

ANNEX 3.2

Technical Optioneering Report: Electrification of the Northern Line between Malahide and Drogheda

SECTION E

OHLE Bridge Clearance works







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Appendices

Appendix A

Risk Assessments for Proposed Electrical Solutions where Contact Wire Height is less than $4700\ \text{mm}$





Abbreviations

Abbreviation	Definition
CAF	Common assessment framework
CCE	Chief Civil Engineer
CWH	Contact Wire Height
DC	Direct Current
EC	Electrical Case
FRS	Functional Requirements Specification
IÉ	Iarnród Éireann
MCA	Multi-criteria analysis
NIAH	National Inventory of Architectural Heritage
OHLE	Overhead line equipment
OLE	Overhead line electrification
SET	Signalling, electrification and telecoms
SH	Structural Height
ToR	Top of rail
TSS	Train Service Specification



1 Introduction

The purpose of the report is to provide the technical input into the Preliminary Option Selection Report. This document contains the option selection process for necessary clearance improvement works to overbridges as a result of the introduction of overhead line electrification equipment (OHLE). The report sits as a subsection of the overall optioneering report for electrification of the Northern Line between Malahide and Drogheda.

Sufficient clearance must be achieved at overbridges such that overhead wires can be placed at the correct height for future electrified trains' pantographs, along with provision of necessary allowances for tolerance, adjustment and electrical isolation.

Various equipment arrangements exist and are selected based upon a hierarchy of preference from a systems perspective and the current available bridge clearance. Selection of the electrical case is a purely technical exercise and not subject to the multi-criteria analysis (MCA) process. It is deemed that an electrical-only solution is always the most preferable option wherever this is not a derogation from standards due to insufficient bridge soffit height.

Should an electrical-only solution not be possible, other options are explored. Any bridge where significant work to the structure or removal is being considered will be subject to the predefined process of longlisting, shortlisting and MCA to establish an emerging preferred option.

This report provides a technical assessment of the overbridges as a result of the introduction of overhead line electrification equipment (OHLE) between Malahide and Drogheda.

The report includes:

- An introduction and description of the study;
- A summary of the option assessment approach undertaken;
- A description of the existing situation;
- The requirements;
- The technical options available, along with comparison;
- Recommendations.

1.1 Packages of work

The scope of work for DART+ Coastal North covers a wide range of interventions on the Northern Line needed in order to meet the Train Service Specification (TSS) requirements. To appropriately assess options against each other, the works have been split into separate work packages, as detailed in the relevant Annexes. Where appropriate, the works have then been further split down into 'Sections' which define the system which has been subject to the optioneering and design process.





This document is a Section of Annex 3.2 - the overarching optioneering report for the electrification of the Northern Line between Malahide and Drogheda. Please refer to Table 1-1 for a list of the different sections which make up the electrification package of work.

Annex	Section	Title
	А	OHLE system
	В	OHLE foundation solution
	С	OHLE foundation solution at underbridges
22	D	Bridge parapet modifications
3.2	Е	OHLE Bridge Clearance works
	F	Traction Power Supply (will form part of Public Consultation 2)
	G	User worked level crossing south of Donabate
	Н	Fencing and lineside safety

 Table 1-1: List of key documents associated with Electrification of the Northern Line

 from Malahide to Drogheda





1.2 References

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This report should be read in conjunction with the following related optioneering reports:

Annex	Title	Description
N/A	DART+ Coastal North Preliminary Option Selection Report	This is the main report which summarises the optioneering process and the different packages of proposed works on the DART+ Coastal North project.
N/A	DART+ Coastal North Preliminary Option Selection Report – Executive Summary	This report summarises the main Preliminary Option Selection Report.
1	Emerging Preferred Option Maps	Includes drawings for each Emerging Preferred Option, to support the Preliminary Option Selection Report.
2.1	Policy Context	This presents a detailed review of the European, National, Regional and Local policy context for the DART+ Programme and the DART+ Coastal North Project
2.2	Useful Links	Useful links to documents/websites relating to the DART+ Coastal North project.
3.1	Constraints Report	This report reviews the DART+ Coastal North constraints.
3.2	Technical Optioneering Report: Electrification of the Northern Line between Malahide and Drogheda.	The Technical Optioneering Report for the Electrification of the Northern Line between Malahide and Drogheda. The report is divided into a series of sections, as described in Table 1.
3.3	Technical Optioneering Report: Works around Drogheda MacBride Station	The Technical Optioneering Report for Works around Drogheda MacBride Station. The report addresses track and station modifications to allow for the increased number of DART services.

Table 1-2: List of key documents associated with this report



 Rializas nabEireann Government of beland
 Tionscadal Eireann Project Ireland

 2040



Annex	Title	Description
3.4	Technical Optioneering Report: Works around Malahide Station	The Technical Optioneering Report for Works around Malahide Station. The report addresses track modifications required to allow trains to be turned back clear of through running services.
3.5	Technical Optioneering Report: Works around Clongriffin Station	The Technical Optioneering Report for Works around Clongriffin Station. The report addresses track modifications required to allow trains to be turned back clear of through running services.
3.6	Technical Optioneering Report: Works around Howth Junction & Donaghmede Station	The Technical Optioneering Report for Works around Howth Junction & Donaghmede Station. The report addresses the addition of tracks to allow a higher frequency shuttle service.
3.7	Technical Optioneering Report: Howth Branch Level Crossings	The Technical Optioneering Report for the Howth Branch Level Crossings. The report addresses the impacts of all proposed increases in train frequency on existing level crossings on the Howth Branch.

1.3 Option Assessment Approach

In line with the Option Selection Process section of the Preliminary Option Selection Report, elements can be scoped out of the Multi-criteria Analysis (MCA) process based on a number of criteria, one of which is as follows:

'If the type of system to be used is solely governed by IÉ standards and specified by technical requirements, then the CAF/MCA process will not be utilised.'

Since this is true for choosing of the electrical solution for bridge clearance works, the draft emerging preferred options described in this report are not subject to the MCA process and are instead proposed to be based upon technical requirements as set out within this document. Where electrical solutions are not possible without derogations further assessment will be undertaken at a later stage.



2 Existing Situation

2.1 Overview

As part of the DART+ Coastal project, the Northern Line between Malahide and Drogheda is to be electrified with 1.5kV DC overhead line electrification. The OHLE foundation solutions report (Annex 3.2: Section B) provides a general overview of ground conditions. Factors for bridge-specific locations are listed within the relevant sections of this report.

2.2 Structures

There are 29 overbridges along the length of track which is to be electrified. These are, generally, historic structures and hence were constructed without cognisance of necessary clearances for OHLE.

For an overview of the bridge locations, please refer to Annex 1: Emerging Preferred Options Maps.

A summary of the criteria relevant to the bridge clearance works is provided in Table 2-1 below. It should be noted that clearances and widths are shown in bold where confirmed by survey. Other approximate dimensional information has been provided by IÉ. A route-wide survey is proposed which will capture clearances at all bridges. The information provided in this optioneering report is sufficient to present proof of concept and proposals based upon full and current survey information will be submitted following preliminary design. It is expected and assumed that the currently available information in the table below is accurate enough such that there will be no change to the adopted solution following completion of survey works. Clearances stated are measured from top of rail (ToR) to bridge soffit.





Approx. Clearance (ToR - Soffit) (1) Approx. Location **Overbridge** Arch Station Name Function (\mathbf{mm}) Width (m) Miles Yards DONABATE BYPASS OBB32A 0 Road ~ 5800 23.0 11 No No (CLONBURRIS BRIDGE) DONABATE STATION OBB33 11 727 Road No Yes ~5000 12.2 ROADBRIDGE 2.2 Footbridge OBB33A DONABATE FOOTBRIDGE 11 784 No Yes ~5100 4740 4.5 OBB35 **BEAVERSTOWN GOLF CLUB** 12 445 Road No No 4.6 OBB38 13 999 Yes ~5020 ROGERSTOWN LANE Road No **RUSH & LUSK FOOTBRIDGE** Footbridge No 3.0 OBB38A 13 Yes 1564 ~5200 **RUSH & LUSK ROADBRIDGE** 13 1644 OBB39 No Yes 4775 10.7 Road KINGSTOWN/PUBLIC ROAD 14 OBB41 438 No 4700 6.9 Road No OBB44 TYRRELSTOWN/PUBLIC ROAD 14 No No 4585 7.4 1437 Road OBB45 HJ2DA 15 4.8 856 Road No No 4715 7.1 OBB46 BALDONGAN 16 172 Road No No ~4860 OBB47 1038 5.1 Yes 4900 SKERRIES GOLF CLUB 16 Road No 17 No 8.1 OBB49 524 No 4690 **GOLF LINKS RD SKERRIES** Road No 4815 2.6 OBB51A 17 Footbridge Yes SKERRIES FOOTBRIDGE 1708 OBB54 LADIES STAIRS 19 Footbridge No ~5100 2.5 1440 No COUNTY BRIDGE/PUBLIC No OBB55 304 21 Road 4590 11.5 No ROAD 1328 Footbridge No OBB57A BALBRIGGAN FOOTBRIDGE 21 Yes 4775 2.4 FRANKINS/OCCUPATION ROAD 7.9 OBB62 22 1573 No ~4880 No Road FILGATE'S/OCCUPATION ROAD 23 OBB63 4735 4.9 866 Road No No GORMANSTON STATION OBB66 24 19 4880 4.5 Road No Yes ROADBRIDGE OBB66A GORMANSTON STATION ~5270 2.5 (TBC) FOOTBRIDGE (PLANNED)

Table 2-1: Relevant information for clearance works to existing overbridges between Malahide and Drogheda



Overbridge	Name	Apj Loc	prox. ation	Function	Arch	Station	Clearance (ToR - Soffit) ⁽¹⁾	Approx.
		Miles	Yards				(11111)	
OBB68	IRISHTOWN/PUBLIC ROAD	24	1757	Road	No	No	4920	6.6
OBB74A	LAYTOWN FOOTBRIDGE	27	186	Footbridge	No	Yes	~5100	2.8
OBB77	PILTOWN/COLP EAST	29	1452	Road	No	No	~4850	8.2
OBB78	COLPE BRIDGE/PUBLIC ROAD	30	233	Road	No	No	4680	17.5
OBB80A	MCGRATH'S LANE DROGHEDA	31	758	Road	Yes	No	4205	6.9
OBB80	MCGRATH'S LANE DROGHEDA	31	869	Road	Yes	No	4300	6.6
OBB80B	MCGRATH'S LANE DROGHEDA	31	871	Road	No	No	4910	7.2
OBB81	MacBRIDE STATION	31	1259	Footbridge	No	Yes	4465	2.8
OBB81C	MacBRIDE STATION	31	1262	Footbridge	No	Yes	5800	4.4

Notes:

- Vertical clearance heights were initially based on information received from IÉ, based on field measurements. The heights based on this information include an approximate sign (~) in front of them in the table. Bridge specific topographical surveys were undertaken on bridges identified as having a low clearance. The results from these surveys are shown in bold.
- 2) Bridge specific topographical surveys were undertaken on bridges identified as having a low clearance, so lateral clearance has been determined from that survey for these bridges. In these cases, pantograph gauge and OHLE wire and supports (where applicable) have been included in the overbridge cross sections obtained from the survey to check the lateral clearance for OHLE wires. For flat overbridges, the lateral clearance is not a limiting factor for the OHLE solution (contact wire and catenary wires) through the bridges, so it is considered that it will also not be a limiting factor for the overbridges which do not have the survey currently available. Furthermore, assessment of installation of parallel feeder wires through the overbridges is being developed. According to the DART+ Electricity Functional Specifications System-Wide document they are preferably installed aerially supported on the OHLE structures. However, when this is not possible because of the available clearance of the overbridge, it will be passed to an isolated cable and clamped to the structure or by any other means or buried.





2.3 Permanent Ways

Generally, at all overbridge locations there are two tracks which are continuous welded rail on ballast. The exception is at Drogheda depot and OBB80.

2.4 Other Railway Facilities

Seven stations exist along the route to be electrified. These are as follows:

- Donabate: Platforms 1 and 2
- Rush & Lusk: Platforms 1 and 2
- Skerries: Platforms 1 and 2
- Balbriggan: Platforms 1 and 2
- Gormanston: Platforms 1 and 2
- Laytown: Platforms 1 and 2
- Drogheda MacBride: Platforms 1,2 and 3

Where overbridges are adjacent to or within station platforms, the OHLE wire height needs to be cognisant of the requirements to have increased separation between the public and electrical equipment.

2.5 Utilities

There are extensive utility networks in the area surrounding the railway, particularly in the urban areas through which it passes. Service providers with network assets in the area, from whom records have been obtained, include:

- Gas Networks Ireland;
- Irish Water (Water Supply);
- Irish Water (Foul Water Sewers);
- Dublin City Council (Storm Water Sewers);
- Fingal County Council (Storm Water Sewers);
- ESB Networks Low, Medium and High Voltage Networks;
- EirGrid
- Eir;
- BT Ireland;
- Irish Rail Lineside cables parallel to the railway line.

Utility service records have been obtained from all providers in the area. Most services are located within the existing road network surrounding the railway, and in bridge and underpass crossings of the railway. There are also lineside services





running parallel to the railway and some major utilities crossing perpendicularly under the railway. All records should be considered indicative only and must be verified prior to any intrusive works occurring.

The records indicate that there are services at track level or within the railway corridor. These include Irish Rail lineside cables, Eir telecoms cables and BT telecoms cables running parallel to the railway from Malahide to Drogheda.

There are several railway overbridges that have utilities located within them. These are as follows:

- OBB33 at Donabate Station contains underground telecommunications.
- OBB39 at Rush & Lusk Station contains underground telecommunications.
- OBB55 at the R127 road contains underground medium voltage electrical, telecommunications and a 125mm diameter medium pressure gasmain.
- OBB78 at the L1611 road contains underground telecommunications and a 180mm diameter medium pressure gasmain.





3 **Requirements**

The main project requirements relevant to this report subsection are as follows:

- Electrification of the line from the end of the current electrified section at Malahide to Drogheda with 1500V DC overhead;
- Undertake necessary infrastructure change to achieve the clearances required for electrification at bridges and structures;
- Undertake safety improvements resulting from the introduction of 1500V DC overhead.

3.1 Specific Requirements

In achieving the clearances required for electrification at bridges and structures, a predefined approach for electrical clearance design is to be adopted as per DART+ Electricity Functional Specifications System-Wide (MAY-MDC-ELE-DART-SP-E-0002) Section 5.6.7. This lists relevant electrical equipment configurations and their hierarchy for adoption and is explained further in Section 5.1 of this report.

3.2 Systems Infrastructure and Integration

Integration with the signalling system will need to be considered at the next stage of the design

Integration with other electrical cables including OHLE feeder cables though the bridge structure will need to be considered at the next stage of the design

3.3 Design Standards

Table 3-1 contains the key applicable standards that will be used to develop the design. Please note that this is not intended as an exhaustive list.

Source	Description	Comments
European Norm	EN50122-1	Protective provisions against electric shock
European Norm	EN50119	Electric traction overhead contact lines
Irish Rail	I-ETR-4101	Maintenance Parameters for 1500Vdc OHLE
Irish Rail	CCE-TMS-300	Track Construction Requirements and Tolerances

 Table 3-1: Relevant design standards for OHLE bridge clearance works





Source	Description	Comments
Irish Rail	CME-TMS-306	OHLE Interface for IÉ Rolling Stock
Irish Rail	CCE-TMS-321	Track Maintenance Requirements and Tolerances
Irish Rail	CME-TMS-327	Vehicle gauging
Irish Rail	CCE-TMS-410	Civil Engineering Structures Design Standard
Irish Rail	I-PWY-1101	Requirements for Track and Structures Clearances
Irish Rail	SET-AMS-002-012 Iss1.0	Derogation from SET Technical Standards





4 Constraints

4.1 Technical

4.1.1 Electrical system

The total clear height required at any bridge is a sum of the following:

- The desired contact wire height;
- The track maintenance tamping allowance;
- The track construction tolerance;
- The track maintenance tolerance;
- The OHLE construction tolerance;
- The OHLE maintenance tolerance;
- The structural construction tolerance if bridge reconstruction/modification is required;
- An allowance for contact wire and pantograph wear;
- The OHLE system height or allowance for OHLE support;
- The uplift caused to wires by a passing train;
- The required electrical clearances;
- The survey tolerance.

4.1.1.1 Contact wire height

The height of the contact wire (from which the train pantograph draws its power) is defined by system requirements as having a target height of 4.7m. A number of electrical equipment arrangements exist to achieve this, each compatible with differing bridge soffit heights. This can also be reduced to a height of 4.4m before a derogation from standards is required, with a risk assessment and approval from IÉ SET (and CCE depending on values for allowances, tolerances and clearances). The absolute minimum is 4.27m.

4.1.1.2 Track maintenance tamping allowance

Track tamping is the regular maintenance process of correcting geometry and creating a uniform rail bed via adjustments to the ballast. This is generally achieved by a rail-mounted tamping machine. The target maintenance allowance is 100mm although this can be reduced to a minimum of 50mm for ballasted track. Alternatively, the rails can be mounted directly to a concrete slab (referred to as slab track) to remove the need for tamping (i.e. 0mm allowance).





4.1.1.3 Track maintenance tolerance

Track Maintenance Tolerance of 25mm for ballast track is considered in the required clear height.

4.1.1.4 Track and OHLE construction tolerance

Track and OHLE construction tolerances are 5mm and 20mm respectively.

4.1.1.5 **OHLE maintenance tolerance**

During the service lifetime of the OHLE, maintenance operations and adjustments require a tolerance of 30mm, regardless of electrical arrangement selected.

4.1.1.6 Contact wire and pantograph wear

An allowance of 25mm is required to account for wear to the pantograph and contact wire affecting the dynamic behaviour of the system.

4.1.1.7 System height

The system height is the distance between the highest point of the catenary wire within the area underneath the bridge soffit and the contact wire. Typically, support is provided to the contact wire from the catenary wire with 'droppers' as shown in Figure 4-1. The dropper heights can vary from 500 to 100mm.

It is possible to place the catenary and contact wires at the same height and hence reduce the system height to 0mm. This is referred to as a contenary system and is shown in Figure 4-2. This system requires reduced support spacing such that the tension in the contact wire is enough to keep it sufficiently level. This is a maximum distance of 12-13m. Since OHLE masts must be a minimum of 2m from the bridge structure, if the bridge deck is wider than 8m then intermediate support arms fixed to the soffit are required. This is referred to as a 'fitted' system, the preferable opposite of which is a 'free running' system.



Figure 4-1: Example of typical catenary support to contact wire with 500mm droppers, passing under example bridge







Figure 4-2: Example of typical contenary support showing achievement of a system height of 0mm underneath a reduced clearance bridge

In case of fitted solution, an allowance of 120 mm is considered for the installation of the OHLE support arms.

4.1.1.8 Uplift

Passing trains cause movement on the overhead wires. This is relevant when considering dynamic electrical clearance required. For a catenary system, the required dynamic uplift allowance is 110mm. For a contenary system this is typically 70mm but may be reduced to 50mm at reduced clearance overbridges.

4.1.1.9 Electrical clearance

Enhanced electrical clearance (the preferred option) is 150mm under static conditions or 100mm under dynamic for 1.5 kV d.c. Note that the dynamic case governs as this requires the inclusion of uplift allowance. Reduced electrical clearances are 100mm and 80mm under static and dynamic conditions respectively.

In case of modifications of overbridges or construction of new overbridges, passive provision for 25kV a.c. electrification will be considered, so in this case, electrical clearances are 270mm and 150mm under static and dynamic conditions respectively.

4.1.1.10 Surveying

An allowance of 5mm for survey inaccuracies is required.

4.1.2 Gauging

The necessary changes to electric rolling stock on this section of the route requires consideration of gauging (physical clearances) as well as the previously discussed electrical clearances. This is particularly relevant to the pantograph and its interaction with arched bridge profiles. As shown in Figure 4-3 below, this may constrain the track alignment within the bridge cross section and impact on the proposed solution.





Figure 4-3: Example of pantographs clashing with bridge soffit

4.1.3 Track level

Track lowering is an option to improve the bridge soffit height and enable a more favourable electrical arrangement. Track lowering can be achieved in two ways:

- Removal of some of the ballast depth skim dig;
- Adjustment of formation level.

A skim dig can be achieved in some conditions by temporarily supporting rails and digging out some of the ballast from underneath sleepers. This is a relatively simple task with limited construction impact but can only achieve minor reductions to track levels (less than ~ 75mm).

For lowering greater than 75mm, the potential construction operations will be more disruptive. Where enough ballast depth exists, this may be possible via alterations to the overall ballast depth. In cases with minimal ballast depth, the formation may need to be lowered, comprising significantly disruptive construction activities, including removal of track and ballast before the formation can be dug down, followed by reinstatement. It should be noted that further investigation into the existing ballast depth at such locations will be required at subsequent design stages.

Due to gradient limits on track alignment, any lowering operation is likely to impact extensive lengths of rail. Consideration must be given to the interaction with other assets such as station platforms.

Lowering of track is also constrained by impacts on existing drainage, utilities and bridge substructure.

4.1.4 Bridge Modification

As an alternative to track lowering, bridge modification can be considered to achieve additional vertical clearance where alternative solutions prove too constrictive. This can either take the form of raising the bridge superstructure or adopting a more substantial modification/reconstruction of the bridge to achieve the required clearance.





Raising the superstructure is typically achieved by either demolishing and reconstructing the superstructure or jacking up the existing bridge beams and resetting the deck at a higher level. Adjustment to the road level above and tie-in with the road alignment is required. This has a direct impact on the road geometry, particularly the vertical alignment. Many bridges over the existing line have already been raised with noticeably pronounced vertical crest curves and poor intervisibility. Any services carried by the deck above would need to be temporarily diverted or disconnected as part of the works. The existing bridge would need to be structurally assessed to ensure it is suitable for the altered configuration. This type of solution would retain the existing lateral clearance to the abutments.

Similarly, bridge reconstruction would require the structure to be taken out of commission for the duration of the build, while new foundations, abutment walls and deck are constructed. Where a full bridge reconstruction is proposed, it would need to meet the vertical and lateral clearance requirements of the relevant standards, considering a passive provision for 25kV a.c. electrification. Where this cannot be achieved, a derogation will be required.

Unless the works can be done offline, any bridge modification option would have an impact on accessibility and would rely on a suitable alternative route to be put in place during construction.

4.2 Environmental

For a more detailed overview of the existing environmental constraints for DART+ Coastal North refer to Annex 3.1 Constraints Report.

4.2.1 Traffic and transportation

Traffic and transportation will not have a material impact on the electrical solutions proposed at the bridges. For bridges where a non-electrical solution is preferred the traffic and transportation constraints will be considered at the next stage.

4.2.1.1 Landscape and visual impact

Whilst the introduction of OHLE on the bridges will have an impact on the structure the impact will be largely similar for all electrical solutions. Further detailed assessment will be carried out where non-electrical solutions emerge as preferred solutions.

4.2.1.2 Architectural heritage

The table below lists the heritage status of the overbridges.

Overbridge	Name	Protection Status
OBB32A	DONABATE BYPASS	Not protected or included in any
	(CLONBURRIS BRIDGE)	existing inventories.

Table 4-1: Protection status of the bridges





Overbridge	Name	Protection Status
OBB33	DONABATE STATION ROADBRIDGE	A Protected Structure FCC RPS 0876
OBB33A	DONABATE FOOTBRIDGE	In the curtilage of Donabate Station which is not protected but is recognised through inclusion in the NIAH (Ref: NIAH 11336011)
OBB35	BEAVERSTOWN GOLF CLUB	Not protected or included in any existing inventories.
OBB38	ROGERSTOWN LANE	A Protected Structure FCC RPS 0876
OBB38A	RUSH & LUSK FOOTBRIDGE	In the curtilage of Rush and Lusk Station which is not protected but is recognised through inclusion in the NIAH (Ref: NIAH 11323016-8)
OBB39	RUSH & LUSK ROADBRIDGE	In the curtilage of Rush and Lusk Station which is not protected but is recognised through inclusion in the NIAH (Ref: NIAH 11323016-8)
OBB41	KINGSTOWN/PUBLIC ROAD	Not protected or included in any existing inventories.
OBB44	TYRRELSTOWN/PUBLIC ROAD	Not protected or included in any existing inventories.
OBB45	HJ2DA	Not protected or included in any existing inventories.
OBB46	BALDONGAN	Not protected or included in any existing inventories.
OBB47	SKERRIES GOLF CLUB	Not protected or included in any existing inventories.
OBB49	GOLF LINKS RD SKERRIES	Not protected or included in any existing inventories.
OBB51A	SKERRIES FOOTBRIDGE	In the curtilage of Skerries Station which is protected (Ref: FCC RPS 0191)
OBB54	LADIES STAIRS	Not protected or included in any existing inventories.
OBB55	COUNTY BRIDGE/PUBLIC ROAD	Not protected or included in any existing inventories.
OBB57A	BALBRIGGAN FOOTBRIDGE	In the curtilage of Balbriggan Station which is protected (Ref: FCC RPS 0030)
OBB62	FRANKINS/OCCUPATION ROAD	Not protected or included in any existing inventories.
OBB63	FILGATE'S/OCCUPATION ROAD	Not protected or included in any existing inventories.
OBB66	GORMANSTON STATION ROADBRIDGE	In the curtilage of Gormanstown Station which is not protected but is recognised through inclusion in the NIAH (Ref: NIAH 14322016-8)





Overbridge	Name	Protection Status
OBB66A	GORMANSTON STATION	
(TBC)	FOOTBRIDGE (PLANNED)	
OBB68	IRISHTOWN/PUBLIC	Not protected or included in any
	ROAD	existing inventories.
OBB74A	LAYTOWN FOOTBRIDGE	In the curtilage of Laytown Station
		which is protected (Ref: MH028-302)
OBB77	PILTOWN/COLP EAST	Not protected or included in any
		existing inventories.
OBB78	COLPE BRIDGE/PUBLIC	Not protected or included in any
	ROAD	existing inventories
OBB80A	MCGRATH'S LANE	In the curtilage of the protected
	DROGHEDA	structures at Drogheda MacBride
OBB80	MCGRATH'S LANE	Station (Reference LH DB 055, 195,
	DROGHEDA	396-9)
OBB80B	MCGRATH'S LANE	
	DROGHEDA	
OBB81	MacBRIDE STATION	In the curtilage of Drogheda
		MacBride Station which is protected
		(Ref: LH DB 055, 195, 396-9)
OBB81C	MacBRIDE STATION	In the curtilage of Drogheda
		MacBride Station which is protected
		(Ref: LH DB 055, 195, 396-9)

4.2.1.3 Noise and Vibration

Noise and vibration will not have a material impact on the electrical solutions proposed at the bridges. For bridges where a non-electrical solution is preferred the noise and vibration constraints will be considered at the next stage.

4.2.1.4 Air quality and climate

Air quality and climate will not have a material impact on the electrical solutions proposed at the bridges. For bridges where a non-electrical solution is preferred the air quality and climate constraints will be considered at the next stage.

4.2.1.5 Agricultural and Non-agricultural

Surrounding land use will not have a material impact on the electrical solutions proposed at the bridges. For bridges where a non-electrical solution is preferred the surrounding land use constraints will be considered at the next stage.

4.2.1.6 Water Resources

Water resources will not have a material impact on the electrical solutions proposed at the bridges. For bridges where a non-electrical solution is preferred water resources constraints will be considered at the next stage.





4.2.1.7 Biodiversity

There are several potential ecological constraints, however these are similar across all options all electrical options and do not differentiate the preference between options. These include:

- The Overhead line equipment masts (OHLE) pose a potential hazard for birds, through electrocution from the powerlines by causing a short circuit either by touching two live wires or a live and an earthed component;
- Displacement of bats. If there are bat roosts within the existing structure, renovation works would reduce the potential satellite roosts within this well-connected habitat network for wildlife;
- All options involve some level of works on the existing tracks. Railway lines can often support interesting flora species and habitats due to the calcareous nature of the ballast and their often relatively undisturbed nature. If any such habitat is present the level of impact is likely to be similar across all options and might not be a significant differentiator between options.

4.2.2 Geology and Soils

Geotechnical/Geology and soil constraints will not have a material impact on the electrical solutions proposed at the bridges. For bridges where a non-electrical solution is preferred, these constraints will be considered at the next stage and explored via ground investigations.

4.3 Planning

Other than the heritage issues noted above, there are not considered to be any planning constraints for electrical solutions. A full review of planning constraints for non-electrical solutions will be undertaken at the next stage. This includes engagement with local authorities and utility providers.





5 Electrical Solution

This section outlines the proposed electrical solution at each bridge location. The minimum vertical clearance is checked at each bridge and a best fit electrical solution applied based on the hierarchies outlined in the project specification.

5.1 Electrical Case Hierarchy

As detailed in section 4.1.1, a variety of electrical arrangements exist to cater for different available clearances. These are given a hierarchy of preference as shown in Table 5-1. This is as provided and detailed further in section 5.6.7 of the Electricity Functional Specifications System-Wide document (MAY-MDC-ELE-DART-SP-E-0002).

A nominal contact wire height of at least 4700 mm is preferred at overbridge locations. Where this cannot be achieved, a minimum contact wire height (CWH) of 4400 mm can be considered provided the associated risks are suitably addressed. Contact wire heights less than 4400 mm will require a derogation. This is summarised as follows:

• Contact wire height \geq 4700 mm:

Represents nominal contact wire height. No risk assessment or derogation required. These are coloured green in the table below.

• Contact wire height $< 4700 \text{ mm but} \ge 4400 \text{ mm}$:

Electrical solutions with contact wire heights in this range require a risk assessment to be undertaken. These are coloured yellow in the table below.

• Contact wire height < 4400 mm but >4200 mm:

Electrical solutions with contact wire heights less than 4400 mm require a risk assessment and a derogation. These are coloured orange in the table below.

The electrical solution given in the specification favours the contact wire height over the system height. Where possible, the contact wire height is increased, resulting in contenary systems being favoured since increasing the system height typically requires more clearance than that required to increase the system height to a more favourable hierarchy case.

As stated in Section 2.2, it should be noted that soffit heights are shown in bold where confirmed by survey. Other approximate dimensional information has been provided by IÉ. It is expected and assumed that this is accurate enough such that there will be no change to the adopted solution following completion of survey works.





Table 5-1: Electrical case hierarchy at overbridge structures

		Nominal CW height	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Minimum soffit height (mm)
Case 1 CWH of 4700mm nominal SH of 1300mm current carrying	Static EC	4700	100	5	25	20	30	0	500	0	150	5	5535
dropper of 500mm and enhanced EC.	Dynamic EC	4700	100	5	25	20	30	25	500	110	100	5	5620
Case 2 CWIL of 4700mm, reduced SIL with reduced surrout corruing	Static EC	4700	100	5	25	20	30	0	300	0	150	5	5335
dropper of 300mm and enhanced EC.	Dynamic EC	4700	100	5	25	20	30	25	300	110	100	5	5420
Case 3 CWH of 4700mm, raduced SH with raduced current corruing	Static EC	4700	100	5	25	20	30	0	100	0	150	5	5135
dropper of 100mm and enhanced EC.	Dynamic EC	4700	100	5	25	20	30	25	100	110	100	5	5220
Case 4 CWII of 4700mm, reduced SII to zero, contenent and	Static EC	4700	100	5	25	20	30	0	0	0	150	5	5035
enhanced EC. Uplift 70 mm	Dynamic EC	4700	100	5	25	20	30	25	0	70	100	5	5080
Case 5 CWH of 4600mm, reduced SH with reduced current carrying	Static EC	4600	75	5	25	20	30	0	300	0	150	5	5210
dropper of 300mm, reduced tamping allowance to 75 mm and enhanced EC.	Dynamic EC	4600	75	5	25	20	30	25	300	110	100	5	5295
Case 6 CWH of 4600mm, reduced SH with reduced current carrying	Static EC	4600	75	5	25	20	30	0	100	0	150	5	5010
dropper of 100mm, reduced tamping allowance to 75 mm and enhanced EC.	Dynamic EC	4600	75	5	25	20	30	25	100	110	100	5	5095
Case 7	Static EC	4600	75	5	25	20	30	0	0	0	150	5	4910
tamping allowance to 75 mm and enhanced EC. Uplift 70 mm	Dynamic EC	4600	75	5	25	20	30	25	0	70	100	5	4955





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		Nominal CW height	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Minimum soffit height (mm)
Case 15 CWH of 4270mm, reduced SH to zero, contenary, slab track:	Static EC	4270	0	5	5	20	30	0	0	0	100	5	4435
tamping allowance 0 mm and maintenance tolerance 5 mm. Reduced EC. Uplift 50 mm	Dynamic EC	4270	0	5	5	20	30	25	0	50	80	5	4490





5.1.1 Risk Assessments

For bridges where a contact wire height of less than 4.7m is proposed, a risk assessment must be carried out and presented to the IÉ Signalling, Electrification and Telecoms (SET) department. Site specific risks will be evaluated in subsequent design stages however, general risks associated with reduced contact wire heights have been captured.

The figures provided in this section are example extracts from the hazard log and are provided for reference only. 'F' represents the frequency of the hazard event occurring and 'C' the consequence.

5.1.1.1 General risks

The two risks shown in Figure 5-1 are associated with all overbridges where the proposed contact wire height is less than 4.7m. The mitigation measures listed are proposed for each overbridge.

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, lower proposed CWH is 4290 mm considering 10 mm for OHLE maintenance tolerance (as per FRS in crossovers and particular locations) and spans are lower than 10 m, so minimum CWH will be 4193 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS: Maximum Gradient (speed up to 120km/h): 1/250 or 4 % Maximum Change of Gradient (speed up to 120km/h): 1/500 or 2 % These values are according to values indicated in Table 11 of EN50119 for speed up to 120 km/h	3	2	5

Figure 5-1: General hazards associated with reduced contact wire heights at overbridges

5.1.1.2 Station risks

Where an overbridge with reduced contact wire height exists within a station, this introduces further risk as detailed in Figure 5-2.





			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F		Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the north side of the overbridge, the spans are lower than 30 m, so considering CWH is 4550 mm, the absolute minimum CWH will be 4376 mm. Pantograph depth is 211 mm and therefore minimum height for live parts is 4166 mm from ToR Platform height is 9xx mm, so minimum height of live parts from platform standing surface is 3166 mm. Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c.	2	4	6

Figure 5-2: Hazards within stations associated with reduced contact wire heights at overbridges

5.1.1.3 Public use of legacy overbridges and structures with reduced clearances

Similarly, where an overbridge designated for public use has a reduced contact, this introduces further risk as detailed in Figure 5-3.

									EVALU	ATION			EVAL	JATION	
Hazard Cause		Hazard - The unsafe ac	t or co	ndition.	Hazard Ev Descripti RISK) and	v ent on of the H I the conse	lazard Eve quence.	nt (the	F	с	Result	Safety Measures - mitigation description	F	с	Result
Restricted elec clearances of r OHLE at legacy structures, due local route constraints.	trical new e to	Public use of overbridges a with reduced clearances.	legacy and stru electric	ictures cal	Touch po	tential, Ele	ectrocution	I	4	4	8	Proposed OHLE solution consider static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are th minimum values according to I-E 4101 / Maintenance Parameters 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapte 2.2.1 and FRS.	e TR- 2 for	4	6

Figure 5-3: Hazards associated with reduced contact wire heights at overbridges designated for public use

5.2 Proposed Electrical Solutions

The available vertical clearance at each bridge was assessed and an electrical solution proposed based on the requirements of the Functional Specification. Where the soffit of the bridge varies across the width of the tracks (e.g. arch bridges), the pantograph and electrical clearance envelopes were plotted in elevation to confirm proposed solutions.

The electrical solution also takes into account the extra depth needed to install a bridge-arm connection in the case of fitted systems.

Table 5-2 below summarises the proposed electrical solutions at each overbridge location. As for previous tables, bold clearances are those confirmed by survey.





Bridge No.	Soffit Form	Clearance (ToR – Soffit) (mm)	Approx. Abut. Width (m)	Fitted (F) / Free-Running (FR) System	Proposed CWH (mm)	
OBB32A	Flat	~ 5800	23.0	FR	4700	
OBB33	Flat	~5000	12.2	F	4550	
OBB33A	Flat	~5100	2.2	FR	4600	
OBB35	Flat	4740	4.5	FR	4400	
OBB38	Arch	~5020	4.6	FR	4480	
OBB38A	Flat	~5200	3.0	FR	4420	
OBB39	Flat	4775	10.7	F	4370	
OBB41	Flat	4700	6.9	FR	4400	
OBB44	Flat	4585	7.4	FR	4320	
OBB45	Flat	4715	4.8	FR	4400	
OBB46	Flat	~4860	7.1	FR	4500	
OBB47	Arch	4900	5.1	FR	4500	
OBB49	Flat	4690	8.1	FR	4400	
OBB51A	Flat	4815	2.6	FR	4480	
OBB54	Flat	~5100	2.5	FR	4700	
OBB55	Flat	4590	11.5	F	4270	
OBB57A	Flat	4775	2.4	FR	4440	
OBB62	Flat	~4880	7.9	FR	4500	
OBB63	Flat	4735	4.9	FR	4400	

Table 5-2: Summary of the proposed electrical solutions at each overbridge





Bridge No.	Soffit Form	Clearance (ToR – Soffit) (mm)	Approx. Abut. Width (m)	Fitted (F) / Free-Running (FR) System	Proposed CWH (mm)
OBB66	Flat	4880	4.5	FR	4525
TBC	Flat	~5270	2.5	FR	4645
OBB68	Flat	4920	6.6	FR	4540
OBB74A	Flat	~5100	2.8	FR	4700
OBB77	Flat	~4850	8.2	F	4400
OBB78	Flat	4680	17.5	F	4290
OBB80	Arch	4205	6.9	-	-
OBB80A	Arch	4300	6.6	-	-
OBB80B	Flat	4910	7.2	FR	4530
OBB81	Flat	4465	2.8	FR	4270
OBB81C	Flat	5800	4.4	FR	4700

The table above uses various shades of colour to differentiate between the various electrical solutions proposed. These are as follows:

- Green indicates solutions with a nominal contact wire height $(CWH \ge 4700 \text{ mm});$
- Yellow indicates solutions which require a risk assessment (4700 mm < CWH \leq 4400 mm);
- Orange indicates solutions which would require a derogation and risk assessment (CWH < 4400 mm). These are potential solutions only, refer to section 5.3 for details);
- Purple indicates that no electrical solution is possible at this location.

5.2.1 Electrical solutions adopting a Nominal Contact Wire Height (4700 mm)

The bridges listed in the table below have sufficient vertical clearance to adopt an electrical solution with a contract wire height of 4700 mm.





Bridge No.	Clearance (ToR – Soffit) (mm)	Proposed CWH (mm)	Comment		
OBB32A	~5800	4700	Road bridge recently constructed as part of the Donabate relief road.		
OBB54	~5100	4700	Ladies Stairs pedestrian bridge. Bridge arms installed on dedicated OHLE structures each side of the signals on the southern side		
OBB74A ~5100 4700		4700 Pedestrian bridge at Laytown Station. Bridge arms installed on dedicated Ol structures each side of bridge in platfo			
OBB81C	5800	4700	Relatively new footbridge at Drogheda MacBride Station used by maintenance staff to access the depot building.		

Table 5-3: Bridges with a proposed contact wire height of 4700 mm

Please note that distance between the uplifted pantograph and the overbridge soffit for OBB54 and OBB74A is 125 mm.

5.2.2 Electrical Solutions requiring a risk assessment

The proposed electrical solution for bridges where the contact wire height is less than 4700 mm but greater than or equal to 4400 mm is summarised the tables below. A risk assessment has been undertaken for the solutions at each of these bridges and is contained in Appendix A of this report.



Table 5-4: Proposed electrical solution with 4500 mm ≤ CWH < 4700 mm

OBB33 OBB3		OBB33A	OBB46	OBB47	OBB62	OBB66	OBB66A (TBC)	OBB68
			Current	Structure Para	meters			
Structure Name	Donabate Station Roadbridge	Donabate Station Footbridge	Baldongan	Skerries Golf Club	Frankins/Occupation Road	Gomrnaston Station Roadbridge	Gormanston Station Footbridge (planned)	Irishtown/Public Road
Chainage	11 miles & 727 yards	11 miles & 784 yards	16 miles & 172 yards	16 miles & 1038 yards	22 miles & 1573 yards	24 miles & 19 yards	24 miles & 120 yards	24 miles & 1757 yards
Bridge Type	Roadbridge	Footbridge	Roadbridge	Roadbridge	Roadbridge	Roadbridge	Footbridge	Roadbridge
Is the Structure Listed	Yes	No	No	No	No	No	No	No
Width of Structure	12.2	2.2	7.1	4.7	7.9	4.5	2.6	6.6
Worst Vertical Clearance - TOR to Soffit	~5000	~5100	~4860	4900	~4880	4880	~5274	4920
Structure type	Flat	Flat	Flat	Arched	Flat	Flat	Flat	Flat
Bridge Constraints	Donabate station	Donabate station, OBB33	None	None	None	Gormanston station, Planned footbridge	Gormanston station, OBB66	None





	OBB33	OBB33A	OBB46	OBB47	OBB62	OBB66	OBB66A (TBC)	OBB68				
	Current Structure Parameters											
Proposed OHLE solution	Contenary with zero encumbrance	OHLE solution with minimum dropper of 100 mm	Contenary with zero encumbrance	OHLE solution with minimum dropper of 100 mm	Contenary with zero encumbrance	Contenary with zero encumbrance	OHLE solution with minimum dropper of 100 mm	Contenary with zero encumbrance				



Table 5-5: Proposed electrical solution parameters with 4500 mm ≤ CWH < 4700 mm

	OBB33	OBB33A	OBB46	OBB47	OBB62	OBB66	OBB66A (TBC)	OBB68
Proposed OHLE solution	Contenary with zero encumbrance	OHLE solution with minimum dropper of 100 mm	Contenary with zero encumbrance	OHLE solution with minimum dropper of 100 mm	Contenary with zero encumbrance	Contenary with zero encumbrance	OHLE solution with minimum dropper of 100 mm	Contenary with zero encumbrance
OHLE Arrangement	Fitted with Elastic Bridge Arms	Free Running	Free Running	Free Running	Free Running	Free Running	Free Running	Free Running
Static Clearance (Csc) - 1500Vdc	150	150	150	150	150	150	270	150
Dynamic Clearance (Cdc) - 1500Vdc	100	100	100	100	100	100	150	100
Minimum Position of the Contact Wire (considering tamping)	4411	4352	4336	4223	4311	4361	4421	4351
Actual Design Contact Wire Height (Cdcl) (After Tamping)	4550	4600	4500	4500	4500	4525	4645	4540



	OBB33	OBB33A	OBB46	OBB47	OBB62	OBB66	OBB66A (TBC)	OBB68
Maximum Design Contact Wire Height [Pre- Tamping]	4600	4675	4575	4575	4600	4600	4745	4640
OHLE System Depth (Csd)	0	110	0	0	0	0	150	0
OHLE Uplift (Cwu)	70	110	70	110	70	70	110	70
OHLE Construction/ Installation (Cct) + Maintenance Tolerance (Cmt)	50	50	50	50	50	50	50	50
Structure Construction Tolerance (St)	0	0	0	0	0	0	5	0
Track Maintenance Tamping Allowance (Tla)	50	75	75	75	100	75	100	100
Track Construction Tolerance (Tct)	0	0	0	0	0	0	0	0
Track Maintenance Tolerance (Tmt)	25	25	25	25	25	25	25	25


	OBB33	OBB33A	OBB46	OBB47	OBB62	OBB66	OBB66A (TBC)	OBB68
Considered OHLE span through the overbridge (as per hierarchy cases)	15	40	15	45	15	15	30	15
Sag and Ice Load	39	123	39	152	39	39	74	39
Survey Tolerance	5	5	5	5	5	5	5	5
Loading Gauge	4064	4064	4064	4064	4064	4064	4064	4064
Mechanical Clearance	225	210	110	110	105	105	314	105
Speed through the structure	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph
Acceptance - CCE	TMTA 50 mm	TMTA 75 mm	TMTA 75 mm Mech. clearance 110 mm	TMTA 75 mm Mech. clearance 110 mm	Mech. clearance 105 mm	TMTA 75 mm Mech. clearance 105 mm	No	Mech. clearance 105 mm
Acceptance - SET	CW<4700 mm	CW<4700 mm	CW<4700 mm	CW<4700 mm	CW<4700 mm	CW<4700 mm	CW<4700 mm	CW<4700 mm





	OBB33	OBB33A	OBB46	OBB47	OBB62	OBB66	OBB66A (TBC)	OBB68
Derogation - SET	No	No	No	No	No	No	No	No



Table 5-6: Proposed electrical solution with $4400 \le CWH < 4500 \text{ mm}$

	OBB35	OBB38	OBB38A	OBB41	OBB49	OBB51A	OBB57A	OBB63	OBB77
Current Structure Paramet	ters								
Structure Name	Beaverstow n Golf Club	Rogerstown Lane	Rush & Lusk Footbridge	Kingstown/ Public Road	Golf Links Road Skerries	Skerries Footbridge	Balbriggan Footbridge	Filgate's/ Occupation Road	Piltown
Chainage	12 miles & 445 yards	13 miles & 999 yards	13 miles & 1564 yards	14 miles & 438 yards	17 miles & 524 yards	17 miles & 1708 yards	21 miles & 1328 yards	23 miles & 866 yards	29 miles & 1452 yards
Bridge Type	Roadbridge	Roadbridge	Footbridge	Roadbridge	Roadbridge	Footbridge	Footbridge	Roadbridge	Roadbridge
Is the Structure Listed	No	No	No	No	No	No (but located in a station which protected)	No (but located in a station which protected)	No	No
Width of Structure	4.5	4.6	3.0	6.7	7.4	2.3	2.4	4.5	8.2
Worst Vertical Clearance - TOR to Soffit	4740	~5020	~5200	4703	4690	4815	4775	4735	~4850
Structure type	Flat	Arched	Flat	Flat	Flat	Flat	Flat	Flat	Flat
Bridge Constraints	_	_	Rush & Lusk station, OBB39	_		Skerries station	Balbriggan station		





	OBB35	OBB38	OBB38A	OBB41	OBB49	OBB51A	OBB57A	OBB63	OBB77
Current Structure Parameters									
Proposed OHLE solution			OHLE						
	Contenary	Contenary	solution with	Contenary	Contenary	Contenary	Contenary with	Contenary with	Contenary with
	with zero	with zero	minimum	with zero	with zero	with zero	zero	zero	zero
	encumbrance	encumbrance	dropper of	encumbrance	encumbrance	encumbrance	encumbrance	encumbrance	encumbrance
			300 mm						



	OBB35	OBB38	OBB38A	OBB41	OBB49	OBB51A	OBB57A	OBB63	OBB77
Proposed OHLE solution	Contenary with zero encumbrance	Contenary with zero encumbrance	OHLE solution with minimum dropper of 300 mm	Contenary with zero encumbrance					
OHLE Arrangement	Free Running	Free Running	Free Running	Free Running	Free Running	Free Running	Free Running	Free Running	Fitted with Elastic Bridge Arms
Static Clearance (Csc) - 1500Vdc	100	100	150	100	100	100	100	100	100
Dynamic Clearance (Cdc) - 1500Vdc	80	80	100	80	80	80	80	80	80
Minimum Position of the Contact Wire (considering tamping)	4236	4316	4221	4275	4275	4316	4276	4236	4261
Actual Design Contact Wire Height (Cdcl) (After Tamping)	4400	4480	4420	4400	4400	4480	4440	4400	4400

Table 5-7: Proposed electrical solution parameters with $4400 \le CWH < 4500 \text{ mm}$



DAR	+
Coastal	North

	OBB35	OBB38	OBB38A	OBB41	OBB49	OBB51A	OBB57A	OBB63	OBB77
Maximum Design Contact Wire Height [Pre- Tamping]	4475	4555	4495	4450	4450	4555	4515	4475	4450
OHLE System Depth (Csd)	0	0	320	0	0	0	0	0	0
OHLE Uplift (Cwu)	70	70	110	50	50	70	70	70	70
OHLE Construction/ Installation (Cct) + Maintenance Tolerance (Cmt)	50	50	50	50	50	50	50	50	50
Structure Construction Tolerance (St)	0	0	0	0	0	0	0	0	0
Track Maintenance Tamping Allowance (Tla)	75	75	75	50	50	75	75	75	50



	OBB35	OBB38	OBB38A	OBB41	OBB49	OBB51A	OBB57A	OBB63	OBB77
Track Construction Tolerance (Tct)	0	0	0	0	0	0	0	0	0
Track Maintenance Tolerance (Tmt)	25	25	25	25	25	25	25	25	25
Considered OHLE span through the overbridge (as per hierarchy cases)	15	15	30	12	12	15	15	15	15
Sag and Ice Load	39	39	74	25	25	39	39	39	39
Survey Tolerance	5	5	5	5	5	5	5	5	5
Loading Gauge	4064	4064	4064	4064	4064	4064	4064	4064	4064
Mechanical Clearance	90	290	490	98	85	85	85	85	225







	OBB35	OBB38	OBB38A	OBB41	OBB49	OBB51A	OBB57A	OBB63	OBB77
Speed through the structure	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph
Acceptance - CCE	TMTA 75 mm Mech. clearance 90 mm	TMTA 75 mm	TMTA 75 mm	TMTA 50 mm Mech. clearance 98 mm	TMTA 50 mm Mech. clearance 85 mm	TMTA 75 mm Mech. clearance 85 mm	TMTA 75 mm Mech. clearance 85 mm	TMTA 75 mm Mech. clearance 85 mm	TMTA 50 mm
Acceptance - SET	"CW<4700 mm	"CW<4700 mm Reduced electrical clearances	"CW<4700 mm	"CW<4700 mm	"CW<4700 mm	"CW<4700 mm	"CW<4700 mm	"CW<4700 mm	CW<4700 mm
Derogation - SET	No	No	No	No	No	No	No	No	No





5.3 Bridges for further consideration

The following section identifies the bridges which will undergo further optioneering at the next stage to identify a preferred solution. The bridges can generally fall in to two categories

- 1. Bridges which have a potential electrical solution but would require a derogation
- 2. Bridges with no viable electrical solution in the existing arrangement

These are discussed in the following sections

5.3.1 Electrical Solutions requiring a derogation

Potential electrical solution for bridges where the contact wire height is less than 4400 mm but greater than 4200mm is summarised the tables below. A risk assessment has been undertaken for the solutions at each of these bridges and is contained in Appendix A of this report. In addition to this, a derogation would need to be sought for these bridges as the contact wire height is below minimum.



Table 5-8: Potential electrical solution with 4200mm < CWH < 4400 mm (Derogation required)

	OBB39	OBB44	OBB55	OBB78	OBB81
Current Structure Parameters					
Structure Name	Rush & Lusk Roadbridge	Tyrrelstown / Public Road	County Bridge / Public Road	Colpe Bridge / Public Road	MacBride Station
Chainage	13 miles & 1644 yards	14 miles & 1437 yards	21 miles & 304 yards	30 miles & 233 yards	31 miles & 1259 yards
Bridge Type	Roadbridge	Roadbridge	Roadbridge	Roadbridge	Footbridge
Is the Structure Listed	No	No	No	No	No (but located in a station which protected)
Width of Structure	10.08	7.18	11.5	17.46	2.82
Worst Vertical Clearance - TOR to Soffit	4776	4585	4590	4680	4464
Structure type	Flat	Flat	Flat	Flat	Flat
Bridge Constraints	Rush&Lusk station	-			Drogheda MacBride Station
Potential OHLE solution	Contenary with zero encumbrance				



Table 5-9: Potential electrical solution parameters with CWH < 4400 mm (Derogation required)</th>

	OBB39	OBB44	OBB55	OBB78	OBB81
Potential OHLE solution	Contenary with zero encumbrance	Contenary with zero encumbrance	Contenary with zero encumbrance	Contenary with zero encumbrance	Contenary with zero encumbrance
OHLE Arrangement	Fitted with Elastic Bridge Arms	Free Running	Fitted with Elastic Bridge Arms	Fitted with Elastic Bridge Arms	Free Running
Static Clearance (Csc) - 1500Vdc	100	100	100	100	100
Dynamic Clearance (Cdc) - 1500Vdc	80	80	80	80	80
Minimum Position of the Contact Wire (considering tamping)	4245	4215	4215	4193	4223
Actual Design Contact Wire Height (Cdcl) (After Tamping)	4370	4320	4270	4290	4270
Maximum Design Contact Wire Height [Pre-Tamping]	4420	4370	4270	4340	4270



	OBB39	OBB44	OBB55	OBB78	OBB81
OHLE System Depth (Csd)	0	0	0	0	0
OHLE Uplift (Cwu)	50	50	50	50	25
OHLE Construction/ Installation (Cct) + Maintenance Tolerance (Cmt)	50	30	30	30	30
Structure Construction Tolerance (St)	0	0	0	0	0
Track Maintenance Tamping Allowance (Tla)	50	50	0	50	0
Track Construction Tolerance (Tct)	0	0	5	0	5
Track Maintenance Tolerance (Tmt)	25	25	5	25	5
Considered OHLE span through the overbridge (as per hierarchy cases)	12	12	12	10	10



	OBB39	OBB44	OBB55	OBB78	OBB81
Sag and Ice Load	25	25	25	17	17
Survey Tolerance	5	5	5	5	5
Loading Gauge	4064	4064	4064	4064	4064
Mechanical Clearance	201	80	90	205	104
Speed through the structure	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	160km/h - 100 mph	50km/h - 30 mph
Acceptance - CCE	TMTA 50 mm	TMTA 50 mm Mech. clearance 80 mm	Slab track Mech. clearance 90 mm	TMTA 50 mm	Slab track Mech. clearance 104 mm
Acceptance - SET	CW<4700 mm	CW<4700 mm	CW<4700 mm	CW<4700 mm	CW<4700 mm Reduced electrical clearances OHLE construction + maintenance tolerance 30 mm OHLE Uplift 25 mm





	OBB39	OBB44	OBB55	OBB78	OBB81
Derogation - SET	CWH - 4370 Post tamping	CWH - 4320 Post tamping	CWH -4270	CWH - 4290 Post tamping	CWH - 4270





5.3.1.1 Derogations

There are five bridges that have been identified as requiring a derogation should an electrical only solution be adopted.

The potential electrical solutions for OBB39, OBB44 and OBB78 all require contact wire heights less than 4400 mm; however, they avoid the need for a slab track.

The potential electrical solution for OBB55 adopts the minimum contact wire height of 4270 mm and requires a slab track.

The potential electrical solution for OBB81 similarly adopts a contact wire height of 4270 mm and requires a slab track. It also requires a reduced OHLE uplift allowance of 25 mm to fit the electrical wire beneath the structure at this location.

All these solutions would require a Standard Derogation due to their reduced contact wire heights. This is to be carried out following SET-AMS-002-012 Derogation from SET Technical Standards, to be presented to the IÉ SET Department.

5.3.2 Bridges with no viable electrical solution in the existing arrangement

There are a limited number of bridges whereby the clearance is insufficient to provide an electrical only solution. These bridges include the bridges on the approach to Drogheda MacBride Station, namely the masonry arch bridges OBB80 and OBB80A. OBB80B sites between these two bridges to form a single line of bridges which carries McGraths Lane over the railway line here. An infrastructure solution will need to be developed at this location.

5.3.3 Further optioneering

Further optioneering is proposed at the next design stage for bridges which either require a derogation or for which there is no viable electrical solution in their current from.

Options that consider lowering the track or modifying the bridges will be considered. Where solutions are not driven entirely by technical constraints (such as interface with the community or impact on protected structures), an MCA will be undertaken to identify the emerging preferred solution.



Appendix A

Risk Assessments for Proposed Electrical Solutions where Contact Wire Height is less than 4700 mm

OBB33 DONABATE STATION ROADBRIDGE

Approx.	Miles	11
Location	Yards	727
Soffit height		~5000 mm
Width		12,19 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Fitted contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 10 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB33	10	Static EC	4550	4411	25	14	50	0	25	20	30	0	0	0	150	5	120	0	4950	~5000
000000	10	Dynamic EC	4550	4411	25	14	50	0	25	20	30	25	0	70	100	5	120	0	4995	5000

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALUA	ATION			EVALU	TION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4550 mm and spans are lower than 12 m, so minimum CWH will be 4411 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	C	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the north side of the overbridge, the proposed adjacent spans are lower than 30 m, so considering pretamping CWH is 4600 mm, the minimum CWH will be 4476 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4266 mm from ToR. Worst envelope situation is considering 60 mm cant towards platform and platform height in this section of 1070 mm from nearest rail, so minimum height of live parts from platform standing surface is 3185 mm. Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from lidar surveys in Annex C of tender documentation.	2	4	6

			EVALUATION				EVALUATION		
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	C	Result	Safety Measures - mitigation description	F	С	Result
Insufficient load capacity of overbridge structure	Adding additional construction loads to structure	Instability and collapse of existing structure	3	5	8	Capacity of the overbridge will be checked in the following stages of the design	1	5	6

OBB33A DONABATE FOOTBRIDGE

Approx.	Miles	11
Location	Yards	784
Soffit height		~5100 mm
Width		2,18 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running solution with 100 mm minimum encumbrance based on tolerances/allowances considered in hierarchy case 6 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB33V	6(*)	Static EC	4600	4352	24	99	75	0	25	20	30	0	110	0	150	5	0	0	5015	~5100
00033A	0()	Dynamic EC	4600	4352	24	99	75	0	25	20	30	25	110	110	100	5	0	0	5100	5100

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALU	TION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4600 mm and spans are lower than 12 m, so minimum CWH will be 4352 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALUATION				
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result		
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5		
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the north side of the overbridge, the proposed adjacent spans are lower than 35 m, so considering pretamping CWH is 4675 mm, the minimum CWH will be 4528 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4318 mm from ToR. Worst envelope situation is considering 60 mm of cant towards platform and platform height of 1060 mm from nearest rail, so minimum height of live parts from platform standing surface is 3247 mm. Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from lidar surveys in Annex C of tender documentation.	2	4	6		

OBB35 BEAVERSTOWN GOLF CLUB

Approx.	Miles	12
Location Yards		445
Soffit height		4740 mm
Width		4,54 m
Station		N
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 13 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
	12	Static EC	4400	4236	25	14	75	0	25	20	30	0	0	0	100	5	0	0	4655	4740
00000	12	Dynamic EC	4400	4236	25	14	75	0	25	20	30	25	0	70	80	5	0	0	4730	4740

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	TION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4400 mm and spans are lower than 12 m, so minimum CWH will be 4236 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

OBB38 ROGERSTOWN LANE

Approx.	Miles	13
Location	Yards	999
Soffit height		~5020 mm
Width		4,64 m
Station		N
Flat/arched		Arched



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 13 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
00020	12	Static EC	4480	4316	25	14	75	0	25	20	30	0	0	0	100	5	0	200	4935	~5020
OBB30	15	Dynamic EC	4480	4316	25	14	75	0	25	20	30	25	0	70	80	5	0	200	5010	3020

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	TION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4480 mm and spans are lower than 12 m, so minimum CWH will be 4316 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

OBB38A RUSH & LUSK FOOTBRIDGE

Approx.	Miles	13
ocation Yards		1564
Soffit height		~5200 mm
Width		3 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running solution with 300 mm of minimum encumbrance based on tolerances/allowances considered in hierarchy case 11 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
	11/*)	Static EC	4420	4221	18	56	75	0	25	20	30	0	320	0	150	5	0	0	5045	~5200
UDDS6A	TT(,)	Dynamic EC	4420	4221	18	56	75	0	25	20	30	25	320	110	100	5	0	0	5130	5200

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	TION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4420 mm and spans are lower than 12 m, so minimum CWH will be 4221 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the south side of the overbridge, the proposed adjacent spans are lower than 35 m, so considering pretamping CWH at the overbridge is 4495 mm, the minimum CWH will be 4348 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4138 mm from ToR. Worst envelope situation is considering 10 mm cant away from platform and 1110 mm platform height from the nearest rail, so minimum height of live parts from platform standing surface is 3029 mm. Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from lidar surveys in Annex C of tender documentation.	2	4	6

OBB39 RUSH & LUSK ROADBRIDGE

Approx.	Miles	13
Location	Yards	1644
Soffit height		4776 mm
Width		10,08 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Fitted contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 14 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB39	1/1	Static EC	4370	4245	16	9	50	0	25	20	30	0	0	0	100	5	120	0	4720	1776
	14	Dynamic EC	4370	4245	16	9	50	0	25	20	30	25	0	50	80	5	120	0	4775	4770

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUATION		
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4370 mm and spans are lower than 12 m, so minimum CWH will be 4245 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALUATION			
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result	
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5	
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the south side of the overbridge, the proposed adjacent spans are lower than 25 m, so considering pretamping CWH is 4420 mm, the minimum CWH will be 4315 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4105 mm from ToR. Worst envelope situation is considering 85 mm cant towards track and 1060 mm of platform height from nearest rail, so minimum height of live parts from platform standing surface is 3027 mm. Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from lidar surveys in Annex C of tender documentation.	2	4	6	

			EVALU	ATION			EVALUATION		
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6
Insufficient load capacity of overbridge structure	Adding additional construction loads to structure	Instability and collapse of existing structure	3	5	8	Capacity of the overbridge will be checked in the following stages of the design	1	5	6
Approx.	Miles	14							
---------------	-------	---------							
Location	Yards	438							
Soffit height		4703 mm							
Width		6,7 m							
Station		N							
Flat/arched		Flat							



PROPOSED ELECTRICAL SOLUTION

Free running solution with contenary with zero encumbrance based on tolerances/allowances considered in hierarchy case 14 given in the Functional Requirement Spectification for DART+ Programme but with 4400 mm CW height.

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB/11	1/1	Static EC	4400	4275	16	9	50	0	25	20	30	0	0	0	100	5	0	0	4630	1702
06641	14	Dynamic EC	4400	4275	16	9	50	0	25	20	30	25	0	50	80	5	0	0	4685	4705

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALU/	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4400 mm and spans are lower than 12 m, so minimum CWH will be 4275 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

Approx.	Miles	14
Location	Yards	1437
Soffit height		4585 mm
Width		7,18 m
Station		Ν
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running solution with contenary with zero encumbrance without slab track based on tolerances/allowances considered in hierarchy case 14 reducing the contact wire height given in the Functional Requirement Spectification for DART+ Programme and considering 10 mm for OHLE maintenance tolerance, as specified by Functional Requirement Spectification for DART+ Programme for crossovers and particular locations.

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB44	14	Static EC	4320	4215	16	9	50	0	25	20	10	0	0	0	100	5	0	0	4530	4585
00044	<u>-</u>	Dynamic EC	4320	4215	16	9	50	0	25	20	10	25	0	50	80	5	0	0	4585	4505

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4320 mm and spans are lower than 12 m, so minimum CWH will be 4215 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

Approx.	Miles	15
Location	Yards	856
Soffit height		4715 mm
Width		4,81 m
Station		N
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running solution with contenary with zero encumbrance based on tolerances/allowances considered in hierarchy case 13 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
	12	Static EC	4400	4261	25	14	50	0	25	20	30	0	0	0	100	5	0	0	4630	1715
06645	12	Dynamic EC	4400	4261	25	14	50	0	25	20	30	25	0	70	80	5	0	0	4705	4715

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4400 mm and spans are lower than 12 m, so minimum CWH will be 4261 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

OBB46 BALDONGAN

Approx.	Miles	16
Location	Yards	172
Soffit height		~4860 mm
Width		7,1 m
Station		Ν
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 10 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB/16	10	Static EC	4500	4336	25	14	75	0	25	20	30	0	0	0	150	5	0	0	4805	~1860
00040	10	Dynamic EC	4500	4336	25	14	75	0	25	20	30	25	0	70	100	5	0	0	4850	4800

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALU/	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4500 mm and spans are lower than 12 m, so minimum CWH will be 4336 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5

OBB47 SKERRIES GOLF CLUB

Approx.	Miles	16
Location	Yards	1038
Soffit height		4900 mm
Width		4,74 m
Station		N
Flat/arched		Arched



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 13 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB/17	٥	Static EC	4500	4223	27	125	75	0	25	20	30	0	0	0	150	5	0	0	4805	4900
06647	9	Dynamic EC	4500	4223	27	125	75	0	25	20	30	25	0	110	100	5	0	0	4890	4500

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALUA	ATION			EVALU	TION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4500 mm and spans are lower than 12 m, so minimum CWH will be 4223 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

OBB49 GOLF LINKS RD SKERRIES

Approx.	Miles	17
Location	Yards	524
Soffit height		4690 mm
Width		7,42 m
Station		N
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running solution with contenary with zero encumbrance based on tolerances/allowances considered in hierarchy case 14 given in the Functional Requirement Spectification for DART+ Programme but with 4400 mm CW height.

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB/10	1/1	Static EC	4400	4275	16	9	50	0	25	20	30	0	0	0	100	5	0	0	4630	1600
06649	14	Dynamic EC	4400	4275	16	9	50	0	25	20	30	25	0	50	80	5	0	0	4685	4090

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALU/	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4400 mm and spans are lower than 12 m, so minimum CWH will be 4275 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

OBB51A SKERRIES FOOTBRIDGE

Approx.	Miles	17
Location	Yards	1708
Soffit height		4815 mm
Width		2,25 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 13 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
	12	Static EC	4480	4316	25	14	75	0	25	20	30	0	0	0	100	5	0	0	4735	101E
OBBJIA	15	Dynamic EC	4480	4316	25	14	75	0	25	20	30	25	0	70	80	5	0	0	4810	4015

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALU/	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4480 mm and spans are lower than 12 m, so minimum CWH will be 4316 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the station the proposed adjacent spans are lower than 40 m, so considering pretamping CWH is 4555 mm, the minimum CWH will be 4382 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4172 mm from ToR. Worst point is 80 mm cant away from platform and platform height of 1165 mm from nearest rail, so minimum height of live parts from platform standing surface is 3011 mm.Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from lidar surveys in Annex C of tender documentation. This distance has been compared with those of the latest overbridge survey and used the highest one.	2	4	6

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	С	Result
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

Approx.	Miles	21
Location	Yards	304
Soffit height		4590 mm
Width		11,5 m
Station		N
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Fitted solution with contenary with zero encumbrance and slab track based on tolerances/allowances considered in hierarchy case 15 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB25	15	Static EC	4270	4215	16	9	0	5	5	20	10	0	0	0	100	5	120	0	4535	4500
0893	13	Dynamic EC	4270	4215	16	9	0	5	5	20	10	25	0	50	80	5	120	0	4590	4590

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4270 mm and spans are lower than 12 m, so minimum CWH will be 4215 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6
Insufficient load capacity of overbridge structure	Adding additional construction loads to structure	Instability and collapse of existing structure	3	5	8	Capacity of the overbridge will be checked in the following stages of the design	1	5	6

OBB57A BALBRIGGAN FOOTBRIDGE

Approx.	Miles	21
Location	Yards	1328
Soffit height		4775 mm
Width		2,38 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 13 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB57A	13	Static EC	4440	4276	25	14	75	0	25	20	30	0	0	0	100	5	0	0	4695	1775
CEDJIA	13	Dynamic EC	4440	4276	25	14	75	0	25	20	30	25	0	70	80	5	0	0	4770	7775

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4440 mm and spans are lower than 12 m, so minimum CWH will be 4276 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the station the proposed adjacent spans are lower than 40 m, so considering pretamping CWH is 4515 mm, the minimum CWH will be 4342 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4132 mm from ToR. Worst point is 80 mm cant away from platform and platform height of 1105 mm, so minimum height of live parts from platform standing surface is 3031 mm.Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from lidar surveys in Annex C of tender documentation. This distance has been compared with those of the latest overbridge survey and used the highest one.	2	4	6

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	С	Result
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

Approx.	Miles	22
Location	Yards	1573
Soffit height		~4880 mm
Width		7,85 m
Station		N
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 10 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB62	10	Static EC	4500	4311	25	14	100	0	25	20	30	0	0	0	150	5	0	0	4830	~1880
00002	10	Dynamic EC	4500	4311	25	14	100	0	25	20	30	25	0	70	100	5	0	0	4875	4000

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	C	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4500 mm and spans are lower than 12 m, so minimum CWH will be 4311 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

		EVALUA	ATION			EVALU	ATION		
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5

Approx.	Miles	23
Location	Yards	866
Soffit height		4735 mm
Width		4,47 m
Station		N
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 13 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
	12	Static EC	4400	4236	25	14	75	0	25	20	30	0	0	0	100	5	0	0	4655	4725
00003	12	Dynamic EC	4400	4236	25	14	75	0	25	20	30	25	0	70	80	5	0	0	4730	4755

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	C	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4400 mm and spans are lower than 12 m, so minimum CWH will be 4236 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6

OBB66 GORMANSTOWN STATION ROADBRIDGE

Approx.	Miles	24
Location	Yards	19
Soffit height		4880 mm
Width		4,52 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 10 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
	10	Static EC	4525	4361	25	14	75	0	25	20	30	0	0	0	150	5	0	0	4830	1000
OBB00	10	Dynamic EC	4525	4361	25	14	75	0	25	20	30	25	0	70	100	5	0	0	4875	4080
- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	C	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4525 mm and spans are lower than 12 m, so minimum CWH will be 4361 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the station the proposed adjacent spans are lower than 30 m, so considering pretamping CWH is 4600 mm, the minimum CWH will be 4476 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4266 mm from ToR. Worst situation is considering 110 mm cant towards the platform and platform height is 1050 mm, so minimum height of live parts from platform standing surface is 3189 mm.Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from lidar surveys in Annex C of tender documentation. This distance has been compared with those of the latest overbridge survey and used the highest one.	2	4	6

OBB66A? GORMANSTOWN STATION FOOTBRIDGE (PLANNED)

Approx.	Miles	24
Location	Yards	120
Soffit height		~5274 mm
Width		2,55 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running solution with 100 mm minimum encumbrance based on tolerances/allowances considered in hierarchy case 6 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB66A2	6(*)	Static EC	4645	4421	18	56	100	0	25	20	30	0	150	0	270	5	0	0	5245	E274
OBB00A!	0()	Dynamic EC	4645	4421	18	56	100	0	25	20	30	25	150	110	150	5	0	0	5260	5274

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALUA	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4645 mm and spans are lower than 30 m, so minimum CWH will be 4421 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In the station the proposed adjacent spans are lower than 30 m, so considering pretamping CWH is 4745 mm, the minimum CWH will be 4621 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4411 mm from ToR. Worst situation is considering 110 mm cant towards the platform and platform height is 1050 mm, so minimum height of live parts from platform standing surface is 3334 mm.Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from lidar surveys in Annex C of tender documentation. This distance has been compared with those of the latest overbridge OBB66 survey and used the highest one.	2	4	6

OBB68

Approx.	Miles	24
Location	Yards	1757
Soffit height		4920 mm
Width		6.55 m
Station		N
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 10 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB68	10	Static EC	4540	4351	25	14	100	0	25	20	30	0	0	0	150	5	0	0	4870	1020
CDB08	10	Dynamic EC	4540	4351	25	14	100	0	25	20	30	25	0	70	100	5	0	0	4915	4920

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4540 mm and spans are lower than 12 m, so minimum CWH will be 4351 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5

OBB77

Approx.	Miles	29
Location	Yards	1452
Soffit height		~4850 mm
Width		8,2 m
Station		N
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Fitted contenary solution with zero encumbrance based on tolerances/allowances considered in hierarchy case 13 given in the Functional Requirement Spectification for DART+ Programme

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
	12	Static EC	4400	4261	25	14	50	0	25	20	30	0	0	0	100	5	120	0	4750	~1950
00077	12	Dynamic EC	4400	4261	25	14	50	0	25	20	30	25	0	70	80	5	120	0	4825	4850

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALUA	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	C	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4400 mm and spans are lower than 12 m, so minimum CWH will be 4261 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6
Insufficient load capacity of overbridge structure	Adding additional construction loads to structure	Instability and collapse of existing structure	3	5	8	Capacity of the overbridge will be checked in the following stages of the design	1	5	6

OBB78

Approx.	Miles	30
Location Yards		233
Soffit height	-	4680 mm
Width		17,46 m
Station		N
Flat/arched		Flat

PROPOSED ELECTRICAL SOLUTION



Fitted solution with contenary with zero encumbrance without slab track based on tolerances/allowances considered in hierarchy case 14 reducing the contact wire height given in the Functional Requirement Spectification for DART+ Programme and considering 10 mm for OHLE maintenance tolerance, as specified by Functional Requirement Spectification for DART+ Programme for crossovers and particular locations.

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
OBB78	1/	Static EC	4290	4193	11	6	50	0	25	20	10	0	0	0	100	5	120	0	4620	4680
00070	14	Dynamic EC	4290	4193	11	6	50	0	25	20	10	25	0	50	80	5	120	0	4675	4080

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU/	TION			EVALU	TION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4290 mm and spans are lower than 10 m, so minimum CWH will be 4193 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6
Insufficient load capacity of overbridge structure	Adding additional construction loads to structure	Instability and collapse of existing structure	3	5	8	Capacity of the overbridge will be checked in the following stages of the design	1	5	6

OBB81 MacBRIDE STATION

Approx.	Miles	31
Location Yards		1259
Soffit height		4464 mm
Width		2,82 m
Station		Y
Flat/arched		Flat



PROPOSED ELECTRICAL SOLUTION

Free running solution with contenary with zero encumbrance and slab track based on tolerances/allowances considered in hierarchy case 15 given in the Functional Requirement Spectification for DART+ Programme and considering 25 mm of uplift (speed limitation of 50 km/h in the station) and 10 mm for OHLE maintenance tolerance, as specified by Functional Requirement Spectification for DART+ Programme for crossovers and particular locations.

			Nominal CW height	Minimum position of the contact wire	Pre/Natural sag (OHLE Messenger + Contact wire)	Sag due to Ice Load (OHLE Messenger + Contact wire)	Track Maintenance Tamping allowance	Track Construction tolerance	Track Maintenance tolerance	OHLE construction tolerance	OHLE maintenance tolerance	CW and panto wear	System height	Uplift	Electrical clearance	Survey tolerance	Support height (fitted solution)	Arched allowance (Arched deck overbridges)	Minimum soffit height (mm)	Actual soffit height (mm)
	16	Static EC	4270	4223	11	6	0	5	5	20	10	0	0	0	100	5	0	0	4415	1161
00001	10	Dynamic EC	4270	4223	11	6	0	5	5	20	10	25	0	25	80	5	0	0	4445	4404

- Result 7 or higher: Intolerable risk
- Result 5 or 6: Tolerable risk
- Result 4 or lower: Negligible low risk

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	С	Result	Safety Measures - mitigation description	F	С	Result
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the overbridge, proposed CWH is 4270 mm and spans are lower than 10 m, so minimum CWH will be 4223 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS. In adjacent spans, span lengths will be limited in order to maintain the CWH higher than 4190 mm in any case.	1	4	5

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed.	3	2	5
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In this area of station the proposed adjacent spans are lower than 20 m, so considering CWH is 4270 mm, the minimum CWH will be 4203 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 3993 mm from ToR. Worst point along the platforms has 20 mm cant towards the platform and platform height of 1030 mm, so minimum height of live parts from platform standing surface is 2960 mm. However the horizontal distance from the edge of the platform to the pantograph is 686 mm, so the distance from the platform to the live parts is 3038 mm Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from Drogheda station survey	2	4	6

			EVALU	ATION			EVALU	ATION	
Hazard Cause	Hazard - The unsafe act or condition.	Hazard Event Description of the Hazard Event (the RISK) and the consequence.	F	с	Result	Safety Measures - mitigation description	F	с	Result
Restricted electrical clearances of new OHLE at legacy structures, due to local route constraints.	Public use of legacy overbridges and structures with reduced electrical clearances.	Touch potential, Electrocution	4	4	8	Proposed OHLE solution considers static electrical clearance of 100 mm and dynamic electrical clearance of 80 mm, which are the minimum values according to I-ETR-4101 / Maintenance Parameters for 1500 Vdc OHLE; chapter 2.2 Electrical Clearances - subchapter 2.2.1 and FRS. Additionally flashover protection could be also considered.	2	4	6