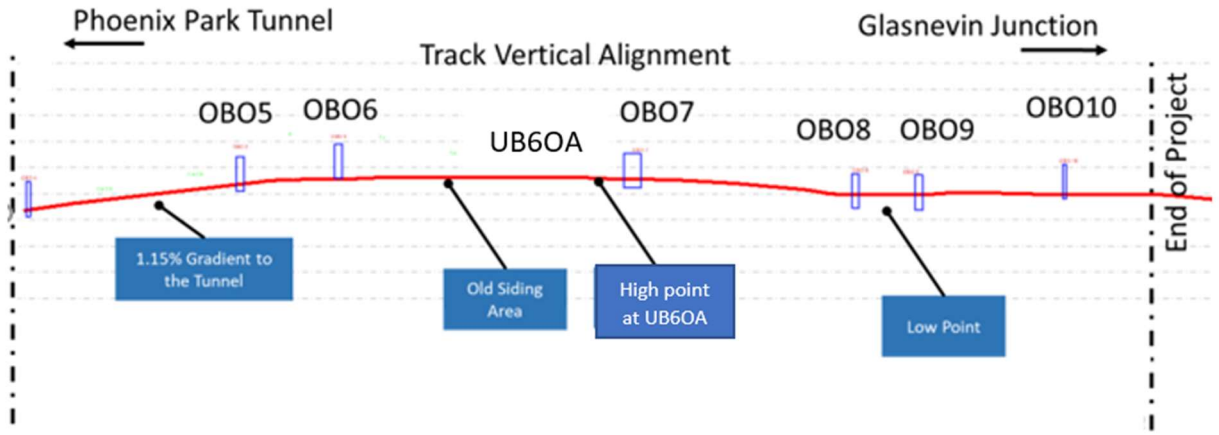


Figure 2-6 Track vertical alignment.

2.4. Structures

2.4.1. McKee Barracks Bridge (OBO3)

The McKee Barracks Bridge (OBO3) is a single span masonry arch bridge, the bridge is not currently in use. There are no drawings available for this structure, however, topographical information suggests the bridge has a minimum soffit height over the cess rail of 7.23m.

The track through the McKee Barracks Bridge (OBO3) can be electrified with no structural or track intervention required.

Figure 2-7 McKee Barracks Bridge (OBO3) south elevation

2.4.2. Blackhorse Avenue Bridge (OBO4)

The Blackhorse Avenue Bridge (OBO4) is a single span masonry arch bridge that carries the Blackhorse Avenue Road over two railway tracks. The bridge has a span of 8.5m approx. and a minimum soffit height over the cess rail of 5.16m. On the south side, there is a services bridge with a minimum height of 4.40m.

The track through the Blackhorse Avenue Bridge can be electrified with no major track intervention if the services bridge is removed. Otherwise, track intervention would be required. The services bridge design and track intervention will be determined prior to Public Consultation No. 2.

Figure 2-8 Blackhorse Avenue Bridge (OBO4) south elevation

2.4.3. Old Cabra Road Bridge (OBO5)

The Old Cabra Bridge (OBO5) is a single span masonry arch bridge that carries the Old Cabra Road over two railway tracks. On the north side, there is a pipe bridge that has a lower soffit level than Old Cabra Road Bridge (OBO5). The pipe bridge has a minimum soffit height over the cess rail of 6.08m.

The track through Old Cabra Road Bridge (OBO5) can be electrified, and no structural or track intervention is required. However, the nature of services/utilities through the adjacent pipe and potential constraints associated with the proximity of the contact wire will be confirmed prior to Public Consultation No. 2.

Figure 2-9 Old Cabra Road Bridge (OBO5) north elevation

2.4.4. Cabra Road Bridge (OBO6)

The Cabra Road Bridge (OBO6) is a single span bridge that carries the Cabra Road over two railway tracks. A structural drawing dated February 1946 indicates the bridge has a skew clear span of 8.70m and a soffit height of 4.36m above rail level. The bridge has a width of 13.92m, including a 9.30m carriageway, a southern footpath of 1.65m and a northern footpath of 2.97m. The drawing refers to “girders” and proposals for renewal including reinforced concrete slab, and reinforced concrete beams of H-section with slab on top. This suggest that the bridge deck may have been replaced. Recent photographs indicate the superstructure consists of reinforced concrete slabs butted together.

The route through Cabra Road Bridge (OBO6) cannot be electrified without structural and/or track intervention. A derogation from Standard may be required.

Figure 2-10 Cabra Road Bridge (OBO6) north elevation

2.4.5. Fassaugh Avenue Bridge (OBO7)

The Fassaugh Avenue Bridge (OBO7) carries the Fassaugh Road over two railway tracks. The original bridge is a single span masonry arch bridge with a clear span of 8.50m and a width of 6.86m. The original bridge has been widened either side with a concrete beam deck on concrete piers. As-built drawings for the bridge extension are not available.

The route through the Fassaugh Road Bridge (OBO7) cannot be electrified without structural and/or track intervention. A derogation from Standard may be required.

Figure 2-11 Fassaugh Avenue Bridge (OBO7) north elevation

Figure 2-12 Fassaugh Avenue Bridge (OBO7) south elevation

2.4.6. Royal Canal and LUAS Twin Arch Bridge (OBO8)

The Royal Canal and LUAS Twin Arch Bridge (OBO8) is a 55m long twin arch bridge that carries the Royal Canal and two LUAS tracks over the railway corridor. As-built drawings for the bridge are not available. The minimum soffit height is 4.54m.

The route through the Royal Canal and LUAS Twin Arch Bridge (OBO8) cannot be electrified without structural and/or track intervention. A derogation from Standards may be required.

Figure 2-13 The Royal Canal and LUAS Twin Arch Bridge (OBO8) north elevation

2.4.7. Maynooth Line Twin Arch Bridge (OBO9)

The Maynooth Line Twin Arch Bridge (OBO9) is a 35m long twin arch bridge that carries two railway tracks for the Maynooth Line over the railway corridor. As-built drawings for the bridge are not available. The twin arch has a soffit height of 4.57m at the low point.

The track through the Maynooth Line Twin Arch Bridge (OBO9) cannot be electrified without structural and/or track intervention. A derogation from Standards will be required.

Figure 2-14 Maynooth Line Twin Arch Bridge (OBO9) north elevation

2.4.8. Glasnevin Cemetery Road Bridge (OBO10)

The Glasnevin Cemetery Road Bridge (OBO10) is a single span reinforced concrete slab bridge that provides vehicle access to the Glasnevin Cemetery from the cemetery carpark. As-builts drawings for the bridge are not available. The bridge has a minimum soffit height of 4.58m.

The route through the Glasnevin Cemetery Road Bridge (OBO10) cannot be electrified without structural and/or track intervention. A derogation from Standards will be required.

Figure 2-15 Glasnevin Cemetery Road Bridge (OBO10) east Elevation

2.4.9. Retaining walls and minor structures

According to existing IE database records, the following retaining walls are recorded at the following locations:

Table 2-1 Existing Retaining Wall Assets

Track Section	Asset ID	Start Mileage	End Mileage	Side	Wall Type	Wall Height	Description
Connolly - Heuston	RWO001U	2m 1250yrds	2m 1320yrds	Up	Mass Concrete	1.7m	N/A

Track Section	Asset ID	Start Mileage	End Mileage	Side	Wall Type	Wall Height	Description
Connolly - Heuston	RWO001D	2m 1200yrds	2m 1350yrds	Down	Mass Concrete	4.3m	N/A
Connolly - Heuston	RWO000DC	2m 1170yrds	2m 1180yrds	Down	Block Wall	1.5m	LOCATION CASE
Connolly - Heuston	RWO000UO	2m 0885yrds	2m 0890yrds	Up	Precast Concrete	1.8m	LOCATION CASES
Connolly - Heuston	RWO000UG	2m 0286yrds	2m 0289yrds	Up	Block Wall	2.1m	LOCATION CASES
Connolly - Heuston	RWO000UF	2m 0113yrds	2m 0143yrds	Up	Gabions	1.2m	N/A
Connolly - Heuston	RWO000UE	2m 0084yrds	2m 0113yrds	Up	Mass Concrete	1.2m	N/A
Connolly - Heuston	RWO000UD	1m 1704yrds	1m 1715yrds	Up	Gabions	1.6m	N/A
Connolly - Heuston	RWO000UH	1m 1505yrds	1m 1508yrds	Up	Precast Concrete	1.8m	LOCATION CASES
Connolly - Heuston	RWO000DB	1m 1339yrds	1m 1457yrds	Down	Masonry	2.5m	N/A
Connolly - Heuston	RWO000UC	1m 0835yrds	1m 0838yrds	Up	Block Wall	1.6m	LOCATION CASES
Connolly - Heuston	RWO000UB	1m 0242yrds	1m 0248yrds	Up	Block Wall	1.6m	LOCATION CASES

2.5. Roads

There are several roads crossing over the railway in this area.

In principle, it is anticipated that the works to the existing bridges can likely be accommodated within the existing rail corridor, minimising disruption to the existing roads infrastructure. However, other options (including bridge reconstruction) remain under consideration should further technical analysis prove track lowering is not feasible and additional works, potentially outside of the existing rail corridor, may be required.

The 3 No. road overbridges that may potentially require bridge reconstruction are Cabra Road Bridge (OBO6), Fassaugh Avenue Bridge (OBO7) and the Glasnevin Cemetery Road Bridge (OBO10).

It is noted that residential and small-scale independent retailers line the streets of Cabra Road, this coupled with the junction proximity with other local roads, affords little opportunity to raise road levels without impacting the access to these properties (vehicular and pedestrian). There are similar issues at Fassaugh Avenue to the north of the bridge. The Cemetery Road has minimal physical constraints to the north of the track but is very close to individual burial sites in the cemetery.

2.6. Topography and Ground Conditions

The topography of the area is typically flat, sloping gently towards the east. The railway is almost entirely located within steep cuttings covered by vegetation. A short section west of the railway between Cabra Road Bridge (OBO6) and Fassaugh Avenue Bridge (OBO7) is locally at grade.

Geological mapping indicates the superficial deposits comprise till underlain by bedrock (limestone and shale). Existing historical ground investigation has been reviewed within in the rail corridor and adjacent to the railway.

To the south, close to the Phoenix Park Tunnel, historical ground investigations show the ground conditions to comprise gravel stone fill (likely ballast associated with the railway) underlain by stiff to very stiff black gravelly clay. Bedrock consisting of a medium strong to strong limestone was encountered at 7.20m bgl (17.90m AOD). Groundwater strikes are shown to be recorded between existing ground level and 4.70m bgl.

Towards Cabra, made ground described as sandy gravelly clay with glass, red brick and organic fragments has been recorded up to 3.10m thick. The made ground is underlain by firm to stiff gravelly clay with unproven thickness. The recorded groundwater levels towards Cabra range from 2.85m bgl to 3.45m bgl.

Further north, to the east of the railway at Quarry Road, historical ground investigation shows the ground conditions comprise made ground or fill underlain by stiff to very stiff black gravelly clay. The till is overlain by pockets of sand or firm brown gravelly clay in places. Groundwater at Quarry Road was recorded between 2.10m bgl to 6.20m bgl.

An Electrical Resistivity Tomography (ERT) geophysical survey was completed along the Phoenix Park Tunnel cutting. The survey shows that bedrock levels appear to undulate across the length of the rail corridor, however in general rock is shallower to the south.

Sections of cutting along this area have exhibited historical instability and are now soil nailed. In addition to this, recent failures along cutting locations (e.g. Cabra) show the stability of sections of the nailed cutting is less than marginal, with shallow slope failures occurring on nailed sections. Anecdotal evidence also suggests significant cutting failures have occurred due to construction of buildings close to the top of the existing earthworks.

2.7. Environment

This section of the rail corridor encompasses the area from Glasnevin Junction to approximately north-east end of the Phoenix Park Tunnel. The existing line crosses under the Connolly-Sligo Commuter/Intercity line, under the Royal Canal, under the Luas Cross City line, then crosses under Faussagh Avenue, the R147 (Cabra Road), R805 (Old Cabra Road) and the R806. Much of the residential areas are serviced by mainly low-pressure gas pipelines at the major road crossings, and there is one crossing of an overhead line.

Glasnevin Cemetery is located to the north of the rail corridor. Prospect Cemetery is located just on the inside bend of the existing line. Both cemeteries are sites of historical, archaeological and cultural heritage value. Both are also Designated Landscapes (Conservation Areas). The Royal Canal Way is an amenity walking trail and also has a landscape protection objective. The tunnel under the Royal Canal is on the Dublin City Industrial Heritage Record. The Cabra Road Bridge (OBO6) over the Cabra Road (R147) is on the Record of Protected

Structures (RPS), the Old Cabra Road Bridge (R805) is a National Inventory of Architectural Heritage (NIAH), and the Blackhorse Avenue Bridge (OBO4) is an NIAH. McKee Barracks Bridge (OBO3) at Marlborough Road is an NIAH. There are also designated buildings/features on Quarry Road, Old Cabra Road and Ellesmere Avenue.

There is existing residential development on the northern side of the existing line at Glasnevin; community features include a national school and secondary school. South of the Royal Canal are Mount Bernard Park and a Pitch & Putt course. Around St Attracta Road and Bannow Road, there is residential development either side of the rail corridor, as well as some commercial development near the Luas line/ canal, and two national schools. There is extensive residential development either side of the rail corridor in the Cabra area, another national school, a GAA Club, HSE Health Centre and a B&B. Approaching the Phoenix Park Tunnel, the McKee Military Barracks and the Garda Headquarters are adjacent to the existing rail line on the west side.

The presence of the existing rail line has reduced biodiversity potential along the route to a large degree, however there remain hotspots of interest in relation to hedgerows and treelines for bats, in particular (Royal Canal and LUAS Twin Arch Bridge (OBO9) has bat roost potential), and there is potential for spreading invasive species as the scheme progresses. The invasive Himalayan balsam was noted near the Royal Canal and LUAS Twin Arch Bridge (OBO9), with other invasives noted at the Old Cabra Road and the R806 overbridges. The former cement storage site in Cabra has potential to host amphibians. Glasnevin Cemetery is also a Geological Heritage Area/ County Geological Site. Much of the subsoils traversing the zone are comprised of till derived from limestones. Groundwater vulnerability is rated as low to moderate.

Refer to **Section 4.1** (Environment) for further details.

2.8. Utilities

There are a considerable number of utilities typical of an urban environment. Service providers with network assets in this area include the following:

- Aurora
- British Telecoms (BT)
- 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
- Gas Networks Ireland (GNI)
- Virgin Media

Data in the form of utility service records have been gathered from all providers in the area. Most 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.

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

Significant utilities are also located in parallel to the railway along both the northern and southern boundaries. In terms of proposals to widen the railway corridor, an examination of the impacts on these services will be required.

Utilities present a particular challenge in this area in that there a number of utilities crossing the line that are within the clearance envelope of the electrification on either service bridges or strapped to the main bridges. Designs to overcome these will be developed at the next stage.

2.9. Drainage

There is some track drainage installed in this area, from PPT up to the Royal Canal and LUAS Twin Arch Bridge (OBO8). However, along most of this corridor, storm water is thought to run following the track gradient, percolating into the terrain. Between the Royal Canal and LUAS Twin Arch Bridge (OBO8) and the Maynooth Line Twin Arch Bridge (OBO9) there is a low point and a pumping station was installed as part of the cutting stabilisation works between Cabra Sidings and Royal Canal and LUAS Twin Arch Bridge (OBO8). The pumping station drains into an attenuation / infiltration tank located to the northwest.

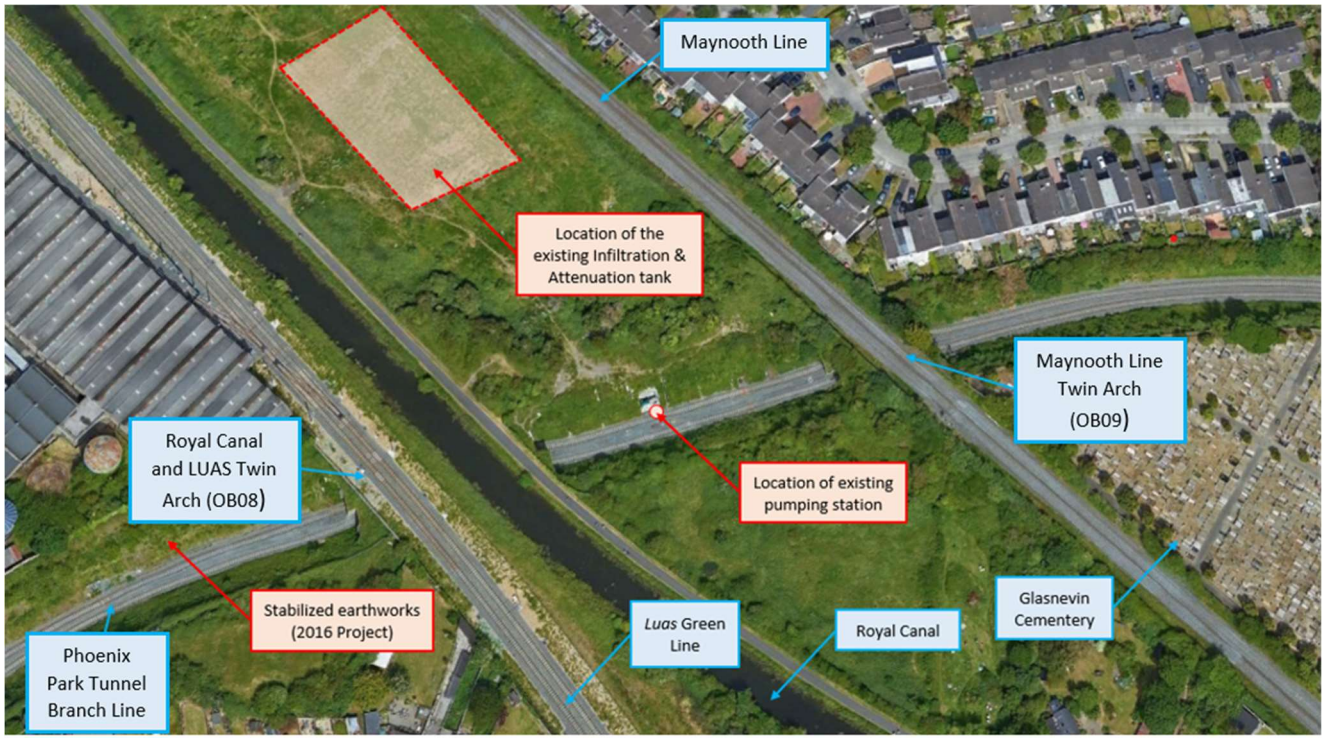


Figure 2-16 Location of drainage features and stabilization works.

3. Requirements

3.1. Specific Requirements

- Electrification of 2 no. tracks for DART+.
- Provide sufficient vertical clearance for OHLE at structures through track lowering and /or structural interventions.
- Track alignment and drainage requirements (standards).

3.2. Systems Infrastructure and Integration

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

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

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

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

3.2.1. Electrification System

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

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

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

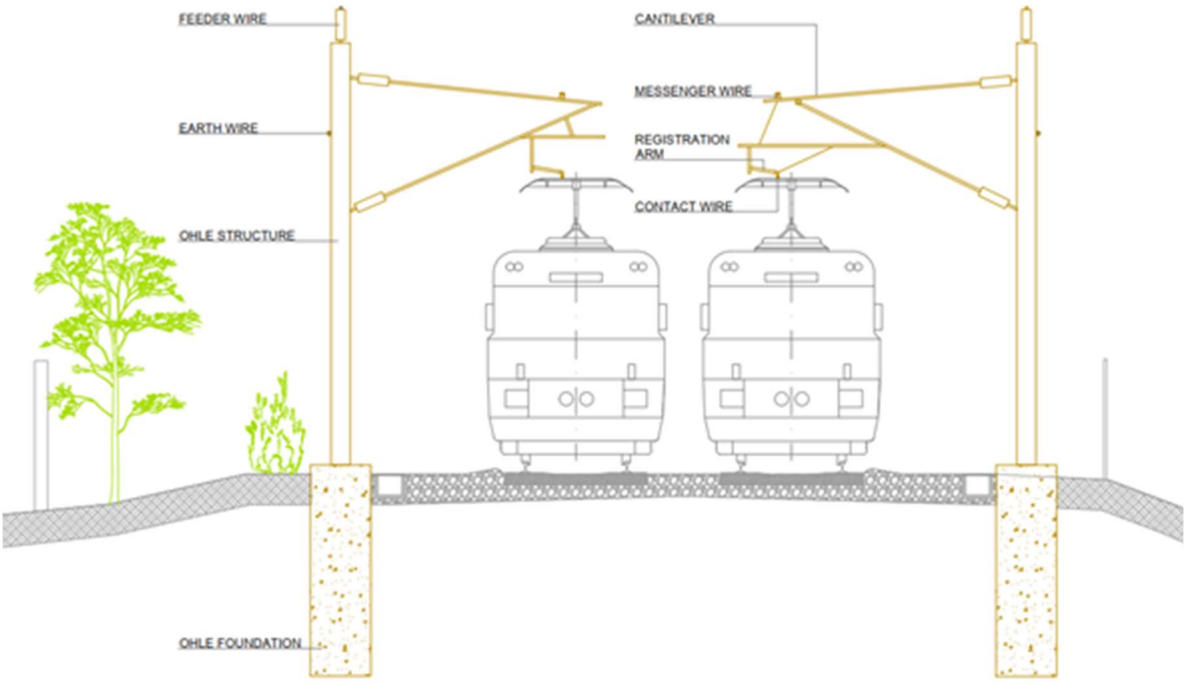


Figure 3-1 Typical OHLE arrangement in two track open route

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

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

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

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

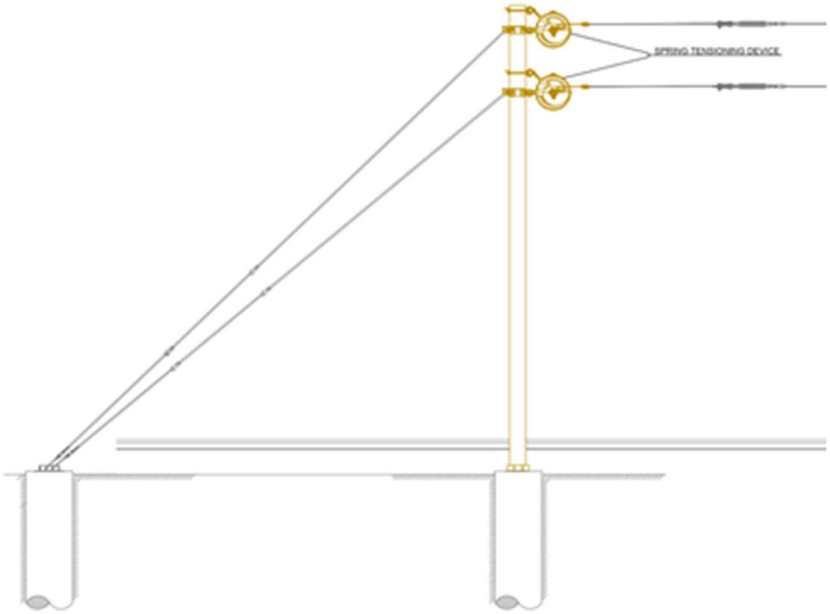


Figure 3-2 Typical anchor structure

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

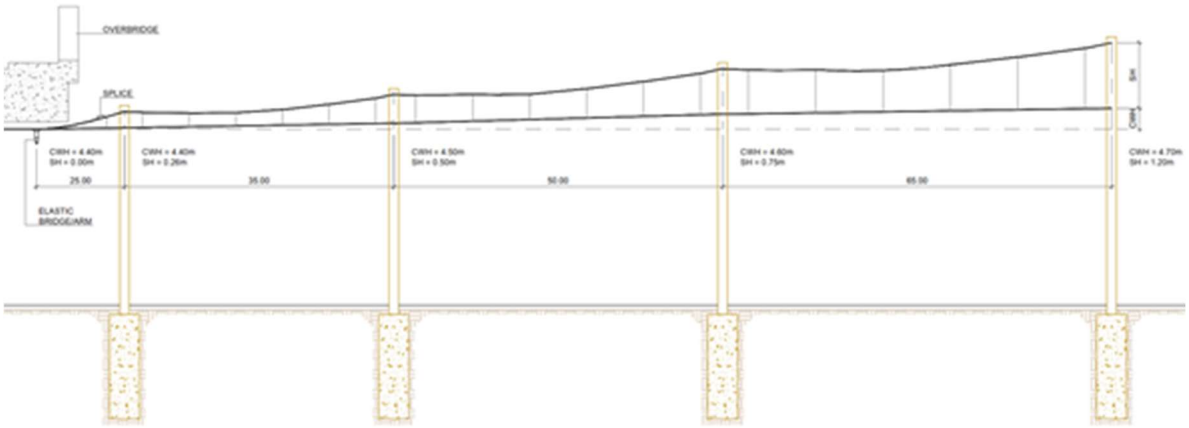


Figure 3-3 Typical arrangement on approach to a low bridge

The OHLE configuration through the tunnels is dependent on the shape, size and construction of the tunnel. Options available include continuation of the flexible OHLE system through the tunnel with a small system height with more frequent supports from the tunnel roof. This arrangement will be hidden within the tunnel.

Occasionally, the size, shape or construction of a tunnel may be restrictive enough that a rigid bar system needs to be used instead of flexible wires. This arrangement will also be hidden within the tunnel, but may extend for a short distance outside the tunnel before reverting to the flexible wire system.

3.2.2. Substations

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

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

3.3. Design Standards

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

4. Constraints

4.1. Environment

Starting at Glasnevin, there is existing residential development on the northern side of the existing line (Claremont and Dalcassian), backing onto the R135 (Finglas Road). To the north-east of the existing line is Saint Vincent's Christian Brothers National School and Saint Vincent's Secondary School. Glasnevin Cemetery is located further north, the southern part of it just within the 250m buffer band of the existing rail centreline. The Glasnevin Museum is also located here and is a Fáilte Ireland visitor attraction. The cemetery is also a Geological Heritage Area/ County Geological Site. Prospect Cemetery is located just on the inside bend of the existing line; this cemetery also hosts a number of pauper's graves. Both cemeteries are sites of historical, archaeological and cultural heritage value.

The existing line then crosses under the Connolly-Sligo Commuter/Intercity line, then under the Royal Canal, and under the Luas Cross City line. The Royal Canal Way is an amenity walking trail. Dublin City Council (DCC) also has a landscape protection objective (Z11) to "protect and improve canal, river and coastal amenities." The Royal Canal and Prospect Cemetery are also Designated Landscapes (Conservation Areas). Just to the south of the canal are Mount Bernard Park and Shandon Pitch & Putt. The tunnel under the Royal Canal is on the Dublin City Industrial heritage Record.

The twin arch underbridge of the Luas line was identified in the 2020 ecology survey for bat roost potential. Evidence of invasive species [Himalayan balsam] was noted in centre of the existing railway track ballast on the south side of this bridge.

There is residential development on both sides of the rail corridor (houses along St Attracta Road and Bannow Road), as well as some commercial development near the Luas line/ canal, comprising Valeo Foods and Batchelor's. Christ the King Boys National School and Girls National School are located just outside the 300m buffer from the existing rail centreline on Offaly Road.

The line then crosses under Faussagh Avenue, the R147 (Cabra Road), R805 (Old Cabra Road) and the R806. There is extensive residential development either side of the rail corridor in the Cabra area. Just south of Faussagh Avenue and adjacent to the rail corridor is Gaelscoil Bharra National Primary School, Saint Finbar's GAA Club and HSE Health Centre Cabra. The Hill of Tara House B&B is located to the west of the rail corridor on Carnlough Road.

There is a former cement storage site located adjacent the existing rail line on the west side between Faussagh Avenue and the Cabra Road. In this area, some small ephemeral ponds of standing water were noted in the 2020 ecology survey, with alkaline plants; these have potential to host amphibians. On the other side of the existing rail line, Jack Pott's Bingo (1945-50) is a building on the NIAH on Quarry Road approx. 100m to the east of rail centreline; the building complex is also on the RPS. The overbridge over the Cabra Road is also on the RPS.

The overbridge over the Old Cabra Road is designated as an NIAH. Approx. 100m to the west of the existing rail centreline is a post-box on the Old Cabra Road which is also an NIAH. Just south of the Old Cabra Road and adjacent to the rail corridor is Ryan's B&B. A house approx. 100m to the east of the rail centreline at the corner of Ellesmere Avenue is an NIAH (1920-40, of regional importance). Further evidence of invasive plant species was noted during the 2020 ecology survey at the bridge over the Old Cabra Road and at the R806 overbridge on the south-eastern side of the bridge and extending upslope. The overbridge over the R806 is also an NIAH.

Following the R806 towards the Phoenix Park Tunnel, another overbridge over the existing line (Marlborough Road) is an NIAH. The McKee Military Barracks and the Garda Headquarters are then adjacent to the existing line on the west side.

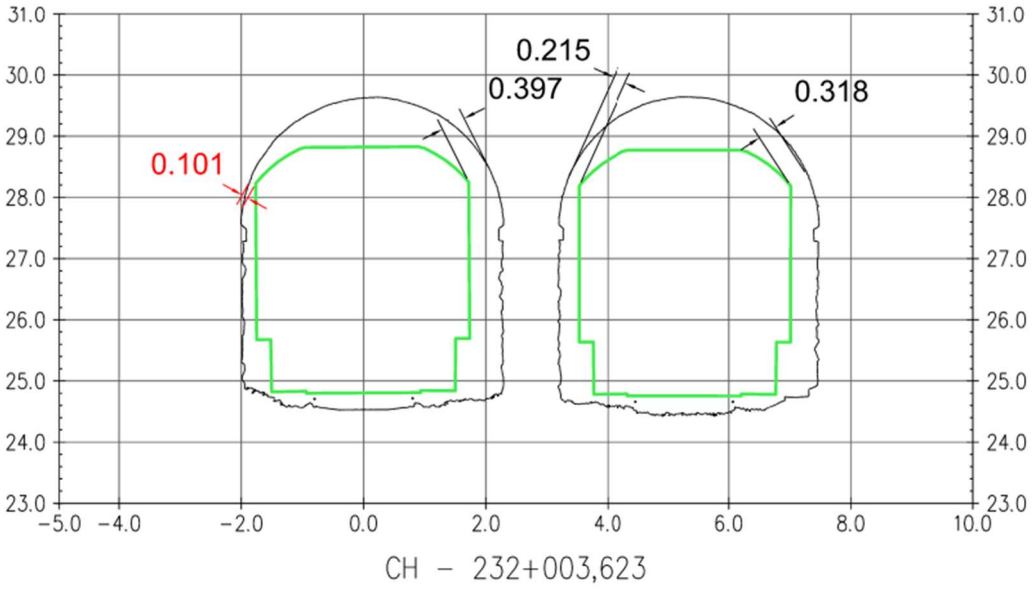
Much of the residential areas are serviced by mainly low-pressure gas pipelines, crossing the existing rail corridor at the major road crossings. One medium pressure and some low-pressure pipelines traverse the rail corridor along the Cabra Road. There is a crossing of a 110 KV overhead line here also.

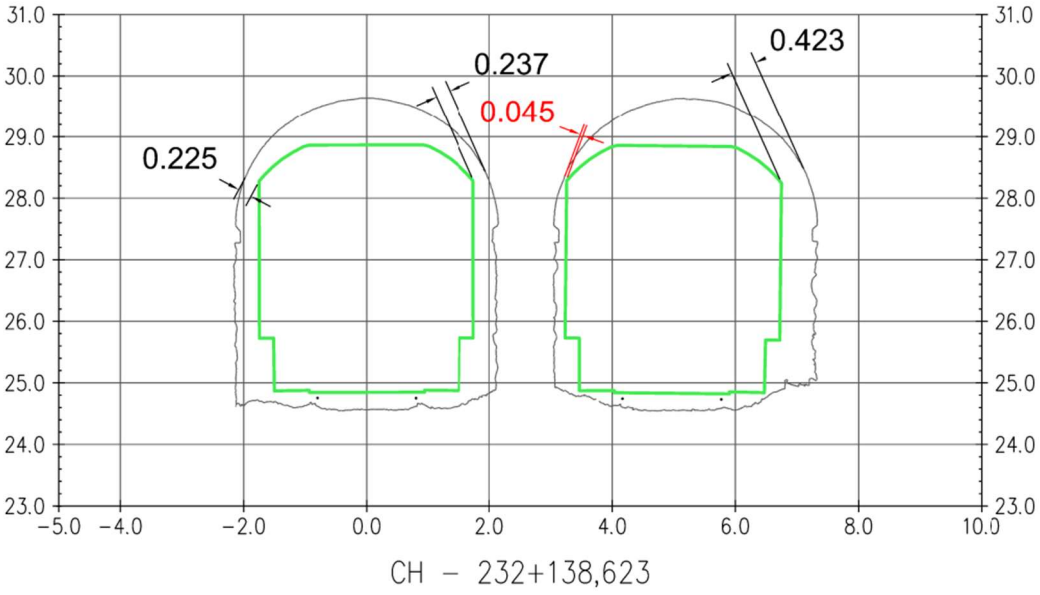
The groundwater vulnerability underlying this area is rated as low; in the Cabra West area it rises to moderate. Much of the subsoils traversing the zone are comprised of till derived from limestones.

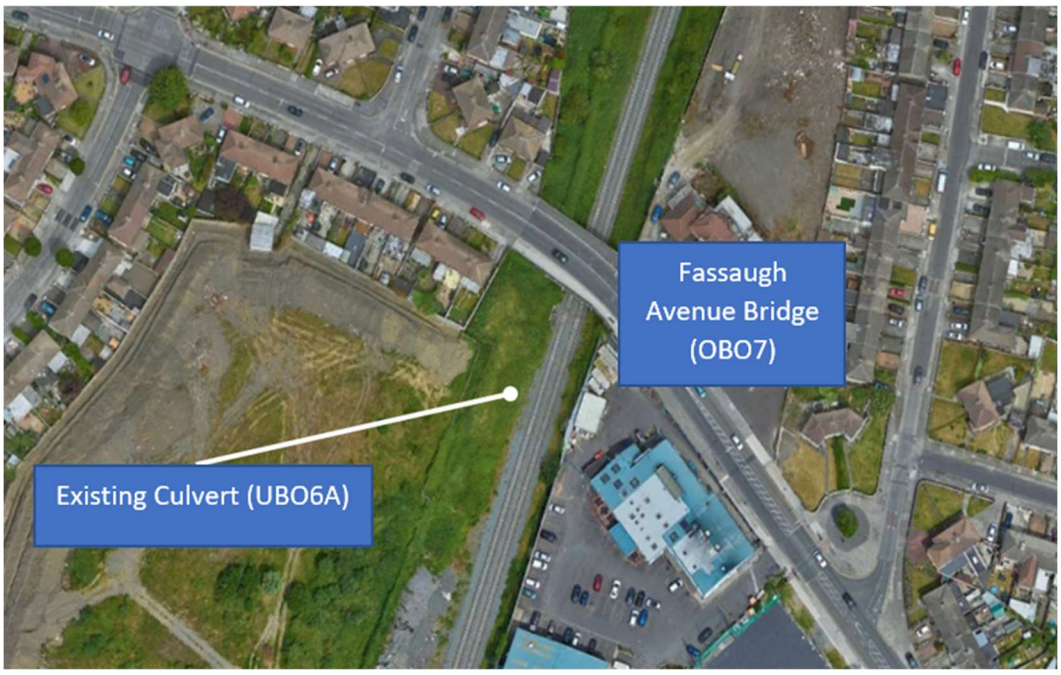
4.2. Permanent Way

The details of each of the features that would constrain the Per Way solutions in the Zone 3 are demonstrated in Table 4-1.

Table 4-1 Details of the Per Way constraints

Name	Description of Constraints
Royal Canal and LUAS Twin Arch Bridge (OBO8)	The horizontal clearances at Royal Canal and LUAS Twin Arch Bridge (OBO8) are tight. The existing lateral passing clearances in Royal Canal and LUAS Twin Arch Bridge (OBO8) has been assessed (refer to Figure 4-1). It has a minimum lateral clearance of 101mm to the IRL2 reference profile in the existing situation.  **Figure 4-1 The left track (Up Branch)**

Name	Description of Constraints
Maynooth Line Twin Arch Bridge (OBO9)	The horizontal clearances at Maynooth Line Twin Arch Bridge (OBO9) are tight. The existing lateral passing clearances in Maynooth Line Twin Arch Bridge (OBO9) have been assessed and it becomes apparent substandard lateral clearances in the Down Branch Line exist (refer to Figure 4-2). It has a minimum lateral clearance of 45 to the IRL2 reference profile in the existing situation.  **Figure 4-2 The right track (Down Branch)**

Name	Description of Constraints
Existing Culvert UBO6	The existing Culvert UBO6A crosses the tracks close to Fassaugh Avenue Bridge (OBO7). And constrains downward realignment of the tracks (Figure 4-3).  **Figure 4-3 Location of Culvert UBO6A, south of Fassaugh Avenue Bridge (OBO7)**

4.3. Existing Structures

Following an initial OHLE assessment of the eight overbridge structures, it has been found that:

- At McKee Barracks Bridge (OBO3), Blackhorse Avenue Bridge (OBO4) and Old Cabra Road Bridge (OBO5), an OHLE solution with 4.7m contact wire height can be achieved without structural or track intervention. However, the services bridge south of the Blackhorse Avenue Bridge needs to be removed.
- At Cabra Road Bridge (OBO6) and Fassaugh Avenue Bridge (OBO7), an OHLE solution is not possible, and structural and/or track intervention (more than 100mm track lowering) is required.
- At Royal Canal and LUAS Twin Arch Bridge (OBO8), Maynooth Line Twin Arch Bridge (OBO9) and Glasnevin Cemetery Road Bridge (OBO10), an OHLE solution with reduced clearance and 4.2m contact wire height is possible with a 100mm track lowering. For an OHLE solution without derogations, structural or track intervention (more than 100mm track lowering) is required.

4.4. Geotechnical

Based on the existing information, groundwater conditions could be challenging in this area, which has been known to flood in the past. Where track lowering is required at or close to existing structures or earthworks, an assessment of the stability of existing structures will be required. A compressive assessment of the stability of the existing earthworks will be required due to the history of instability of the cuttings within this area. Where

earthworks are subjected to track lowering, this may negatively impact the existing stability of the earthworks and further interventions such as soil nailing and/or earthworks retention may be required.

In addition to this, a suitable track drainage solution will be required, incorporating the pumped systems that are already in place between Royal Canal and LUAS Twin Arch Bridge (OBO8) and Maynooth Line Twin Arch Bridge (OBO9).

For existing retaining walls, the horizontal alignment of the railway is remaining largely unchanged therefore it is not anticipated that major interventions will be required to existing retaining walls for horizontal clearance purposes. However, the stability of the existing retaining walls should be checked against any proposed nearby track lowering. New retention or minor retaining walls may be required within existing earthwork cuttings at the location to proposed OHLE foundations and trackside equipment.

4.5. Existing Utilities

The majority of utilities that cross the rail corridor are concentrated in Blackhorse Avenue Bridge (OBO4), Old Cabra Road Bridge (OBO5), Cabra Road Bridge (OBO6) and Fassaugh Avenue Bridge (OBO7), with exception to 3 no. combined sewers and 1 no. stormwater pipe that cross underneath the tracks, and 1 no. combined sewer pipe bridge (locations outlined below). Any option that requires minor / major bridge reconstruction works will cause major disruption to the associated services. Should there be a requirement to lower the existing track, this may impact on existing Irish Water services and will require careful examination. Irish Water services are shown below**Error! Reference source not found.**:

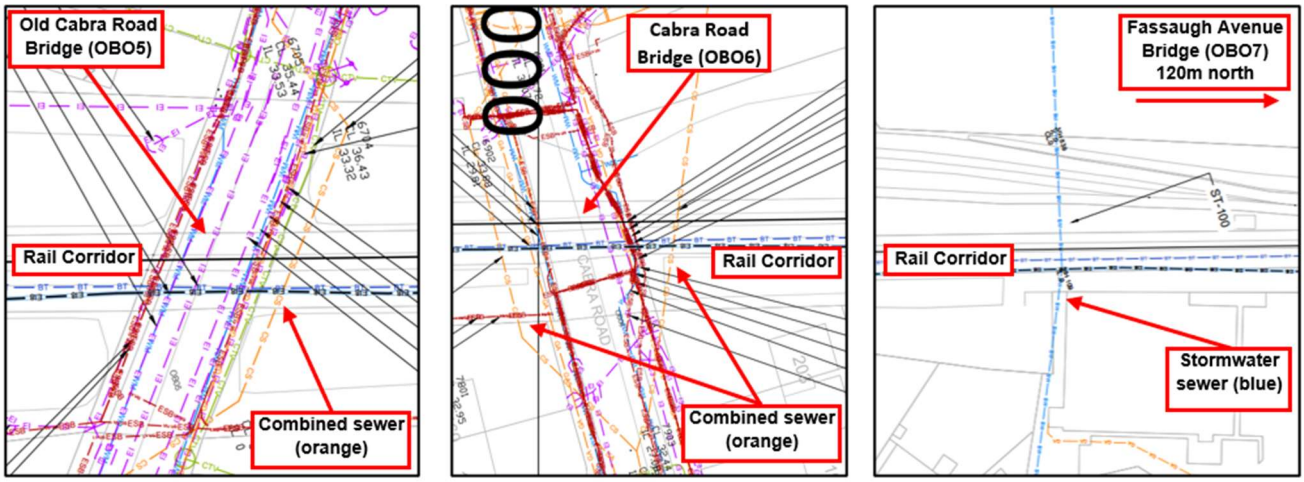


Figure 4-4 Utility Crossings

Note: (a) 2no Combined Sewers at Cabra Road Bridge (OBO6), (b) 1no Combined Sewer at Old Cabra Road Bridge (OBO5), (c) 1no Stormwater Sewer 120m west of Fassaugh Avenue Bridge (OBO7)

An existing foul/combined sewer is located at Blackhorse Avenue Bridge (OBO4) (Reference ID CS-105). Shown in Figure 4-5, this pipe bridge spans the rail corridor along the southern side of Blackhorse Avenue Bridge (OBO4), crossing the tracks at a lower elevation. This conflicts with the required clearance for rail electrification and must be diverted.

Figure 4-5 Pipe Bridge at Blackhorse Avenue Bridge (OBO4)

4.6. Property

Subject to further design development and subject to the location of suitable construction compounds, it is not anticipated that works will be required outside of the rail corridor / publicly owned land in this section of the line.

4.7. Drainage

The railway through this section is in cut, meaning that it is generally below surrounding ground levels. This means that the main constraint for the track drainage system is the location of a suitable outfall in the area and the existing track gradient.

There is no outfall identified if a new track drainage was to be installed and future track work proposals will carefully assess the existing drainage situation.

Particular attention is required in the area between Royal Canal and LUAS Twin Arch Bridge (OBO8) and Maynooth Line Twin Arch Bridge (OBO9). There is a low point between these overbridges and there are recurring flooding events.

5. Options

5.1. Options Summary

The main requirement is the installation of the OHLE equipment. The main constraints for fitting the OHLE equipment are the existing overbridges in the area. An initial assessment has been carried out in relation to the clearances at each overbridge and different options are proposed for each of the overbridges.

The Main 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 Main Options is presented in the Table 5-1.

Table 5-1 Main Options Summary

Option	Description			
	McKee Barracks Bridge (OBO3)	**Blackhorse Avenue Bridge (OBO4)**	**Old Cabra Bridge (OBO5)**	**Cabra Road Bridge (OBO6)**
Option 0: Do Nothing	The existing infrastructure remains unchanged. There are no interventions. (bridge currently not in use).	The existing infrastructure remains unchanged. There are no interventions.	The existing infrastructure remains unchanged. There are no interventions.	The existing infrastructure remains unchanged. There are no interventions.
Option 1: Do Minimum		Diversion of the existing service bridge. Raising of parapets.		Combination of track lowering and OHLE derogations from standards / fitted solution. No bridge reconstruction. Raising of parapets.
Option 2		The existing services bridge cannot be diverted. Combination of track lowering and OHLE derogations from standards / fitted solution Raising of parapets.		Partial bridge reconstruction. Track lowering and / or OHLE derogations from standards / fitted solution if required. Reconstruction of parapets.

Option	Description			
	Fassaugh Avenue Bridge (OBO7).	**Royal Canal and LUAS Twin Arch Bridge (OBO8)**	**Maynooth Line Twin Arch Bridge (OBO9)**	**Glasnevin Cemetery Road Bridge (OBO10)**
Option 0: Do Nothing	The existing infrastructure remains unchanged. There is no intervention.	The existing infrastructure remains unchanged. There is no intervention.	The existing infrastructure remains unchanged. There is no intervention.	The existing infrastructure remains unchanged. There is no intervention.
Option 1: Do Minimum	Combination of track lowering and OHLE derogations from	Combination of track lowering (or slab track) and OHLE derogations	Combination of track lowering (or slab track) and OHLE derogations	Combination of track lowering and OHLE derogations from

Option	Description			
	Fassaugh Avenue Bridge (OBO7).	**Royal Canal and LUAS Twin Arch Bridge (OBO8)**	**Maynooth Line Twin Arch Bridge (OBO9)**	**Glasnevin Cemetery Road Bridge (OBO10)**
	standards / fitted solution. No bridge reconstruction. Raising of parapets.	from standards / fitted solution. No bridge reconstruction. Raising of parapet on the east side.	from standards / fitted solution. No bridge reconstruction. Raising of parapets.	standards / fitted solution. No bridge reconstruction. Amendment of parapets.
Option 2	Partial bridge reconstruction. Track lowering and / or OHLE derogations from standards / fitted solution if required. Reconstruction / raising of parapets.	Bridge reconstruction. Track lowering and / or OHLE derogations from standards / fitted solution if required. Reconstruction of parapets.	Bridge reconstruction. Track lowering and / or OHLE derogations from standards / fitted solution if required. Reconstruction of parapets.	Partial bridge reconstruction. Track lowering and / or OHLE derogations from standards / fitted solution if required. Reconstruction of parapets.

5.2. Options Description

This section describes the Main Options that have been considered, the options relate predominantly to structures along the rail corridor which may be impacted by the proposed works. The do-nothing options typically mean do-nothing to the existing bridge or track, although linear works such as OHLE and signalling will be deployed without significant alteration to the existing elements, as opposed to do-minimum options which would typically require an element of track lowering, fitting OHLE to the bridge, or other interventions to the existing elements.

5.2.1. McKee Barracks Bridge (OBO3)

5.2.1.1. Option 0: Do-Nothing

The Do-Nothing Option proposes no changes to the existing rail infrastructure. There are no changes to the existing McKee Barracks Bridge (OBO3) structure, (bridge currently not in use).

5.2.2. Blackhorse Avenue Bridge (OBO4)

5.2.2.1. The Do-Nothing Option

The Do-Nothing Option proposes no changes to the existing rail infrastructure.

5.2.2.2. Option 1: Do-Minimum

Option 1 proposes no changes to the existing rail infrastructure. The existing services bridge south of Blackhorse Avenue Bridge (OBO4) is demolished to allow for installation of the electrification system. There are no changes to the existing Blackhorse Avenue Bridge (OBO4) structure, other than raising the parapets to 1.8m height for pedestrian protection.

5.2.2.3. Option 2: Do-Something

Option 2 assumes that the service bridge cannot be diverted. Because the service bridge is the one constraining the installation of the electrification system (the actual Blackhorse Avenue Bridge (OBO4) bridge is higher), a combination of track lowering, and OHLE derogations would be needed. Parapets would be raised to 1.8m height for pedestrian protection. Amendment of the Blackhorse Avenue Bridge (OBO4) bridge foundations may be required if the lower tracks clash with the existing bridge foundations. This option would apply should Option 1 be deemed unfeasible.

5.2.3. Old Cabra Road Bridge (OBO5)

5.2.3.1. The Do-Nothing Option

The Do-Nothing Option proposes no changes to the existing rail infrastructure, although works to the existing bridge parapets may be required for pedestrian protection.

5.2.4. Cabra Road Bridge (OBO6)

5.2.4.1. The Do-Nothing Option

The Do-Nothing Option proposes no changes to the existing rail infrastructure.

5.2.4.2. Option 1: Do-Minimum

Option 1 proposes to achieve an OHLE solution by combination of track lowering and OHLE derogations from standards / fitted solution. No reconstruction of the bridge is proposed, although minor intervention to the bridge foundations may be required depending upon their depth and geometry. Bridge parapets would be raised to 1.8m height for pedestrian protection.

For an OHLE solution with a 4.2m contact wire height, the anticipated additional vertical clearance required is 301mm, however this value may be revised as the assessment progresses.

5.2.4.3. Option 2

Option 2 proposes to achieve an OHLE solution by partial bridge reconstruction, as well as track lowering and / or OHLE derogations from standards / fitted solution if required.

This option proposes to replace the bridge deck at a higher soffit level. The existing abutments would be retained, and the abutment seats would be raised as required to accommodate the new deck. Bridge parapets would be upgraded to H4a Containment and 1.8m parapet height for pedestrian protection. For an OHLE solution with a 4.4m contact wire height, the anticipated additional vertical clearance required is 501mm, however this value may be revised as the assessment progresses.

Realignment of Cabra Road is likely to be needed, but due to the proximity of residential properties and road junctions, the extent of road level raising would be limited within the bridge and up to adjacent side roads. Traffic would be accommodated via a temporary traffic management diversion over Old Cabra Bridge (OBO5) and Faussagh Avenue Bridge (OBO7). Anticipated vehicle journeys increasing by 2 to 3 mins and pedestrians by 10 to 20mins, depending on destination.

Track lowering and / or OHLE derogations from standards / fitted solution may be required in order to minimize impact to road levels.

Option 2 would apply should Option 1 be deemed unfeasible.

Figure 5-1 Extent of Potential Road Works considering Access and Junction Constraints

Figure 5-2 Potential Impact on Vehicular and Vulnerable Road Users during Construction

5.2.5. Fassaugh Avenue Bridge (OBO7)

5.2.5.1. The Do-Nothing Option

The Do-Nothing Option proposes no changes to the existing rail infrastructure.

5.2.5.2. Option 1: Do-Minimum

Option 1 proposes to achieve an OHLE solution by combination of track lowering and OHLE derogations from standards / fitted solution. No reconstruction of the bridge is proposed, although minor intervention to the bridge foundations may be required depending upon their depth and geometry. Bridge parapets would be raised to 1.8m height for pedestrian protection.

For an OHLE solution with a 4.2m contact wire height, the anticipated additional vertical clearance required is 178mm, however this value may be revised as the assessment progresses.

5.2.5.3. Option 2

Option 2 proposes to achieve an OHLE solution by partial bridge reconstruction, as well as track lowering and / or OHLE derogations from standards / fitted solution if required.

This option proposes to replace the original bridge arch structure with new portal units installed on the existing abutments, while retaining the newer beam and slab bridge extensions if possible. Bridge parapets would be raised to 1.8m height for pedestrian protection. Details of the connection between the flat deck bridge widenings and the original arch bridge need to be considered to determine whether partial reconstruction of the bridge widenings will also be required. In this case, the bridge parapets would be upgraded to H4a Containment and 1.8m parapet height for pedestrian protection. For an OHLE solution with a 4.4m contact wire height, the anticipated additional vertical clearance required is 378mm, however this value may be revised as the assessment progresses.

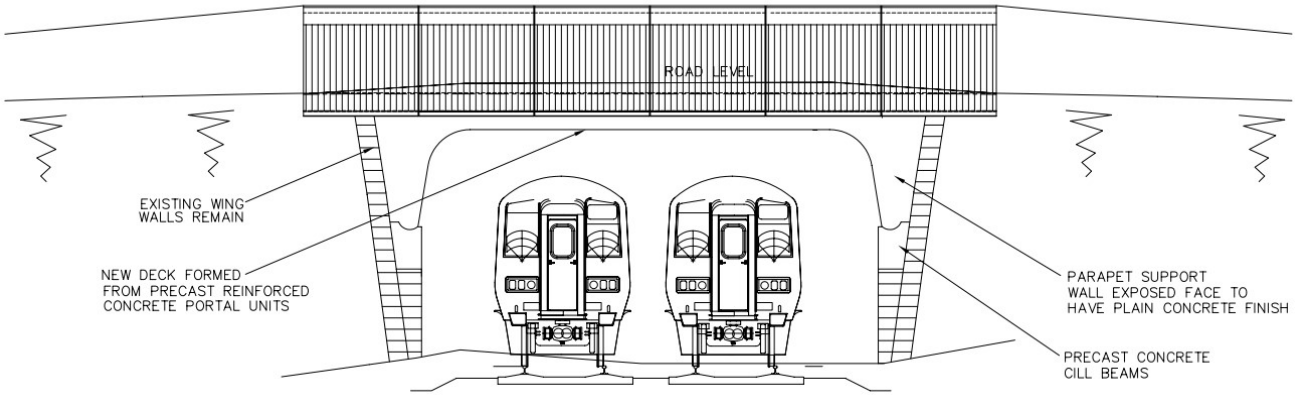


Figure 5-3 Indicative Arch Bridge Intervention

Realignment of Fassaugh Avenue may be required, but due to the proximity of residential properties and road junctions, the extent of road level raising would be limited within the bridge and up to adjacent side roads. General traffic would be accommodated via a temporary traffic management diversion over Cabra Road Bridge (OBO6) and/or Old Cabra Road Bridge (OBO5).

Track lowering and / or OHLE derogations from standards / fitted solution may be required in order to minimize impact to road levels.

Option 2 would apply should Option 1 be deemed unfeasible.

Figure 5-4 Extent of Potential Road Works considering Access and Junction Constraints

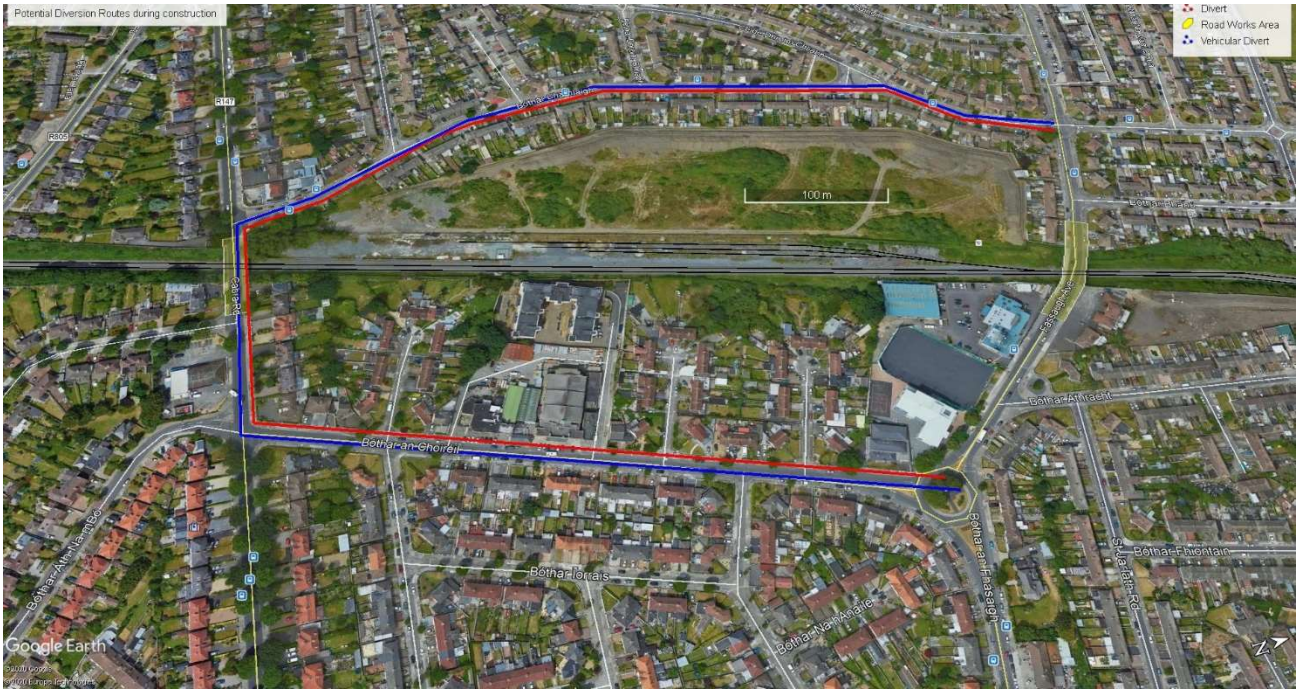


Figure 5-5 Potential Impact on Vehicular and Vulnerable Road Users during Construction

5.2.6. Royal Canal and LUAS Twin Arch Bridge (OBO8)

5.2.6.1. The Do-Nothing Option

The Do-Nothing Option proposes no changes to the existing rail infrastructure.

5.2.6.2. Option 1: Do-Minimum

Option 1 proposes to achieve an OHLE solution by combination of track lowering and OHLE derogations from standards / fitted solution. There are no changes to the existing Royal Canal and LUAS Twin Arch Bridge (OBO8) structure, other than raising the parapet on the east side of the bridge to 1.8m height for pedestrian protection.

For an OHLE solution with a 4.2m contact wire height, the anticipated additional vertical clearance required is 100mm, however this value may be revised as the assessment progresses. The electrification solution would involve the installation of OHLE Multiple fitted Tunnel arms.

In addition to track lowering, the tracks may also need to be realigned horizontally to obtain compliant lateral clearances.

5.2.6.3. Option 2

Option 2 proposes to achieve an OHLE solution by reconstructing the bridge, as well as track lowering and / or OHLE derogations from standards / fitted solution if required.

The existing Royal Canal and LUAS Twin Arch Bridge (OBO8) would be replaced with a new single span long buried portal, completed with new parapets designed to H4a Containment and 1.8m height for pedestrian protection.

For an OHLE solution with a 4.4m contact wire height, the anticipated additional vertical clearance required is 300mm, however this value may be revised as the assessment progresses. The electrification solution would

involve the installation of OHLE Multiple fitted Tunnel arms. Track lowering and / or OHLE derogations from standards may be required in order to minimize impact to the LUAS and Royal Canal levels.

Option 2 would apply should Option 1 be deemed unfeasible.

5.2.7. Maynooth Line Twin Arch Bridge (OBO9)

5.2.7.1. The Do-Nothing Option

The Do-Nothing Option proposes no changes to the existing rail infrastructure or Maynooth Line Twin Arch Bridge (OBO9) structure.

5.2.7.2. Option 1: Do-Minimum

Option 1 proposes to achieve an OHLE solution by combination of track lowering and OHLE derogations from standards / fitted solution. There are no changes to the existing Maynooth Line Twin Arch Bridge (OBO9) structure, other than raising the parapets to 1.8m height for pedestrian protection.

For an OHLE solution with a 4.2m contact wire height, the anticipated additional vertical clearance required is 100mm, however this value may be revised as the assessment progresses. The electrification solution would involve the installation of OHLE Multiple fitted Tunnel arms.

5.2.7.3. Option 2

Option 2 proposes to achieve an OHLE solution by reconstructing the bridge, as well as track lowering and / or OHLE derogations from standards / fitted solution if required

The existing Maynooth Line Twin Arch Bridge (OBO9) would be replaced with a new single span buried portal completed with new parapets designed to H4a Containment and 1.8m height for pedestrian protection.

For an OHLE solution with a 4.4m contact wire height, the anticipated additional vertical clearance required is 300mm, however this value may be revised as the assessment progresses. The electrification solution would involve the installation of OHLE Multiple fitted Tunnel arms.

Track lowering and / or OHLE derogations from standards may be required in order to minimize impact to the Maynooth Line levels. In addition, the tracks may need to be realigned horizontally to obtain compliant lateral clearances.

Option 2 would apply should Option 1 be deemed unfeasible.

5.2.8. Glasnevin Cemetery Road Bridge (OBO10)

5.2.8.1. The Do-Nothing Option

The Do-Nothing Option proposes no changes to the existing rail infrastructure.

5.2.8.2. Option 1: Do-Minimum

Option 1 proposes to achieve an OHLE solution by combination of track lowering and OHLE derogations from standards / fitted solution There are no changes to the existing Glasnevin Cemetery Bridge (OBO10) structure, other than raising the parapets to 1.8m height for pedestrian protection and solid infill/sheeting to prevent pedestrians making contact with wires.

For an OHLE solution with a 4.2m contact wire height, the anticipated additional vertical clearance required is 100mm, however this value may be revised as the assessment progresses.

5.2.8.3. Option 2

Option 2 proposes to achieve an OHLE solution by partial bridge reconstruction, as well as track lowering and / or OHLE derogations from standards / fitted solution if required.

This option proposes to replace the bridge deck at a higher soffit level. The existing abutments would be retained, and the abutment seats would be raised as required to accommodate the new deck. The bridge parapets would be upgraded to H4a Containment and 1.8m parapet height for pedestrian protection.

Track lowering and / or OHLE derogations from standards / fitted solution may be required in order to minimize impact to road levels.

Option 2 would apply should Option 1 be deemed unfeasible.

5.3. Electrification

McKee Barracks Bridge (OBO3), Blackhorse Avenue Bridge (OBO4) and Old Cabra Road Bridge (OBO5) have sufficient vertical clearance such that they can be electrified under all Options (with free running solutions) without any track lowering or major structural interventions. This is assuming that a steel service bridge on the south side of Blackhorse Avenue Bridge (OBO4) would be removed prior to electrification.

Cabra Road Bridge (OBO6), Fassaugh Avenue Bridge (OBO7), Royal Canal and LUAS Twin Arch Bridge (OBO8), Maynooth Line Twin Arch Bridge (OBO9) and Glasnevin Cemetery Road Bridge (OBO10) currently have insufficient vertical clearance to be electrified with OHLE. Each would need intervention requiring a combination of track lowering, and / or structural intervention and / or OHLE derogation from standards.

For Cabra Road Bridge (OBO6) and Fassaugh Avenue Bridge (OBO7), Options 1and 2 provide sufficient vertical clearance for an OHLE configuration with graded contact wire, twin contact equipment (zero system height), and a contact wire height of 4.2m through each bridge. Derogation would be required for a reduced contact wire height below 4.4m. The OHLE would be fitted with elastic bridge arms supported from a single location on each structure. These connections would not be visible from road level. Electrical clearances would be 100mm static, and 80mm dynamic. Allowance has been made for 25mm of upward track movement. OHLE masts would be positioned at 20m, 55m and 105m on each side of the bridge before reverting to normal spacings.

For Royal Canal and LUAS Twin Arch Bridge (OBO8) and Maynooth Line Twin Arch Bridge (OBO9), these two tunnels are in proximity to each other so must be considered together when defining the OHLE solution for each Option.

For these tunnels Options 1 and 2 provide sufficient vertical clearance for an OHLE configuration with graded contact wire, twin contact equipment (zero system height), and a contact wire height of 4.2m through each of the tunnels. Derogation will be required for a reduced contact wire height below 4.4m. Due to the width and shape of the tunnels, the OHLE would be fitted with tunnel arms supported from the structure at multiple locations. Electrical clearances would be 100mm static, and 50mm passing. Allowance has been made for 25mm of upward track movement. OHLE masts would be positioned at 20m, 55m and 105m on each side of the tunnels before reverting to normal spacings.

For Glasnevin Cemetery Road Bridge (OBO10) Options 1 and 2 provide sufficient vertical clearance for an OHLE configuration with graded contact wire, twin contact equipment (zero system height), and a contact wire height of 4.2m through the bridge. Derogation will be required for a reduced contact wire height below 4.4m. In this

configuration the OHLE would be supported by a mast and be positioned at 5m on each side of the bridge. This mast will be visible from road level. OHLE masts would be positioned at 20m, 55m and 105m on each side of the bridge support mast before reverting to normal spacings.

5.4. Cabra. Passive provision for a station (Not part of DART+)

The provision of a new station at Cabra does not form part of the scope of DART+. However, passive provision for a potential station was assessed.

5.4.1. Site Constraints

The main site considerations:

- Property limits. The corridor width is narrow at various points, limiting the areas that a station could be located. The potential visual and noise impact on private properties will vary dependant on the position of the station.
- Track profile. According to CCE-TMS-345 a maximum 1/400 gradient is required for new platforms. Please refer to Figure 2-6 Track vertical alignment.
- Available space for: Platform length (174m plus ramps to track access); public access to the station including set-down areas for road users; Emergency vehicle access.
- Feasibility and accessibility for construction.
- Connectivity with other modes of transport including the LUAS, Bus and other Rail connections.
- Protected structures. Cabra Road Bridge (OBO6) is protected, and Old Cabra Road Bridge (OBO5) and Blackhorse Ave (OBO4) are NIAH listed.
- New development in Cabra, a new housing development is under construction. Access points and the property limits to be taken into consideration. See Figure 5-6 below.

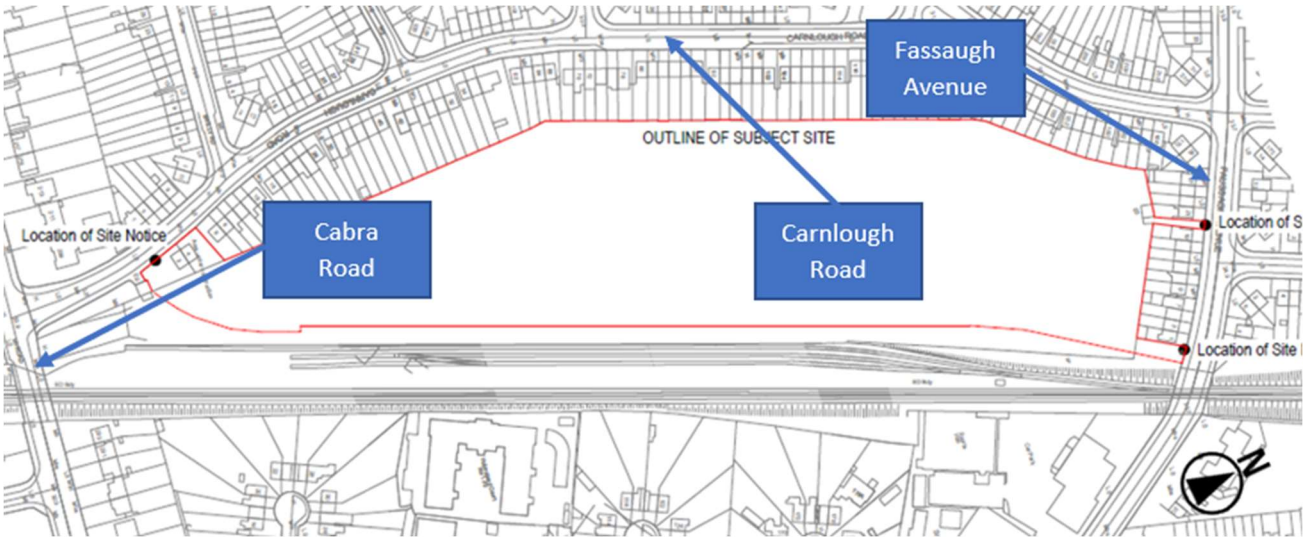


Figure 5-6 New housing project at Cabra

5.4.2. Design Criteria

The new station design will consider the latest design criteria applicable to station design and development. The design concept for the station is constrained by the track alignment and the physical site boundary. The station design will include the following:

- Two open platforms, 174 m long, finished with ramps for maintenance and emergency access to the tracks.
- Platforms will have a minimum width of 3m, subject to further capacity and evacuation analysis. The arrangement will include two refuges per platform which will not reduce the general platform width.
- Access by road, including a set-down \ stop area for vehicles and for emergency services vehicle access.
- Accessibility requirements, access to the footbridge to be considered, options include the provision of a combination of stairs and ramps, or stairs and lifts.

5.4.3. Location Options

Preliminary drawings of the various station location and configuration options are included in Appendix A.

Figure 5-7 Options overview plan

Option 1.a (North of Cabra Road Bridge (OBO6)

- In this option the footbridge structure would be close to residential properties. An option with stairs and a lift would reduce width and impact.
- The position and configuration of the station platforms to be determined, based on the track profile and distance to Cabra Road Bridge (OBO6).
- This option provides the most favourable position for public access.

Option 1.b: (Located between Cabra Road and Faussagh Ave)

- Reduced impact on private properties.
- Favourable location from a track gradient perspective.
- Longer access route from Cabra Road area.

Option 1.c: (Adjoining Cabra Road Bridge (OBO6). Footbridge or direct access from bridge deck)

- The position and configuration of the station platforms to be determined.
- This option requires a more complicated structure due to the proximity to the Cabra Road Bridge (OBO6) structure.
- There will be an impact on the existing bridge structure, which is a protected structure.

Option 1.d: (Adjoining south side of Faussagh Ave Bridge)

- Less favourable position due to the track gradient.

- Higher impact on existing properties, requiring significant land acquisition.

Option 2.a: (South of Old Cabra Road. Deck adjacent to bridge)

- Less favourable from a site topography perspective, the track gradient is also an issue at this location.
- The track is located in a cutting approx. 8m deep, access to the station platforms would require significant ramps and / or lifts. Due to the site topography, construction access would be difficult.
- Construction activities would have a significant impact along Cabra Road.

Option 2.b: (South of Cabra Road Bridge (OBO6). No deck, direct access to platforms)

- Similar issues as per Option 2a in terms of site topography and track gradient
- This option would not provide sufficient space for access and set-down from the road.
- Significant impact on Cabra Road Bridge (OBO6).

Option 3.a: (North of Blackhorse Ave. Deck adjacent to bridge)

- Similar issues as per Option 2a in terms of site topography and track gradient

Option 3.b: (North of Blackhorse Ave. No deck, direct access to platforms)

- Similar issues as per Option 2a in terms of site topography and track gradient

Option 4: (Between Old Cabra Road and Old Cabra Road)

- Difficult to accommodate 174m length platforms, due to the proximity of both bridges.
- Issues with track gradient.
- Impact on both bridges would be significant.

5.4.4. Station Option Summary

The options south of Cabra Road are not deemed feasible due to issues associated with the track gradient. The options between Cabra Road and Fassaugh Avenue are anticipated to be feasible, although further site investigations will be required.

5.5. Geotechnical (All Do-Something Options)

All Options (excluding Option 0) for track alignment and electrification interventions and will require detailed geotechnical design for the following elements:

- Track bed formation design and assessment of the stability of the existing structures for any proposed track lowering
- Overhead Line Equipment foundation design

The horizontal alignment of the railway remains largely unchanged therefore it is anticipated that there will be no major interventions required for the existing retaining walls to achieve horizontal clearances. However, existing structures (e.g bridges, retaining walls and earthworks) subjected to track lowering should comprehensively assessed as to their existing suitability for the proposals. Given the history of earthworks instability in this area, at this stage, it is prudent to assume that some form of earthworks remedial solutions will be required in areas subjected to track lowering.

5.6. Roads (Option 4 for Cabra Road Bridge (OBO6) & Fassaugh Avenue Bridge (OBO7))

Subject to further investigation, it is not anticipated that interventions will be required to the existing roads for any of the bridges. However; in the event that bridge reconstruction is required, it is anticipated that the required clearances can be achieved with minimal intervention to the road network. Depending on the extent of bridge works required, road works are anticipated to be limited to realignment of the area immediately adjacent to the bridge, but possibly extending to adjacent side roads.

5.7. Drainage

At locations where track lowering is proposed to achieve the necessary clearance under the current structures, these changes may require the upgrade of the existing drainage system at certain locations along this section of the line.

The drainage system at structure Fassaugh Avenue Bridge (OBO7) currently falls to the south (at approximately 1% gradient), towards the northern portal of the Phoenix Park Tunnel.

At structures Royal Canal and LUAS Twin Arch Bridge (OBO8), Maynooth Line Twin Arch Bridge (OBO9) and OBO10, it is proposed to lower the track by approx. 100 mm from the current level. This is not expected to change in a significant way the drainage catchments and gradients. However, it could present a potential impact to the performance of the existing pumping station located between structures OBC8 and OBC9. Indeed, there is a pumping station that drains the excess of water on the cutting located immediately to the west of OBC8 (Twin Arch Bridge 1 in Figure 2-16). This facility directs the inflows to the attenuation tank located to the northwest, being then infiltrated in principle (this needs to be confirmed).

Since the pumping station also seems to receive inflows from the track when the water depth reaches a certain level, the track lowering can represent an alteration on the current hydraulic balance. As a result, more water could potentially need to be pumped, with an extra head of 100 mm. Consequently, the existing tank could potentially receive additional volume as well. Further assessment is therefore required in order to fully understand the pumping station performance and the possibilities for the existing system (pumping station, pressure pipe, attenuation tank and soakaway) to cope with the potential changes. In this sense, a geotechnical survey to determine the infiltration capacities of the existing soakaway may be required in further stage.

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

Existing containment routes consist of buried duct, surface troughing and ladder rack/tray Except for Option 0, all Options will require the relocation of a variety of service cables, utilities and containment throughout and the integration of the existing maintenance routes in Inchicore with the new track arrangement. With the exception of Option 0, all other engineering options will require the relocation of various cables and containment.

Where new containment is required to interface with the proposed SET installation these shall be interfaced appropriately with the existing containment runs. Where cable ducts are required to pass under the railway track they shall be contained by a suitable under track crossing.

Where there is a required change of direction for cabling draw-chambers shall be installed (surface or otherwise). Draw-pits will be of adequate size to enable cables to be drawn in without damage and accommodating the cable bending radius.

These containment solutions shall be utilised for all SET cabling requirements with services separated as far as is reasonably practical.

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 Project Route 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, Economic 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 options assessed, ranged from a 'Do-Nothing' Option, Do-Minimum' Option to a range of 'Do-Something' Options, each of the options were assessed to determine if they were feasible and met the Project Objectives / Requirements.

The Options mainly focused on the existing structures in this area which were analysed to determine if they could accommodate the installation of the new Overhead Line Electrification (OHLE) system. There are no proposals to add tracks in this area, so widening of the rail corridor is not envisaged.

6.3. Preliminary Assessment (Sifting)

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

Table 6-1 Sifting Process for McKee Barracks Bridge (OBO3)

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
		Electrical clearance for electrification	PASS. Standard clearance. Free running solution
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**

Table 6-2 Sifting Process for Blackhorse Avenue Bridge (OBO4)

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.
		Electrical clearance for electrification	FAIL Not achieved.
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
1	Engineering	Constructability	PASS. Assuming Service bridge can be diverted.
		Geometrical fitness for intervention	PASS. Minor interventions without geometrical fitness concerns are possible.
		Safety	PASS. Minor interventions that pose no safety concerns are possible.
		Electrical clearance for electrification	PASS. Standard clearance for electrification and 4.4 m cw height and free running solution
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.

Option	Requirements		Description
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
2	**Engineering**	Constructability	PASS. Assuming Service bridge cannot be diverted.
		Geometrical fitness for intervention	PASS. Minor interventions without geometrical fitness concerns are possible.
		Safety	PASS. Minor interventions that pose no safety concerns are possible.
		Electrical clearance for electrification	PASS. Standard clearance for electrification and 4.4 m cw height and free running solution
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations
		Structural soundness of the Bridge (if track interventions)	PASS Pending outcome of GI investigations
		Keep current functionality of roads	PASS Pending outcome of GI investigations
	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**

Table 6-3 Sifting Process for Old Cabra Road Bridge (OBO5)

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.
		Electrical clearance for electrification	PASS. Standard clearance. Free running solution
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**

Table 6-4 Sifting Process for Cabra Road Bridge (OBO6)

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.
		Electrical clearance for electrification	FAIL Not achieved.
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
1	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for. 4.2 m cw height
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
2	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for 4.2 m cw height or Standard Electrical clearance
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations
		Structural soundness of the Bridge (if track interventions)	PASS Pending outcome of GI investigations
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**

Table 6-5 Sifting Process for Fassaugh Avenue Bridge (OBO7)

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.
		Electrical clearance for electrification	FAIL Not achieved.
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
1	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for. 4.2 m cw height
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations .
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
2	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for 4.2 m cw height or Standard Electrical clearance
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations.
		Structural soundness of the Bridge (if track interventions)	PASS Pending outcome of GI investigations
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**

Table 6-6 Sifting Process for Royal Canal and LUAS Twin Arch Bridge (OBO8)

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.
		Electrical clearance for electrification	FAIL Not achieved.
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
1	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for. 4.2 m cw height
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
2	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for 4.2 m cw height or Standard Electrical clearance
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations
		Structural soundness of the Bridge (if track interventions)	PASS Pending outcome of GI investigations
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**

Table 6-7 Sifting Process for Maynooth Line Twin Arch Bridge (OBO9)

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.
		Electrical clearance for electrification	FAIL Not achieved.
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
1	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for. 4.2 m cw height
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
2	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for 4.2 m cw height or Standard Electrical clearance
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations
		Structural soundness of the Bridge (if track interventions)	PASS Pending outcome of GI investigations
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**

Table 6-8 Sifting Process for Glasnevin Cemetery Road Bridge (OBO10)

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.
		Electrical clearance for electrification	FAIL Not achieved.
		Track alignment and drainage (standards)	Not applicable. No intervention proposed.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
1	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for. 4.2 m cw height
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations.
		Structural soundness of the Bridge (if track interventions)	Not applicable. No intervention proposed.
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**
2	Engineering	Constructability	PASS in principle until a more detailed analysis is carried out after GI.
		Geometrical fitness for intervention	PASS Pending detailed analysis
		Safety	PASS Pending detailed analysis
		Electrical clearance for electrification	PASS. Electrical clearance derogation for 4.2 m cw height or Standard Electrical clearance
		Track alignment and drainage (standards)	PASS Pending outcome of GI investigations
		Structural soundness of the Bridge (if track interventions)	PASS Pending outcome of GI investigations
		Keep current functionality of roads	Not applicable. No intervention proposed.
	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**

6.4. Preliminary Assessment Summary

The table below summaries the Main Options developed for each of the bridges, showing which options pass the sifting process and are brought forward to Stage 2: MCA.

Table 6-9 Summary of Sift Process Results

Options	Sifting Process Result							
	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 Arch Bridge (OBO8)	Maynooth Line Twin Arch Bridge (OBO9)	Glasnevin Cemetery Road Bridge (OBO10)
Option 0: Do Nothing	PASS	FAIL	PASS	FAIL	FAIL	FAIL	FAIL	FAIL
Option 1: Do Minimum	N/A	PASS	N/A	PASS	PASS	PASS	PASS	PASS
Option 2	N/A	PASS	N/A	PASS	PASS	PASS	PASS	PASS

6.5. Stage 2: Multi-Criteria Analysis (MCA)

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

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

Relevant considerations include:

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

At the current stage of design development, the Emerging Preferred Option aligns with do-minimum option which in all cases anticipates little or no intervention to the bridges. Where the required electrical clearance beneath the bridges is sub-standard, clearances will be increased by means of track lowering, fitted OHLE and / or derogation from Standard.

Detailed surveys are currently being undertaken, this information will be used to establish if the do-minimum options under consideration are feasible, or if more significant interventions are required to the bridges. Should derogations not be acceptable then bridge interventions will be required.

Appendix A. Sifting Process Backup