Stáisiún Uí Chonghaile, Baile Átha Cliath 1, D01 V6V6
Connolly Station, Dublin 1, D01 V6V6
T 01 703 4293 E foi@irishrail.ie W www.irishrail.ie

Iarnród Éireann
Irish Rail

6th May 2021

[redacted]

Email: [redacted]

Re: FOI request IE_FOI_460

Dear [redacted],

I refer to your request dated 2nd April 2021 made under the Freedom of Information Act 2014, which was received on by my office on that date, for records held by Iarnród Éireann.

Request:

- final report from the 'Infrastructure study for BEMU operation'

The decision maker handling your request is Mr. Mark Conroy.

Response:

I, [redacted], Decision Maker have now made a final decision to part grant your request on 6th May 2021.

Please find response document and schedule of records attached.

Rights of appeal

In the event that you are not happy with this decision you can make an appeal in relation to this matter, you can do so by writing to the FOI Unit, Corporate Communications, Iarnród Éireann Irish Rail, Connolly Station, Amiens St, Dublin 1 or by e-mail to foi@irishrail.ie. You should make your appeal within 4 weeks (20 working days) from the date of this notification, where a day is defined as a working day excluding, the weekend and public holidays, however, the making of a late appeal may be permitted in appropriate circumstances.
The appeal will involve a complete reconsideration of the matter by a more senior member of the staff of this body.

Should you have any questions or concerns regarding the above, please contact the FOI Officer on [redacted] or by email at foi@irishrail.ie

Yours sincerely,

[redacted]

[redacted] **FOI Decision Maker, Infrastructure Mgmt, Iarnród Éireann**

Freedom of Information Request:
Schedule of Records for IE_FOI_460 : Summary for Decision Making

Record No.	Date of Record	Brief Description	No. of Pages	Decision: Grant/Part Grant/Refuse	Section of Act if applicable	Record Edited/Identify Deletions
1	10.02.2021	BEMU Concept Study - Redacted	139	Part Grant		
		~		Part Grant	S37	Personal Information of others
		Page 5		Part Grant	S29	Deliberations of a Public Body
		Page 6		Part Grant	S36	Commercially Sensitive Information
		Page 11		Part Grant	S37	Personal Information of others
		Page 14		Part Grant	S37	Personal Information of others
		Page 15		Part Grant	S36	Commercially Sensitive Information
		Page 54		Part Grant	S36	Commercially Sensitive Information
		Page 59		Part Grant	S29	Deliberations of a Public Body
		Page 60		Part Grant	S36	Commercially Sensitive Information

		Page 67-70		Part Grant	S36	Commercially Sensitive Information
		Page 73		Part Grant	S36	Commercially Sensitive Information
		Page 75 - 79		Part Grant	S36	Commercially Sensitive Information
		Page 83		Part Grant	S36	Commercially Sensitive Information
		Page 89 - 102		Part Grant	S36	Commercially Sensitive Information
		Appendix R		Part Grant	S36	Commercially Sensitive Information
		Appendix S		Part Grant	S36	Commercially Sensitive Information
		Appendix U		Part Grant	S29	Deliberations of a Public Body

Signed:

Freedom of Information / Data Protection Executive

BEMU Options Study

D3422300-JAC-REP-EMF-000001 | P04

10 February 2021

Iarnród Éireann

Project:	**BEMU Infrastructure Study**		
Client:	**Irish Rail**	**Project Number:**	**D3422300**
Document Title:	BEMU Options Study		
Doc. No:	D3422300-JAC-REP-EMF-000001		

		Originated by		Checked by		Reviewed by	
ORIGINAL	**ISSUE P01**	NAME	Initials	NAME	Initials	NAME	Initials
		[redacted]					
Approved by		NAME	[redacted]				[redacted]
		[redacted]					
[redacted]							

[redacted]							

[redacted]							

[redacted]							
DATE	**10.2.2021**	**Document status: Final Issue**					

Contents

Executive Summary

As part of the DART + Programme, Iarnród Éireann is purchasing a new fleet of trains to enhance the capacity on the DART network. This procurement forms Work Package 1 of the overall programme and has been designed to allow the purchaser to choose a fleet made up of Electric Multiple Units (EMUs) and Battery Electric Multiple Units (BEMUs). The provision of BEMUs is to allow for the possibility of running enhanced services on the network in advance of full electrification. For BEMUs to operate successfully, charging facilities are required to recharge the batteries to enable operations that are not on the electrified network. IÉ have identified the Northern Line as the most suitable route for potential BEMU deployment and Drogheda Station and depot area as the preferred charging station location.

In August 2020, IÉ commissioned Jacobs to identify the BEMU infrastructure requirements at Drogheda Station (including maintenance infrastructure and equipment), with an aim of minimal intervention and operational impact, for 3 different timetable scenarios and to develop Life Cycle Costs accordingly for the resulting requirements. Following timetabling work that IÉ completed as part of DART+ WP3 (Maynooth Line upgrade), three alternative Train Service Specifications (TSS's) were generated. IÉ asked Jacobs to consider these three alternative timetable scenarios as follows:

- A Base Scenario of 2 or 3 trains per hour (tph) (based on the current timetable)
- Train Service Specification 1b (this has a total of 5tph DART services to/from Drogheda, of which 2tph operate as empty stock (not in passenger service) between Laytown and Drogheda)
- Train Service Specification 3 (6tph DART services to/from Drogheda)

Jacobs performed an operational assessment of these three different scenarios and from that formulated the platforming requirements of the BEMU trains. This was based on a 12-minute turnaround time for charging each BEMU. With the platforming requirements established for the three different scenarios, Jacobs undertook a 2 stage optioneering exercise in line with Common Appraisal Framework guidelines to consider the best approach for each scenario. The conclusion of that exercise led to the proposals for the following infrastructure options for each of the TSS scenarios:

- **Scenario 1: (Base TSS)**: Infrastructure Option 1a – Charging Station on Platform 3 and Depot Road 4 (Completion Nov 2023)
- **Scenario 2: TSS 1B**: Infrastructure Option 1b – As option 1a above plus Charging Station on Platform 2 (Completion July 2024)
- **Scenario 3: TSS 3**: Infrastructure Option 2b – As option 1b above PLUS Charging Station on Navan Line (single tracking short section) (Completion July2024)

Note completion dates are based on commencement of Multi-Disciplinary Consultant in Jan 2021 (See Appendix I for programme details).

<u>**Scenario 1: Base TSS (2/3 tph)**</u>

Infrastructure Option 1a was chosen for the base scenario because it provides the simplest, lowest cost and least disruptive way of meeting the requirements. In normal service, trains would charge in Bay Platform 3. The depot road no.4 would generally be used for servicing the BEMUs or initially for commissioning purposes. In terms of redundancy, should there be a breakdown in Platform 3, trains could be directed into depot road 4 to be charged. In this situation, once charged, they would need to move out onto the mainline and back into one of the through platforms (most likely platform 2) to allow passenger boarding. Alternatively, if this manoeuvre was not considered an attractive prospect, the train could be sent empty to Laytown where it would commence passenger service.

If neither of these scenarios was considered acceptable in a failure situation, an additional charging station could be provided on Platform 2. To do this, the additional cost of installing and maintaining this extra piece of infrastructure would have to outweigh the operational limitations outlined above. [This situation has been provided for as Option 1c].

It should be noted that in this situation, even with three charging stations now in place (Platform 3, Platform 2 and Depot Road 4), only one train could be charged at a time due to the limitation in the power available from the installed sub-station.

In terms of stabling requirements in this scenario, the existing depot plus the addition of one stabling berth on the Navan Branch line will suffice.

Scenario 2: TSS 1b (5tph)

Infrastructure Option 1b was chosen as the preferred solution for TSS 1b. Once again, this was considered the most cost-effective way of achieving the requirements of this train operating scenario. This option builds on Option 1a with the addition of a charging station on Platform 2 AND an upgrade in power availability from the existing installed sub-station to allow up to three trains to be charged simultaneously. It was found that the power demand would be greater than could reasonably be made available by ESB and the concept of battery buffers was developed (These allow input power at a lower level to be "stored up" and released at a greater rate and thereby reducing the input power requirements. In this scenario, there are up to 5 trains per hour required to depart Drogheda, however in this TSS, two of these would do so running empty to Laytown. The intention of this option is that the two empty running vehicles would be charged in Depot Road 4 (where there are no platform facilities or passenger access) and from there would depart directly for Laytown once sufficiently charged. In normal operation, there should be no more than two trains charging simultaneously (on two of the three charging stations available). However, it is possible during perturbation that three trains would require to be charged at the same time but the power available from the existing installed sub-station will not be enough to provide for this situation. Therefore, battery buffers will be utilised in this scenario to provide the additional power requirement without the need for an increased rate of input power from the ESB.

It should be noted that under normal operation for Scenario 2, only 2 charging roads would be used and hence there would still be 1 spare road. However, in a failure situation where 3 trains require simultaneous charging, there would not be further redundancy to fall back on. If a further level of redundancy was required an additional charging platform would be needed, as proposed under Option 2a or 2b as described below for example, where the Navan branch line is utilised.

In terms of stabling requirements in this scenario, IÉ have confirmed that [redacted] should be considered for the stabling of 48 additional vehicles (in addition to those stabled in the existing depot).

Scenario 3: TSS 3 (6tph)

The preferred solution for TSS 3 is **Infrastructure Option 2b.** In addition to charging stations on Platforms 2, 3 and Depot Road 4, this option involves the construction of a new platform on the Navan branch line just to the south and west of Drogheda station. This platform would also require a charging station to be installed, bringing the total number of charging stations to 4 in this case (i.e. Platforms 2 and 3, Depot Road 4 and the Navan Line platform). Battery buffers would also be required for this option.

As the Navan Line is currently lightly utilised, it is possible to install a platform on the existing track bed on the north side of this branch line, thereby converting this section to single track and avoiding the need for additional land purchase and the environmental impact that would occur by locating a new platform adjacent to the existing twin track layout.

In normal operation for this scenario there should be no more than 2 trains charging simultaneously. In a delay situation there could be a need to have 3 trains charging at one time but even in this case, there will still be further redundancy via the charging station in depot road 4.

In terms of stabling requirements for Scenario 3, (as for Scenario 2) IE have confirmed that [redacted] should be considered for the stabling of 48 additional vehicles (in addition to those stabled in the existing depot).

Costing of Options

Once the preferred infrastructure options were selected for each of the three operating scenarios, concept designs were developed in order to provide enough information to develop high level cost estimates. These estimates provide Life Cycle Costs in each case covering the capital and operational expenditures required to facilitate each option. It is noted that the CAPEX costs are the predominant driver in all cases and the annual cost profile for Option 1a is the lowest cost.

The Life Cycle Costs for each of the preferred options for each TSS scenario are estimated as follows:

		Fleet size	Capital Cost (€millions)	Discounted Cumulative Cost (€millions)	
Operating Scenario	Infrastructure Option	(no. of BEMUs)	Capex	Year 5	Year 35
Base Scenario (2/3 tph)	Option 1a	52	[redacted]		
Base Scenario (2/3 tph)	Option 1c [1a + charging OHLE on Platform 2]	52	[redacted]		
TSS 1b (3tph in service + 2 empty to Laytown)	Option 1b	216	[redacted]		
TSS 3 (6tph)	Option 2b	196	[redacted]		

Note as per Common Appraisal Framework guidance all costs stated are exclusive of VAT (see also 8.1.1)

In the case of Option 1a, the infrastructure installed could be utilised in a future full electrification scenario and would not be abortive cost. In the case of Option 1b, most of the infrastructure installed could be utilised in a future full electrification scenario with the battery buffers then being surplus to requirements. In the case of Option 2b, all the additional electrical infrastructure works on the Navan line branch along with the battery buffers would be surplus to requirements in a future full electrification scenario.

As Jacobs understand from IE that scenario TSS 3 requires a platform on the Navan branch line in any case, the cost of the new platform would not be abortive. In the case of Options 1b and 2b stabling, this work would not be abortive assuming the stabling facility could be used for EMUs. Note in this case additional expenditure would then be required since the yard would need to be fully electrified.

BEMU Operational Constraints

It should be noted that there are some operational challenges associated with BEMUs. The requirement for charging limits BEMU turnaround flexibility in responding to timetable delays. In a similar vein, further enhancement of the timetable is also limited by the use of BEMUs compared to EMUs. Timetable recovery options which exist today during disruption on the Northern line by way of interchanging DMU fleets from other routes will not be possible as other routes will now be operated by EMUs; during disruption, operating EMUs north of Malahide will not be an option and this will reduce operational flexibility.

Section 3.5.3 deals with these limitations in more detail.

1. Introduction

1.1 Purpose of the Study

In July 2020, Iarnród Éireann invited consultants to tender for a study entitled, "*DART+ Studies and Cost Estimate associated to the BEMU operating infrastructure on the Northern Line*". Jacobs Engineering Ireland Ltd. was subsequently appointed, and we are pleased to present this document and its findings. The study is intended to feed into the overall DART+ Programme under the National Development Plan 2018-2027, which is a series of projects that will create a full integrated metropolitan area DART network for Dublin. It consists of seven interrelated projects to expand the heavy rail electrified commuter network in Dublin from the existing c.50 km to c.150km. These projects or "Work Packages" are as follows:

- Work Package 1 – Rolling Stock
- Work Package 2 – City Centre Enhancements
- Work Package 3 – Maynooth Line
- Work Package 4 – Kildare Line
- Work Package 5 – Northern Line
- Work Package 6 – Southeast Line
- Work Package 7 – DART Underground

The Suburban network envisaged is shown in Figure 1-1.

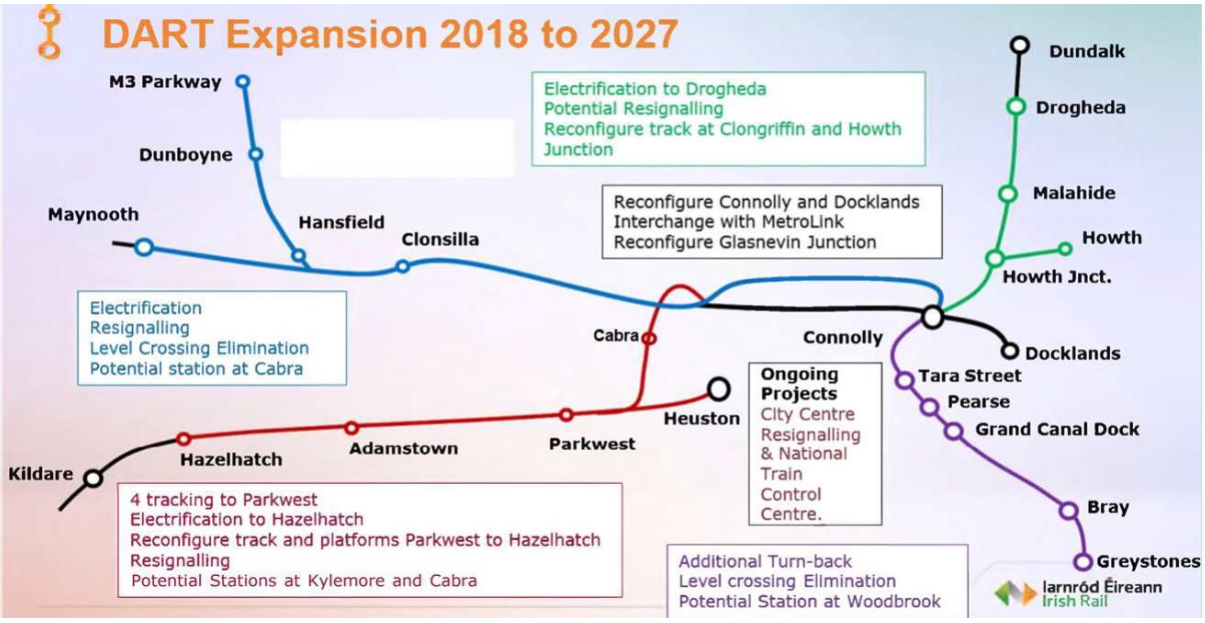


Figure 1-1 DART Expansion Programme 2019 to 2027 (rebadged DART+ Programme)

"Work Package 1 – Rolling Stock" allows for the procurement of a new fleet of trains consisting of both Electric Multiple Unit (EMU) and Battery Electric Multiple Unit (BEMU) trains. The EMUs will run under the electrified wires (both existing on the current DART line and newly installed as part of the DART + Programme). Work Package 1 allows for the purchase of BEMUs to operate in areas where electrification has yet to be delivered.

IÉ has identified the Northern Line as suitable for implementation of the BEMU strategy. Under Work Package 5 – Northern Line electrification is planned as far north as Drogheda. However, until electrification is completed to this point trains would run north under the existing DART electrification system as far as Malahide and then from there under battery power on to Drogheda. At this terminus, the train batteries would need to be charged to a sufficient level for the return leg from Drogheda to Malahide, where they would re-join the existing DART electrified network.

The necessary charging stations require investment both in terms of capital expenditure (CAPEX) and operating expenditure (OPEX). The purpose of this report is to present the infrastructure requirements for a range of operating scenarios and BEMU fleet sizes, so that IÉ can confirm their plan for BEMU fleet procurement and take account of the Life Cycle Cost (LCC) of installing and operating the infrastructure.

The following table notes the scope requirements and indicates where these items are addressed in the report.

Scope Requirements	Report Reference
Operation of BEMUs on the Northern Line, from Drogheda to Grand Canal Dock, including the Loop Line Bridge, with charging at Drogheda Station & Depot.	Covered in Section 3 - Operational Assessment
Determine Electrical Infrastructure	Covered in section 5 under discipline comments on each option and Appendix F
Determine Mechanical Infrastructure	Covered in section 5 under discipline comments on each option
Determine Civil Infrastructure	Covered in section 5 under discipline comments on each option
Determine Track Infrastructure	Covered in section 5 under discipline comments on each option
Consider the following operating frequencies	This is revised now to the following and covered in Section 3 - Operational Assessment
BEMU units at 2tphpd	BEMU units at 2/3 tphpd (as per current timetable)
BEMU units at 3tphpd	BEMU units at 2/3 tphpd (as per current timetable)
BEMU units at 4tphpd	BEMU units at 3 tphpd + 2 empty runners (as per IE provided TSS 1b)
BEMU units at 6tphpd	BEMU units at 6 tphpd (as per IE provided TSS 3)
BEMUs are to operate from Drogheda to Grand Canal Dock, including the Loop Line Bridge and back, with no upgrade to the existing electric infrastructure between Malahide and Connolly	Covered in Section 3 - Operational Assessment
Investigating impact of extending BEMU operation further south of grand Canal Dock to Greystones	Covered in Section 3 - Operational Assessment
Development of the study deliverables	
Operational Requirements and Impacts	Covered in Section 3 - Operational Assessment
Interfaces of the Preferred Options with all disciplines inter alia track, SET including OLE, Civils, structures.	Covered in section 5 under discipline comments on each option

Infrastructure - all infrastructure requirements, designs & impacts	Covered in section 5 under discipline comments on each option
Property - the outline right of way, impacts on properties,	Base Option does not require land outside IE ownership. Other options covered in section 5 under discipline comments and Appendix U.
Mitigations – for works, noise etc.	Covered under Environment comments in Section 5 for each option.
Cost – outline costs of schemes & value management	Covered in Section 8 - Cost (and Appendix D)
Risk – assessment of risks, safety, planning, commercial	Covered in Section 10 - Risk (and Appendix J)
Environmental – general impacts, etc	Covered under Environment comments in Section 5 for each option and Appendix E.
Utilities – supplies, existing services	Covered in section 5 under discipline comments on each option where applicable.
Draft implementation plan and programme	Covered under Section 9 - Programme (and Appendix I)
Safety Approvals – APIS, SMS 14	Covered under Section 7 - Safety in Design
Lifecycle costs (Operation & Maintenance) for electrification and BEMU's and associated infrastructure	Covered under Section 8 (and Appendix D)
Assessment of options and recommendation for preferred option.	Covered under Section 4 - Option Assessment
Strategy for implementation & next steps.	Covered under Section 12 - Recommendations and next steps
Advise on eventual need for Planning Permission / Railway Order application	Covered under Environment comments in Section 5 for each option and Appendices E and U.
Report Deliverables	
The proposed operational pattern strategy, to be developed in collaboration with IE	Covered in Section 3 - Operational Assessment
Functional, Technical and Operational Requirements of the infrastructure	Covered in Section 5 under discipline comments on each option
Architecture and specification of the charging infrastructure	Covered in Section 5 under discipline comments on each option
Specification of the track infrastructure modifications required to operate BEMUs (depot, platforms, sidings – including	Covered in Section 5 under discipline comments on each option

potential property acquisition - turnouts, etc)	
Specifications of additional ESB power supply(ies) and route to required locations	Covered in Section 5 under discipline comments on each option and Appendix F
Advice on the upgrades required specifically at Drogheda depot (electrification for BEMUs, specialist equipment, sidings, storage, etc…) to support commissioning & maintenance of the BEMU fleet in advance of Maynooth depot being ready	Covered in Section 6 - Depot
High-level Lifecycle Cost estimate and implementation Schedule of the proposed electrical, civil and track infrastructure on the Northern Line	Covered in Section 8 - Cost, and Section 9 - Schedule (and Appendices D and I respectively)
High-level Lifecycle Cost estimate and implementation Schedule of the Kildare Line (extrapolation exercise using data from the Northern Line);	Covered in Section 8 - Cost, (and Appendix D) – [Note schedule no longer required by IE] (CAPEX only agreed) Operational requirements Covered in Section 3 – Operational Assessment
List of potential manufacturers / installers	Covered in Appendix R
High-level project Risk Register (technical, commercial and safety)	Covered in Section 10

1.2 Report Overview

The Executive Summary gives the reader an overview of the task, how it was addressed and the consequent outcomes.

The main report introduces the task and describes its background, before outlining the methodology used to assess the operating scenarios and the identified infrastructure options. It then discusses the BEMU vehicles and their charging mechanism to be clear on the requirements of the proposed infrastructure installation.

The operational analysis of the Northern Line and its timetables, existing and proposed, are then evaluated to understand the operational pattern that will exist at Drogheda station and hence set the parameters for the options to be considered.

The optioneering process is then described, which aligns with the Common Appraisal Framework guidelines, followed by the options considered, the criteria against which they were assessed and the results of that assessment. This was done using a 2-stage Multi-Criteria Analysis with the first stage providing an initial sift for the options that were technically and operationally feasible and a second stage using the CAF guideline criteria to arrive at the preferred options for each scenario. The full details of the assessment can be found in the Options Matrix and CAF Matrix as part of the Appendices.

Once the preferred options for each operating scenario emerged, an engineering exercise was performed to develop the design required to further describe and evaluate each one. Any additional requirements for the depot are then outlined for each of the options. With the design sufficiently developed Capex and Opex costs were generated for each of the options. The proposed implementation schedule is presented complete with a Gannt Chart to show how the preferred option for each Scenario could potentially be developed.

Conclusions and Recommendations for next steps are then noted at the end of the report followed by a number of Appendices containing additional information for some of the report sections.

1.3 Methodology

1.3.1 Getting started

Jacobs approach to this task was to follow the steps outlined below, methodically working through the practical options, to arrive at the best solution in determining the amount of BEMU vehicles to purchase as part of the upcoming Fleet Framework contract. Life Cycle Costs (LCC) were developed which encompass the Capital Expenditure (Capex) and the Operational Expenditure (Opex) required for the BEMU infrastructure for BEMU (including maintenance costs) to give an overall Life Cycle Cost for the options to help inform the decision-making process.

Jacobs knowledge of other aspects of the DART+ programme, in particular, the work carried out last year on the Traction Options Report [as part of the Rail Fleet Advisory Services (DART+ WP1)] provided a strong basis for understanding the infrastructure requirements of charging stations, the cost of installing them and the operational expenditure to both run the fleet and maintain the infrastructure. Engagement with suppliers/manufacturers (such as for batteries or pantographs) on that task meant that Jacobs could save considerable time researching this information as we already had an awareness of the key issues such as battery charging times or current limitations of the conductor systems.

Jacobs were able to engage productively and in collaboration with Iarnród Éireann from day one with pre-determined, targeted and specific information requests, as we already had a lot of the information needed for this task, to hand. For example, we knew the type of vehicles likely to make up the BEMUs including the type of battery and charging systems they are likely to employ. From our previous work, we knew the lifetime of the batteries and their related maintenance requirements. We knew the limitations on charging the batteries from both the batteries themselves and the infrastructure required to charge them, such as the overhead wire and the pantograph. In addition, through our train scheduling expert [redacted] work recently with the IÉ Operations department on timetabling, we also had the latest information available on the working timetable.

With our existing knowledge of Iarnród Éireann's systems for Requests for Information (RFIs) and Technical Queries (TQs) we were able to generate relevant and targeted RFIs and TQs right from project commencement. (See Appendix Q for the RFIs and TQs raised on the project). We also set up and maintained a shared working environment and correspondence log to collaborate and track communications.

With our background knowledge of the task, and early productive engagement with IÉ it was possible to present initial options to IÉ for consideration by the third week after the task commencement. As such we were able to transition very quickly from the Information Gathering phase to the Option Proposal phase, saving valuable time for the overall study programme.

1.3.2 Operations

We considered three timetable scenarios as instructed by IÉ instead of those originally specified:

- Base scenario of 2 and 3 trains per hour at Drogheda (which is the current timetable);
- Train Service Specification TSS 1b (this had a total of 5tph DART services, of which 2tph operated as empty stock (not in passenger service) between Laytown and Drogheda); and
- Train Service Specification TSS 3 (6tph DART services at Drogheda).

In order to examine the operational feasibility of BEMU operation we conducted a review of the current timetable.

For the Base scenario we identified train services currently operated by diesel rolling stock that could instead be operated by BEMUs. We assessed the operational changes that would be required, including longer turnaround times at Drogheda and the need to make changes to the rolling stock deployment plans because currently some services at Drogheda also work to Dundalk and on other routes such as to Maynooth, where BEMUs will not operate.

For TSS 1b and TSS 3, IÉ issued a timetable extract for each of these scenarios and these gave details of the times of trains at Drogheda and the proposed platform workings and turnaround times. The timetables were based on DART services being operated by electric rolling stock with short turnaround times at Drogheda. We then had to modify the timetable and rolling stock deployment to account for these services being operated by BEMU rolling stock and the implications of this, such as longer turnaround times and increased platform occupancy at Drogheda. This then informed our approach to train battery charging at Drogheda; assessing where this may be carried out, the charge duration, and the periods that BEMUs would be occupying platform(s) at Drogheda. Other services (operated by diesel rolling stock) between Dublin, Dundalk and Belfast were included in the analysis so that these trains were accommodated at Drogheda in the times stated in the timetables for TSS1b and TSS3. We then calculated the likely fleet sizes to operate TSS 1b and TSS 3 using BEMU rolling stock.

1.3.3 Rail Infrastructure

Jacobs met with IÉ to consider the possible options available to operate the BEMU vehicles effectively and efficiently on the Northern Line as per the service patterns specified key Jacobs team members ware already familiar with the situation from our work on the Rail Fleet Advisory Services project and in particular the Traction Options Report. Therefore, the project team could be expertly guided and quickly brought up to speed on the key issues and constraints. The team considered the most appropriate way to charge BEMUs at Drogheda station focusing on overhead charging with no specific intervention required by IÉ staff. (During previous work on the "DART Extension Traction Power Options report - Issue C" (as per Appendix 6.2 of the tender documentation for this project) as part of the Rail Fleet project, Jacobs and IÉ agreed that direct overhead charging was preferable compared to a shore supply. This was because of the additional operational requirements, additional manpower, additional training requirements, manual handling and safety considerations. This is in line with the developing scenario planned for the new fleet and offers the safest and most efficient means of recharging the BEMUs. The pros and cons of on-line vs. off-line charging were evaluated with the team - considering a possible bay platform or siding for charging as a possible alternative to charging from the existing service platforms.

The options to be considered were evaluated across a number of technical criteria such as the required track arrangements along with the corresponding signalling, OLE and civil engineering requirements. In addition, specific electrical infrastructure requirements to support charging, such as new or enhanced substations and potential ESB connections or upgrades, were also developed to ensure all capital costs for charging stations were considered. As well as the charging stations, the team also considered the required modifications to Drogheda Depot to fulfil the maintenance and stabling requirements of the proposed BEMU vehicles running on the Northern Line. Throughout the process Jacobs were cognisant of the instruction in the tender documents (section 3.3 of the Scope of Services) that "The consultant shall minimise the extent of infrastructural changes, wherever possible".

Jacobs designed Drogheda Depot so we have a unique insight into how it operates and how best to modify it as required to account for the new fleet requirements. The project team were able to consult the original design team to more fully understand the depot, and its numerous constraints, in developing the new options.

The development of these options was done in close consultation with our rail operations team to ensure that they fitted with timetabling and operational flexibility constraints. As the options were developed, their corresponding Life Cycle Costs were also developed by our costing team in parallel. As the infrastructure design evolved, we calculated Capex and Opex for building and maintaining the infrastructure. The combination of these items facilitated the production of the Life Cycle Cost for each option.

In addition to the basic engineering elements mentioned above, the options were also evaluated on their environmental and planning implications by our environmental specialist. Any potential property impacts were also considered although we have sought to find solutions that stay within current IÉ boundaries as much as possible.

1.3.4 Life Cycle Cost

We developed high level models to determine the life cycle cost associated with BEMU operating infrastructure, providing comprehensive through-life capital and operating costs to inform the Business Case (done by others) and demonstrate Value for Money comparisons.

The lifecycle cost models were developed iteratively, based on the options considered, by applying an agile methodology to expedite delivery. This is our standard approach, which is proven from similar schemes we have undertaken, and tailored specifically to this project. The steps taken were to:

- Define the cost drivers and value criteria against which the feasible options will be appraised, in accordance with the Multi Criteria Analysis (MCA) framework.
- Develop, configure and validate lifecycle models; capturing key assumptions.
- Collate alternative CAPEX cost schedules for the proposed electrical, civil and track infrastructure i.e. battery charging system, sidings and turnouts. (We referenced the extensive experience we have acquired from major rail infrastructure projects globally including those in the UK and Republic of Ireland and these provided appropriate benchmark costs for the proposed solutions and alternatives.)
- Estimate OPEX costs from use of benchmarked unit cost data to include all through-life expenditure including planned maintenance costs.
- Validate the outputs to support the narrative and for each feasible option.

1.3.5 Option Selection

We developed three options sufficiently to capture the following items:

- Operational Pattern
- High level design for infrastructure upgrades (e.g. charging point, depot, station)
- Capex and Opex for these infrastructure upgrades
- Life Cycle Cost (LLC) (from a combination of the above)

The NTA published "Guidelines for the Management of Public Transport Investment Projects" states (in relation to Phase 2 - Option Selection):

"The purpose of Phase 2 is to assess the more significant options for the various features that make up the Scheme and, through applying a robust and systematic selection process, to determine a preferred solution which will fulfil the Project Brief."

As such, we tested the three options developed through our Multi-Criteria-Analysis (MCA) developed for the project. We engaged early with IÉ to demonstrate and agree on the testing criteria to be used for the MCA. This resulted in some alterations such as the addition of a specific "Planning/Railway Order" criterion in the Options Matrix. The successful options were then further tested under the CAF criteria to arrive at the final selected options. Further detail of the Optioneering phase is given under section 4 "Optioneering".

Our Environmental team ensured that environmental issues were considered as part of option assessment. For example, issues pertaining to architectural heritage, land contamination or ecology may impact on possible charging station locations or on proposed modifications to the depot. They also considered any possible planning or railway order implications to the options under consideration.

The project team liaised closely to ensure any potential property requirements and the implications of same were highlighted at an early stage. We have attempted to minimise additional property requirements as part of the option selection process.

The result of the MCA was to conclude on a preferred option for each of the required BEMU operational patterns.

1.3.6 Report Development

With the selected options clear from the previous phase, we compiled our final option selection report outlining the options considered, approach taken, results obtained, and conclusions drawn. The report provides Iarnród Éireann with a preferred option, including an overall Life Cycle Cost, for the scenarios agreed.

1.3.7 Key Assumptions

Some key assumptions that were made at the outset of this report were as follows:

- A maximum of three options were to be developed
- All information required to complete the assessment would be readily available from Iarnród Éireann
- No surveys were to be required to perform the study
- Study was to be undertaken entirely remotely (especially considering Covid-19 restrictions in place)

[For a comprehensive list of the assumptions that were made in developing the report, please see Appendix S].

1.3.8 BEMU Report Review

A review of the document was undertaken by a senior reviewer within Jacobs that was not part of the project team nor had any involvement in the development of the report. This review was undertaken by [redacted], [redacted] as part of his role as Project Principal on this project. The Project Principal role in Jacobs is that of an experienced reviewer independent of the project and is designed to ensure high quality project deliverables are produced. [redacted]

2. BEMU Overview

2.1 Introduction to BEMU

The purpose of the BEMU is to allow for operation of new DART multiple units on lines for the DART Expansion which are not electrified at present, prior to, full electrification of those lines. Previous work and discussions between Irish Rail, the NTA and Jacobs has identified that the Malahide to Drogheda route is the most likely of the DART Expansion routes to be feasible for battery operation, because of the relatively low service frequency and potential locations for charging the batteries at Drogheda.

For the purposes of this report, 316 kWh per HLU has been assumed as an indicative amount of energy that needs to be replaced at Drogheda. This has been taken from the Traction Power Options report 32109500/B.06/0005, Issue C, dated 23 August 2019 and produced by Jacobs. It should be noted that this was based on an early estimate using average station spacings and speeds but did not involve computer modelling of specific routes. Further simulations done by Jacobs earlier in 2020 as part of the Rail Fleet Advisory Services project for the NTA gave the following for the energy needed to be supplied from train batteries for a round trip from Drogheda – Connolly – Drogheda (assuming use of the existing overhead line from Connolly to Malahide and then batteries from Malahide to Drogheda) of:

- Flat-out (running as fast as possible) = 436 kWh
- Optimised (introducing coasting to give timings to match the motion time requirements exactly but no faster) = 230 kW

It is therefore a reasonable assumption that 316 kWh represents a typical battery energy requirement for this route, which is at an intermediate level between the worst case (flat-out) and the optimised case, thus allowing for some level of recovery from delays between Drogheda and Malahide.

2.2 BEMU Technology

A tender process is underway at present for the new DART+ fleet, which includes the possibility of pure EMUs and BEMUs. The tenders are being evaluated at present, [redacted] In the meantime, it is necessary to make assumptions on the battery requirements. The estimated energy requirement stated above is consistent with the requirements that the bidders have been asked to meet.

The battery type that will be used for the new fleet will depend on the chosen vehicle supplier but is likely to be lithium ion or lithium titanate, in order to deliver the required energy and power capacity within a feasible mass and space envelope. For the purposes of this report, the exact choice of battery type does not need to be known. From Jacobs' experience and from the simulation work on the DART Expansion Rail Fleet Advisory Services project, it is considered likely that the maximum level of power that will be delivered by batteries during acceleration will be approximately 1200 kW per HLU.

2.3 Battery charging - Static

The main method of battery charging that is considered in this report is fast charging while stationary at Drogheda. It has been stated in the client brief for this project and confirmed subsequently in meetings that the time to be allowed for static charging at Drogheda is 12 minutes including turnaround activities.

Irish Rail has mentioned the possible need to provide trickle charging overnight for each BEMU. This would consist of supplying a relatively low current for a prolonged period. Jacobs has investigated this possibility by reading general literature on lithium ion and lithium titanate batteries, looking at technical data from companies that supply rail vehicle traction batteries such as Toshiba, Hoppecke and Akasol. We have also discussed the matter with technical staff from Jacobs and Stadler working on the Energy Storage project on the Merseytravel class 777 units, which involves fitting Toshiba lithium titanate batteries as part of a system supplied by ABB and integrated by the vehicle manufacturer Stadler.

We do not have any evidence from the research and discussions referred to above to consider that it is necessary to have overnight trickle charging. This could be confirmed with the bidders for the fleet if necessary.

2.4 Battery charging – from a new section of overhead line

One further possible solution is to have a section of new overhead line fitted to allow electrified running and battery charging from Drogheda southwards for some distance short of Malahide.

It should be noted that this is not a solution to allow for the use of battery units in advance of electrification, given that it involves a level of electrification, with the associated planning, costs, need for a Railway Order, etc. However, since it is a possible solution to providing battery charging, an estimate can be made of how long this electrification would have to be. This is given below. Note that this is an approximation and detailed analysis would require specific simulations.

It has been agreed through discussion with Irish Rail that it is reasonable to assume a minimum turnaround of 6 mins at Drogheda, which is time that can therefore be used for charging from a normal overhead line.

Assume that the current through a normal overhead line is approximately 200 A per pantograph. Assuming two pantographs on an HLU gives a power of 2 x 200 A x 1500 V = 600 kW per HLU. Assuming that the minimum turnaround time at Drogheda is 6 mins (=0.1 h), the energy that can be stored during that time is 600 kW x 0.1 h = 60 kWh per HLU. Therefore, the amount of energy that would need to be supplied from the OHL while running south from Drogheda would be 316 kWh – 60 kWh = 256 kWh per HLU.

It is known that the existing DART OHL can deliver a line current of 3000 A for 60 s and 1300 A continuously. For the purposes of this calculation, assume that a new higher specification overhead line would be able to deliver 3000 A continuously. This means that the power that can delivered from the new OHL is 3000 A x 1500 V = 4500 kW. From previous simulation work done by Jacobs, it is likely that the power that will be delivered while accelerating by a BEMU is approximately 1200 kW per HLU, and that a large proportion of the motion time will be spent drawing this power. It is a reasonable assumption that the BEMUs will run when under the new section of OHL with the same performance as in battery mode, rather than with the same performance as an EMU running in normal operation on an electrified section, to reduce the power demand for traction and so maximise the spare power available for charging. This means that the total power demand of 2 x HLUs would be 2 x 1200 kW = 2400 kW.

Therefore, the spare power available from the OHL will be 4500 kW – 2400 kW = 2100 kW.

There will be some time when the power demand is less than assumed above, for example, if the train has reached line speed or is coasting, meaning that more power would be available for charging. On the other hand, while the train is braking, the batteries are not likely to have sufficient power capacity to absorb braking energy (which is allowed for in the original value of 316 kWh) and take additional current from the OHL and so no additional charging can be allowed for while braking. To gain an estimate, it is considered reasonable to assume that these two effects approximately cancel each other out and so an average spare power of 2100 kW per train can be used. Taking half of that for an HLU gives an average charging power of 1050 kW per HLU.

Assume that the section of OHL for charging is fitted on the lines in both directions south of Drogheda for a proportion of the overall distance to Malahide, where P represents this proportion. (For example, if a quarter of the distance between Drogheda and Malahide was fitted, P would be a value of 0.25).

Where new OHL is fitted, a train can be powered from the OHL rather than drawing from the battery, so the total energy that needs to be supplied from the battery will be reduced as the value of P increases. What this means in particular is that the energy that needs to be supplied = 256 kWh per HLU (from above) can be reduced to a value of 256 x (1-P) kWh.

The total motion time allowed for in the new fleet Train Technical Specification for the BEMU on a journey from Drogheda to Connolly is 50 mins. From previous simulation work done by Jacobs, this would be made up of approximately 34 mins for Drogheda to Malahide and approximately 16 mins for Malahide to Connolly. So, the total round trip motion time for a journey Drogheda – Malahide – Drogheda is 2 x 34 mins = 68 mins.

The proportion of this journey fitted with OHL, as defined above, is P, so the time spent by a BEMU running on the OHL section in both directions is 68 x P mins, which is 1.13 x P hours.

This is the best case, in that it assumes that the train runs no faster than the maximum time allowed by the timetable, so would not be able to make up for any lost time while under the new section of OHL. This is considered to be a reasonable assumption because it is logical to carry out charging where the new OHL is fitted to the greatest extent possible, which means maximising the time and so running the train as slowly as is practical over that section.

The energy that can be supplied by the OHL for the length fitted is 1050 kW per HLU x time spent under the OHL, which is 1050 x 1.13 x P kWh = 1186.5 x P kWh.

Equating the energy that needs to be supplied and the energy that can be supplied by the new OHL for the length fitted gives 256 x (1-P) = 1186.5 x P. This can be rewritten as 256 – 256 x P = 1186.5 x P; and rearranging gives (1186.5 + 256) x P = 256.

This gives P = 256 / (1186.5 + 256) = 0.18.

The single journey distance from Drogheda to Malahide is 36.63 km, so a proportion of 0.18 of that is 6.6 km.

So, the new OHL would need to be fitted in both directions over a distance of approximately 6.6 km. Laytown is at a distance of approximately 7.64 km from Drogheda so the electrification would need to reach from Drogheda to just north of Laytown. If this was done, it would be reasonable to install the OHL from Drogheda to Laytown itself, to allow for contingency through the additional motion time under the OHL and for some charging while static at Laytown.

Note that the actual amount of OHL new needed could be more (flat-out) or less (fully optimised) and assumptions may vary from those made above.

It should be noted that there are two additional opportunities to reduce the amount of charging needed at Drogheda or over a new section of OHL. Firstly, if battery units only operate as single HLUs then the energy that needs to be supplied in total to a train halves. Secondly, if BEMUs run beyond Connolly they can store more braking energy.

The energy consumption estimate of 316 kWh allows for brake energy recovery while in the existing OHL between Malahide and Connolly, but not beyond. Simulations have indicated that the amount of braking for a typical station stop allows approximately 6 kWh per HLU. It is useful to note that allowing for running further than Connolly gives additional battery charging and reduces the amount of charging needed at Drogheda or on new OHL running south from Drogheda, as follows:

- Connolly to Grand Canal Dock – 3 stops in a single journey = 6 stops in a return journey = 6 x 6 kWh = 36 kWh

- Connolly to Greystones – 18 stops in a single journey = 36 stops in a return journey = 36 x 6 kWh = 216 kWh.

This could potentially reduce the amount of charging needed at or around Drogheda, potentially to a significant degree for running as far as Greystones. It is noted that this would increase the number of BEMUs needed since it would extend the length of the round trip and therefore extend the time for a given unit to do a round trip and be back at Drogheda ready for a following service.

3. Operational Assessment

3.1 Introduction

As stated previously, as part of the DART+ Programme, IÉ has identified that the operation of self-powered Battery Electric Multiple Units (BEMU) rolling stock will be required to operate train services where the network is currently not electrified between Drogheda and Malahide. South of Malahide trains will operate on existing overhead electric power infrastructure through to Dublin Connolly, Grand Canal Dock and Greystones.

This section of the report presents the assessment of the BEMU train operations, taking account of the charging requirements and necessary infrastructure.

3.2 Timetable Option Testing

The study brief identified scenarios for train service frequencies on the Northern Line to be considered with trains operating between Drogheda and Grand Canal Dock based on train service frequencies of 2, 3, 4 and 6 trains per hour. In discussion with IÉ, this has been modified to be three scenarios:

- Scenario 1: 2 and 3 trains per hour (tph) with 52 BEMU vehicles.

This scenario is effectively the December 2019 timetable and is the current Train Service Specification (TSS). This will be used as the base case service for timetable option testing.

In addition, an enhanced train service frequency scenario will be assessed based on TSS 1b and TSS 3 as provided by IÉ. These TSSs have superseded the 4 and 6tph scenario in the study brief and are based on trains operating with Electric Multiple Unit (EMU) rolling stock between Dublin and Drogheda. The following train service frequencies apply:

- Scenario 2: TSS 1b: 5tph; and

- Scenario 3: TSS 3: 6tph.

The analysis in this report is to assess the timetable and infrastructure interventions required if these three TSSs are operated by BEMU rolling stock. Concept infrastructure options will be considered at Drogheda to allow the batteries in BEMU trains to be charged whist trains turnaround at the station. The engineering of these options is presented in Section 5 of this report.

3.3 Northern Line

A route map is shown in Figure 3-1, which shows key stations relevant to the timetable options discussed in this report. This does not show all stations.

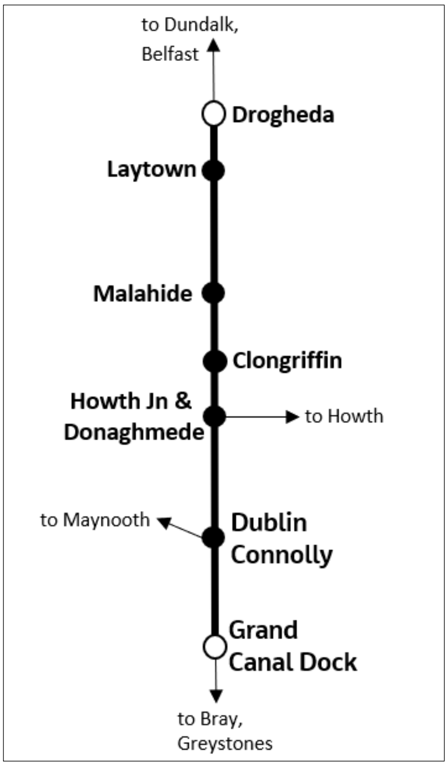


Figure 3-1 Northern line route map showing key stations between Dublin and Drogheda

3.4 Train Service Scenarios

Train Service Scenario 1 is the December 2019 timetable, and this will be used as the base for assessing infrastructure options for 2tph and 3tph.

3.4.1 Train Service Scenario 1 as the Current Situation

As an overview of train service on the Northern Line between Drogheda and Dublin Connolly, in the high peak there are 11 trains arriving at Dublin Connolly between 07:59 and 08:59. This comprises 6tph DART services (3tph from each of Malahide and Howth), 4tph from Dundalk/Drogheda and 1tph Enterprise service from Belfast (or Newry, as counted in the 08:00 hour at Dublin). Off-peak, the 10-minute interval DART timetable continues to operate all day with 3tph to each of Malahide and Howth. Typically, 1tph operates between Dundalk/Drogheda and Dublin Connolly. The Enterprise service operates every two hours.

The 6tph DART service continues to operate through the evening peak with 4tph operating north of Malahide to Balbriggan, Drogheda and Dundalk – these services originate from Bray, Pearse or Connolly.

3.5 Train Service Scenario 2 and 3: DART+ Train Service Specification

The Northern line Operational Pattern comprises an uplift in train service as part of the DART+ enhancement. The TSS is indicative and does not specify intermediate calling patterns but rather origin and destination pairings and service frequency expressed as the number of trains per hour.

There are two DART+ TSSs to be considered in addition to the base case of the current timetable:

- Scenario 2: TSS 1b; and
- Scenario 3: TSS 3.

In relation to the Northern line, both TSSs assume that other than the Belfast and Dundalk services, which are operated by Enterprise and DMU rolling stock respectively, all other services are operated by EMU rolling stock.

Howth is served by a frequent 6tph shuttle service from Howth Junction with connections there for Dublin.

The design of TSS 1b and TSS 3 was based on EMU operation and as such consideration of a 12-minute turnaround was not applied as a planning principle. The planning assumption was of an 8-minute turnaround. In the design of all TSS options the key deliverable was to maximise operation of services over the Loop Line Bridge at Connolly, it was established that the maximum stated capacity of 15tph could be delivered. All of the TSS options deliver this service level at this location and this by default became the primary service design point of each of the options. The variation of EMU and limited stop Dundalk and Belfast services on the Northern line provides a particularly difficult timetabling pattern, which required the flighting of services to allow for limited stop services on the route. The amalgamation of the above timetabling challenges and the at-grade nature of the network does not easily allow for manipulation of the timetable at terminals because the above issues dictate a service pattern at terminals in order to deliver a specific sequence of trains at the convergence of all lines at Connolly. Each TSS is described briefly in the next section in relation to the Northern line.

3.5.1 Scenario 2: TSS 1b

The proposed Northern line timetable comprises a total of 12tph. These are shown here with the possible BEMU services in bold:

- 1tph Dublin Connolly to Belfast;
- 2tph Dublin Connolly to Dundalk;
- **5tph Bray to Drogheda †;**
- 2tph Bray to Clongriffin;
- 2tph Greystones to Malahide.

† – of the 5tph Bray to Drogheda services (operated by EMUs), it is planned that 2tph will operate as empty coaching stock (not in passenger service) between Laytown and Drogheda. This means that these 2tph can turnaround in the depot rather than occupying a passenger platform at Drogheda.

3.5.2 Scenario 3: TSS 3

The proposed Northern line timetable comprises a total of 15tph. These are shown here with the possible BEMU services in bold.

- 1tph Dublin Connolly to Belfast;
- 2tph Dublin Connolly to Dundalk;
- **2tph Dublin Connolly to Drogheda;**
- **4tph Bray to Drogheda;**
- 3tph Dublin Connolly to Clongriffin;
- 3tph Bray to Malahide;

There are a total of 6tph operated by EMU rolling stock at Drogheda that are required to turnaround in passenger platforms.

3.5.3 Operational Challenges

The operational challenge of operating train services on the Northern line with BEMUs is the indicated minimum charging time of 12 minutes at Drogheda. While the current timetable and service levels can accommodate this turnaround requirement, there is concern that during periods of disruption and late running these delays cannot be recovered at the terminal, as is the case today, due to the minimum charging time required at Drogheda. This requirement will extend delays onto the second leg of the journey. With only one exception in TSS 3, turnaround times at Drogheda exceed the minimum 12-minute turnaround time, so operational contingency will exist (given that the TSS required turnaround times are greater than the required battery charging times).

Greater enhancement of the timetable above the current service levels, even with the purchase of additional BEMUs, will create greater platforming requirements due to the minimum charging requirements. Any further increase in service level beyond TSS 1b and TSS 3 will further increase capacity and platforming requirements.

Timetable recovery options which exist today during disruption on the Northern line by way of interchanging DMU fleets from other routes will not be possible as other routes will now be operated by EMUs; during disruption, operating EMUs north of Malahide will not be an option and this will reduce operational flexibility.

The use of BEMUs requires extending the turnaround times at Drogheda due to the charging requirement (as opposed to when EMUs are used where no charging is required). This in turn means extra vehicles are required to support the timetable.

3.6 Rolling Stock

3.6.1 Current Situation

Train services between Dundalk, Drogheda and Dublin Connolly are operated by 29000 Class DMUs and 22000 Class Intercity Rail Cars. Rolling stock diagrams are not self-contained; trains from Drogheda operate through to Bray for example, or also operate to and from Maynooth during part of the day.

Belfast services are operated by Enterprise sets consisting of a locomotive and eight vehicles including a generator van and driving van trailer.

It is proposed that BEMUs will replace the current diesel rolling stock on services between Drogheda, Dublin Connolly and Grand Canal Dock. This means that:

- Existing rolling stock diagrams will have to be re-worked to keep Dundalk, Drogheda and Maynooth services separate;
- Timetable changes will be required to serve some through journeys between Drogheda and Bray;
- Service levels south of Dublin Connolly will have to be maintained by extending Maynooth or Hazelhatch trains through to Bray instead;
- The aim should be to create self-contained diagrams that operate between Drogheda and Grand Canal Dock.

3.6.2 Battery Electric Multiple Units

It is planned that BEMUs will operate as a pair of Half-Length Units (HLU) to form one train consist of eight vehicles. For the 2tph and 3tph scenarios, a total of 52 vehicles (13 HLUs) will be in the fleet. Based on trains operating as a pair of HLUs, then a total of 12 HLUs can be in diagrammed service (6 circuits).

For the purposes of this report, we have been advised by IÉ to assume that BEMUs will require12 minutes turnaround time including battery charging time at Drogheda.

3.6.3 Electric Multiple Units

The Train Service Specifications 1b and 3 for 5tph and 6tph respectively are based on trains between Drogheda and Dublin being operated throughout by EMUs. The operational issues of these services being operated instead with BEMUs is considered in this report.

3.7 Drogheda Station

3.7.1 Overview

Drogheda station is situated 31.5 miles (50.7 Km) from Dublin Connolly on the main line linking Dublin with Dundalk and Belfast. The station has 3 platforms:

- Platform 1 – northbound through platform for trains from Dublin to Dundalk and Belfast;
- Platform 2 – southbound through platform for trains from Belfast and Dundalk to Dublin; and
- Platform 3 – for trains arriving from – and departing to – the south.

Operationally, the preferred platforming arrangements would have all terminating services use platform 3, with through services using platforms 1 and 2. There is flexibility in the layout with bi-directional working allowed in platforms 1 and 2 (southbound trains from Belfast and Dundalk can use platform 1 for example).

The Navan line to Tara Mines branches off immediately before and south of Drogheda station. This line is now lightly used. Inspection of the December 2019 Working Timetable shows a total of five freight trains per weekday. The rolling stock depot for the DMU fleet is adjacent and east of Drogheda station. Trains can access the depot directly from platform 3. Trains in platforms 1 and 2 require a shunt to access the depot. Immediately to the north of Drogheda station is the single line section across the Boyne Viaduct. Figure 3-2 shows the platform and track locations at Drogheda station.

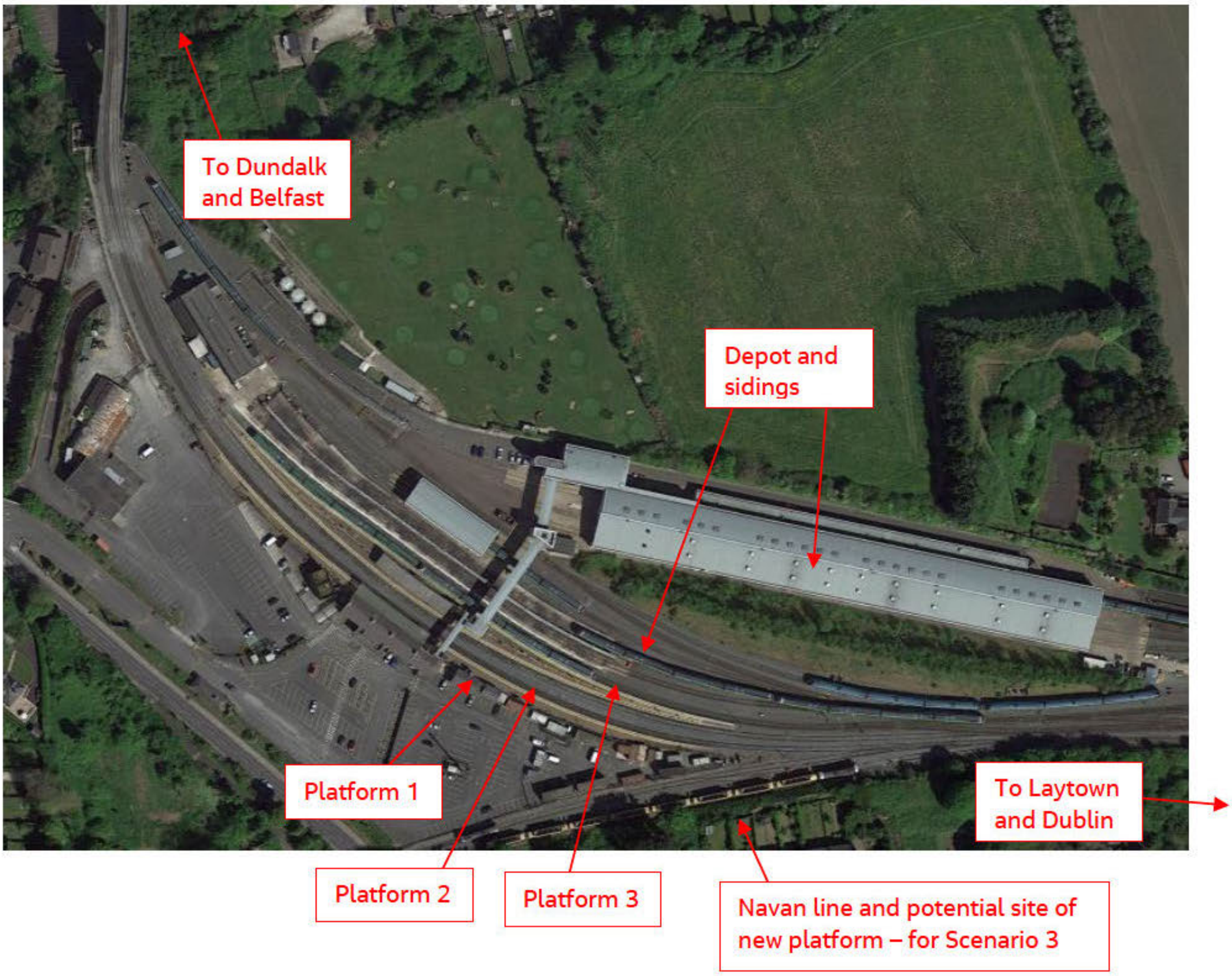


Figure 3-2 Drogheda Station and Depot

3.8 Infrastructure Options for Charging Points at Drogheda

The BEMU trains need to be charged at Drogheda station and/or at the depot. The turnaround time at Drogheda will be used to charge the train batteries and therefore it is planned that trains will require 12 minutes at Drogheda for charging purpose. It is assumed that the 12 minutes charging time is inclusive of turnaround activities, for example passengers boarding and alighting and pantograph raising/lowering.

Each of these options assumes a charging point is provided in the depot (depot road 4) – the Scenario 2: TSS 1b timetable requires use of the depot charging point twice per hour during the day to enable trains (not in passenger service) to turnaround at Drogheda.

Infrastructure Option 1a – Charging Point on Platform 3 and Depot Road 4

Only one platform (Platform 3) will have a charging point for this Option. This can accommodate up to 3tph. Therefore, the Scenario 1: December 2019 timetable level of service can be accommodated with selected trains operated with BEMU rolling stock turning around in platform 3. Depot road 4 will also have a charging point. We have assumed that as the number of BEMUs increase and enter service, the number of diesel trains required in traffic on the Northern line will be reduced therefore reducing the instances of fuelling required at Drogheda in the busiest times of the day and that one fuelling road would be sufficient. Redundancy here is available by charging a train in depot road 4 should there be a problem in platform 3.

To provide contingency and redundancy, **Infrastructure Option 1c** is proposed so that a BEMU can also be charged in platform 2 should platform 3 be unavailable for any reason. This will only be used to charge one train at a time and will not be used in the planned timetable operation.

Infrastructure Option 1b – Charging Point on Platforms 2 and 3 and Depot Road 4

In this option two platforms will have a charging point. Platform 3 and a through platform (platform 2) will both have a charging point that can be used simultaneously. In terms of redundancy this provides greater operational flexibility in accommodating 3tph turning around in two platforms, for example during service perturbation when two BEMUs might be at Drogheda at the same time, or if platform 3 is occupied or blocked with another train. Both the Scenario 2: TSS 1b (5tph) timetable and the Scenario 1: December 2019 timetable level of service can be accommodated in this option.

Infrastructure Option 2 – Charging Point on Platforms 2 and 3 and New Platform and Charging Point on the Navan line and Depot Road 4

A new platform situated on the Navan line would allow trains from Dublin to terminate and turnaround here. Operationally, trains terminating in the new platform would be conflict free with Dundalk and Belfast services. Trains departing from the new platform would cross to the Up line (towards Dublin) and this is a conflicting move with trains heading north to Dundalk and Belfast.

Any new platform on the Navan line would have to be of sufficient length to accommodate an eight vehicle FLU (or two HLUs joined together).

In this option, it is assumed that a new platform and charging point on the Navan line would be in addition to a charging point on platforms 2 and 3, and depot road 4 and this means that 6tph could be timetabled to turnaround at Drogheda and this therefore delivers Scenario 3: TSS 3.

3.9 Option Testing

3.9.1 Scenario 1 – Current Timetable (DART 2tph and 3tph)

The 2tph and 3tph scenario is based on the December 2019 timetable and replacing existing DMU rolling stock with BEMUs on selected services. This is based on a fleet size of 52 BEMU vehicles. With 48 vehicles expected to be available for passenger service, this means 12 HLUs can be diagrammed in traffic. Since trains will be paired (two HLUs operating together in one 8-vehicle formation), there are six trains that could be operated by BEMUs as replacements for the Class 29000 DMUs, as set out in **Error! Reference source not found.**.

The Working Timetable shows all passenger and freight train schedules along with ancillary moves such as empty coaching stock schedules. Movements between the depot and the station at Drogheda are, however, not shown (it is likely these are planned under local arrangement). Based on the rolling stock diagrams a platforming plan can be worked out – this is shown in Appendix N.

Based on the December 2019 Working Timetable, this shows that:

- Four trains start from Drogheda station in the morning originating from the depot;
- There is one empty stock move from Drogheda to Dundalk in the morning to form an early service from there to Dublin;
- During the day there are instances of 11-minute turnaround times at Drogheda – these will need to be extended slightly to allow for battery charging should BEMUs be deployed on these particular diagrams; and;

- There are two instances in the evening of six-minute turnarounds at Drogheda – if these trains are to be formed of BEMUs then a timetable and diagramming solution will have to found to allow for a 12-minute turnaround at Drogheda.

Based on the December 2019 timetable, there are four opportunities to use BEMU rolling stock. However, this cannot be a 'like-for-like' replacement as the diagrams will require to be modified as discussed briefly here (more detail is shown in Appendix N):

- **06:28 Drogheda to Pearse** – the next working is a service from Pearse to Dundalk. A timetable and diagram swap will be required.

- **06:45 Drogheda to Pearse** – after arriving at Pearse this diagram then works a service to Maynooth which will have to be swapped with an inbound train from Maynooth.

- **07:05 Drogheda to Bray** – this diagram can still be self-contained by working an evening Bray to Drogheda service (16:50 from Bray) rather than working the 17:30 service from Bray to Maynooth as it currently does. Based on the current timetable and diagrams, this 8-vehicle BEMU could then stable at Bray during the day, or return empty stock to Drogheda if required.

- **07:58 Drogheda to Bray** – can turnaround at Connolly (or at Grand Canal Dock, assuming the Phoenix Park Tunnel line timetable is different) and work a service back to Drogheda. The service to Bray will have to be worked by a train from Maynooth or Hazelhatch.

Additionally, there is one diagram that starts at Connolly that could be operated by a BEMU:

- **07:50 Connolly to Drogheda** – this diagram starts at Connolly and can be self-contained. Assumes out-stabling at Connolly rather than being stabled overnight at Drogheda. This diagram will no longer be able to act as a standby should the Enterprise set be unavailable to work the 07:35 from Dublin Connolly to Belfast.

This train plan uses 40 out of 52 vehicles.

In 2022 it is planned that 41 intermediate ICR vehicles will be added to the 22000 Class InterCity Railcar fleet. In respect of the Northern line this means that cascaded rolling stock will be available to operate an additional peak service, departing Drogheda after 08:00. This is could then be operated by an 8-vehicle BEMU which then accounts for operating 48 vehicles in traffic.

With some timetable and platform alterations trains can turnaround in platform 3 and therefore a charging point need only be provided here for trains in passenger service. Operational flexibility would be increased if a charging point was also installed in platform 2. Depot road 4 will also have a charging point.

The current timetable is shown at Drogheda for the start of service covering the time period 06:00 to 08:30 and this shows trains identified as being formed of BEMUs using platform 3.

Table 3-1 Current timetable and platform workings at Drogheda

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Use BEMU Stock?
05:40 Dundalk	06:03	2	06:04	Pearse	8 x 29000	No
Depot	Arrive platform 3 no later than 06:16	3	06:28	Pearse	4 x 29000	Yes
Depot	Arrive platform 3 no later than 06:33	3	06:45	Pearse	7 x 22000	Yes
06:30 Dundalk	06:54	2	06:55	Bray	8 x 29000	No

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Use BEMU Stock?
Depot	Arrive platform 3 no later than 06:53	3	07:05	Bray	8 x 29000	Yes
06:30 Newry	07:19	1	07:21	Connolly	7 x 22000	No
07:10 Dundalk	07:34	1	07:36	Pearse	8 x 29000	No
Depot	Arrive platform 3 no later than 07:46	3	07:58	Bray	8 x 29000	Yes
07:35 Connolly	08:09	1	08:11	Belfast	Enterprise	No
Depot	Arrive platform 3 no earlier than 08:02	3	08:xx (no earlier than 08:14)	To be confirmed; new service from 2022		Yes
06:45 Belfast	08:22	1	08:24	Connolly	Enterprise	No
07:09 Pearse	08:05	2	08:30	Pearse	8 x 29000	No
07:50 Connolly	08:49 (retimed to arrive 1 minute earlier)	3	09:00	Connolly	8 x 29000	Yes

A platform occupancy chart is shown in Figure 3-3, where:

- Minutes are shown on the x-axis and platform numbers are shown on the y-axis;
- Green bars show BEMU trains turning around at Drogheda;
- Blue bars show DMU trains turning around at Drogheda;
- Yellow bars are northbound trains to Dundalk/Belfast; and
- Orange bars are southbound trains from Dundalk/Belfast;

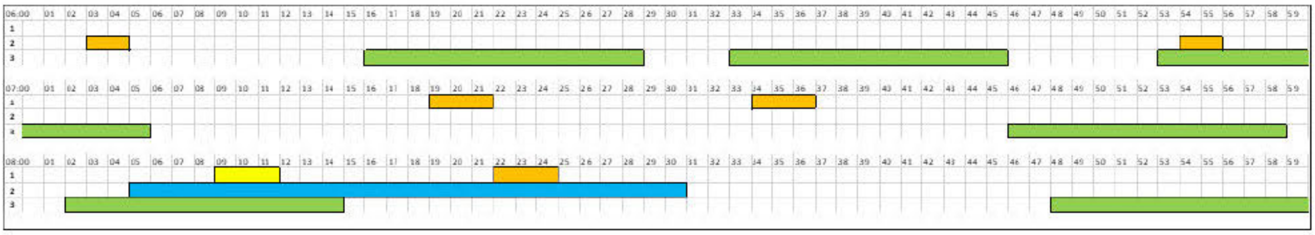


Figure 3-3 Platform Occupancy Chart at Drogheda station for base scenario

3.9.2 Scenario 2 – TSS 1b (DART 5tph)

The 5tph DART EMU services (to be replaced with BEMUs) together with the Belfast and Dundalk services are shown in Table 3-2, using the 08:00 – 08:59 hour as a typical hour (sorted by departure time). This shows all trains arriving at, and departing from, Drogheda together with platform details. BEMUs can replace the EMU diagrams without any change to the turnaround times at Drogheda.

Table 3-2 TSS 1b timetable and platform workings at Drogheda

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Note
Dublin Connolly	08:08	1	08:09	Dundalk	DMU	
Bray	07:53	3	08:10	Bray	BEMU	

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Note
Empty from Laytown	07:45	Depot	08:17	Laytown	BEMU	Empty to Laytown then passenger service to Bray
Belfast	08:19	1	08:20	Dublin Connolly	Enterprise	
Dundalk	08:27	1	08:28	Dublin Connolly	DMU	
Dublin Connolly	08:36	1	08:37	Dundalk	DMU	
Empty from Laytown	08:25	Depot	08:41	Laytown	BEMU	Empty to Laytown then passenger service to Bray
Bray	08:13	2	08:46	Bray	EMU	
Bray	08:23	3	08:50	Bray	BEMU	
Dublin Connolly	08:49	1	08:54	Belfast	Enterprise	Extended dwell waiting for the Southbound Dundalk service to arrive
Dundalk	08:54	2	08:55	Dublin Connolly	DMU	

This shows that:

- The EMU turnaround times at Drogheda are no less than 12 minutes;
- Trains turnaround in platforms 2 and 3;
- 2tph use the depot to turnaround; and
- With one exception, Belfast and Dundalk services use platform 1.

If Bray-Laytown/Drogheda services were operated by BEMUs then charging points would be required on:

- Platform 2;
- Platform 3; and
- Depot road 4.

Platforming at Drogheda

A platform occupancy chart is shown in Figure 3-4, where:

- Minutes are shown on the x-axis and platform numbers are shown on the y-axis;
- Green bars show BEMU trains turning around at Drogheda;
- Yellow bars are northbound trains to Dundalk/Belfast;
- Orange bars are southbound trains from Dundalk/Belfast; and
- DR4 is Depot Road 4.

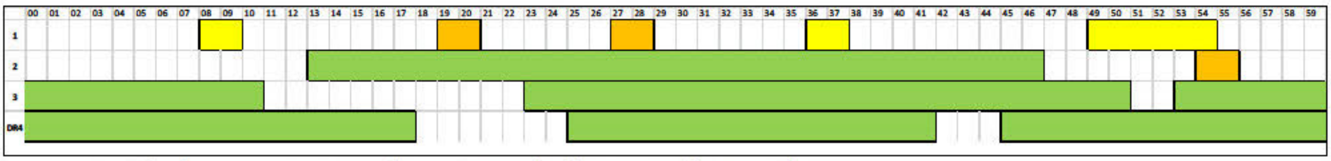


Figure 3-4 Platform Occupancy Chart at Drogheda station for TSS 1b

3.9.3 Scenario 3 – TSS 3 (DART 6tph)

The 6tph service operated by EMU rolling stock together with the Belfast and Dundalk services are shown in Table 3-3, using the 08:00 – 08:59 hour as a typical hour (sorted by departure time). This shows all trains arriving at, and departing from, Drogheda together with platform details.

Table 3-3 TSS 3 timetable and platform workings at Drogheda

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Note
Belfast	08:00	2	08:01	Dublin Connolly	Enterprise	
Dublin Connolly or Bray	07:59	3	08:07	Dublin Connolly or Bray	EMU	8-minute turnaround
Dublin Connolly	07:17½	1	08:19½	Dundalk	DMU	
Dundalk	08:19	2	08:19½	Dublin Connolly	DMU	
Dublin Connolly or Bray	08:04	New	08:23	Dublin Connolly or Bray	EMU	
Dublin Connolly or Bray	08:11	3	08:27	Dublin Connolly or Bray	EMU	
Dublin Connolly or Bray	08:30	3	08:35	Dublin Connolly or Bray	EMU	5-minute turnaround
Dublin Connolly	08:40½	1	08:41	Dundalk	DMU	
Dundalk	08:47	2	08:47½	Dublin Connolly	DMU	
Dublin Connolly or Bray	08:43	3	08:51	Dublin Connolly or Bray	EMU	8-minute turnaround
Dublin Connolly	08:53	1	08:54	Belfast	Enterprise	
Dublin Connolly or Bray	08:46	New	08:55	Dublin Connolly or Bray	EMU	9-minute turnaround

This shows that:

- There are four instances each hour where EMU turnaround times at Drogheda are less than 12 minutes;
- Trains turnaround in platform 3 and in a new platform;
- Platforms 1 and 2 are used by Belfast and Dundalk services (no EMUs turnaround in these through platforms).

If services between Bray/Dublin Connolly and Drogheda are to be operated by BEMUs, then:

- Turnaround times at Drogheda will need to be increased to be at least 12 minutes;
- Platforms 2, 3 and two new additional platforms will require charging points at Drogheda;
- The new platforms could be on the Navan line and depot road 4 (with a platform face).

Increasing Turnaround Times

To remove the instances of 5, 8 and 9-minute turnaround times, the following associations (inbound train forms outbound train) should apply, as shown in Table 3-4. Note that the increases in turnaround times are based on keeping DART services at the times specified in TSS 3.

Table 3-4 Changes required to trains operated by BEMUs at Drogheda in TSS 3

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Turnaround Time(minutes)
Dublin Connolly or Bray	07:46	2	08:07	Dublin Connolly or Bray	BEMU	21
Dublin Connolly or Bray	07:59	3	08:23	Dublin Connolly or Bray	BEMU	24
Dublin Connolly or Bray	08:11	2	08:27	Dublin Connolly or Bray	BEMU	16
Dublin Connolly or Bray	08:04	New	08:35	Dublin Connolly or Bray	BEMU	31
Dublin Connolly or Bray	08:30	3	08:51	Dublin Connolly or Bray	BEMU	21
Dublin Connolly or Bray	08:43	New	08:55	Dublin Connolly or Bray	BEMU	12

The use of BEMUs requires extending the turnaround times at Drogheda due to the charging requirement (as opposed to when EMUs are used where no charging is required). This in turn means extra vehicles are required to support the timetable. The extra BEMU requirement is two additional HLUs in traffic (8 vehicles).

Platforming at Drogheda

Changing the associations at Drogheda to create longer turnaround times means that the BEMU trains would need to turnaround in platforms 2, 3 and 2 additional new platforms (shown here as platform 4 and DR4 for example). This is shown in the platform occupancy chart in Figure 3-6, where

- Green bars show BEMU trains turning around at Drogheda;
- Yellow bars are northbound trains to Dundalk/Belfast; and
- Orange bars are southbound trains from Dundalk/Belfast

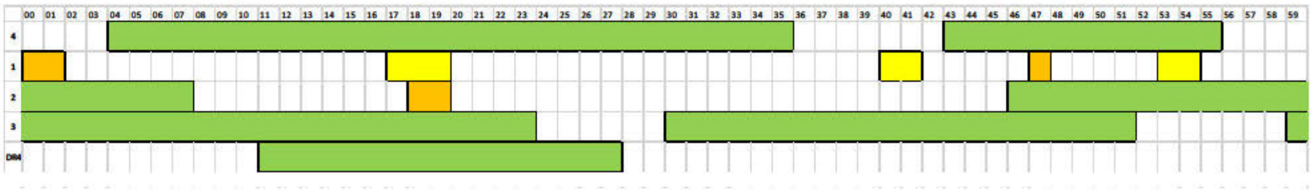


Figure 3-5 Platform occupancy chart for Drogheda (TSS 3) based on BEMU rolling stock (with no timetable change)

To avoid the construction of two new platforms at Drogheda, either:

- One of the six trains per hour DART services that uses Depot Road 4 will do so operating as empty stock between Laytown and Drogheda (this then fails to meet the requirements of TSS 3); or
- Minor adjustments to the timetable will be required to make better use of the available platform capacity (avoiding platforms 1 and 2 being occupied by a diesel service at the same time)

Timetable Changes

One Dublin Connolly to Dundalk service is required to be retimed to arrive at Drogheda later and then operate 4 minutes later throughout to Dundalk. This then creates space in platform 1 to allow a southbound train to depart first, freeing up space in platform 2 to allow a BEMU to turnaround there. All the DART timings and southbound departures from Drogheda remain unaltered therefore not impacting on the tightly defined operating pattern on the Northern line.

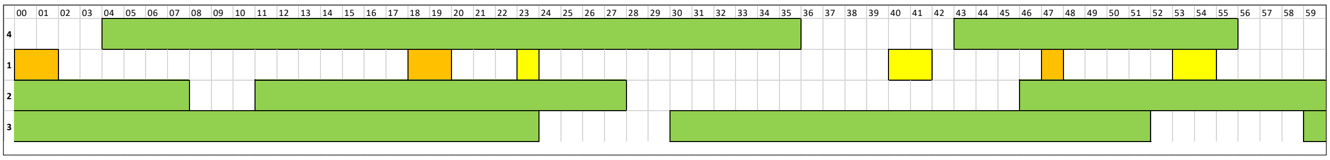


Figure 3-6 Platform occupancy chart for Drogheda (TSS 3) based on BEMU rolling stock (with a timetable change)

3.10 BEMU Fleet Size

3.10.1 BEMU Fleet Size for Current Timetable (DART 2tph and 3tph)

IÉ have advised that 52 BEMU vehicles are specified for the 2 and 3tph scenario. This means that 48 vehicles can be in service giving 92% availability.

This could either be reduced to 44 vehicles out of 52 (85% availability meaning one train will have to be formed of 4 vehicles rather than 8), or 48 vehicles out of an increased fleet size of 56 vehicles (86% availability).

3.10.2 BEMU Fleet Size for TSS 1b

The information provided by IÉ for TSS 1b shows the times of trains at Drogheda and at Bray, together with the associations at Bray. This shows that services inter-work between routes and origin-destination pairs (for example, a service from Drogheda would then work a service to Maynooth or to Clongriffin). When all services are operated by the same train type of rolling stock, then this is not a problem and makes productive use of the rolling stock and the available capacity at Bray to turnaround (there are three sidings on the Down side of the station – a train arrives at Bray from the north and then proceeds forward to the siding to turnaround before returning to Bray station to form a northbound service). With Drogheda services now planned to be operated by BEMUs, this would mean operating BEMUs on some Maynooth services. However, to avoid this, some re-working of the associations at Bray means that 3tph Maynooth services can be self-contained with EMUs working these trains. BEMUs would have to operate both the Drogheda and Clongriffin services (the timetable extract showing these services is shown in Appendix O).

This requires in total 24 circuits (48 HLU) BEMUs in traffic. Based on 89% availability, 216 vehicles (54 HLU) will be required in the fleet.

3.10.3 BEMU Fleet Size for TSS 3

TSS 3 requires some inter-working between services at Bray but with some minor swaps Drogheda services can be self-contained with Hazelhatch and Maynooth inter-working in one instance each hour out of a total of 6tph. At Connolly, the 2tph Drogheda service has to inter-work with two out of the three Connolly to Clongriffin services (the third train per hour at Clongriffin is operated by a self-contained circuit, which can be an EMU). A timetable extract is shown in Appendix P.

With BEMUs operating services between Drogheda, Clongriffin, Connolly and Bray, 22 circuits are required in traffic (44 HLU). Based on 90% availability, 49 HLU (196 vehicles) will be required in the fleet.

It is noted (perhaps counter intuitively) that TSS 1b requires more BEMUs than TSS 3 because:

- TSS 1b has 5tph between Drogheda and Bray whereas TSS 3 has 4tph between Drogheda and Bray;
- TSS 1b requires interworking at Bray so BEMUs are required to operate the Bray-Clongriffin service whereas in TSS 3 interworking is required at Connolly to work Connolly-Clongriffin service.

The use of BEMUs requires extending the turnaround times at Drogheda due to the charging requirement (as opposed to when EMUs are used where no charging is required). This in turn means extra vehicles are required to support the timetable. The extra BEMU requirement is two additional HLUs in traffic (8 vehicles).

3.10.4 Extensions to Greystones

Both TSS 1b and TSS 3 show 2tph operating through to Greystones (from Malahide in TSS 1b and Maynooth in TSS 3). The single line section between Bray and Greystones limits the overall capacity to 2tph in both directions. Extension of Drogheda BEMU operated services to Greystones will either be on the assumption of replacing the existing 2tph, or will require additional infrastructure. As part of the DART+ Coastal South enhancement, there is a potential proposal that a short section of track is doubled, and this intervention would allow for one additional train to operate in each direction.

If 2tph from Drogheda were extended to Greystones (instead of the Malahide or Maynooth service), then this would require additional BEMU vehicles in traffic. One additional circuit (one 8-vehicle FLU) would be required bringing the total fleet size required in traffic to:

- TSS 1b: 200 vehicles out of a fleet size of 224 (89% availability);
- TSS 3: 184 vehicles out of a fleet size of 204 (90% availability).

3.11 Stabling Requirements

3.11.1 Current Situation (2 – 3 TPH)

There is a total of 35 vehicles stabled overnight at Drogheda that are required in passenger service on weekdays. This comprises 28 vehicles of the 29000 Class DMU and 7 vehicles of the 22000 Class Intercity Railcar fleet. The train consists are shown in Table 3-5.

Table 3-5Stabling requirement at Drogheda (December 2019 timetable)

Departure Time	Formation	No of Vehicles	Destination	Note
06:20	8 x 29000	8	Dundalk	empty stock to Dundalk
06:28	4 x 29000	4	Pearse	Could be 8 x BEMU
06:45	7 x 22000	7	Pearse	Could be 8 x BEMU
07:05	8 x 29000	8	Bray	Could be 8 x BEMU
07:58	8 x 29000	8	Bray	Could be 8 x BEMU
08:xx	8 x 22000	8	To be confirmed	▪ New service from 2022 when additional intermediate Inter City Railcars enter service; ▪ Could be 8 x BEMU

It is planned that once the 41 intermediate InterCity Railcars are added to the fleet this allows for services to be strengthened and vehicles cascaded to allow for additional services to operate from 2022. On the Northern line it is planned that one additional peak service will be provided in the morning, departing Drogheda after 08:00.

In addition, at Drogheda there are also:

- 16 vehicles of the 29000 Class DMUs in the depot for maintenance; and
- 4 vehicles of the DART EMU fleet for wheel turning.

When BEMUs become operational and are introduced into service, the trains identified in Table 3-5 will be diagrammed to be formed of 8-vehicle BEMUs. This requires 40 vehicles starting from Drogheda in the morning (10 HLU). The diesel units (22000 Class ICR's & 29000 Class DMUs) will be cascaded to provide additional services elsewhere. The 29000 Class DMUs cascaded to the Maynooth line will still need to come to the Drogheda Depot for Maintenance and this would most likely happen during the day between the peak hours. One service starting from Connolly in the morning will also be operated by a 8-vehicle BEMU.

It is planned that with the introduction of BEMUs, a total of 76 vehicles will be required to be accommodated overnight at Drogheda:

- 40 x BEMU vehicles;
- 4 x BEMU vehicles in maintenance;
- 8 x 29000 vehicles (for the Dundalk service);
- 16 x 29000 vehicles in maintenance; and
- 8 x other vehicles as contingency capacity.

The capacity at Drogheda depot is for 70 vehicles (or 68 vehicles useable space when trains are in multiple of 4-car sets), as shown in Table 3-6.

Table 3-6Stabling Capacity at Drogheda Depot

Location	Capacity (Vehicles)
Road 3 – Bay Road	8
Road 4 – Service Slab	8
Road 5 – Service Slab	8
Road 6 – 1 in lathe	4
Road 7a (10 vehicles, but useable space for 8 when trains are in 4-car sets)	8
Depot Building	24
Sidings at McGraths Lane (1 x 4-car leaves the 174m and 2-car shunts free)	4
Viaduct shunt head	4
Navan branch line (New stabling facility to be added)	8

(To accommodate all of the 40 BEMU vehicles it is proposed to stable one 8-vehicle BEMU on the Navan line)

3.11.2 TSS Scenarios

The overall stabling strategy for the DART+ Programme has not yet been finalised. However, for the purposes of this study it is assumed that 80 BEMU vehicles will be stabled at Drogheda overnight utilising a new stabling facility to augment capacity, which will be constructed to the south of the existing Drogheda depot.

The overall stabling requirement is determined by the timetable, particularly the specified first and last trains times and service frequency by time of day. Sensitivity to operating earlier services from either Drogheda or Dublin or Bray also informs stabling requirement. The stabling requirement could be reduced if departures in the 06:00 hour from Drogheda are reduced to 2, 3 or 4tph, or the stabling requirement could increase if the first train from Drogheda is required to arrive in Dublin earlier at 06:30.

Based on the December 2019 timetable, the starting point is to assume that the first southbound departure from Drogheda should arrive at Dublin Connolly no later than 07:00, and that the first northbound arrival at Drogheda should be no later than 08:00.

3.11.3 TSS 1b

Based on the TSS 1b timetable, the following departures from Drogheda will have to be formed of rolling stock starting from Drogheda in the morning:

- Departures from Drogheda at: 06:10, 06:46, 06:50, 07:10, 07:46, 07:50 (and in addition the following empty coaching stock moves from Drogheda to Laytown at 06:17, 06:41, 07:17 and 07:41);
- 10 trains start from Drogheda before the first northbound train arrives. This requires 20 HLU trainsets at Drogheda (80 vehicles);
- Dundalk services will require five circuits with trains operated by 8-vehicle 29000 Class DMUs. 16 vehicles will be stabled each night at Dundalk and the remaining 24 vehicles at Drogheda;
- At a minimum, 4 x BEMU and 16 x DMU vehicles will be at Drogheda for maintenance purposes.

At Drogheda, there will be useable stabling space for a total of 116 vehicles:

- 68 vehicles within the existing depot footprint (Table 3-6);
- 48 vehicles in the new stabling site;

Based on the TSS 1b timetable (Appendix O) and extending this back to show the first services arriving at Bray in the morning (based on the assumption the first service arrives at Bray no later than in the December 2019 timetable at 06:55), then six trains (12 HLU, 48 vehicles) are required to start at Bray in the morning (06:14, 06:22, 06:34, 06:42, 06:50 and 06:54). Early southbound Northern line services that start from Connolly requires 14 HLU, 56 vehicles. Two services that start from Clongriffin (07:01 and 07:29) can originate from Connolly or Maynooth.

Table 3-7 shows indicative stabling locations for BEMUs for TSS 1b.

Table 3-7 BEMU Stabling for TSS 1b

Location		DMU (Vehicles)	BEMU (Vehicles)
Existing Drogheda Depot & Sidings	Road 3 – Bay Road	8	
	Road 4 – Service Slab	8	
	Road 5 – Service Slab	8	

	Road 6 – 1 in lathe		4
	Road 7a (10 vehicles, but useable space for 8 when trains are in 4-car sets)		8
	Depot Building	16	8
	Sidings at McGraths Lane (1 x 4-car leaves the 174m and 2-car shunts free)	4	
	Viaduct shunt head	4	
New Drogheda Sidings	Road 1		8
	Road 2		8
	Road 3		8
	Road 4		8
	Road 5		8
	Road 6		8
Bray			48
Connolly	(Northbound service start)		16
Connolly	(Southbound service start)		56
Connolly	(Clongriffin service start)		8
Maynooth			20

3.11.4 TSS 3

Based on the TSS 3 timetable, the following departures from Drogheda will have to be formed of rolling stock starting from Drogheda in the morning:

- Departures from Drogheda at: 06:07, 06:23, 06:27, 06:35, 06:51, 06:55, 07:07, 07:23, 07:27, 07:35, 07:51, 07:55 and 08:07;
- 13 trains start from Drogheda before the first northbound train arrives. This requires 26 HLU trainsets at Drogheda (104 vehicles);
- Given 104 vehicles exceeds the capacity at Drogheda, it is assumed that the TSS will have the first service from Dublin arriving at Drogheda earlier or trains will operate as empty stock from Connolly (or Maynooth depot) to Drogheda in the morning;
- Dundalk services will require five circuits with trains operated by 8-vehicle 29000 Class DMUs. 16 vehicles will be stabled each night at Dundalk and the remaining 24 vehicles at Drogheda;
- At a minimum, 4 x BEMU and 16 x DMU vehicles will be at Drogheda for maintenance purposes.

Based on the TSS 1b timetable (Appendix P) and extending this back to show the first services arriving at Bray in the morning (based on the assumption the first service arrives at Bray no later than in the December 2019 timetable at 06:55), then two trains are required to start from Bray in the morning (06:27 and 06:39), four trains would start from Connolly (Northern line southbound), one train would start from Connolly (northbound, to Clongriffin at 07:15) and two train would start from Clongriffin (07:04 and 07:12). One service that starts from Drogheda would have to operate as empty stock to Drogheda – shown in Table 3-8 as operating from Connolly.

Table 3-8 BEMU Stabling for TSS 3

Location		DMU (Vehicles)	BEMU (Vehicles)
Existing Drogheda Depot & Sidings	Road 3 – Bay Road	8	
	Road 4 – Service Slab	8	
	Road 5 – Service Slab	8	
	Road 6 – 1 in lathe		4
	Road 7a (10 vehicles, but useable space for 8 when trains are in 4-car sets)		8
	Depot Building	16	8
	Sidings at McGraths Lane (1 x 4-car leaves the 174m and 2-car shunts free)	4	
	Viaduct shunt head	4	
New Drogheda Sidings	Road 1		8
	Road 2		8
	Road 3		8
	Road 4		8
	Road 5		8
	Road 6		8
Bray			16
Connolly	(Northbound service start)		40
Connolly	(Southbound service start)		32
Connolly	(Clongriffin service start)		16
Maynooth			24

3.12 Kildare Line

3.12.1 Current Timetable

In the current timetable there is an hourly service between Hazelhatch and Grand Canal Dock during the day increasing to 2tph in the Peaks. Services are operated by 22000 Class ICRs which also interwork with other services and not completely self-contained to Hazelhatch-Grand Canal Dock services. For the purposes of calculating a fleet size, five diagrams/circuits are required and assuming trains operate in 8-car formation, then 10 HLU, 40 vehicles are required in traffic. 11 HLU (44 vehicles) would be needed assuming a 91% availability (or 12 HLU, 48 vehicles, 83% availability).

In addition, we have also been asked to consider 2tph service between Hazelhatch and Heuston which doesn't currently exist. This would require three diagrams/circuits (6 HLU, 24 vehicles) in traffic if operated separately from the Grand Canal Dock service. When combined with the 2tph Grand Canal Dock service a total of seven diagrams (14 HLU, 56 vehicles) with a total fleet size of 16 HLU (64 vehicles) assuming 88% availability. The net saving of one diagram is based on shorter turnarounds at Hazelhatch.

Two platforms (or sidings) would be required at Hazelhatch to turn trains around and therefore both would require a charging point.

3.12.2 TSS 1b

The TSS 1b timetable has 11tph at Hazelhatch on the Slow Lines. These services operate to Heuston (4tph), Docklands (4tph) and Grand Canal Dock (3tph). Based on the information in the TSS 1b timetable, if these services were operated by BEMUs then five platforms or sidings would be required at Hazelhatch to accommodate BEMUs turning around (Note the TSS 1b EMU timetable requires three turnback sidings).Turnaround times would be between 17 and 22 minutes.

This shows that 19 diagrams/circuits (38 HLU, 152 vehicles) are required in traffic. A fleet size of 42 HLU, 168 vehicles (90% availability) would be the required fleet size

4. Option Assessment

4.1 Process

The operational analysis described above outlines the differing scenarios that Jacobs were required to analyse and provide options for, based on the initial scope in the brief to look at the following train frequencies arriving at Drogheda: 2tph; 3tph; 4tph; and 6tph.

However, during the task IÉ advised new Train Service Specifications had been developed and these were provided to Jacobs with an instruction that they were to be used instead of the originally briefed train frequencies. The revised timetable scenarios are described as follows:

- **Scenario 1**: 2/3 tph as per the existing timetable
- **Scenario 2**: Train Service Specification 1b (3tph in normal service + 2 empty running vehicles arriving/departing Drogheda)
- **Scenario 3**: Train Service Specification 3 (6 tph)

Once the operational analysis was completed, it was possible to understand what platforming capacity was required to achieve the above timetables given the charging time needed for BEMUs to charge in Drogheda. The direction by IÉ was that a12-minute turnaround time should be allowed for the charging and associated activities.

Jacobs undertook an optioneering exercise to select the best option for the three timetable scenarios. The optioneering process followed the Common Appraisal Framework guidelines using a two stage Multi Criteria Analysis (MCA) approach. The first stage allows for an initial "sift" based on a number of operational, technical and other criteria, to identify options that are technically and operationally feasible. The result of this first stage is essentially a "Pass" or "Fail", determining which of these options are carried through to the second stage. This second stage uses the criteria specified in the CAF Guidelines (as outlined below) to further evaluate the options and select the ones that are most appropriate to the three specified scenarios.

This process began with a brainstorming workshop which was held by the Jacobs project team to consider potential options. Following the meeting, the options were documented in the Optioneering Matrix that was developed for the project, with an assessment made on each option against numerous criteria covering technical, operational, environmental, commercial and other considerations.

The options were evaluated against each of the criteria and a summary comment provided in each case. A colour coding was also assigned to each evaluation based on the traffic light or RAG (Red-Amber-Green) system. Green represents the most favourable assessment with few difficulties or disadvantages considered for the option. Amber (or Yellow) represents the next level of assessment where there may be some disadvantages, but which are generally considered to be at a level that can be overcome by reasonable intervention. And finally, Red represents an assessment where there were some significant concerns or disadvantages with the proposed option for that particular criterion which would likely make it difficult to achieve the intended result.

Based on the assessment, the options with the most "Green" categories received a favourable assessment whilst the options with the most "Red" categories received a less favourable assessment. These assessments were then followed with a Pass/Fail designation being awarded to each option as appropriate. Please see Appendix L for the full Stage 1 Options Matrix.

Once the above assessment was complete, it was clear that a number of options were not operationally or technically feasible. Those options that were considered feasible were brought forward for a second stage assessment using the criteria of the Common Appraisal Framework.

These criteria are as follows:

- Economy
- Safety
- Integration
- Environment
- Accessibility and Social Inclusion
- Physical Activity (if applicable)

For an assessment such as this which is looking at the potential installation of technical infrastructure in one fixed location, it was considered that the Integration and Physical Activity criteria could be scoped out of the assessment.

- **Physical Activity –** This criterion is included in the CAF procedure to consider benefits such as walking or cycling if they are applicable to the particular options being assessed. As the options here all relate to a technical installation in one location at Drogheda station/depot, this criterion is deemed to be not applicable for the purpose of this assessment.
- **Integration –** This criterion is included in the CAF procedure to consider benefits such as how a newly proposed piece of transport infrastructure connects with existing transport infrastructure and the community into which it is to be located. As the options here all relate to a technical installation in one location at Drogheda station/depot, this criterion is deemed to be not applicable for the purpose of this assessment.

Furthermore, it was noted that there will likely be little to separate the options under the criteria of Safety and Accessibility and Social Inclusion although these were assessed for completeness. In essence then, as far as the CAF process is concerned, the main criteria are Economy and Environment. Whilst it is permissible under the CAF guidelines to give "weightings" to the most significant criteria, it is not mandatory. It was felt that this was not necessary in this case. With "Economy" and "Environment" being the key criteria here, additional weightings would have provided the same result. Please see Appendix M for the full stage 2 CAF Matrix.

4.2 Optioneering Outcome

The result of this assessment process yielded the following preferred infrastructure options for each of the Timetable Scenarios:

- **Scenario 1:** 2/3 tph as per the existing timetable – Infrastructure Option 1a. Charging station only on Platform 3 and conversion of depot road 4 to a charging station for depot functionality.

- **Scenario 2:** Train Service Specification scenario 1b (3tph in normal service + 2 empty running vehicles arriving/departing Drogheda) – Option 1b. Charging points on Platforms 2 and 3 and conversion of depot road 4 to a charging point for depot functionality and to serve empty runners.

- **Scenario 3:** Train Service Specification scenario 3 (6 tph) – Option 2b. Charging stations on Platform 3 and 2 and conversion of depot road 4 to a charging station for depot functionality - PLUS new platform and charging station on the Navan line branch. In this case, the platform is located on the existing track (north side), thereby single-tracking the required section length.

5. Preferred Infrastructure Option for each Timetable Scenario

5.1 Scenario 1 (Base Scenario 2 or 3 tph): Infrastructure Option 1a – Charging at Platform 3 and Depot Road 4.

5.1.1 Permanent Way (Base Scenario)

The proposed alterations to the existing Permanent Way infrastructure are limited to the installation of new Insulated Rail Joints (IRJs) as required by Electrical & Power to block traction return, as detailed within Section 5.1.4 below. At each location, this will involve the removal of the existing rail which is to be replaced by a shop-glued IRJ rail.

In total, eight IRJ rails are proposed, as shown on drawing D3422300-JAC-DRG-EMF-000001 within Appendix A. The position of each IRJ rail shown is indicative only and is to be reviewed at a subsequent stage when further survey information is available to ensure that minimum rail lengths, etc. are achieved.

Along with the above IRJ works, new trapping protection is proposed to protect the mainline from trains proposed to be stabled overnight on the Navan Line. This trapping protection will be provided via a turnout leading to a buffer stop positioned within the cess. It is currently envisaged that the IRJs proposed in this location to block traction return can be utilised as part of this trapping arrangement.

5.1.2 Civils (Base Scenario)

The civils input to this option is limited to providing ancillary civils support to E&P and OLE equipment. At this design stage it assumed this will principally be as follows:

- New concrete raft foundation to support new substation building. Assumed to be formed of 250mm thick reinforced concrete slab with a minimum 250mm well compacted subbase. This is subject to confirmation of ground conditions and equipment loading.
- Assumed pile foundations to new OLE support structures. Assumed to be 610mm diameter steel driven piles subject to confirmation of the ground conditions.
- Cable troughing to facilitate new cable routes.
- New approximately 135m long sheet piled retaining wall, between 1m-1.5m high, along the cess of the down Navan line to create space for a new driver's walkway to facility stabling of one full train set. Walkway to be formed of a 700mm wide gravel walking route along the base of the new retaining wall. Retaining wall embedment depth and form will be subject to confirmation of ground conditions.

[A gravity precast L-shaped unit was also considered here to avoid sheet piling given the proximity of residential properties. However, the over dig for installing the L retaining wall would be more labour intensive and it would need temporary works and temporary land access for its installation. Also, it would then be required to confirm the new backfilled 1 in 1 slope is suitable and it would probably need to utilise some slope stabilisation such as a GEOgrid/Geotextile/Soil Nails (subject to GI outcome)]

5.1.3 Overhead Line Equipment (OLE) (Base Scenario)

The new BEMU trains are to be charged at Drogheda station. For charging these units, a number of possible charging systems were considered.

5.1.3.1 Overhead Charging Options

Two different overhead line systems were considered for the charging process: Conductor Bar and an OLE wire system. These different systems are explained below with their pros and cons.

- **Conductor bar system:** A contact wire of conventional cross section is clamped into the conductor rail profile. The conductor bar is extruded from aluminium alloy. It is usually 12m in length so the conductor bar will require support at 10m-12m intervals. Figure 5-1 below (*photos taken from Furrer & Frey manual*) shows a typical conductor bar and its support assembly. Due to its simplicity the overall conductor bar system requires less maintenance and fewer interventions than a wire system although the cost of installation is typically 20% more expensive than the equivalent wire system.

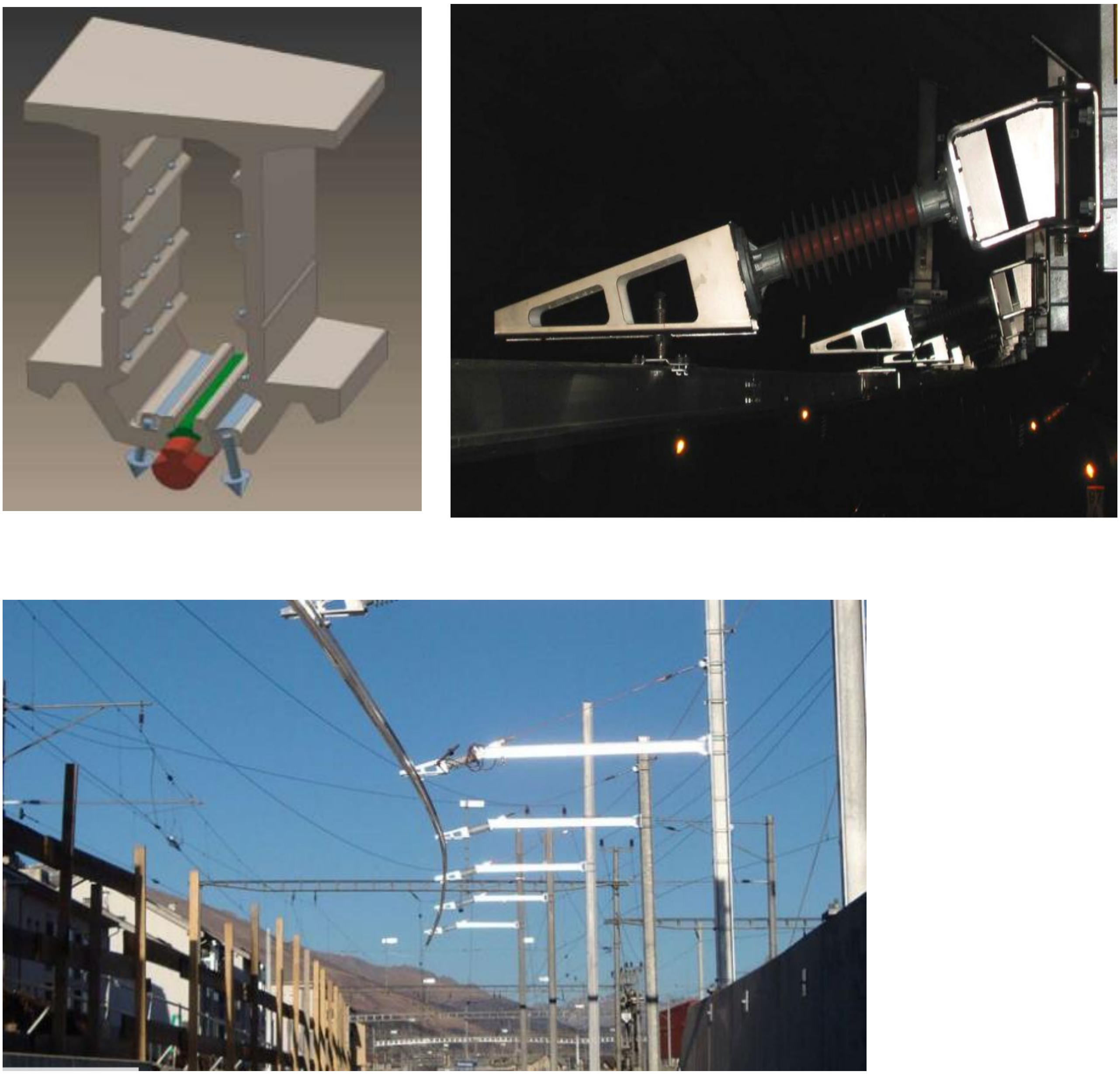


Figure 5-1 Typical Conductor Bar Installation

- **Wire system:** As shown in Figure 5-2, a conventional wire system consists of contact wires, catenary wire and current carrying droppers, which are supported by cantilevers installed on the structures. For bonding, an earth wire will be connected to all the structures which carries any return current back to the substation.

Figure 5-2 OLE System

5.1.3.2 Option selection for overhead charging

Based on the two systems describe in the previous section, three options have been considered for the Drogheda situation. These are the Continuous Conductor Bar System through the Platform Area; Discrete Conductor Bar System; and the Wire system.

- **Continuous Conductor Bar System Through Platform Area**
  The continuous conductor bar system throughout the platform area will have conductor bar, contact wire, support assembly and structure. For future electrification the conductor bar system can be interfaced with the conventional wire system. Although the installation of a conductor bar system has several advantages compared to a wire system, this option is not favoured due to the following points:

  - At Drogheda station, the length of platform 2 and platform 3 is approximately 217m as they share the same island, which means number of structures required will be approximately 21.
  - Due to the bi-metallic contact between the conductor bar and the contact wire, extreme humidity in conjunction with aggressive dust can cause fast wear/oxidation of the components.
  - For bridge clearances the conductor bar is approximately 115mm deep, so in extreme cases the twin contact wire system (OLE catenary system), gives better clearance than the conductor bar.
  - With this conductor bar option there will be major modifications required to the existing canopy.
  - Due to track curvature, and number of structures required for conductor bar this will impact with signal sighting. Relocation of signals would very likely be required and may be very difficult to achieve successfully.

- **Discrete Conductor Bar System**
  This system will have a conductor bar system with two structures at the location where the train pantograph will be raised during the static condition. There will be 4 pantographs per FLU at 42m centres (i.e. 2 pantographs per HLU). To feed power to each pantograph, a conductor bar with two supports are required.

  Although the installation of a conductor bar system has several advantages compared to a wire system. This option is not favoured due to following points:

- To feed every pantograph through conductor bar there will be a separate cable route, these will be difficult to install and maintain on the platform area.
- To have a feeder wire from the first conductor bar arrangement to all of them will require even more structures to support the aerial feeder wire.
- For future planning, when this route will be electrified using a catenary system, the conductor bars and structures will be redundant.
- With this conductor bar option there will be modifications required to the existing canopy.

- **Wire system**
  The contact/catenary wires are supported by cantilever assemblies mounted on the structures. These structures are placed 65-70m apart for straight routes or 20-40m apart on routes with curvature. For bonding, an earth wire will be connected to all the structures which helps to carry return current back to the substation. Bridge clearances could be achieved with a different catenary system arrangement and transition to a future wire system will require minimal changes.

A type description is given in Table 5-1 below.

Table 5-1 Brief summary of all above system and different comparison between them

Description/ System	Discrete Conductor bar system	Conductor bar system through platform area	Catenary/Wire system
Number of Structures	2 structures to feed per pantograph. For FLU with 4 pantographs require 8 structures	Every 10-12m	Maximum span of 65m and due to curvature, every 20-40m
Bridge Clearance	Not applicable as this option will have conductor bar only at specific locations	Conductor bar is approximately 115mm high, so can't use in very reduced clearance structures	In extreme cases twin contact wire system gives better clearance
Cost	20% more expensive than a wire system	20% more expensive than a wire system	Cheaper than conductor bar system
Static or dynamic charging	Static charging only	Static or Dynamic charging	Static or Dynamic charging
Modification to Existing Infrastructure	Major as cable route to be routed on platform area, modification to existing canopy	Major modification required for existing canopy	Minor, modification not required to canopy as structures could be place either side of canopy
Maintenance	Less maintenance as compared to catenary system	Less maintenance as compared to catenary system	Maintenance requirement is more than conductor bar system due to the number of elements of the system
Tensioning Devices	No tensioning devices are required as contact wire is clamped with conductor bar	No tensioning devices are required as contact wire is clamped with conductor bar	Tensioning devices are required for anchoring contact wire and catenary wire

Signal Sighting	May impact signal sighting and relocation of signals may require solving signal sighting issue	May impact signal sighting and relocation of signals may require solving signal sighting issue	Relocation of signals not required, OLE structure could be positioned to avoid signal sighting issue

5.1.3.3 Wire system description

For all the charging options (1a,1b and 2b), the wire system is the preferred option. Due to the current (amperage) requirement the proposed wire system will consists of two contact wires, instead of one as per the existing Irish rail system, and catenary wire with droppers. The current required to charge a FLU is approx. 2.1kA Based on the current required there will 2x107mm^2 contact wires and 1x153mm^2 catenary wire. (ref: Appendix G). The dual contact wire design has been used extensively in the ADIF (Administrator of Railways Infrastructure) CR-160, known as Conventional system in Spain and is designed for use up to 160km/h. The Conventional system is designed for 3000 V DC with power traction substations approximately 20 km apart.

The photographs in Figure 5-3 show the dual contact wire system installed on the Madrid-Albacete line in Spain.

Figure 5-3 dual contact wire dropper arrangement(left) and registration support(right)

Based on current requirement ADIF has designed different systems as shown in ADIF manual and copied in Table 5-2.

Table 5-2 ADIF Manual Designs

CONCEPTO	CR 160	C.R.U. 220	CR 200/220	A.V.E.
H.C. (Cu).	2 x 107 mm²	2 x 120 mm²	2 x 150 mm²	1 x 120 mm²
SUSTENTADOR.	CU 153 mm²	CU 153 mm²	CU 184 mm²	Bz 70 mm²
SEC. TOTAL (H.C. +SUST.) mm²	367	393	484	190
Y. MÁXIMA (A).	1.651/3.302	1.768/3.537	2.178/4.356	850
FEEDER (mm²).	NO	Cu 2 x 153	Cu 1 x 225	
TENSE H.C. (Kg.).	1.000	1.530	2.025	1.529
TENSE CARACTERÍSTICO (Kg/ mm²).	9.35	12.75	13.5	12.74
TENSE SUSTENTADOR (Kg.).	1.389	1.620	2.550	1.529
VELOCIDAD ONDA (Km/h).	365	426	439	426
VELOCIDAD TREN (Km/h).	160	220	220	300
VELOCIDAD ONDA/V. TREN (Km/h).	2.28	1.93	1.99	1.42
PÉNDOLAS (TIPO).	NO. EQUIPOTENC	EQUIPOTENCIAL	EQUIPOTENCIAL	EQUIPOTENCIAL
MÉNSULAS (TIPO).	ADIF	ADIF	TUBULAR/ACERO	TUBULAR/ACERO
LONGITUD MÁXIMO VANO.	60	60	60	65
LONGITUD MÁXIMO CANTÓN.	1.200	1.200	1.200	1.200
Nº EJES SECCIONAMIENTOS.	1	1	1	2
RELACIÓN COMPENSACIÓN.	5 a 1	3 a 1	5 a 1	3 a 1
AGUJAS.	CRUZ Y TANG	TANGENCIALES	TANGENCIALES	CRUZADAS

Based on above details for the CR 160, at Drogheda the proposed catenary system will be 2 x contact wires, 1 x catenary wire and current-carrying droppers.

The incoming power to the OLE will be from the newly installed substation through feeder cables to the switching mast. A switch will be mounted on the mast for isolation purposes. Each track will have a separate feed taken from the substation. The mast to support the contact wire and catenary wire will be installed on the platform and/or near the cess. The type of mast will be single track cantilever, two track cantilever, portals and self-supporting anchor structures. The contact wire and catenary wire anchor system will be either Balance Weight Anchor (preferred for the proposed system) or a Tensorex. There will be a Balance Weight Anchor on one end of contact/catenary wire and a fixed anchor on another end. The foundation for the mast will be either concrete gravity foundation or a pile foundation as preferred at this stage by our civil engineers.

5.1.3.4 OLE Option 1a development

- The proposed option 1a will provide charging infrastructure for platform 3 and depot road 4.
- For OLE registration and supports, back to back single-track cantilever structures will be proposed in the cess between platform 3 and depot road 4. (ref: Appendix A for details).
- The incoming supply will be from the north end of the platform taken from a new substation. There will be a switching portal at the end of depot road 4 to feed to the OLE through a switch. The switch will be a 2-position switch or a CME (circuit main earth) switch. (Type of switch to be discussed at later stages.)
- The switching will also have a fixed anchor for OLE wires to run for depot road 4. Instead of this portal a Twin Track Cantilever (TTC) could be used depending on the structure loading calculation at a later design stage. At the end of the depot road these wires will be terminated with a balance weight anchor (preferred for this design) or Tensorex.
- The OLE wiring for platform 3 will begin from north of platform 3 with BWA or Tensorex and will run through the platform and at the south end this will be terminated.
- An earth wire will be installed connecting all the structures together for carrying return current back to the substation and for bonding.

- It has been noted that there is a footbridge crossing this track leading to the depot. According to data received from IE the vertical clearance is 5.765m. and with reduced encumbrance bridge clearances could be achieved. For details of bridge clearance assessment refer to Appendix H.

- All bridges that are within contact line zone (as per standard BS EN 50119-2020, BE EN 50122-1 and BS EN 50122-2) are bonded to main earth terminal of the station area to allow a robust earthing system. Detailed Bridge bonding assessment to undertaken at later stages.

5.1.4 Electrification & Plant (E&P) (Base Scenario)

The proposed E&P works associated with Option 1a are based on the provision of a new traction substation located between the mainlines and the Drogheda Depot turn back siding on the north side of Drogheda Station. The disused turntable will need to be relocated to build the substation in this location. The approximate price of relocation is provided in section 8. Figure 5-4 below shows the preferred indicative location for the traction substation identified:

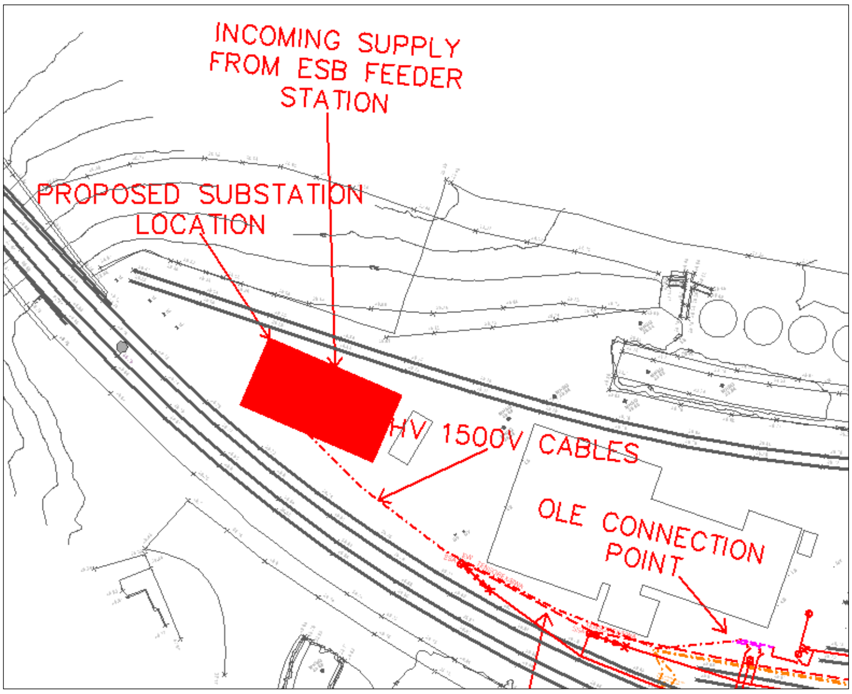


Figure 5-4 Proposed traction substation location for Option 1a

The proposed traction substation will supply the charging OLE equipment positioned through Platform 3 and on the depot road 4. The operational priority charging is to be reserved for Platform 3 with automatic switchgear control provided to limit charging to a single BEMU train at any given time. Therefore, the depot lane will only charge trains when no BEMU's are charging in the main charging station.

Based on the operational and rolling stock requirements of the BEMU rolling stock, the size of the traction substation required to supply the charging infrastructure for Option 1a has been calculated as a minimum of 3.2MVA, Maximum Import Capacity (MIC) from the ESB. An approximate cost of the ESB works is provided in section 8, it should be noted that formal quotations should be sought at subsequent stages of design. We note that ESB will require payment a minimum of 6 weeks prior to their works commencing.

The traction transformer will be supplied directly from an ESB grid connection with a secondary side terminating to a 12-pulse rectifier unit for the conversion of AC to DC. The High Voltage AC switchboard will provide protection on the primary side of the transformer and protection to the grid connection. DC circuit breakers on the secondary side of the transformer will protect the charging infrastructure and any secondary side equipment. A negative return path will be provided through negative return cables via terminations between the rails and negative busbar in the traction substation. SCADA control and monitoring to be provided between the Substation and Connolly ECR.

Table 5-3 below shows a high-level breakdown of the equipment required for the traction substation for Option 1a.

Table 5-3 Option 1a Substation Equipment

Equipment	Rating	Quantity	Example Supplier
Grid Connection	MIC 3.2MVA	1 No	ESB
Positive DC Cable	500mm² (1500V DC)	4 (Length as required)	Caledonian Cables
Negative DC Cable	240mm² (1500V DC)	4 (Length as required)	Caledonian Cables
HV AC Switchboard	320A @10kV AC	1 No	Schneider Electric
Transformer	3.2MVA	2 No	ABB
12-Pulse Rectifier	2.1kA	2 No	ABB
DC Circuit Breaker for rectifier protection	2.1kA @ 1500V DC	1 No	Schneider Electric
DC Circuit Breakers for feeder	2.1kA @ 1500V DC	2 No + spare	Schneider Electric

Below Figure 5-5 provides a high-level view of the traction substation arrangement for Option 1a.

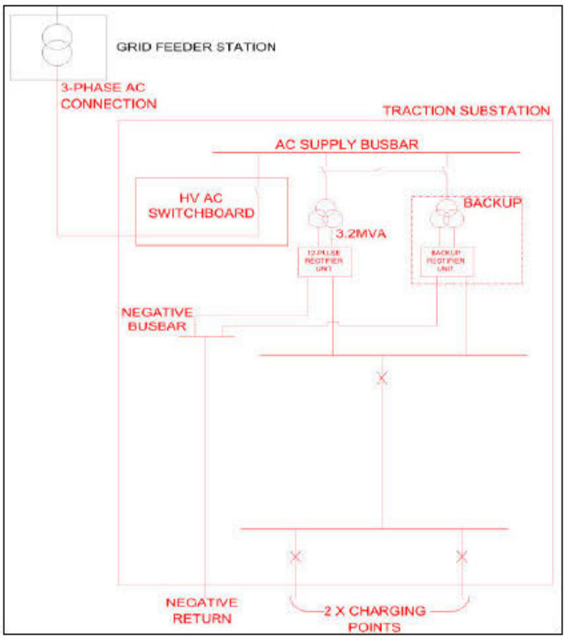


Figure 5-5 Traction substation schematic for Option 1a

To provide a defined DC return current path, a pair of IRJs positioned at both ends of the charging roads are required to provide a buffer zone. The DC return cables are to be bolted directly to the rail and will be routed to the traction substation to terminate on to the negative busbar. To ensure redundancy, 2 No return cables to substation will be provided per OLE charging point.

Stabling for Option 1a is envisaged to be in the existing depot with provision for one additional trainset on one of the Navan lines. To achieve this new lighting and CCTV cameras will be required, it is assumed that the new lighting and the cameras shall be fed from existing supplies at Drogheda Station. Costings for this equipment is provide in section 8.

Option 1a has the lowest energy demand out of the 3 options proposed. A smaller energy demand equates to a reduced operational cost as well as a reduced capital expenditure, because of the reduced capacity and cheaper equipment required.

During consultations with ESB and Irish Rail, details have been provided on the currently available grid connection and infrastructure in place. ESB has indicated that the existing 10kVA feeder station may have sufficient supply capacity, such that charging of a single BEMU train at one time may be possible without the need for network reinforcement. ESB has further stated that to provide power to more than one BEMU train at a time, significant resilience upgrades would likely be required to the local electricity grid.

A key design constraint and disadvantage is apparent in Figure 5-4 where it is shown that the traction substation will sit between the mainlines and the turnback siding of the depot. The problem with having a substation in this location is the availability of access for the ESB. It has been noted that ESB already has an agreement in place for the existing Depot substation. Agreements need to be in place between Irish Rail and the grid supplier (ESB) to allow for safe egress to the substation. We note that there is potential access stairs from the underbridge road access which avoids the need for ESB personnel crossing track to access the substation. Another design constraint of this location is the limited route for the incoming ESB cables to the substation. As the proposed location is between running lines, the ESB incoming cable route will either travel around the running lines, under the rails via the underbridge, or over the rails.

A Battery Buffer system has been investigated to reduce and smooth the overall demand. It is not deemed to be necessary for this option since the output power requirement will be similar to the input power provided. Thus, there would be little saving in terms of ESB connection cost or subsequent energy costs. As such the costs of installing a battery buffer system in this case would outweigh the benefits, however further detail on the system is provided for the other options discussed below.

For additional details regarding the E&P design decisions, infrastructure, systems, specifications, and limitations, refer to Appendix F. This Appendix Includes sections on DC stray currents, EMC, Earthing & Bonding, cable routes, and MOS equipment.

5.1.5 Signalling (Base Scenario)

Signal DA294 is positioned beyond the OLE anchor point structure which could compromise the signal sighting from the train cab stopping position on Platform 3. The most workable solution would be to relocate signal DA294 approximately 20m closer to the end of the platform and ensure that it is situated on the approach side of the anchor point structure. The cost for this signal relocation is reflected in the signalling allocation noted in Appendix D for the base option.

All existing signal positions are currently assumed. Actual positions are subject to survey. All signal sighting will need to be subject to a more detailed review in order to confirm the assumptions made in this study.

The immunisation of signalling infrastructure in and around the proposed OLE equipment would need to be investigated further to ensure any potential compatibility issues are addressed.

5.1.6 Environmental (Base Scenario)

A summary of key environmental and planning considerations is set out below.

1) The Railway Order 'route' is not considered to be the most appropriate mechanism to achieve consent for Option 1a as it is entirely within lands owned by Irish Rail. (However, where third party lands are required to facilitate additional stabling accommodation under Options 1b and 2b a Railway Order may be required).
2) In regard to Option 1a, the submission of a 'local' planning application to Louth County Council is potentially the most efficient mechanism. The Drogheda Borough Council Development Plan (DBCDP) 2011 – 2017 Drogheda Transport Development Area (DTDA) Zoning objective as well as the emerging Draft Louth County Development Plan 2021 – 2027 (DLCDP) J1 'Transport Development Bub' appears to support the proposed works as they are considered to be an enhancement to the operational needs of McBride Station and link with the DART expansion (see Appendix E 1-3). However, this does not guarantee planning consent and careful integration with the cluster of Protected Structures will require a built heritage led approach;
3) To facilitate all proposed options, it is understood that the ESB would need to upgrade the existing substation off the Marsh Road further to the north. It is noted that there is an existing connection from this substation to the existing substation at McBride Railway Station however a new connection will be required to the newly proposed substation for this project. It is understood that the ESB would require upgrades of a minimum of 3.2 MVA for Option 1a and (potentially) 9.48 MVA for Options 1b and 2b,unless battery buffers are provided. It is recommended that the feasibility of any required upgrade works to the substation and any potential upgrade works required to the existing electricity connection to McBride Station is reviewed before taking any options forward. It is apparent that any option that is taken forward will require off site (and outside Irish Rail owned lands) electricity network upgrade works. However, in regard to Option 1a, it is possible to submit two separate planning applications without the need to compulsory purchase lands through the mechanism of a Railway Order. A planning application for upgrade works to the substation off the Marsh Road as well as electricity cable connection to McBride Station could be made by ESB to Louth County Council ideally in advance of or in parallel with an application made by Irish Rail for the works required within the McBride Station lands. However, it is crucial that an assessment of the potential effects of both the proposed developments is undertaken and included with the Irish Rail application. Both proposals should be subject to an EIA/AA screening process. Furthermore, this approach should be agreed with both ESB and Louth County Council through pre application discussion well in advance of any application being submitted. Legal advice should be sought on the submission of two planning applications to facilitate whichever option is taken forward. There is potential to be accused of project splitting and a robust argument will need to be put forward to demonstrate that this is not the case and that the combined effects of both applications have been considered. It is a project risk if an application for the aforementioned ESB upgrade works is refused as it could lead to project delay and in worst case mean that the project cannot be delivered. (Alternatively, for Options 1b and 2b it may be possible to subsume the required ESB upgrade works within a Railway Order application.)

Option 1a Specific Considerations:

- Option 1a is not considered to 'trigger' the need for an EIA and an Environmental Impact Assessment Report (EIAR), however, this will require a full consideration through an EIA Screening process;
- Any application will require an Environmental Report to consider potential environmental impact. This is likely to include topics such as built heritage, landscape visual impact assessment, noise and potentially EMF. Also, the removal and replacement of any rail as well as any underground electricity cabling has the potential to raise issues with contaminated lands and vermin which would need to be assessed;
- Protected Structures is a key issue given the cluster of such buildings at McBride Station. The planning history shows that an assessment of the potential impacts upon these buildings and their settings must

be undertaken and any design process should include a built heritage consultant to guide from the outset. The potential relocation of the turntable was an issue discussed when Drogheda depot was developed within ABP Ref PL54.123480 (See Appendix E8) and formed part of the reasons of appeal taken forward by the Preservation Society of Ireland (PSOI). Any proposed relocation would need to be agreed with An Taisce/NMS/Louth County Council and should be discussed in detail with same prior to submission of any application;

- As with all proposed structures, the proposed substation which is nearby to the west of an existing Protected Structure should be designed sensitively so as to integrate appropriately and this should be led by a built heritage consultant;
- There is an SAC and SPA located further to the north and AA screening should be undertaken, including for any GI to support surveys prior to submission;
- The location of the proposed stabling on the Navan Line could cause potential amenity issues to those properties further to the south. Noise abatement fencing, adjusting the orientation of any proposed lighting downwards and the planting of semi-mature trees in the lands between the siding and the boundary nearest the residential properties to help 'soften' any perceived impacts is recommended;
- The DBCDP 2011-2017 indicates two areas of Protected Trees nearby that appear to be to the south of the Navan Line. The emerging DLCDP 2021 – 2027 appears to include 'Trees and Woodland of Special Amenity Value' to the immediate west/south west of McBride Station (but outside), see Appendix E) The proposals do not appear to impact upon these trees the potential for impacts upon same should be considered prior to the submission of any planning application as it is only by exception that these trees can be removed and, if permitted, replacement must be at a rate of four semi mature species for every tree lost.

5.2 Scenario 2 (TSS 1b) : Option 1b – Charging at Drogheda Platform 2 & 3 and Depot Road 4.

5.2.1 Permanent Way (TSS 1b)

The proposed alterations to the existing Permanent Way infrastructure are limited to the installation of new IRJs as required by E&P to block traction return, as detailed within Section 5.2.4 below. At each location, this will involve the removal of the existing rail which is to be replaced by a shop-glued IRJ rail.

In total, twelve IRJ rails are proposed, as shown on drawing D3422300-JAC-DRG-EMF-000002 within Appendix B. The position of each IRJ rail shown is indicative only and is to be reviewed at a subsequent stage when further survey information is available to ensure that minimum rail lengths, etc. are achieved.

Six additional stabling roads have been provided with access via the extension of an existing depot road headshunt. Each stabling road is long enough to accommodate an eight-car vehicle (assumed total length 168m) with sufficient additional length for buffer stop and signal stand back. Fixed buffers have been proposed on all roads.

The layout has been developed such that it utilises an IP10 turnout from the existing headshunt and IP8 turnouts throughout the stabling fan. The fan is arranged such that the stabling facility is split into three pairs of tracks.

Standard siding track spacings of 2.470m running edge to running edge has been proposed throughout. This should be reviewed at a subsequent design stage with respect to possibly increasing this dimension once inspection / maintenance regimes for this stabling facility are known.

The layout has been developed in 2D only at this stage and is shown on drawing D3422300-JAC-DRG-EMF-000004 within Appendix T

5.2.2 Civils (TSS 1b)

The civils input to this option is limited to providing ancillary civils support to PerWay, E&P and OLE equipment. At this design stage it assumed this will principally be as follows:

- New concrete raft foundation to support new substation building. Assumed to be formed of 250mm thick reinforced concrete slab with a minimum 250mm well compacted subbase. This is subject to confirmation of ground conditions and equipment loading.
- Assumed pile foundations to new OLE support structures. Assumed to be 610mm diameter steel driven piles subject confirmation of the ground conditions.
- Cable troughing to facilitate new cable routes.
- New 700mm wide gravel driver's walkway to be provided between each of the new stabling roads.
- New access road of off McGrath's Lane to provide access to the new stabling area.
- Provision of 20 new parking spaces.
- Provision of 2 new modular buildings, one for cleaner stores and one for drivers sign in including welfare facilities.
- New hardstanding area to provide space for two new modular buildings.
- New perimeter security fence to be provided around the new stabling area with lockable access gate at access road.
- The raising of the footbridge over platforms 1 and 2 to provide sufficient clearance for the OHLE required in this scenario.

5.2.3 Overhead Line Equipment (OLE) (TSS 1b)

For different OLE options and details of the system to be installed refer to section 5.1.3.

OLE Option 1b development

- Option 1b will need charging infrastructure for platform 2, 3 and depot road 4. The charging infrastructure for platform 3 & depot road 4 will be same as in option 1a.
- For OLE registration and supports for charging on platform 2, single track cantilever structures are proposed, maintaining minimum clearance of 2.73m from face of OLE structure and the running edge of the nearest rail. (Ref: drawings in Appendix B).
- Two TTC structures are proposed on either side of canopy, to avoid any modification to existing canopy.
- The incoming supply will be from the north end of the platform from the new substation. There will be a switching portal at the north end of depot road 4 to feed the depot road 4 OLE through a switch. There will be an another switching portal at the north end of platform to feed platform 2 & 3. The switch will be a 2-position switch or a CME (circuit main earth) switch. Type of switch to be discussed at later stages.
- The switching will also have a fixed anchor for OLE wires to run to depot road 4. Instead of a portal, a TTC could be used depending on the structure loading. At the end of depot road these wires will be terminated with a balance weight anchor (preferred for this design) or Tensorex.

- The OLE wire termination for platform 2 & 3 will be at both the ends of platform, with a BWA (preferred) or Tensorex to be determine at later stages.
- An earth wire will be installed connecting all the structures together for carrying return current back to substation and for bonding.
- It has been noted that there is a footbridge this track linking platforms 1 and 2. For details of bridge clearance assessment refer to Appendix H.
- All bridges which are within contact line zone (as per standard BS EN 50119-2020, BE EN 50122-1 and BS EN 50122-2) are bonded to main earth terminal of the station area to allow a robust earthing system. Detailed Bridge bonding assessment to undertaken at later stages.

Note: the soffit height data initially considered were estimates only. Different soffit heights will have different solutions to achieve electrical clearances. The assessments are to be undertaken at detailed design stage.

5.2.4 E&P (TSS 1b)

Option 1b introduces charging infrastructure on through platforms 2 and 3 in Drogheda Station. As detailed in the operational requirements it is also necessary to have Empty Coaching Stock (ECS) trains charging on depot road 4 to depart for Laytown Station. The operational requirement of the ECS movements equates to the need to have three BEMU trains charging simultaneously. Option 1b requires a minimum MIC from the ESB supply of 9.48MVA.

The preferred location of the traction substation as outlined in Option 1a is also the preferred location of the substation for Option 1b, as shown in Figure 5-6.

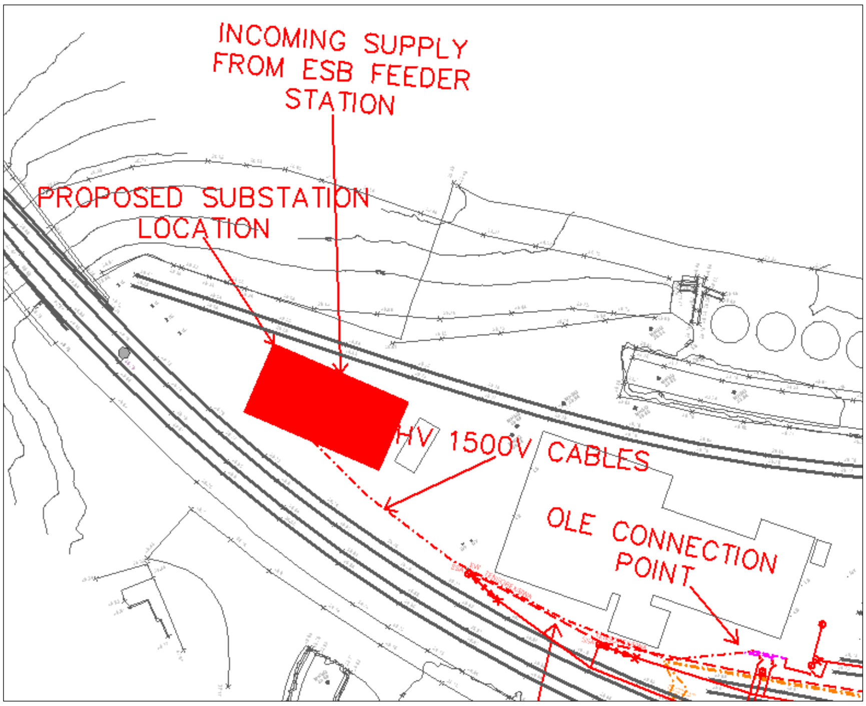


Figure 5-6 Proposed traction substation location for Option 1b

Option 1b requires the same amount of main traction substation equipment as specified under Option 1a, however, where the equipment for Option 1a is rated to supply charging for a single BEMU train, the equipment specified for Option 1b has been rated to supply 3No. BEMU trains simultaneously. Table 5-4 below provides a high-level breakdown of the primary equipment required.

Table 5-4 Option 1b Substation Equipment

Equipment	Rating	Quantity	Example Supplier
Grid Connection	MIC 9.48MVA	1 No	ESB
Positive DC Cable	500mm^2 (1500V DC)	6 (Length as required)	Caledonian Cables
Negative DC Cable	240mm^2 (1500V DC)	6 (Length as required)	Caledonian Cables
HV AC Switchboard	948A @10kV AC	1 No	Schneider Electric
Transformer	10MVA	2 No	ABB
12-Pulse Rectifier	6.4kA	2 No	ABB
DC Circuit Breaker for rectifier protection	6.4kA @ 1500V DC	1 No	Schneider Electric
DC Circuit Breakers for feeder	2.1kA @ 1500V DC	3 No + spare	Schneider Electric

Figure 5-7 below provides a high-level view of the traction substation arrangement for Option 1b.

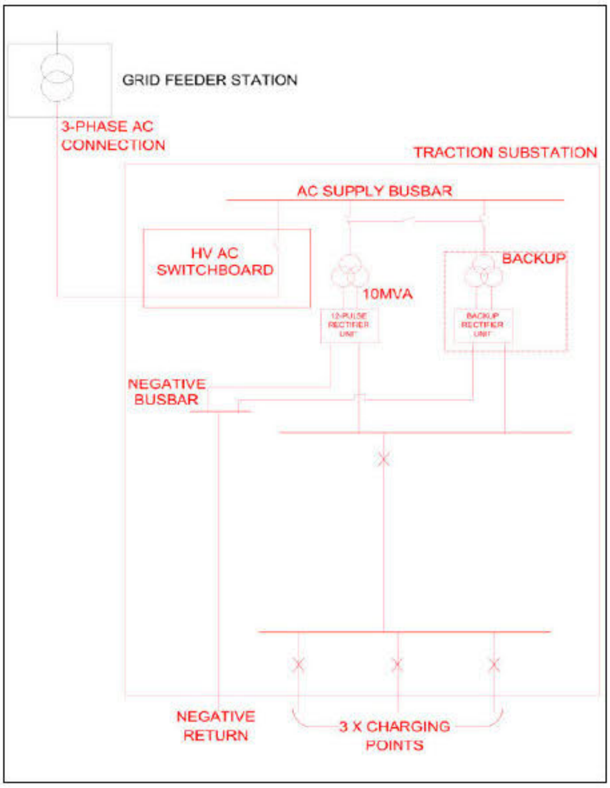


Figure 5-7 Traction substation schematic for Option 1b

Through initial consultations with ESB, it appears the limitation of the current grid infrastructure in proximity to Drogheda Station suggests that the current installation would not be capable of supplying more than one BEMU simultaneously without major network reinforcements. To reduce the demand on the local grid network and to provide operational flexibility, a sequential control system may be implemented to control the number of BEMU trains charging simultaneously. The sequential control would be supplied via automatic electrical interlocking integral to the DC switchgear located in the traction substation.

Alternatively, a battery buffer system could be implemented to reduce demand and smooth instantaneous peaks. Costings of the battery buffer can be found in section 8 and it is noted that the manufacturer has quoted approximately £500 per kWh. Using the proposed operational timetable requirements, over an hour, the demand with and without battery buffer has been modelled for Option 1b as shown in Figure 5-8 and Figure 5-9:

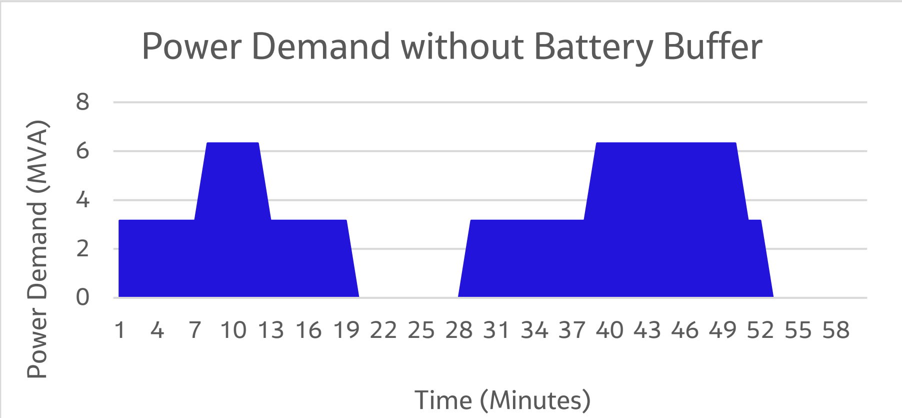


Figure 5-8 Option 1b Power Demand without Battery Buffer

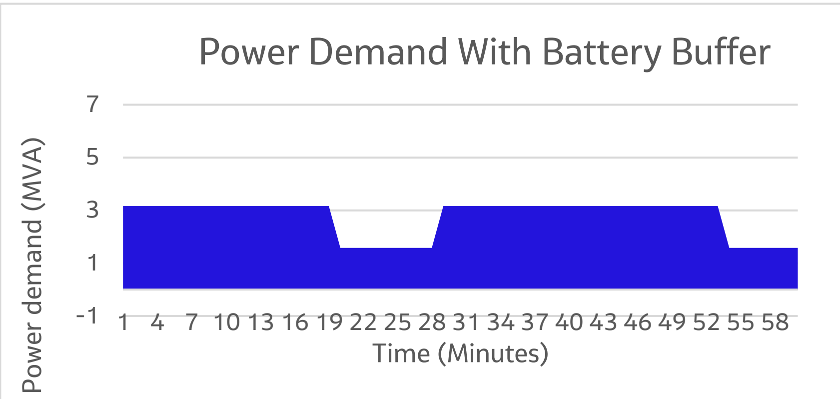


Figure 5-9 Option 1b Power Demand with Battery Buffer

There will be 6 No pairs of IRJs required for Option 1b to provide a DC current return path. Details of IRJ positions can be seen in the Option 1b Layout in Appendix B. The DC return cables to be bolted directly to the rail and will be routed to the traction substation to terminate on the negative busbar. To ensure redundancy, 2 No. return cables should be provided per OLE charging point.

Stabling for Option 1b could be located in a field east of Drogheda Depot and new lighting and telecoms will be required. As the entry to the field is 400m from the Depot a new LV 3-phase ESB connection will be required. The new ESB cubicle shall service new, road lighting, car park lighting, walkway lighting, boundary lighting, telecoms supplies and electrical supplies to the buildings. The lighting will as a minimum comply with EN 12464 part 2. The telecoms will include for boundary CCTV and Call points/ help points for communication back with the main depot area. See drawing D342200-JAC-DRG-EMF-000004 for details. Costings for this equipment is provide in section 8.

The key advantage of Option 1b is that it provides greater operational flexibility when compared with Option 1a (i.e. in the base scenario), and greater capacity with the capability of running more trains out of the station and depot (to facilitate TSS1b).

The disadvantages of Option 1b are similar to those covered in Option 1a. In addition, Option 1b has a further disadvantage as a result of the increased demand for charging multiple BMEU trains at a time. The increase in electrical demand will trigger the need for ESB to provide resilience on their network, increasing the project's operational and capital cost for the procurement, maintenance and running of the traction substation. The alternative to this is use a battery buffer system to reduce the peak power demand from the ESB. It should be noted that if the battery buffers were to fail, they could be switched out to continue to provide charging at the level of the input power (i.e. only one train at a time).

An access agreement will need to be in place with ESB. However, it has been noted that ESB already has an agreement in place for the existing Depot substation. We note also that there is access from the existing stairs via the underbridge road access which avoids the need for ESB personnel crossing track to access the substation.

For further details regarding the E&P design decisions, infrastructure, systems, specifications, and limitations, refer to Appendix F. Appendix Includes sections on DC stray currents, EMC, Earthing & Bonding, cable routes and MOS equipment.

5.2.5 Signalling (TSS 1b)

Signal DA294 is positioned beyond the OLE anchor point structure which could compromise the signal sighting from the train cab stopping position on Platform 3. The most workable solution would be to relocate signal DA294 approx. 20m closer to the end of the platform and ensure that it is situated on the approach side of the anchor point structure. The cost for this signal relocation is reflected in the signalling allocation noted in Appendix D for this option.

There are no potential sighting issues regarding signal DA296, however the OLE anchor point adjacent to signal D297 would need to be positioned beyond the signal structure.

The sighting on signal DA291 at the north end of Platform 2 will be potentially obscured by the introduction of OLE structures along the platform length. The worst-case scenario, based on a through platform speed of 25mph, would be the need to introduce a banner repeater mid-platform.

There are no potential sighting issues regarding signal DA289 at the north end of Platform 1.

The immunisation of signalling infrastructure in and around the proposed OLE equipment would need to be investigated further to ensure any potential compatibility issues are addressed. All existing signal positions are currently assumed. Actual positions are subject to more robust surveying and all signal sighting will need to be subject to a more detailed review in order to confirm the assumptions made in this study.

5.2.6 Environmental (TSS 1b)

Option 1b has the potential for greater impacts than Option 1a given the additional infrastructure and stabling required. In particular, the additional stabling outside Irish Rail lands may require the submission of a Railway Order and therefore trigger the need for an EIAR (see Appendix U). Also, the setting of Protected Structures is more likely to be affected and will require careful consideration.

As is has been identified that the footbridge crossing the mainline is not as high as was first thought and will likely need to be raised to accommodate the OLE here, careful consideration will need to be given to the treatment of this bridge during the planning process and it is recommended that costs are allowed for this treatment.

Specifically, in regard to the proposed stabling outside Irish Rail owned lands, it is noted that the notional area currently being investigated is [redacted] The principle of Railway infrastructure as a main use on these lands does not appear to be supported. Appendix U includes existing planning permission for residential development at the said lands. However, Irish Rail has confirmed that this site is not necessarily the lands that would be progressed and that the exercise is notional. [redacted] It is noted that these lands have two separate zoning objectives for enterprise and employment and amenity use, both in the statutory and emerging development plans. The potential for these lands to be taken forward would require a full planning and environmental review before progressing.

However, both the current DBCDP 2011- 2017 and the emerging DLCDP 2021 – 2027 include zoning objectives DDTA and J1 'Transport Development Hub' (to the immediate north of McBride Station) that are favourable to transport infrastructure type uses. Potentially, the feasibility of these lands to accommodate additional stabling requirements could be discussed through pre application consultation with Louth County Council well in advance of any application to agree the principle and initial layout. It is noted that these lands border residential zoned land further to the north and lands with existing residential planning permissions to the immediate east. If the principle of development was agreed with Louth County Council any proposed scheme would need to mitigate for potential impacts upon residential amenity, such as noise, air quality, dust, visual impacts, etc.

5.3 Scenario 3 (TSS 3): Option 2b – New platform and charging points on Navan lines

5.3.1 Permanent Way (TSS 3)

For this Option 2b and to reduce this section of twin-track alignment on the Navan Line to a single-track alignment, the existing mainline connection and approximately 350m of the existing Navan mainline track is to be recovered, including the existing trap point and buffer stop.

A new IP10 turnout is proposed, along with 100m of plain line renewal and 120m of lift-and-slue, to the south of the proposed platform location to revert the alignment to twin-track; effectively creating a passing loop of approximately 450m as the alignment is single-track only further west.

Twelve IRJ rails are proposed as per Option 1b, along with four further IRJ rails within the vicinity of the new platform on the Navan line as required by E&P to block traction return, as detailed within Section 5.3.4 below. The position of each IRJ rail shown is indicative only and is to be reviewed at a subsequent stage when further survey information is available to ensure that minimum rail lengths, etc. are achieved.

These proposals are shown on drawing D3422300-JAC-DRG-EMF-000003 within Appendix C.

Six additional stabling roads have been provided with access via the extension of an existing depot road headshunt. Each stabling road is long enough to accommodate an eight-car vehicle (assumed total length 168m) with sufficient additional length for buffer stop and signal stand back. Fixed buffers have been proposed on all roads.

The layout has been developed such that it utilises an IP10 turnout from the existing headshunt and IP8 turnouts throughout the stabling fan. The fan is arranged such that the stabling facility is split into three pairs of tracks.

Standard siding track spacings of 2.470m running edge to running edge has been proposed throughout. This should be reviewed at a subsequent design stage with respect to possibly increasing this dimension once inspection / maintenance regimes for this stabling facility are known.

The layout has been developed in 2D only at this stage and is shown on drawing D3422300-JAC-DRG-EMF-000004 within Appendix T

5.3.2 Civils (TSS 3)

The civils input will be the same as options 1a and 1b above with the addition of a new platform over at the Navan line. At this design stage it assumed the civils works will entail the following:

- New platform will be constructed over the existing Navan line on the Up track. It is assumed to be a 174m long, 3m wide platform constructed as either a front wall or cross wall construction. A new access stair and ramp will be provided to the platform from the existing carpark. Alternatively, access to the new platform could be achieved by a connection to the end of platform 1 which will remove the need for separate access and revenue protection to be provided. This will need to be reviewed in conjunction with PED flow analysis.

- New concrete raft foundation to support new substation building. Assumed to be formed of 250mm thick reinforced concrete slab with a minimum 250mm well compacted subbase. This is subject to confirmation of ground conditions and equipment loading.

- Assumed pile foundations to new OLE support structures. Assumed to be 610mm diameter piles subject confirmation of the ground conditions.

- Cable troughing to facilitate new cable routes.

- New 700mm wide gravel driver's walkway to be provided between each of the new stabling roads.

- New access road of off McGrath's Lane to provide access to the new stabling area.

- Provision of 20 new parking spaces.

- Provision of 2 new modular buildings, one for cleaner stores and one for drivers sign in including welfare facilities.

- New hardstanding area to provide space for two new modular buildings.

- New perimeter security fence to be provided around the new stabling area with lockable access gate at access road.

- The raising of the footbridge over platforms 1 and 2 to provide sufficient clearance for the OHLE required in this scenario.

5.3.3 OLE (TSS 3)

For different OLE options and details of the system to be installed refer to section 5.1.3.

OLE Option 2b development

- Option 2B will need charging infrastructure for platform 2, 3, depot road 4 and also on the Navan line. The charging infrastructure for platform 2, 3 & depot road 4 will be same as explained for Option 1b. The only differences will be the incoming feeds to OLE will be from a substation located near the car park. There will switching portal with switches to feed the OLE for platform 3 and depot road 4 and a TTC with switch to feed the OLE for platform 2.

- The charging infrastructure for the Navan line will be TTCs installed on back side of the new platform. The feeding structure will be at the north end of the platform. The option to have switching portal at south end is excluded due to that the switching portal will be on the platform area and for safety reasons the switching structure will be at the north end. (ref drawing in Appendix C)

- The TTCs are proposed on the back side of platform as there is not enough land to locate them in the cess near the track on other side of the platform. This option thus avoids the need to acquire more land.

- An earth wire will be installed connecting all the structures together for carrying return current back to substation and for bonding.

5.3.4 E&P (TSS 3)

Option 2b proposes the introduction of OLE charging infrastructure on the Navan line as well as charging infrastructure on platform 2 & 3 and siding road 4. Based on the information provided by Irish Rail, the Navan lines are not frequently used which introduces the possibility of installing a new platform and charging lane. Further details can be seen in Option 2b Layout drawing in Appendix C.

The preferred location of the traction substation for the supply of the charging for Option 2b is located at the east end of Drogheda Station car park. Ultimately this location provides a direct connection between the traction substation and the charging infrastructure without crossing any tracks. The traction substation location for Option 2b is shown in Figure 5-10.

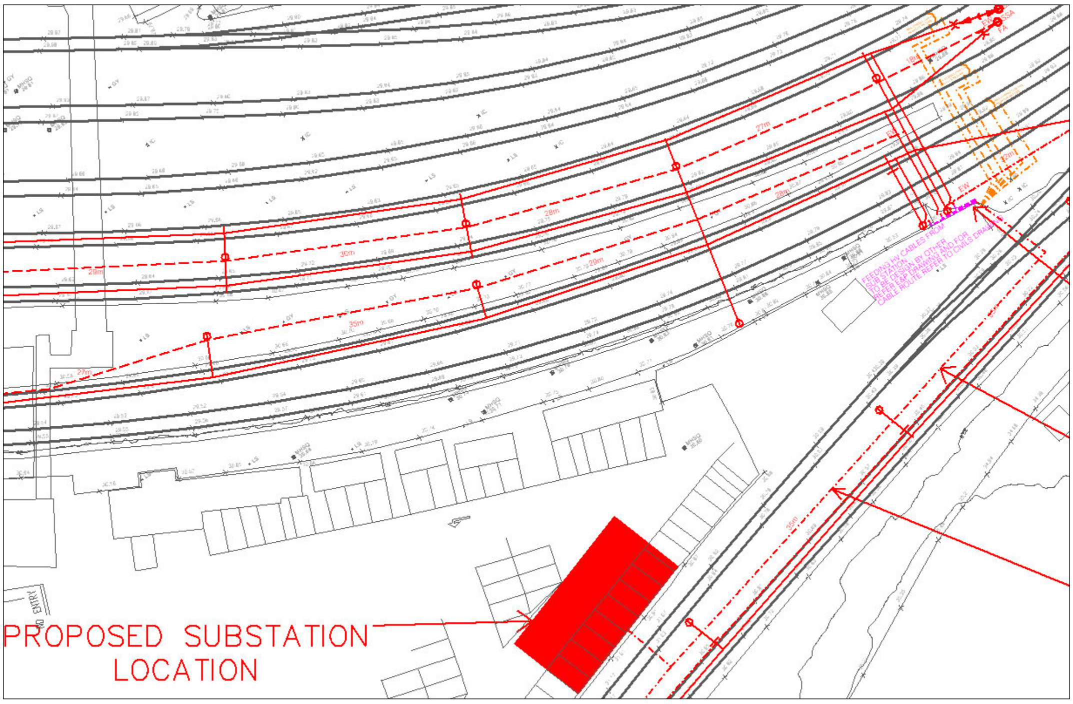


Figure 5-10 Preferred traction substation location for Option 2b

The DC feeder cables shall be routed through the new platform in both directions, as the OLE switch connection points are positioned at the east end Drogheda station and the Navan line OLE connection point positioned at the south of the proposed platform. Further details of the OLE infrastructure can be found in 5.1.3.

The maximum number of trains which can charge simultaneously in option 2b is three, thus the MIC equates to 9.48MVA. If it is not feasible to provide this demand, provision of sequential control could be applied to the DC Switchgear to limit the number of trains charging simultaneously. The sequential control system applies certain operation timetable restrictions.

Alternatively, a battery buffer system could be implemented to reduce demand and smooth instantaneous peaks. Using the proposed operational timetable requirements, over an hour, the demand with and without battery buffer has been modelled for option 2b as shown below:

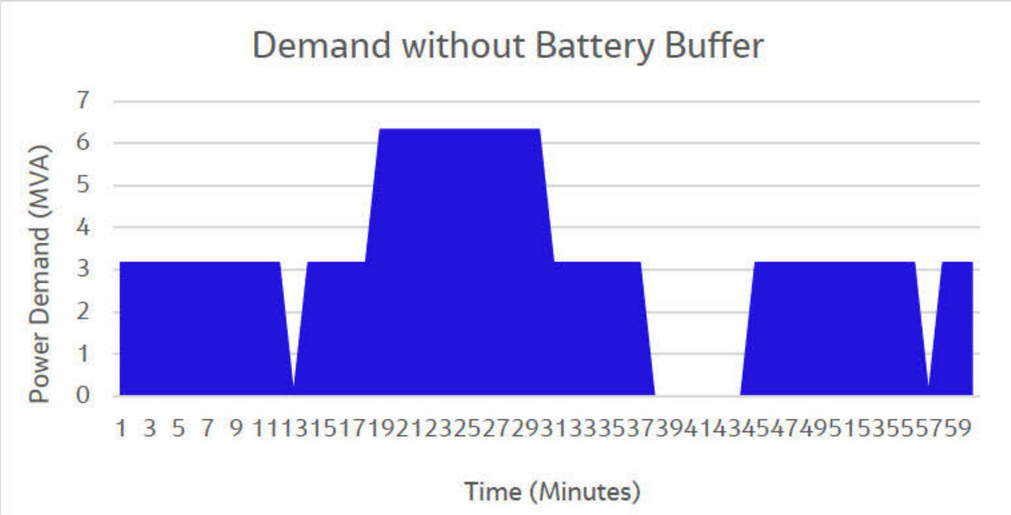


Figure 5-11 Option 2b Power Demand without Battery Buffer

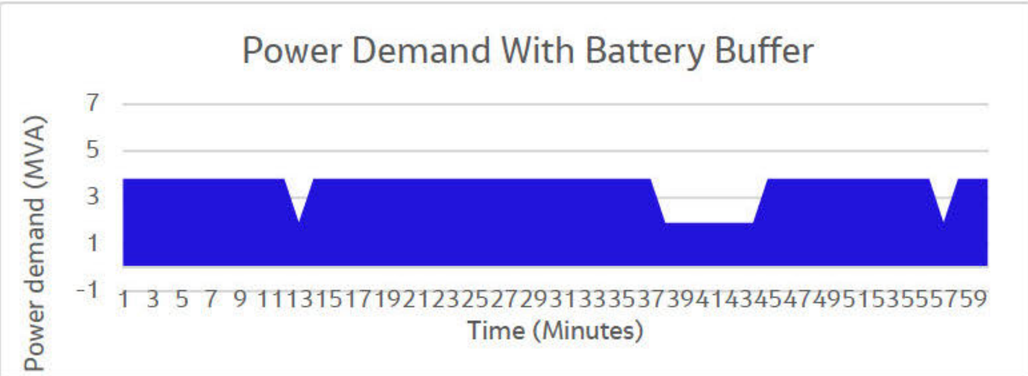


Figure 5-12 Effect of battery buffer on power demand for Option 2b

Table 5-5 below provides a high-level breakdown of the primary equipment for the traction substation with the additional DC circuit breaker for the feed to the Navan lines.

Table 5-5 Option 2b Substation Equipment

Equipment	Rating	Quantity	Example Supplier
Grid Connection	MIC 9.48MVA	1 No	ESB
Positive DC Cable	500mm^2 (1500V DC)	8 (Length as required)	Caledonian Cables
Negative DC Cable	240mm^2 (1500V DC)	8 (Length as required)	Caledonian Cables
HV AC Switchboard	948A @10kV AC	1 No	Schneider Electric
Transformer	10MVA	2 No	ABB

12-Pulse Rectifier	6.4kA	2 No	ABB
DC Circuit Breaker for rectifier protection	6.4kA @ 1500V DC	1 No	Schneider Electric
DC Circuit Breakers for feeder	2.1kA @ 1500V DC	4 No + spare	Schneider Electric

Figure 5-13 below provides a high-level view of the traction substation arrangement for Option 2b.

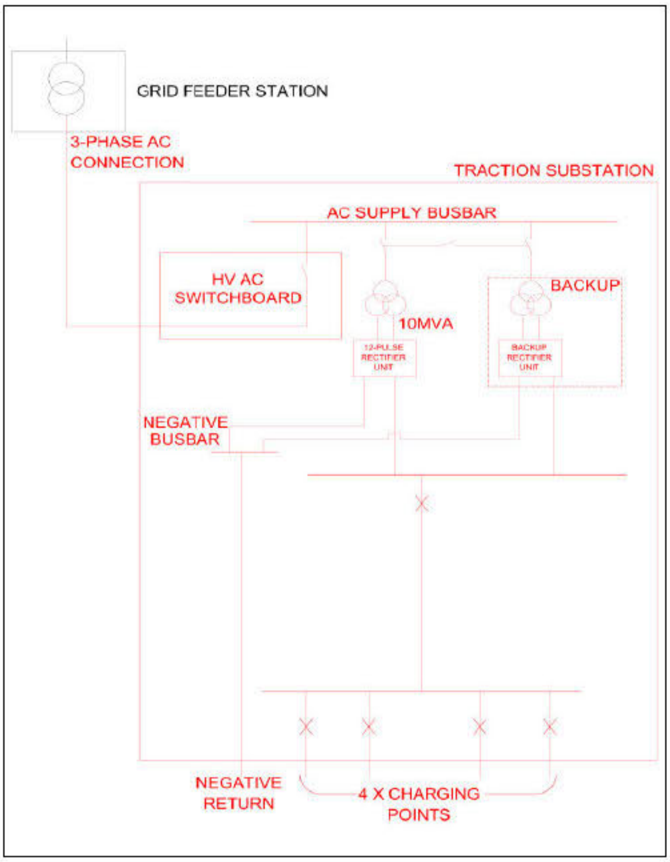


Figure 5-13 Traction substation schematic for Option 2b

Option 2b requires 8 No pairs of IRJs to provide the DC current a return path. Further details of IRJ positions can be seen in the Option 2b Layout in Appendix C. The DC return cables to be bolted directly to the rail and will be routed to the traction substation to terminate on to the negative busbar. To ensure redundancy, 2 No return cables to be provided per OLE charging point.

Stabling for Option 2b is envisaged to be constructed in [redacted]. To achieve this new lighting and telecoms will be required for the new stabling. As the entry to the field is 400m from the Depot a new LV 3-phase ESB connection is assumed to be required. The new ESB cubicle shall service new, road lighting, car park lighting, walkway lighting, boundary lighting, telecoms supplies and electrical supplies to the buildings. The lighting will as a minimum comply with EN 12464 part 2. The telecoms will include for boundary CCTV and Call points/ help points for communication back with the main depot area. See drawing D342200-JAC-DRG-EMF-000004 for details. Costings for this equipment is provide in section 8.

The inherent disadvantage associated with Option 2b is due to the increased electrical demand of charging multiple BEMU's simultaneously. The increase in electrical demand will trigger the need for ESB to provide resilience on their network, increasing the project's operational and capital cost for the procurement, maintenance, and running of the traction substation. Furthermore, the preferred location of the substation is currently positioned within the station car park and therefore the parking capacity will be reduced. The substation is also positioned south of the station and the closest known grid connection is located North of the station. Potentially causing difficulties for routing the HV connection to the substation and thus increasing cost for the connection.

For Further details regarding the E&P design decisions, infrastructure, systems, specifications, and limitations, refer to Appendix F. Appendix Includes sections on DC stray currents, EMC, Earthing & Bonding, cable routes and MOS equipment.

5.3.5 Signalling (TSS 3)

Signal DA294 is positioned beyond the OLE anchor point structure which will compromise the signal sighting from the train cab stopping position on Platform 3. The most workable solution would be to relocate signal DA294 approx. 20m closer to the end of the platform and ensure that it is situated on the approach side of the anchor point structure.

There are no potential sighting issues regarding signal DA296, however the OLE anchor point adjacent to signal D297 would need to be positioned beyond the signal structure.

There are no potential sighting issues regarding signal DA314. However, this option would need to be subject to an operational review as the charging point location will prevent usage of this route/line and the current passing loop length is reduced.

The sighting on signal DA291 at the north end of Platform 2 will be potentially obscured by the introduction of OLE structures along the platform length. The worst-case scenario, based on a through platform speed of 25mph, would be the need to introduce a banner repeater mid-platform.

There are no potential sighting issues regarding signal DA289 at the north end of Platform 1.

The immunisation of signalling infrastructure in and around the proposed OLE equipment would need to be investigated further to ensure any potential compatibility issues are addressed.

All existing signal positions are currently assumed. Actual positions are subject to more robust surveying.

All signal sighting will need to be subject to a more detailed review in order to confirm the assumptions made in this study.

For Option 2b (changes to the Navan Line) a further 2 additional signal changes have been allowed for and these costs are reflected in the signalling allocation noted in Appendix D for this option.

5.3.6 Environmental (TSS 3)

The comments in regard to the stabling for Option 1b also apply here to Option 2b (see Appendix U). As set out for Option 1b, Irish Rail has confirmed that the reviewed site is not necessarily the lands that would be progressed and that the exercise is notional. [redacted] It is noted that these lands have two separate zoning objectives for enterprise and employment and amenity use both in the statutory and emerging development plan. The potential for these lands to be taken forward would require a full planning and environmental review before progressing.

It has been identified that the footbridge crossing the mainline is not as high as was first thought and will likely need to be raised to accommodate the OLE here, careful consideration will need to be given to the treatment of this bridge during the planning process and it is recommended that costs are allowed for this treatment.

Specific considerations for Option 2b include the following:

1) Works on the Navan Line could potentially have more planning and environmental issues given the proximity of residential dwellings and the potential for impacts upon amenity. Noise abatement fencing,

adjusting the orientation of any proposed lighting downwards and the planting of semi-mature trees in the lands between the siding and the boundary nearest the residential properties (to help 'soften' any perceived impacts is recommended.

2) It is an objective of the Drogheda Borough Council Development Plan (DBCDP) 2011 – 2017 and the emerging Draft Louth County Development Plan (DLCDP) 2021 – 2027 to re-open the Drogheda to Navan rail line to regular passenger traffic. Any option taken forward should not compromise this objective;
3) The DBCDP 2011-2017 indicates two areas of Protected Trees nearby that appear to be to the south of the Navan Line. The DLCDP 2021 – 2027 indicates these trees to the south/south west (see Appendix U). The proposals do not appear to impact upon these trees, however, the potential for impacts upon same should be considered prior to the submission of any planning application;
4) The DBCDP 2011-2017 and DLCDP 2021 – 2027 include an Architectural Conservation Area (ACA) to the south of the Navan Line. Part of the objective of such areas is to protect their setting. Similar to Protected Structures, any planning application should consider in the design any potential impact upon the setting of this ACA; and
5) As with all proposed structures, the proposed substation should be designed to integrate into the setting of the other existing Protected Structures.

6. Depot Requirements

This section applies to all three Train Service Scenarios.

6.1 Existing Facility

Drogheda maintenance depot is currently the principal location used to maintain the 29 four-car Class 29000 DMU fleet. The site consists of a three-road maintenance building, long enough for two four-car units on each, a wheel lathe, two roads with access to fuel facilities and a train wash.

The maintenance building has two roads with pits and one road with the capability for lifting vehicles.

6.2 Future Facility

6.2.1 General

It is assumed that BEMU servicing and light maintenance will be undertaken at Drogheda for a period of about three years, until the new depot at Maynooth opens. Thereafter, servicing of BEMUs will be undertaken at Maynooth.

Servicing is expected to include cleaning and daily checks such as screenwash and sand topping up. Servicing of BEMUs will be similar to that of EMUs. which includes fewer tasks than on DMUs and no additional facilities would be required for this.

DMU servicing additionally includes fuelling, and facilities for this remain available on Depot Road 5, which is unaffected in all the options chosen and discussed in this report.

The additional equipment that is required for both light and heavy maintenance and major component changes on the new fleet is assumed to be included in the Special Tools, which will be provided by the train supplier. However, the exact list of special tools proposed may vary between the possible suppliers and so it is recommended that this is verified later.

6.2.2 Facilities required – major component changes

During the first three years, it is assumed that no overhauls or changes of major components (heavy maintenance) will be scheduled.

However, a small number of major components may need to be changed due to unexpected failures. Therefore, changing major components that require lifting of vehicles needs to be considered. The existing lifting arrangements are by means of a Neuero underfloor lifting system dedicated to lifting a complete four-car class 29000 unit. Therefore, this may or may not be at the correct spacing for the BEMU fleet. From the meeting of 6th November 2020 Jacobs understands that Drogheda also has movable jacks, but the number of jacks and the extent that they can be moved is unknown, so it is expected that to lift the vehicles, they will need to be moved to another location and it is further assumed that, because a wide range of vehicles are already lifted at Inchicore, this work will be possible there.

For other major components, if the additional required equipment is not included in the Special Tools provided by the train supplier, such equipment would need to be procured, irrespective of whether the units are being maintained at Drogheda or Maynooth. The options for this include:

- Procure any such additional equipment that will be required at Maynooth, early in the programme for that depot and temporarily locate the equipment at Drogheda. Whilst possibly incurring a cost early, there might be a compensating lower price by avoiding inflation.
- Until such equipment is available, undertake the work at another location such as Inchicore. This would incur operational inconvenience.

- Procure a second set of all the equipment that would be required for the work to be done at Drogheda in addition to that for Maynooth. This would be disproportionally expensive for the number of times it would be used and is therefore not recommended.

6.2.3 Facilities required – light maintenance

Consideration has been given to the locations on the vehicles of equipment fitted on BEMUs, that is different from DMUs, and hence the additional equipment required to carry out light maintenance on BEMUs. For this purpose, as the use of the depot is temporary, it is assumed that an Automatic Visual Inspection System (AVIS) will not be provided, as this will be built into the infrastructure of Maynooth depot. The additional equipment required for access to roof-mounted equipment for light maintenance is assumed not to be included in the Special Tools provided by the train supplier. The following roof-mounted equipment has been considered:

- HVAC module. These are assumed to be similar in concept to those fitted on DMUs, and if well-designed, light maintenance should be possible from inside the vehicles. Therefore, no additional equipment is expected to be required maintain them.
- Pantographs. These require regular inspection, typically at the shortest examination interval, plus carbon strip changes as required.
- Based on comparable vehicles, other equipment that may be located on the roof, depending on the design of the train, may include batteries, battery chargers, air compressors and brake reservoirs.

Therefore, additional roof access equipment is expected to be required. A mobile access platform sometimes called a 'boxing ring' (Figure 6-1 Sample "Boxing Ring" vehicle roof access platform) is recommended. The cost of these is around €10,000 each. The number of access platforms required depends on the design of the selected unit, the maintenance frequency and duration, which are unknown, and the fleet size (see below), but to avoid moving access platforms between roads in the depot, at least two should be obtained.

Figure 6-1 Sample "Boxing Ring" vehicle roof access platform

Due to the temporary use of the depot for BEMUs, installation of permanent fixed roof access equipment would be disproportionately expensive and is not recommended.

Jacobs understands that shore supply for DMUs is installed in the depot but is disused. The BEMUs will be charged on the roads equipped with overhead line and the energy used moving around the depot will be insignificant compared to the capacity of the traction batteries. Therefore, a shore supply is not required for BEMUs.

Following maintenance, if testing under overhead line is required, this can be undertaken on the roads that are proposed to be electrified. Installation of overhead line in the shed, specifically for testing, is considered to be disproportionally expensive for the additional benefit and also introduces safety risks. It is therefore not recommended.

Storage for spare parts for light maintenance of the BEMUs will be required for the few years of BEMU light maintenance. This might be provided in various ways, for example:

- Review the use of the existing storage spaces, for example for large and non-moving items, and hold BEMU major components and large items that are required infrequently at Inchicore
- Provide a temporary building located on the hard standing in the depot. This could be based on, for example, shipping containers. The cost of renting shipping containers is in the hundreds of Euros per month.
- Rent warehouse space nearby to hold 29000 Class major components and large items that are required infrequently and are currently held at Drogheda. The cost of renting warehouse space is in the order of €1 per square foot per month.

6.2.4 Other changes required to the depot

Jacobs has considered other changes that might be required to maintain BEMUs in a DMU depot and the only additional item identified is a possible modification to the train wash. It is assumed that this has roof brushes. If this is correct these should be removed or at the very least switched off before any BEMU is washed due to the risk of pantograph damage and electrical problems. In Jacobs' experience, train washes in depots maintaining vehicles with pantographs do not have roof brushes.

6.3 Depot capacity

From the meeting on 6th November 2020, Jacobs understands that the existing Class 29000 fleet will need to be maintained in Drogheda until 2027 and full electrification is expected to be complete.

RFI0009 describes the 'base case' service and Scenarios 1b and 3.

For the Base Case (current timetable), IÉ has advised that 52 BEMU vehicles (13 HLUs) are specified.

Clause 3.10 of this report shows that TSS 1b requires 54 HLUs and TSS 3 requires 49HLUs.

To estimate at high level whether the DMU maintenance building at Drogheda has sufficient capacity to undertake light maintenance on the BEMU fleet in addition to the Class 29000 DMUs, Jacobs has reviewed the number of units in a sample of DMU and EMU fleets and the number of unit spaces for light maintenance in the maintenance buildings where they are maintained. This showed that DMU depots typically maintain about seven units for each unit space in the maintenance building and EMU depots about twelve.

Drogheda currently maintains a fleet of 29 DMUs and would therefore be expected to require a light maintenance building with 29/7= about four unit spaces and indeed this is the size of the maintenance building at Drogheda. This suggests that there is minimal spare capacity for additional units to be maintained there.

For the Base Case, the proposed BEMU fleet would require a depot with nominally one (13/12) unit space, an increase of 25% in the required capacity of the maintenance building. At the high-level consideration being made here, this might be achievable with some actions, for example:

- Undertake some of the maintenance on the DMUs elsewhere
- Ensure that the maintenance proposed by the BEMU suppliers is optimised, is balanced to suit the needs of the train service, the sequence of work is planned carefully etc.
- Review the staffing level to check whether this is the limiting factor on capacity, rather than maintenance building space
- Review the maintenance of the DMU fleet for potential efficiencies, if this has not been done already
- As the BEMUs are introduced, reduce the size of the DMU fleet

For Scenario 1b, which requires a larger fleet size than Scenario 3, the proposed BEMU fleet would require a depot with four to five (54/12) unit spaces in the shed. It is assumed that by the time either of these scenarios will be implemented, the new depot at Maynooth will be open and therefore no further capacity increase in the maintenance building at Drogheda will be required.

6.4 Recommendations

It is recommended that:

- The exact list of special tools proposed by the possible suppliers should be verified
- To lift the vehicles, they are likely to need to be moved to another location
- The options described above for any additional equipment that is required, and that is not included in the Special Tools provided by the train supplier, should be considered
- At least two mobile access platforms should be obtained
- The options outlined for storage of spare parts for light maintenance of the BEMUs should be considered
- The roof brushes on the train wash should be removed or at the very least switched off before any BEMU is washed.
- For the Base Case, the options described above for increasing the capacity of the maintenance building should be considered.

7. Safety in Design

7.1 APIS and SMS-14

Iarnród Éireann have informed Jacobs that the approval requirements for this project would be dealt with during a later stage as part of the DART + Coastal Programme.

7.2 Jacobs Hazard Evaluation and Risk Reduction Register (HERRR)

This covers the requirements of BS EN 12100 Machinery Safety (Risk Assessments), EU Directives and Construction Regulations. The HERRR is a Jacobs document and provides a means of recording mitigation and risk reductions actions taken. See Appendix K for the HERRR.

The HERRR is a live document and will be updated throughout the duration of the project.

8. Life Cycle Costing Analysis

8.1 Introduction

Life Cycle Costing (LCC) is used to inform decision making by providing an understanding of costs incurred by an organisation over an asset or system lifecycle. It is used to produce comparative assessments of investment options, enabling decisions based on anticipated costs over the period of operation. Analysis incorporates the aggregation of both up-front capital costs (CAPEX) and operational costs (OPEX) and may incorporate multiple renewals of individual Assets over the period of analysis. This following section outlines the methodology used to produce the LCC Analysis.

8.1.1 Note about LCC and Value Added Tax (VAT)

Jacobs note that LCC analysis is intended as a comparative assessment and not as an in-depth accurate predictor of future expenditure. We have followed accepted practice in generating the LCC. VAT is not usually implemented within an LCC Analysis as this is treated in different ways by organisations, most of which are concerned with the cost net of VAT within their accounting practice. In particular please also note that Section 4.1.3 of the Common Appraisal Framework states that VAT should not be included in financial assessments.

8.2 LCC Methodology

The methodology details the processes undertaken to develop the LCC analysis of the options, and is comprised of two sections, CAPEX and OPEX.

8.2.1 CAPEX Development

This Section provides an overview of the principles used in developing the CAPEX for each option. CAPEX summary and breakdown tables for each option can be found in Appendix D.

8.2.1.1 Basis of Cost Estimates

The costs for each of the options proposed in this study are based on the scope outlined in Part 5 of this report. The costs have been prepared in accordance with relevant practice and procedures, including Jacobs internal procedures and those outlined in NTA Cost Management Guidelines.

8.2.1.2 Preliminaries, Overhead and Profit

Main Contractor's preliminaries have been set at a level of [redacted] of works costs. This accounts for the nature of the works and takes cognisance of the challenges of working in and around an operational railway station with the requirement to programme and phase works to permit continued operations and the need to plan and implement temporary enabling works. The addition for preliminaries also accounts for possession costs which will be significant.

Overhead and profit has been allowed for with an addition of [redacted] on costs which in our experience is a reasonable level for works of this nature.

8.2.1.3 Professional Fees

An allowance of [redacted] of total works cost has been added to the costs in respect of professional fees, which again is set at a reasonable level for works of this nature.

8.2.1.4 Planning, Environmental Impact Report and Railway Order Fees

Appropriate provisions have been made in respect of anticipated disbursements in connection with Planning, Environmental Impact Report and Railway Order fees.

8.2.1.5 Risk

We have allowed for a construction risk and contingency factor of [redacted] of overall cost. The risk and contingency factor is based on experience of similar projects at a similar stage in the development process and also takes account of the possibility of planning authorities mandating external aesthetics in keeping with the heritage / listed building status of Drogheda MacBride Station e.g. natural stone finish or similar to external walls of the proposed sub-station. We would expect a more refined level of risk to be determined at a later stage in the development process following a quantitative cost risk analysis with all relevant stakeholders contributing to this process as appropriate.

8.2.1.6 Benchmarking

The costs as compiled have been benchmarked against costs for comparable works in both the Republic of Ireland and the UK.

8.2.1.7 Estimate Base Date

The base date of the estimate is [redacted], and allowance is made in the section below for future inflation.

8.2.1.8 Inflation

We have made an allowance for inflation from 4Q 2020 until the mid-point of construction for each of the options considered. The Society of Chartered Surveyors Ireland (SCSI) are recording a year on year (2019-20) movement in tender prices of approximately 1.6% whereas in the previous year (2018-19) this movement equated to approximately 6.3%. The SCSI note that COVID-19 has continued to have an unprecedented impact across all aspects of society. The social and economic consequences including adherence to lockdown measures as a result of COVID-19 can be attributed to the significant slowing of tender price inflation. Given this backdrop it is extremely difficult to predict future trends in tender price movements, however for the purposes of allowing a factor for inflation we have assumed [redacted] in the year 2021 followed by a movement to previous levels of circa [redacted] in successive years. This results in the following additions for inflation:

- **Option 1a -** [redacted]
- **Option 1c -** [redacted]
- **Option 1b and 2b -** [redacted]

8.2.1.9 Range of Accuracy

All estimates are classified in accordance with Jacobs estimating matrix contained within Jacobs Business Management System – Buildings and Infrastructure Europe – Work Instruction WI 3100. Jacobs classify estimates based upon the amount and quality of the information available at the time the estimate is delivered, and this Cost Estimate we consider ranks between a Class 4 and 5 classification and therefore has an expected overall range of accuracy of [redacted]

8.2.1.10 Assumptions and Exclusions

Table 8-1 and 8-2 detail the assumptions and exclusions used in developing the CAPEX estimates.

Table 8-1 CAPEX Assumptions.

CAPEX COST DATA ASSUMPTIONS LIST			
The following assumptions have been made in the preparation of the costs contained in this report			
Element	**Item**	**Description**	**Assumption**
P-Way			
1	Scope of work	Installation of IRJ's	Assumed that existing sleepers and ballast remain (Options 1a and 1b)
OLE			
1	Scope of Work	Testing & Commissioning	[redacted]
SIGNALLING			
1	Scope of Work	Signalling requirements	Assumed scope restricted to general allowance for relocating 2 nr signals for each option, (See below for Navan Line stabling)
ELECTRIC POWER & PLANT			
1	Scope of Work	ESB Connection to Grid (Option 1a)	**We have included an allowance of** [redacted] **for ESB connection to the sub-station which covers the connection charge and cabling costs** as noted in ESB Networks Statement of Charges Dated Sept 2020. We are advised through informal discussions with ESB that in the case of Option 1a, significant network reinforcement is not likely to be necessary
2	Scope of Work	Cabling	Includes all ducting, troughing or other containment
3	Scope of Work	Battery buffer unit	Assumed not required for Option 1a

4	Scope of Work	Testing & Commissioning	Assumed [redacted] of total E&P cost
CIVILS			
1	Scope of Work	Piling to OLE supports	Assumed 610mm diameter steel driven piles max depth 5m, subject to confirmation of ground conditions includes making good existing platform 2/3
2	Scope of Work	Excavation	Assumed no existing materials are being reused
3	Scope of Work	Raising existing bridge (Options 1b, 1c and 2a)	Provisional sum allowed of [redacted] to include any heritage preservation requirements.
4	Scope of Work	New platform (Option 2b)	The platforms are assumed to be of a typical front wall construction • 665 x 1100mm solid concrete blockwork walls with cope. • Concrete strip foundations 1100 x 470mm, subject to confirmation of ground conditions • Concrete support • Between walls it is assumed that that it will be filled with 6N material. • Typical platform make up; 50mm dense bitumen base and 25mm bitumen wearing. course • 400mm wide concrete tactile slabs to run the length of the platform • Includes Lighting, CCTV, Passenger Information Displays and other Comms

5	Scope of Work	Existing Platform 2/3	Assumed platform will be re-surfaced
BUILDINGS			
1	Scope of Work	Sub-station	Assumed brick-built substation on reinforced concrete raft foundation subject to confirmation of ground conditions
2	Scope of Work	Sub-station	Assumed substation building, transformers and battery buffer unit contained within fenced compound
3	Depot	Mobile roof access platforms	Assumed 2 nr required
4	Depot	Storage	Assumed lightweight metal clad structure, floor area approx 100m2
5	Depot	Existing turntable	Assumed removed to another location in the depot.
Stabling on Navan Line			
1	Scope of Work	P-way	Assumed new switch (trap) required
2	Scope of Work	Signalling	Assumed 2 new signals required
3	Scope of Work	Civils	Assumed new retaining wall required for full length of stabled train to accommodate walking route
4	Scope of Work	Civils	Assumed new walking route required on either side of stabled train
5	Scope of Work	Civils	Assumed acoustic barrier required on top of new retaining wall
6	Scope of Work	Civils	Assumed rail access point and 'Strail' type foot crossing required

7	Scope of Work	M&E	Assumed lighting and CCTV required for stabling area
8	Scope of Work	Landscaping and planting	Assumed some landscaping and semi-mature trees may be required next to some neighbouring properties
Stabling in Adjacent Field			
1	Scope of Work	P-way	Includes 1775m of track, S&C units and buffer stops
2	Scope of Work	Signalling	Assumed no signalling required
3	Scope of Work	Civils	Includes access road, sheet piled retaining wall along access road up to new surface level, bulk upfill to form new levels, car parking, walking routes, Strail type track crossings, palisade security fencing and entrance gates. Acoustic fencing to neighbouring residential properties
4	Scope of Work	Portakabins	Includes services and utility connections
5	Scope of Work	M&E	Includes lighting to stabling area, car park and access road, CCTV and call/help points
6	Scope of Work	Landscaping and planting	Assumed some landscaping and semi-mature trees may be required next to some neighbouring properties
METHODOLOGY			
1	Method of work	Sequence of construction	It is assumed that this work can be carried out as a phased construction utilising Possessions as required

The Table 8.2 below details the exclusions to the CAPEX estimates.

Table 8-2– CAPEX Estimate Exclusions

CAPEX COST EXCLUSIONS & QUALIFICATIONS		
The following Items are EXCLUDED from the reported costs		
Item	**Element**	**Description**
[redacted]		
	[redacted]	[redacted]
[redacted]		
	[redacted]	[redacted]
	[redacted]	[redacted]
	[redacted]	[redacted]
[redacted]		
[redacted]		
	[redacted]	[redacted]
[redacted]		
[redacted]		

8.2.2 OPEX Development

LCC modelling was undertaken in line with the requirements of BS ISO 15686-5:2017[1]. The costs were developed over a 35-year period of analysis. This provides an understanding of the costs that would be incurred during the operational life of the BEMU units. Whilst operation may continue beyond this period, it is possible that with the current rate of change in the rail industry, technological advancement or strategic change may result in alternative infrastructure requirements. This may incorporate systems not yet available and as such analysis beyond this period would introduce greater uncertainty into the assessment.

[1] Buildings and Constructed Assets – Service Life Planning, Part 5 – Life-cycle costing. *British Standards institute*, 2017

The development of the LCC tool was achieved using an understand, build, and calculate approach, as shown in Figure 8.1. The understand phase provides an appreciatation of the proposed options and various lifecycle activities associated with the assets. This key stage is undertaken using a combination of engagement with Subject Matter Experts (SMEs), reference to applicable maintennce and inspection standards, and benchmarking of unit rates and frequencies to comparable railway systems. Within the build phase, the 'infrastructure' of the model is developed, mapping activity profiles to assets and establishing core assumptions wihtin the modelling input. Finally, the calculation stage incorporates the application of unit costs and computes the LCC over the period of analysis.

Understand

- Design engineers were engaged in collaborative sessions to understand the options; and the types and quantities of assets in each
- Standards were reviewed and discipline-specific SMEs were engaged to understand lifecycle activities associated with each asset type.
- Benchmarking information was assessed to understand typical asset failure rates.
- Effort associated with each activity i.e. person-hours, was established for each activity.

Build

- Lifecycle activities were mapped against the assets within each option, including the associated activity profile.
- Areas of operational efficiency were established to reflect real-life operations. E.g. efficiencies in maintaining mutlipe cables in the same shift.

Calculate

- Unit rates were applied to the LCC tool, which translates the activity profile into annualised cost profile. The annualised profile is then discounted to calculate the Net Present Value (NPV) of each option.

Figure 8-1 OPEX methodology phases

NPV was calculated by discounting the annualised costs using the discount rates shown in Table 8.3 in accordance with the Irish government's common appraisal framework for transport projects[2].

Table 8-3 Discount rates used in LCC Analysis

Project Lifetime (Years)	Discount rate (%)
0-30	4
31-60	3.5
61-100	3

8.2.2.1 Exclusions

Table 8-4 presents the exclusions from LCC modelling.

[2] Common Appraisal Framework for Transport Projects and Programmes. Republic of Ireland Department of transport, Tourism and Sport, 2016.

Table 8-4 LCC Analysis Exclusions

Reference	Asset Type	Comments
E-1	All	Energy usage excluded as this is anticipated to be incorporated in BEMU operational cost in ongoing Irish Rail tender exercise.
E-2	All	Excludes Life Cycle Cost assessment of asset already in situ.
E-3	All	All costs exclude VAT and the impacts of inflation.

8.3 Results

[redacted]

Table 8-5 LCC per option.

Discounted Cumulative Cost (€millions)				
	Year 5	Year 15	Year 25	Year 35
Option 1a	[redacted]	[redacted]	[redacted]	[redacted]
Option 1b	[redacted]	[redacted]	[redacted]	[redacted]
Option 1c	[redacted]	[redacted]	[redacted]	[redacted]
Option 2b				

To inform Irish Rail's strategy of upgrading to an OLE solution in approximately 3.25 years, Table 8-6 displays the cumulative costs incurred to year 3 and 4. This is provided as a guide to the estimated cost prior to installation of a full OLE option. Variations in maintenance timing and scheduling in practice mean that the costs incurred within a single quarter cannot be effectively estimated without significant uncertainty.

Table 8-6 Cumulative costs to year 3 and 4.

Discounted Cumulative Cost (€millions)		
Option	Year 3	Year 4
Option 1a	[redacted]	[redacted]
Option 1b	[redacted]	[redacted]
Option 1c	[redacted]	[redacted]
Option 2b	[redacted]	[redacted]

Figure 8-2 displays the cumulative discounted cost profile of the three proposed Options. The trends indicate the significance of the Total Construction Cost in the LCC of these options and indicate a similar cost profile across both options 1b and 2b. By comparison the cost profile of Option 1a shows less pronounced increases over the 35 years. This is related to the lesser volume of assets to be installed in this option. The large increases seen in the cost profile of Options 1b and 2b relate to the requirement to renew the battery buffer a number of times over the period of analysis.

[redacted]

Figure 8-2 Cumulative Cost Profile (Discounted)

The annual cost profile displayed in Figure 8-3 indicates that the through-life costs associated with Option 1a remain broadly consistent across the period of analysis. The through-life costs associated with Options 1b and 2b whilst broadly consistent across much of the period of analysis are of a greater magnitude than those of Option 1b. This is primarily driven by the increased maintenance and inspection requirements as a result of the addition of sidings and the battery buffer in these options. A number of spikes in cost occur across the analysis, the spikes in years 9, 18 and 27 are notable as they occur only in Options 1b and 2b as a result of the renewal requirements of the batter buffer system. The smaller spike in year 26 of the analysis across all options is the result of a number of wiring assets within the system reaching the end of their anticipated design life simultaneously. The cost differs between options as a result of the differing volumes of wiring assets proposed in each option.

[redacted]

Figure 8-3 Discounted annual cost profile.

8.4 Kildare Extrapolation

IE also required the results obtained for Drogheda Station to be extrapolated onto the Kildare line for Hazelhatch station. It was agreed with IE during the development of this exercise that CAPEX costs would be adequate and that Life Cycle Costs and programme were not required in this case.

The logic for extrapolating the operational scenario to be found at Hazelhatch is outlined in Section 3.12.

IE required that costs be provided for a base scenario and for the TSS1b scenario and these are the costs now provided in Appendix D for the Kildare Line extrapolation.

As per the format above for the Northern line and Drogheda station, the assumptions and conclusions are noted here in the following tables.

8.4.1.1 Assumptions and Exclusions

CAPEX COST DATA ASSUMPTIONS LIST			
The following assumptions have been made in the preparation of the costs contained in this report			
Element	**Item**	**Description**	**Assumption**
SIDINGS TRACK & ANCILLIARIES			
1	Scope of Work	P-way	Includes track, S&C units and buffer stops
2	Scope of Work	Signalling requirements	Assumed scope restricted to 2 nr new signals
3	Scope of Work	OLE Testing & Commissioning	Assumed [redacted] of total OLE cost
4	Scope of Work	Cabling	Includes all ducting, troughing or other containment
5	Scope of Work	Battery buffer unit	2No TB-45-2,466 (2.4MVA) battery units accompanied with a single TB-40-1,644 (1.6MVA) battery unit would provide a combined supply of 6.4MVA. [redacted]
6	Scope of Work	Lighting, CCTV and Comms	Includes lighting to stabling area, car park and access road, CCTV and call/help points
7	Scope of Work	ESB Connection to Grid	12.8MVA grid connection at medium voltage, 3 -Phase 20kV. [redacted]
8	Scope of Work	Testing & Commissioning	Assumed [redacted] of total E&P cost
CIVILS			
1	Scope of Work	Piling to OLE supports	Assumed 610mm steel driven piles max depth 5m, subject to confirmation of ground conditions
2	Scope of Work	Civils	Includes upgrading existing access road, car parking, walking routes, Strail type track crossings, palisade security fencing and entrance gates. Acoustic barrier to neighbouring residential properties
3	Scope of Work	Excavation	Assumed no existing materials are being reused
BUILDINGS			
1	Scope of Work	Sub-station	Assumed brick-built substation on reinforced concrete raft foundation subject to confirmation of ground conditions
2	Scope of Work	Sub-station	Assumed substation building, transformers and battery buffer units contained within fenced compound
3	Scope of Work	Portakabins	Includes services and utility connections
METHODOLGY			
1	Method of work	Sequence of construction	It is assumed that this work can be carried out as a phased construction utilising Possessions as required

CAPEX COST EXCLUSIONS & QUALIFICATIONS

The following Items are EXCLUDED from the reported costs

Item	Element	Description
[redacted]		
[redacted]		[redacted]
[redacted]		[redacted]
[redacted]		[redacted]
[redacted]		[redacted]
[redacted]		[redacted]
[redacted]		[redacted]
[redacted]		
[redacted]		[redacted]
[redacted]	[redacted]	[redacted]
[redacted]		[redacted]
[redacted]		[redacted]

9. Implementation Schedule

The high-level schedule has been produced for Options 1a and 1b and 2b to give an overall view of the stages involved from the planning through to construction. See Appendix folder I for Schedules.

Note the schedule has been developed based on traditional Employer's design since this allows development of the design in parallel with preparation of the planning application/ railway order. Design and Build options could be considered for the more specialist items such as the electrical installation, however this would mean planning approval would need to be secured in advance. Also, it is likely that elements of the project would still remain traditional employer's design with works around a live station and so a D&B element would just provide yet another interface that had to be managed.

10. Risk

Throughout the Study Jacobs and IÉ have identified key risks that could impact on each Operational Scenario and the relevant Infrastructure Options. These risks are presented in Appendix J in the form of a spreadsheet complete with scoring system and mitigation actions. In summary, while project risks vary with each Operational Scenario the common thread running through them all is:

- Availability of ESB Grid Power
- Stabling capacity at Drogheda (or elsewhere to serve Drogheda)
- Charging points and interfaces in the Depot

As the train frequency rises from 2tph to 6tph the scale of infrastructure intervention increases such that for example, the new platform on the Navan Line could need new land purchase. This might be mitigated by single tracking a section for the platform (Option 2b as proposed).

The Risk Register will be maintained over the course of the project development.

11. Summary and Conclusions

The purpose of this study is to identify the BEMU infrastructure requirements at Drogheda (including maintenance infrastructure and equipment), with an aim of minimal intervention and operational impact, for 3 different timetable scenarios and to develop Life Cycle Costs accordingly for the resulting requirements.

A long list of infrastructure interventions to provide battery charging infrastructure at Drogheda has been considered, which through a process of multi-criteria analysis was reduced to four key infrastructure options to satisfy the three TSSs provided by IÉ.

The TSS Scenarios have been assessed as shown in *Table 11-1* together with the infrastructure solutions needed for efficient battery charging.

Table 11-1 TSS Scenarios and Infrastructure Options

Scenario	Timetable	DART Train Service Frequency (Trains per hour)	Number of platforms with a charging point	Platform Infrastructure Required	Depot Infrastructure Required
2 and 3 DART trains per hour (the base scenario)	December 2019 timetable	Up to 3	1 (Option 1a)	Platform 3 to have a charging point	Depot Road 4 to have a charging point; Roof Access to be provided in Maintenance Building; Storage to be provided for running spares. Modification to train wash.
			2 (Option 1c)	In addition, a charging point on platform 2 would provide operational contingency and flexibility	Depot Road 4 to have a charging point Roof Access to be provided in Maintenance Building; Storage to be provided for running spares. Modification to train wash.
TSS 1b	Train Service Specification 1b	5 (includes 2tph empty stock between Laytown and Drogheda)	2 (Option 1b)	Charging points on platforms 2 and 3	Depot Road 4 to have a charging point Roof Access to be provided in Maintenance Building; Storage to be provided for running spares. Modification to train wash.
TSS 3	Train Service Specification 3	6	3 (Option 2b)	Platforms 2 and 3 and one new platform to have charging points	Depot Road 4 to have a charging point Roof Access to be provided in Maintenance Building; Storage to be provided for running spares. Modification to train wash.

The conclusion of this study is that it is feasible to install and operate BEMU infrastructure at Drogheda in a manner that will support the existing and proposed future timetables. Relevant considerations are listed below.

- The extent of infrastructure required increases as the timetable scenarios become more demanding in terms of train frequency.
- The cost and impact of the infrastructure required increases in a similar way.
- There are some operational challenges associated with BEMUs, e.g. The requirement for charging will limit their turnaround flexibility in responding to timetable delays. Enhancement of the timetable any further is also somewhat limited by the use of BEMUs vs EMUs. Ability to recover timetable issues today using DMUs will not be an option in future if all services are replaced by EMUs.
- The infrastructure requirements to meet the base scenario of 2/3tph to fulfil the current timetable requires the least investment and would have the least redundant costs. For this scenario we have recommended infrastructure Option 1a. Based on observations of other rail networks and their standard operations and maintenance procedures, it is felt that this option provides an acceptable level of redundancy. [If IE are concerned about a possible breakdown making Platform 3 unavailable and were not satisfied with charging a train for passenger service in depot road 4, and hence even further operational flexibility was required, the addition of a charging station on Platform 2 could be considered (equivalent to Option 1c).]
- Option 1a has a CAPEX estimate of approximately [redacted] and an LCC estimate for the 3 to 4-year timescale envisaged before full electrification of approximately [redacted]
- The enhanced redundancy option for the base scenario (Option 1c) has a CAPEX estimate of approximately [redacted] and an LCC estimate for the 3 to 4-year timescale envisaged before full electrification of approximately [redacted]
- The additional infrastructure requirements for the two other scenarios (TSS1b and TSS3) and in particular, the increased power requirements and requirement for additional stabling in these scenarios, corresponds to a significant uplift in costs. The requirement for a new platform for the TSS 3 scenario increases these costs yet further.
- Option 1b, recommended for the TSS 1b scenario, has a CAPEX estimate of approximately [redacted] and an LCC estimate for the 3 to 4-year timescale envisaged before full electrification of approximately [redacted].
- Option 2b, recommended for the TSS 3 scenario, has a CAPEX estimate of approximately [redacted] and an LCC estimate for the 3 to 4-year timescale envisaged before full electrification of approximately [redacted] 3[redacted].

  Note: All costs quoted here as elsewhere, are exclusive of VAT.

We trust that this report provides sufficient information to enable a decision to be made on the provision of necessary infrastructure to suit the TSS and appropriate BEMU fleet.

12. Recommended Next Steps

Following this initial study into the BEMU Infrastructure requirements and their associated costs, we suggest that the next steps for IÉ in this process are as follows:

- Confirmation of preferred option to pursue
- Confirmation from across IÉ departments of all issues being considered
- Finalise proposed timetable to confirm viability of operational assumptions
- Confirm stabling requirements for all scenarios
- Confirm BEMU vehicle details when preferred bidder for new fleet has been chosen
- Confirmation of grid connection capability with the ESB for all scenarios ***[Note this is considered one of the most important next steps]***
- Confirmation of proposed Substation location and ESB access arrangements
- Confirmation of likely ESB incoming cable routing
- Recommended that legal/ planning advice is sought in regard to parallel application for ESB upgrade works and any application for works to McBride Railway Station;
- Recommend that legal advice is sought in regard to any potential Railway Order Application;
- Recommend that any proposed stabling area outside Irish Rail Owned lands is proposed on lands with a favourable zoning objective in both the current Drogheda Borough Council Development Plan 2011-2017 and the emerging Draft Louth County Development Plan 2021- 2027;
- Recommend noise abatement fencing and landscaping around proposed stabling areas in proximity to existing and proposed residential uses;
- Recommended that any separate application submitted by ESB is fully assessed within any environmental report/assessment provided in connection with any application;
- Confirmation of application process and 'consenting route' for the above and timescale involved.
- Submit application (depending on timescale and surety of project proceeding)
- Progressive Engineering Assurance with IÉ to reduce programme timescales.
- Commence early design works including for example:
  - Topographical survey of the proposed works area
  - Geotechnical investigation where required (e.g. Substation area, OLE mast locations)
  - Track condition survey
  - Utilities searches
  - Early Contractor Interface with preferred bidder
- Commence early planning/environmental works for example:
  - Undertake EIA Screening & AA Screening
  - Pre application discussion with Louth County Council and agree application 'route'/ scope of submission
  - Commence early Environmental surveys
  - Engage Architectural Heritage architect
  - Engage with local community to keep them informed of the works and any impact it may have.

    - Undertake Consultation Exercise (could be done at later stage)

- Confirm schedule for potential long lead items and tailor procurement process accordingly
- Development and application of risk-based maintenance prioritisation principles to support performance at most efficient cost.
- Assess potential application of condition monitoring and predictive maintenance regimes for high criticality assets.
- Undertake analysis of economic benefits of increased service volumes to support a business case for investment.
- Undertake systems assurance process to assess the impact of installing current proposed systems within existing infrastructure system and the impact on future further electrification work.

Appendix A. Option 1a Layout

See Appendix A folder for Option 1a layout drawing.

Appendix B. Option 1b Layout

See Appendix B folder for Option 1b layout drawing.

Appendix C. Option 2b Layout

See Appendix C folder for Option 2b layout drawing.

Appendix D. LCC Breakdown

CAPEX Summary

[redacted]

[redacted]	[redacted]		[redacted]		[redacted]		[redacted]	[redacted]		[redacted]	
[redacted]											
[redacted]											
[redacted]											
[redacted]	[redacted]										
[redacted]											
[redacted]	[redacted]		[redacted]								
[redacted]					[redacted]		[redacted]				
[redacted]											

[redacted]

[redacted]

*Redundant costs - The cost of BEMU infrastructure required that will become redundant and will be surplus to requirements following full electrification of the route.

Note: For Option 1b (which corresponds to TSS1b), this is based on the estimated fleet size requirement of 216 vehicles. For Option 2b (which corresponds to TSS 3), this is based on the estimated fleet size of 196 vehicles.

Note: The use of BEMUs requires extending the turnaround times at Drogheda due to the charging requirement (as opposed to when EMUs are used where no charging is required). This in turn means extra vehicles are required to support the timetable.

Option 1a			
BEMU - OPTION 1 (Rounded to '000's)			
			Cost
-			
-			
1		**Track**	[redacted]
	1.1	P-Way	
	1.2	Signalling	
	1.3	OLE	
	1.4	Electric Power & Plant	
2		**Civils**	
	2.1	OLE Piled Foundations	
3		**Buildings**	
	3.1	New Buildings (Sub-station)	
	3.2	Depot (Associated Works)	
4		**Stabling on Navan Line**	
	4.1	P-Way	
	4.2	Signalling	
	4.3	Civils	
	4.4	Acoustic Barrier	
	4.5	Lighting and CCTV	
	4.6	Landscaping and planting	
		Sub Total	
5	**General Preliminaries**	[redacted]	

Option 1a		
BEMU - OPTION 1 (Rounded to '000's)		
6 Overheads & Profit		[redacted]
	Sub Total	
7 Professional Fees Planning Application		
	Sub Total	
8 Construction Risk and Contingency		
Total Construction Costs		

Option 1b			
BEMU - OPTION 1b (Rounded to '000's)			
			Cost
-			[redacted]
-			
1		**Track**	
	1.1	P-way	
	1.2	Signalling	
	1.3	OLE	
	1.4	Electric Power & Plant	
2		**Civils**	
	2.1	OLE Piled Foundations	
	2.2	Platforms	
	2.3	Raising of Existing Bridge	
3		**Buildings**	
	3.1	New Buildings (Sub-station)	
	3.2	Depot (Associated Works)	
4		**Stabling**	
	4.1	P-Way	
	4.2	Signalling	
	4.3	Civils	
	4.4	Portakabins	
	4.5	Lighting, CCTV & Comms	
	4.6	Landscaping and planting	
		Sub Total	

Option 1b	
BEMU - OPTION 1b (Rounded to '000's)	
5 General Preliminaries	[redacted]
6 Overheads & Profit	
Sub Total	
7 Professional Fees	
Railway Order Application	
Planning Application & Environmental Impact Report	
Sub Total	
8 Construction Risk and Contingency	
Total Construction Costs	

Option 1c

BEMU - OPTION 1c (Rounded to '000's)

			Cost
-			
-			[redacted]
1		**Track**	
	1.1	P-Way	
	1.2	Signalling	
	1.3	OLE	
	1.4	Electric Power & Plant	
2		**Civils**	
	2.1	OLE Piled Foundations	
	2.2	Platforms	
	2.3	Raising of Existing Bridge	
3		**Buildings**	
	3.1	New Buildings (Sub-station)	
	3.2	Depot (includes maintenance equipment and turntable relocations)	
4		**Stabling on Navan Line**	
	4.1	P-Way	
	4.2	Signalling	
	4.3	Civils	
	4.4	Acoustic Barrier	
	4.5	Lighting and CCTV	
	4.6	Landscaping and planting	
		Sub Total	

Option 1c	
BEMU - OPTION 1c (Rounded to '000's)	[redacted]
5 General Preliminaries	
6 Overheads & Profit	
Sub Total	
7 Professional Fees Planning Application	
Sub Total	
8 Construction Risk and Contingency	
Total Construction Costs	

Option 2b

BEMU - OPTION 2b (Rounded to '000's) [redacted]

-

-

1		**Track**	
	1.1	P-way	
	1.2	Signalling	
	1.3	OLE	
	1.4	Electric Power & Plant	
2		**Civils**	
	2.1	OLE Piled Foundations	
	2.2	Platforms	
	2.3	Raising of Existing Bridge	
3		**Buildings**	
	3.1	New Buildings (Sub-station)	
	3.2	Depot (includes maintenance equipment and turntable relocation)	
4		**Stabling**	
	4.1	P-Way	
	4.2	Signalling	
	4.3	Civils	
	4.4	Portakabins	
	4.5	Lighting, CCTV & Comms	
	4.6	Landscaping and planting	
		Sub Total	
5	**General Preliminaries**		

Option 2b	
BEMU - OPTION 2b (Rounded to '000's)	[redacted]
6 Overheads & Profit	
Sub Total	
7 Professional Fees Railway Order Application Planning Application & Environmental Impact Report	
Sub Total	
8 Construction Risk and Contingency	
Total Construction Costs	

Annualised LCC Breakdown

Annual discounted cost breakdown (€Thousand)																			
	Year																		
Option	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1a	[redacted]																		
1b																			
1c																			
2b																			

Annual discounted cost breakdown (€Thousand)																	
	Year																
Option	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1a	[redacted]																
1b																	
1c																	
2b																	

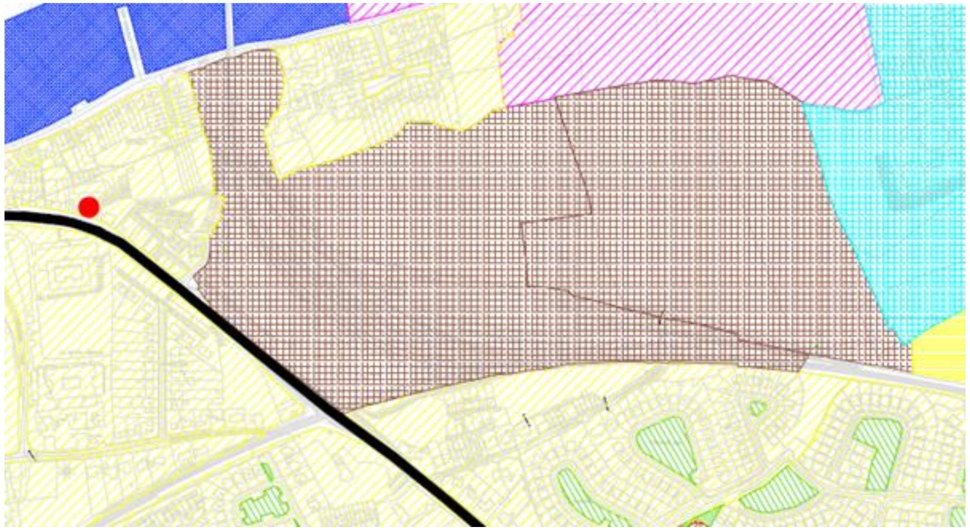
BEMU Infrastructure Study - Hazelhatch Sidings CAPEX				
Group Element		**Base Scenario (2 Sidings)**		**TSS 1b (5 Sidings)**
		Cost		*Cost*
- 1	**Sidings Track and Ancillaries**	[redacted]		
1.1	P-Way			
1.2	Signalling			
1.3	OLE			
1.4	Electric Power & Plant (Inc ESB Connection)			
1.5	Lighting, CCTV & Comms			
2	**Civils**			
2.1	OLE Piled Foundations			
2.2	Upgrade Existing Access Road			
2.3	Car Parking Area			
2.4	Security Fencing			
2.5	Acoustic Barrier			
2.6	Trackside Walking Routes			
3	**Buildings**			
3.1	New Sub-station Building			
3.2	Sub-station Compound and Fencing			
3.2	Portakabins			
	Sub Total			

	Group Element	Base Scenario (2 Sidings)	TSS 1b (5 Sidings)
4	General Preliminaries	[redacted]	
5	Overheads & Profit		
	Sub Total		
6	Professional Fees Railway Order Application Planning Application & Environmental Impact Report		
	Sub Total		
7	Construction Risk and Contingency		
	Sub Total		
8	Inflation (To mid-point of Construction)		
	Total Construction Costs		

Appendix E. Relevant Planning information.

Extracts form the current Drogheda Borough Council Development Plan (DBCDP) 2011-2017 & the emerging Draft Louth County Development Plan (DLCDP) 2021 - 2027

E.1 DBCDP 2011 - 2017 - Drogheda Transport Development Area (DTDA)



Brown Hatched lands = DTDA – Drogheda Transport Development Area

"The wider area surrounding the DTDA within the Borough, together with a larger contiguous area lying within County Meath and referred to as the Mill Road / Marsh Road character area within the Local Area Plan for the Southern Environs of Drogheda 2009-2015, will be subject to the preparation of a Master Plan during the lifetime of the Plan in conjunction with Meath County Council."

*"In the case of Drogheda, Mc Bride Railway Station has been identified in both the Drogheda Transportation Study and the Planning Strategy for the Greater Drogheda Area as being the main public transport hub for the Borough. This transportation hub revolves primarily around the provision of rail services but also attracts significant car borne traffic, cyclists and pedestrians. Due to the fixed route nature of railways, it is vital that the rail service continues to have sufficient critical mass of potential patrons in order to ensure the continued viability of services. In practice this involves the careful siting of major employment generating attractors in close proximity to the rail station. Ease of access by all modes of transport to the station site from more distant locations within the Borough and its environs is also a pre-requisite for the success of a transport hub. Thus, a latent demand for transport services is created and the rail passenger **market** in particular is strengthened by the close spatial matching of origins with destinations and as such, further investment in improving the quality of the rail service itself can be justified."*

DLCDP 2021 – 2027 – J1 ' Transport Development Hub'

The lands in grey are J1 'Transport Development Hub' (which is the current Drogheda Development Transport Area (DDTA) objective).

E.2 Appendix E2. DBCDP 2011 – 2017 Transport Related Policies

Policy TR 9

"To implement the general principles outlined above associated with the Drogheda Transport Development Area. To explore the feasibility in conjunction with Meath County Council, to producing a Master Plan for those lands east of McBride Station bounded to the south by the rail line, to the north by the River Boyne and to the east by the Borough boundary."

Policy TR 12

"Work in partnership with Iarnród Éireann in the provision of upgraded rail facilities at McBride station including extension of the DART service to Drogheda and the provision, in time, of a further rail station and park and ride facility in the northern sector of the town (within County Louth). Co-operate with the railway operator and neighbouring Local Authorities in the event of the proposed re-opening of the Drogheda to Navan rail line to regular passenger traffic. Maintain the abandoned Drogheda Port Rail Link ("Cement Branch") rail alignment for future rail-based use."

Policy TR 13

"Promote and facilitate the development of an Integrated Public Transport Hub (IPTH) at McBride Railway station and facilitate the development of integrated and co-ordinated bus and rail services within the Railway station site."

E.3 Appendix E3. DBCDP 2011 – 2017 Rail

"At present the Borough is served by up to 38 trains per day towards Dublin with an equal number of return services. Drogheda is also a major station on the cross border, Dublin to Belfast intercity route linking the two largest cities on the Island of Ireland. The Dublin to Belfast rail service is due to be upgraded during the course of the Plan, to permit an hourly service on the route. The existing railway station on the southern side of the river is heavily utilised, primarily by commuters to Greater Dublin. In recent years there have been significant capacity constraints in the railway station car park despite a significant expansion of parking on the site. The Planning Authority is presently considering an application to construct a car park along the Marsh Road this will serve Mc Bride Station. The rail station is not served by connecting bus services from other parts of the Borough which only serves to increase pressure on car parking. Many commuters travel from the northern suburbs of the town causing unnecessary vehicle flows at peak hours over the limited amount of river crossings by other means of transport to access the rail station."

1. Drogheda North Railway Station

"*The North Drogheda Environs Master Plan 2005 and the Planning Strategy for the Greater Drogheda Area 2007 both propose the establishment of a second commuter station in Drogheda, serving the expanding Northern Environs area in County Louth on the north side of the river. This would eliminate the need for commuters to travel across the town at peak hours. The proposed station would incorporate park and ride facilities. The creation of this station may necessitate the extension of some services from the Borough including road and pedestrian links. Drogheda Borough Council will co-operate with the railway operator and adjacent Local Authority in order to realise the establishment of a Drogheda North Railway Station."*

2. Drogheda to Navan Railway Line

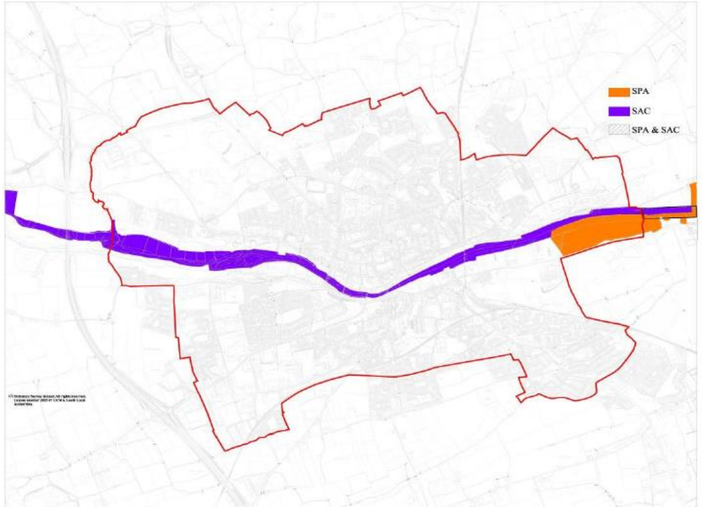
"Drogheda Borough is linked to Navan in County Meath by a freight only rail link. Whilst this line is rarely used by passenger trains, there may be potential in the future for passenger utilisation of sections of this line. The town of Navan is one of three designated Primary Development Centres in the Greater Dublin Hinterland Area. It is not connected directly to Greater Dublin by a rail link at present. However, the town is likely to be reconnected by rail during the course of the Plan. In the interim there is the possibility that a commuter service could be provided from Navan to Dublin via Drogheda."

3. Drogheda Port Rail Link ("Cement Branch")

"A disused but largely intact railway line ("Cement Branch") links the environs of Tom Roe's Point (Cement Factory) to the main rail line north of Drogheda. This link is approximately 1.0 km in length and has remained largely free from development over the course of previous Plans. It has the potential to provide a direct rail-based connection to the Drogheda Port container terminal at Tom Roe's Point in County Louth. This would accord with international policy on encouraging modal shift to environmentally sustainable forms of transport for freight movements, in this case sea and rail. As such, the rail link is of strategic significance. It is the policy of Drogheda Borough Council to maintain this rail alignment for future rail-based use. Whereas the rail service in Drogheda is of strategic importance in economic and transportation terms, the railway line itself can provide a barrier to connectivity between communities and services located on either side of the line. It is therefore important that arrangements are put in place to provide for greater permeability and connectivity across this barrier. Consequently, where development is proposed adjacent to the railway line, the council may require developers to investigate the provision of and where feasible provide, new connections across the line."

E.4 Appendix E4. Nearby SPA/SAC

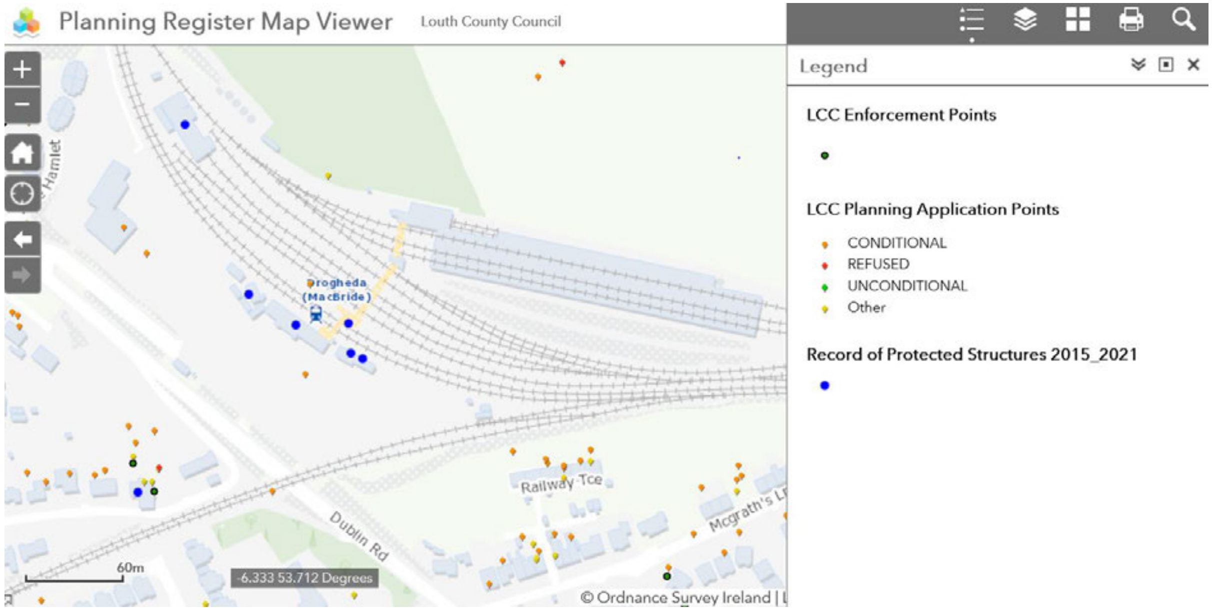
Map 8.1: Special Protection Area and Special Area of Conservation.



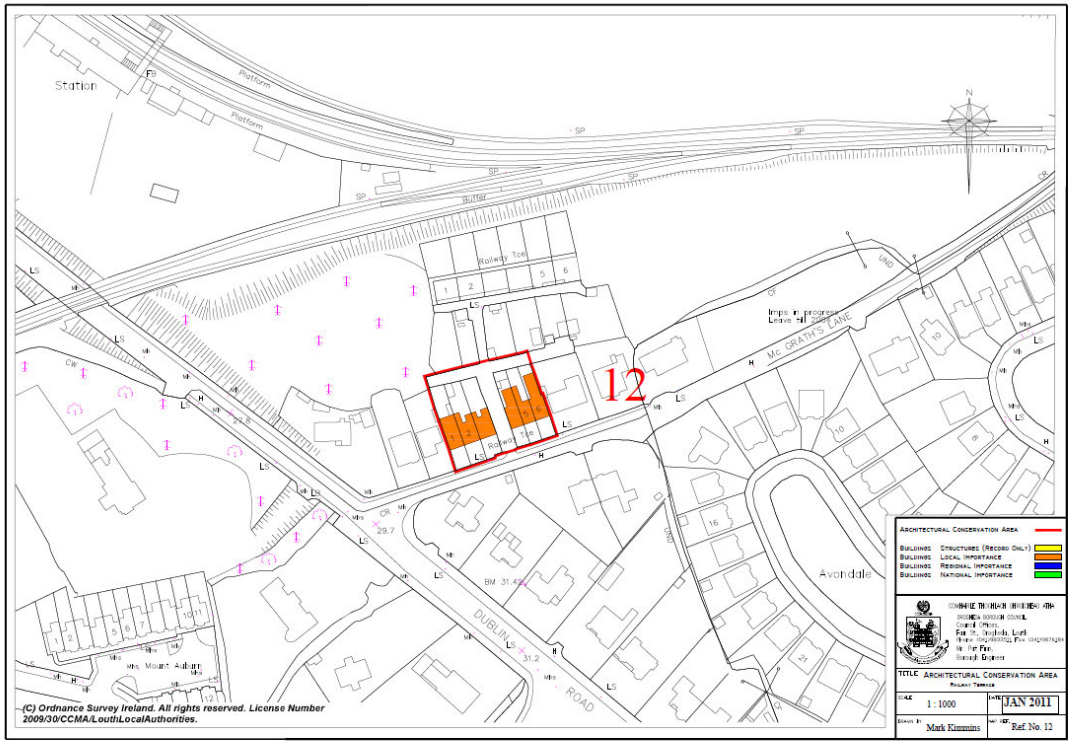
E.5 Appendix E5. Protected Trees

Map 8.4: Areas covered by Tree Survey

E.6 Appendix E6. Record of Protected Structures Buildings



E.7 Appendix E7. Architectural Conservation Areas (ACA)



E.8 Appendix E8. Relevant Planning History

Ref 10510055 (May 2010)
"Development at McBride Railway Station, which is a Protected Structure. Development consists of removal of glass screens and counter to Ticker Office and Waiting Room, introduction of new glass double door to Waiting Room, re-instatement of original arch to Ticket Office, demolition of existing partition wall in Ticket Office & construction of new partition walls in new positions, installations of 5nr automatic ticket gates with associated screens and all associated works."

Required the submission of an "Assessment of the works on the McBride Station" It was considered that the works are minor and will not undermine the character or architectural merit of the building.

Decision: Permission Granted July 2010

Ref 00510255 (November 2000)
ABP Ref PL54.123480
"Construction and operation of an Arrow Fleet Train Servicing Centre, Maintenance Workshop, Administration Building, Single Storey Train Wash Building, workshop, together with associated works and EIS Statement."
Appealed by third parties including the Preservation Society of Ireland (PSOI)
The PSOI were primarily concerned with a proposed relocation and use of the existing turn table on site.

The Inspectors Report sets out that: "*The society's appeal is concerned exclusively with the proposed relocation and use of the existing turn table on site. The society notes that although it is listed as a protected structure in the Drogheda Development Plan it is not "of great heritage value" having been built and installed as recently as the 1940's. Its location in the middle of a car park divorced from any relevant railway infrastructure makes a nonsense of its functional origins and unnecessarily reduces the available car parking area. The society states therefore that the turn table would be better utilised in both heritage and practical terms by relocation and restoration at another site served regularly by steam locomotives where it will be open to view by the public in a working environment.*

In regard to the above, the Inspector stated at paragraph 13.14 " However, as the turntable is a listed structure its relocation off site will require it first to be delisted in accordance with the procedures indicated at Section 6 of the 1999 Local Government (Planning & Development) Act. As the Board does not have any role in such procedures it is unable to acquiesce with any request of the RPSI involving relocation of the turntable to any place outside the boundaries of the site. In that content therefore I am satisfied that the relocation of the turntable to the car park is acceptable."

The inspector continued at paragraph 15.5 to set out that: "With regard to the appeal submission by the RPSI, I note their informed comments on the age, structural integrity and operational potential of the turn table would appear to undermine its status as a listed structure in the current Drogheda Development Plan. However, as the structure is currently a protected structure in the Drogheda Development Plan, and as the Board under the provisions of the 1999 Local Government (Planning & Development) Act does not have any role in the de-listing procedures referred to therein, the relocation of the turntable to an off-site location as suggested by the RPSI is not one which can be acceded to by An Bord Pleanala by way of attached condition. The onsite relocation of the turntable as proposed by the developer is however acceptable. "

The An Bord Pleanala Order sets out at the Second Schedule that 1. "The proposed relocation of the turntable to the car parking area is not permitted. The turntable may be relocated within the site to an alternative location on the rail side of the station building, details to be agreed with the planning authority prior to relocation." Reason: "Having regard to the status of the turntable as a protected structure and to its function, it is considered that its relocation to a car parking area would be contrary to the proper planning and development of the area."

Additional Issues Raised:

- *Dispute over property ownership*
- *Visual Impact*
- *Traffic Impact*
- *Noise Impact*
- *Impact upon Trees*
- *Vermin*

Decision: Permission Granted by ABP September 2001

Appendix F. E&P Details

See Appendix F folder for additional Electrification & Plant details.

Appendix G. OLE Current Calculation

Selection of contact wire and catenary wire

As per standard BS EN 50119 2013, table A.1 - Continuous current-carrying capacity of conductors and contact wires.

The current (AC) carrying capacity for a Cu 107mm^2 is 469A at 30^o C and,

The current (AC) carrying capacity for a Cu 150mm^2 is 583A at 30^o C

To find out the DC equivalent as per standard IEIEC 60287-1-1,

IDC = 2 x IAC

So, for copper wire of107mm^2 the DC current carrying capacity will be 938A at 30^o C

Similarly,

For copper wire of 150mm^2 the DC current carrying capacity will be 1166A 30^o C

So, the total current will be = 2104A

The current required to charge a FLU is 2109.3A (current rating based on E&P calculation).

To get the current of 2109.3A, will have to propose 2nos. of contact wire (2x107mm^2) and 1no. catenary wire(1x150mm^2)

So, total current for a 2 x 107mm^2 + 1x 150mm^2 will be:

Total current = 2x938 + 1166

Total current = 3042A

Appendix H. Bridge Clearance Assessment for OLE

Bridge Clearance Assessment

There are two footbridges within the limit of works, OBB81 on platform area and OBB81C on the depot road. The soffit height for Drogheda Station Footbridge (over platforms 1 & 2)- OBB81 is 4.394m and for Staff Access Footbridge to Depot (over platform 3 and service slabs/sidings)- OBB81C is 5.765m.

As per standard I-ETR-4005 'Clearance Requirement for 1500V DC Electrified line', section 6.1.5, 6.1.6 and 6.1.7 and as per standard I-PWY-1101 'Requirement for track and Structures Clearance', section 7.1.2.2. it has been noted that the minimum contact wire height shall be 4200mm and the maximum permitted height of DART vehicles and all other rolling stock at the centre of the track is 4064mm giving a minimum passing clearance between the vehicle and contact wire of 136mm.

As per standard GL/RT 1210 and BS EN 50119 2013 section 5.1.3, the minimum clearance between live part and earth shown below (extract from BE EN 50119 2013):

Dimensions in millimetres

Voltage	Recommended clearances	
	Static	Dynamic
d.c. 600 V [a]	100	50
d.c. 750 V	100	50
d.c. 1,5 kV	100	50
d.c. 3,0 kV	150	50
a.c. 15 kV	150	100
a.c. 25 kV	270	150

[a] Only for existing systems.

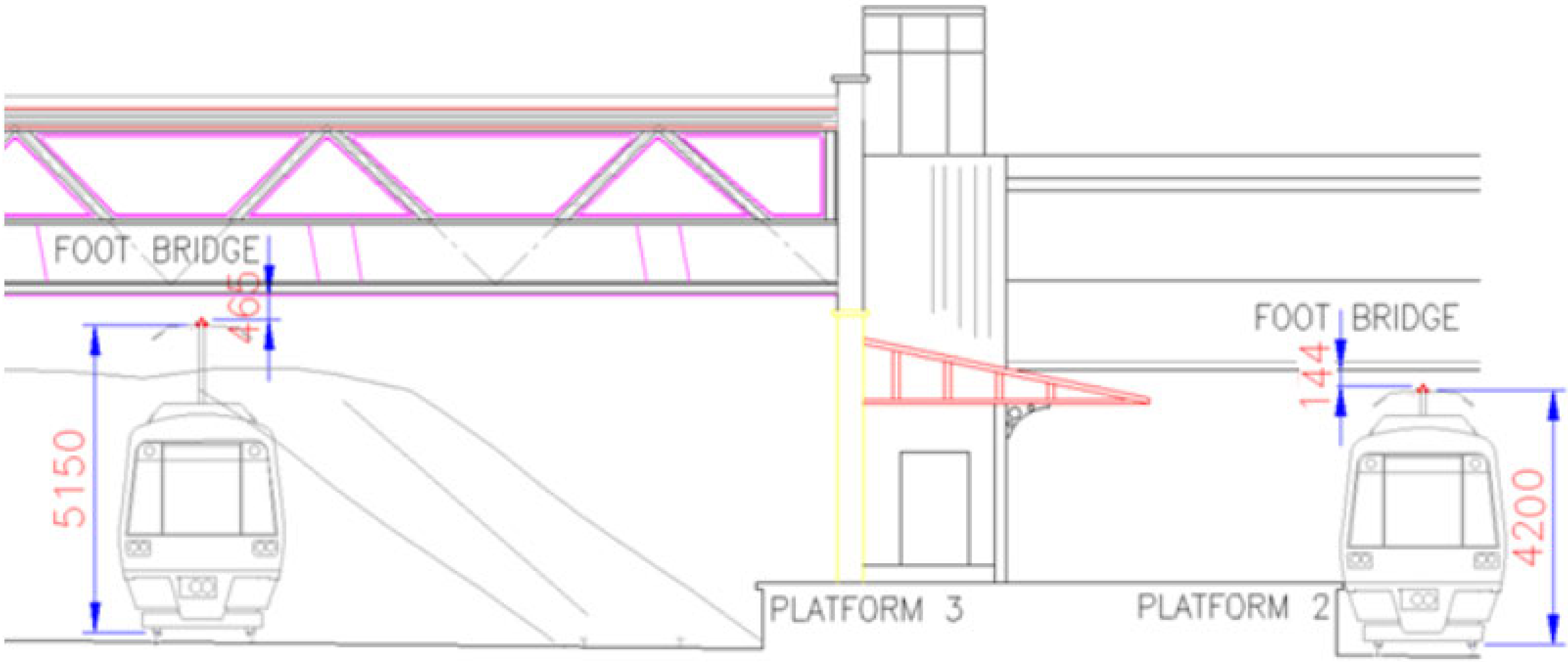
Also, as per standard I-ETR-4005 'Clearance Requirement for 1500V DC Electrified line', section 6.1.13 and 7.1.3 and as per standard I-PWY-1101 'Requirement for track and Structures Clearance', section 7.1.3 and 7.1.4, the static clearance and passing clearance are 150mm and 100mm respectively. The special reduced Static clearance and Passing clearance of 100mm and 80mm limit may only be used in cases of difficulty, the Chief Engineer's written authority must be obtained following notification to the Chief Railway Inspecting Officer.

All bridges which are within contact line zone (as per standard BS EN 50119-2020, BE EN 50122-1 and BS EN 50122-2) are bonded to main earth terminal of the station area to allow a robust earthing system. Detailed Bridge bonding assessment to undertaken at later stages.

All bridges with below 150mm static clearance are bonded to the traction return to allow for a robust earthing system.

Bridge clearance assessment show below at Drogheda station:

The values of the soffit height for the OBB 81 were taken on site on November 2020. By reducing the nominal height of the system and the encumbrance the following electrical clearance can be achieved:



BEMU Station Foot Bridge	Soffit Height (mm)	Contact Wire (mm)	Catenary wire (mm)	Encumbrance (mm)	Static Clearance (mm)
Drogheda Station Footbridge (over platforms 1 & 2)- OBB81	4394	4200	4250	50	144
Staff Access Footbridge to Depot (over platform 3 and service slabs/sidings)- OBB81C	5765	5150	5300	150	465

It can be observed that for the Drogheda Station Footbridge the static clearance is 144mm which is less than the 150mm recommended in the standard. The recommendation is to study the raising of the Station footbridge at the next stage in order that the OLE system can be in compliance.

Note if necessary, for clearance purposes, it would be possible to reduce the encumbrance even further such that the catenary wire will sit just above the two contact wires. (This arrangement would then avoid the installation of rigid droppers.)

Note: the soffit height data considered may not be fully accurate. Different soffit heights will have different solutions to achieved electrical clearances. These are to be undertaken at detailed design stage.

Appendix I. High Level Schedules

See Appendix folder I for high level schedules.

Appendix J. Project Risk Register

See Appendix folder J for Risk Register.

Appendix K. Hazard Elimination and Risk Reduction Register (HERRR)

See Appendix folder K for HERRR document.

Appendix L. Options Matrix

See Appendix folder L for Options Matrix and location sketch.

Appendix M. CAF Matrix

See Appendix folder M for CAF Matrix.

Appendix N. December 2019 Timetable Platform Workings at Drogheda

This Table shows the December 2019 platforming arrangements at Drogheda and the changes required to the rolling stock diagrams if BEMUs replace DMUs on some existing services.

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Use BEMU Stock?	BEMU Diagram	Suggested Change 1	Suggested Change 2	Note
05:40 Dundalk	06:03	2	06:04	Pearse	8 x 29000					
Depot		3	06:28	Pearse	4 x 29000	Yes	1,2	07:55 Pearse – Dundalk terminates Drogheda at 09:03 and forms 09:40 to Pearse	08:40 Connolly – Drogheda empty stock advertised and extended to Dundalk	
Depot		3	06:45	Pearse	7 x 22000	Yes	3,4	07:45 Maynooth - Connolly works 08:23 Pearse - Maynooth (retimed, starts Connolly)	Empty stock stabled at Pearse via 10:19 ex Bray? Return empty stock to Drogheda?	
06:30 Dundalk	06:54	2	06:55	Bray	8 x 29000					
Depot		2	07:05	Bray	8 x 29000	Yes	5,6	Swap Bray departures at16:50 and 17:30 to keep Drogheda diagram self-contained		Use platform 3 at Drogheda
06:30 Newry	07:19	1	07:21	Connolly	7 x 22000					
07:10 Dundalk	07:34	1	07:36	Pearse	8 x 29000					
Depot		3	07:58	Bray	8 x 29000	Yes	7,8	Terminate Connolly 08:58	Forms 09:10 Connolly - Drogheda	
07:35 Connolly	08:09	1	08:11	Belfast	Enterprise					
06:45 Belfast	08:22	1	08:24	Connolly	Enterprise					
07:09 Pearse	08:05	1	08:30	Pearse	8 x 29000					Should be platform 3

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Use BEMU Stock?	BEMU Diagram	Suggested Change 1	Suggested Change 2	Note
07:50 Connolly	08:49	1	09:00	Connolly	4 x 29000	Yes	9,10	Outstabled at Connolly and unable to act as Enterprise standby set if a BEMU	11 minute turnaround time at Drogheda – minor retiming required	Use platform 3 at Drogheda
07:54 Pearse	09:03	1	09:04	Dundalk	4 x 29000					
08+40 Connolly	09+23	2	09:40	Pearse	7 x 22000	Yes	1,2	PM work as booked		
05:35 Rosslare	09:51	1	09:53	Dundalk	4 x 29000					
09:10 Connolly	09:59	2	10:10	Connolly	3 x 22000	Yes	7,8		11 minute turnaround time at Drogheda – minor retiming required	Use platform 3 at Drogheda
09:30 Connolly	10:07	1	10:08	Belfast	Enterprise					
10:15 Dundalk	10:38	2	10:40	Connolly	4 x 29000					
10:50 Dundalk	11:13	2	11:14	Connolly	4 x 29000					
11:20 Connolly	11:54	1	11:55	Belfast	Enterprise					
10:35 Belfast	12:08	2	12:09	Connolly	Enterprise					
11:07 Connolly	12:07	1	12:10	Dundalk	4 x 29000					
10:30 Connolly	11:32	3	12:20	Connolly	4 x 29000	Yes	9,10	09:00 Drogheda – Connolly forms 10:30 Connolly – Drogheda		
12:45 Dundalk	13:08	2	13:10	Connolly	4 x 29000					
11:50 Connolly	12:45	3	13:40	Connolly	8 x 29000	Yes	7,8	10:10 Drogheda – Connolly forms 11:50 Connolly – Drogheda		
13:20 Connolly	13:56	1	13:58	Belfast	Enterprise					
12:35 Belfast	14:08	1	14:09	Connolly	Enterprise					

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Use BEMU Stock?	BEMU Diagram	Suggested Change 1	Suggested Change 2	Note
12:50 Connolly	13:44	2	14:20	Connolly	4 x 29000					
Depot		3	14:50	Bray	8 x 29000	Yes	3,4	Terminate Grand Canal Dock and then work 16:21 Pearse – Drogheda		
13:50 Connolly	14:44	2	15:10	Connolly	8 x 29000	Yes	9,10	formed off 12:20 Drogheda – Connolly	cannot work to Maynooth	
14:05 Belfast	15:41	1	15:43	Connolly	Enterprise					
14:50 Connolly	15:43	2	15:50	Connolly	4 x 29000	Yes	7,8	swaps with 14:47 Connolly – Maynooth at Connolly	works 17:12 Connolly to Ballbriggan – extend to Drogheda? Another set required to work 19:00 Pearse - Maynooth	
15:20 Connolly	15:54	1	15:55	Belfast	Enterprise					
Depot		3	16:02	Pearse	8 x 29000			Cannot then form next working at 18:00 to Dundalk		
15:22 Connolly	16:23	2	16:28	Connolly	4 x 22000					
15:43 Pearse	16:47	2	17:00	Pearse	8 x 29000					
16:50 Connolly		1	*17/28*	Belfast	Enterprise					
16:23 Pearse	17:24	2	17:30	Pearse	8 x 29000	Yes	3,4	very short turnaround at Drogheda		Use platform 3 at Drogheda
16:05 Belfast	17:41	1	17:43	Connolly	Enterprise					
16:53 Pearse	17:56	1	18:02	Pearse	7 x 22000	Yes	1,2	very short turnaround at Drogheda		Use platform 3 at Drogheda
17:13 Pearse	18:21	1	18:22	Newry	8 x 29000					
16:50 Bray	18:38	2	18:50	Pearse	8 x 29000	Yes	5,6			Use platform 3 at Drogheda

Inbound	Arrive	Platform	Depart	Outbound	Rolling Stock	Use BEMU Stock?	BEMU Diagram	Suggested Change 1	Suggested Change 2	Note
16:50 Bray	19:06	1	19:08	Dundalk	8 x 29000					
19:00 Connolly	19:33	1	19:35	Belfast	Enterprise					
18:05 Belfast	19:41	1	19:43	Connolly	Enterprise					
18:50 Connolly	19:44	2	20:00	Pearse	8 x 29000					
19:23 Pearse	20:25	2		Depot	7 x 22000		1,2			Use platform 3 at Drogheda
20:40 Dundalk	21:03	1	21:05	Pearse	8 x 29000					
20:15 Pearse	21:21	2		Depot	8 x 29000					
20:50 Connolly	21:29	1	21:30	Belfast	Enterprise					
20:05 Belfast	21:41	1	21:43	Connolly	Enterprise					
20:46 Pearse	21:50	2		Depot	8 x 29000					
18:24 Pearse	19:24	2	22:05	Connolly	8 x 29000					
21:40 Pearse	22:47	2		Depot	8 x 29000					
22:40 Pearse	00:07	3		Depot	8 x 29000					
23:35 Pearse	01:10	3		Depot	7 x 22000					

Appendix O. Indicative Timetable for TSS 1b Fleet Size Calculation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	2	21
Drogheda	06:10	06:17		06:41	06:46	06:50		07:10	07:17		07:41	07:46	07:50		08:10	08:17		08:41	08:46	08:50		09:10
Clongriffin			07:01				07:29			08:01				08:29			09:01				09:29	
Bray	07:43	07:51	08:02	08:15	08:18	08:23	08:30	08:43	08:51	09:02	09:15	09:18	09:23	09:30	09:43	09:51	10:02	10:15	10:19	10:23	10:30	10:43
	16	15	10	19	20	18	14	22	21	17	23	24	1	2	3	4	5	6	7	8	9	10
Bray	06:14	06:22	06:34	06:42	06:50	06:54	07:02	07:14	07:22	07:34	07:42	07:50	07:54	08:02	08:14	08:22	08:34	08:42	08:50	08:54	09:02	09:14
Clongriffin			07:32				08:00			08:32				09:00			09:32				10:00	
Drogheda	07:45	07:53		08:13	08:23	08:25		08:45	08:53		09:13	09:23	09:25		09:45	09:53		10:13	10:23	10:25		10:45
forms	*08:17*	*08:10*	*08:01*	*08:46*	*08:50*	*08:41*	*08:29*	*09:17*	*09:10*	*09:01*	*09:46*	*09:50*	*09:41*	*09:29*								

Appendix P. Indicative Diagrams for TSS 3

	1	2	3	4	5	6	7	8	9	10	11	3	4	12	13	14	15	16	18	11	3	17	19	20
Drogheda	06:07	06:23	06:27			06:35	06:51	06:55	07:07	07:23	07:27			07:35	07:51	07:55	08:07	08:23	08:27			08:35	08:51	08:55
Clongriffin				07:04	07:12							08:04	08:12							09:04	09:12			
Connolly			07:16	07:20	07:28			07:45			08:16	08:20	08:28			08:45			09:16	09:20	09:28			09:45
Connolly																								
Bray	07:41	07:58				08:10	08:25		08:41	08:58				09:10	09:25		09:41	09:58				10:10	10:25	
	16	17	3	4	18	19	20	5	21	8	11	3	22	1	2	4	6	14	18	11	7	9	10	3
Bray	06:27				06:39	06:55	07:11		07:27				07:39	07:55	08:11		08:27				08:39	08:55	09:11	
Connolly																								
Connolly		07:15	07:35	07:42				07:58		08:15	08:35	08:42				08:58		09:15	09:35	09:42				09:58
Clongriffin			07:51	08:00							08:51	09:00							09:51	10:00				
Drogheda	07:59	08:05			08:11	08:30	08:43	08:46	08:59	09:05			09:11	09:30	09:43	09:46	09:59	10:05			10:11	10:30	10:43	10:46
forms	*08:23*	*08:35*			*08:27*	*08:51*	*08:55*	*09:07*	*09:23*	*09:35*			*09:27*	*09:51*										

Appendix Q. RFIs and TQs

See Appendix folder Q for RFIs and TQs raised on the project.

Appendix R. Manufacturer / Installers

Discipline	Manufacturer/ Installer
E&P- HV Switchgear	[redacted]
E&P- Transformer	[redacted]
E&P- Rectifiers	[redacted]
E&P- DC High speed circuit breaker	[redacted]
E&P- DC Switchgear	[redacted]
E&P- cables	[redacted]
E&P- Battery Buffer	[redacted]
E&P- Lighting	[redacted]
Telecoms-CCTV	[redacted]
OLE	[redacted] [redacted] Approved installer by Irish Rail

Appendix S. Assumptions

Discipline	Assumption	Relevant Scenarios
E&P	ESB can supply the base option from Mornington Road without Grid reinforcement.	Base Scenario
E&P	Mornington Road is assumed to provide 10KV 3-phase supplies	All Scenarios
E&P	20% spare capacity is not required to be applied to the substation capacity as due to the high capacities.	All Scenarios
E&P	All costings are approximate or based on liaison and need to be confirmed at the subsequent design stage.	All Scenarios
E&P	Under the proposals outlined on Option 2b, supply cables will be routed through the new platform.	TSS 3
E&P	For the sizing and specification of the proposed transformers, unity power factor is assumed.	All Scenarios
E&P	The battery buffer is assumed to operate in tandem with the grid connection and smooth the supply peaks. It assumed the battery buffer will be charged during operation.	TSS1b and TSS3
E&P	Lighting and CCTV for the Navan Stabling is serviced by the Station supply.	Base Scenario
E&P	The stabling in the field will require a new supply for lighting, building domestic and telecoms power.	TSS1b and TSS3
E&P	The Existing signalling power has the capacity to service the new stabling in the field.	TSS1b and TSS3
Environment	Assumed that a Railway Order is only required for Options 1b & 2b as they require third party lands for additional stabling. Option 1a (or 1c) does not require third party lands and a planning application to Louth	TSS1b and TSS3

	County Council is considered the most appropriate mechanism. Assumed that and EIA will be screened out for Option 1a and that an environmental report to support any application is sufficient. However, an EIA will be required for Options 1b & 2b as they trigger Railway Order; Assumed there will be no impacts upon the SPA/SAC; Assumed that further development can be accommodated in close proximity to existing Protected Structures; Assumed that the relocation of the turntable can be accommodated; Assumed that the proposed development taken forward is fully compliant with the aims/objectives of the current Drogheda Borough Council Development Plan (DBCDP) 2011 – 2017 and the emerging Draft Louth County Development Plan 2021 – 2027; Assumed that the principle of works on the Navan Line is acceptable and will not compromise the objectives of the Drogheda Borough Council Development Plan (DBCDP) 2011 – 2017 or the emerging Draft Louth County Development Plan 2021 – 2027.	Base Scenario All Scenarios All Scenarios All Scenarios All Scenarios TSS3
Depot	BEMU servicing and light maintenance will be undertaken at Drogheda for a period of about three years, until the new depot at Maynooth opens. Thereafter, servicing of BEMUs will be undertaken at Maynooth. The additional equipment that is required for both light and heavy maintenance and major component changes on the new fleet is included in the Special Tools provided by the train supplier. During the first three years, no overhauls or changes of major	All Scenarios All Scenarios

	components (heavy maintenance) on the BEMUs will be scheduled. Due to the range of vehicles lifted at Inchicore, this work on the BEMUs will be possible there. An Automatic Visual Inspection System (AVIS) will not be provided at Drogheda as this will be built into the infrastructure of Maynooth depot. The additional equipment required for access to roof-mounted equipment for light maintenance is assumed not to be included in the Special Tools provided by the train supplier. The HVAC modules on the BEMUs are similar in concept to those fitted on DMUs. The train wash at Drogheda has roof brushes. By the time either of scenarios 1b or 3 will be implemented, the new depot at Maynooth will be open.	All Scenarios All Scenarios All Scenarios All Scenarios All Scenarios All Scenarios TSS1b and TSS3
QS - OPEX	Inspection of similar components completed simultaneously rather than separately to provide operational efficiency. E.g. wiring assets.	All Scenarios
	Visual inspection to OLE wiring assumes visual inspection of structures completed at the same time to provide operational efficiency.	All Scenarios
	OLE Ground Inspection conducted 7 times a year based on a 7-weekly interval.	All Scenarios
	Height and Stagger survey assumes half a day to inspect up to 16 structures to account for site induction and access.	All Scenarios

	Assumes installation of ballasted track to new sidings requiring tamping on a 5-yearly frequency with all switches and track treated together for operational efficiency.	TSS 1b and TSS 3
	Battery Buffer renewal assumed a every 9 years.	TSS1b and TSS3
	Assumes Lighting and CCTV installation inspection requirement is approximately 2.5 times greater in options 1b and 2b than Option 1a due to greater volume and size of installation area.	TSS1b and TSS3
	It is assumed that there are no catastrophic failures requiring full asset renewal before the end of design life i.e. assets last entire lifetime.	All Scenarios
	It is assumed that maintenance activities occur in half, or full day increments to account for induction, and site access requirements.	All Scenarios
	Structures renewal assumed at 41 years and every 40 years thereafter based on estimated design life of 40-45 years. As such no renewal is incurred within the period of analysis.	All Scenarios
	Wire renewal frequency assumed at 26 years and every 25 years thereafter based on estimated design life of 20 -30 years.	All Scenarios
	OLE Switches renewal assumed at 41 years and every 40 years thereafter based on estimated design life of 40-45 years. As such no renewal is incurred within the period of analysis.	All Scenarios
	Traction substation renewal frequency assumed in year 36 and every 35 years thereafter based on estimated design life of 35 years. As such no renewal is incurred within the period of analysis.	All Scenarios
	Track and switching assets assume a design life of 40 years. As such no renewal is incurred within the period of analysis	All Scenarios

	Hourly rate for engineers assumed at [redacted]/ hour based on benchmarking for comparable works in the UK and Republic of Ireland.	All Scenarios
	Asset renewals costs are assumed to be the same as initial installation.	All Scenarios
	Assumes additional car parking and access road are subject to annual visual inspection.	TSS1b and TSS3
	OLE Wiring elements accounts for [redacted] of overall OLE installation cost.	All Scenarios
	Inspection of similar components completed simultaneously rather than separately to provide operational efficiency. E.g. wiring assets.	All Scenarios
	Visual inspection to OLE wiring assumes visual inspection of structures completed at the same time to provide operational efficiency.	All Scenarios

Appendix T. Additional Stabling Layout

See Appendix folder T for drawing showing the possible additional stabling layout.

Appendix U. Planning Consideration of Additional Stabling Lands (Outside Irish Rail Ownership)

Both the DLCDP and the current DBCDP support the principle of public transport uses as well as other mixed uses in the DTDA Zoning objective under the current Plan and the J1 Transport Development Hub under the emerging plan. The DTDA and J1 objectives appear to encompass the existing Railway Station lands as well as those further to the north (See Appendix E).

However, the subject lands currently selected for the new stabling are [redacted]

As the proposed stabling is on lands is outside Irish Rail ownership it may require the submission of a Railway Order Application to An Bord Pleanala which would trigger the need for an Environmental Impact Assessment Report (EIAR). Before taking this site forward, Irish Rail would need to have undertaken a very robust options assessment where all other sites adjoining and within lands zoned favourably for such uses has been discounted. [redacted]

However, if a similar sized site was taken forward in the DTDA or emerging J1 zoning objective lands it's likely to meet with less objection in regard to the principle of the proposed use. Pre-Application Consultation with An Bord Pleanala as well as Louth County Council should be undertaken at an early stage and well in advance of any application or preparation of EIAR. [redacted] If the principle of the stabling is accepted by An Bord Pleanala/Louth County Council then any application would need to be cognisant of potential impacts upon residential amenity. Boundary planting and a buffer between the use any existing or proposed residential uses should be included in the layout. The EIAR would also need to consider noise, air, dust, and visual impacts among others.

Planning History ([redacted])

[redacted]

[redacted]

[redacted]

[redacted]