Chapter 5
Construction Strategy

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5. CONSTRUCTION STRATEGY

5.1 Introduction

This chapter describes the construction programme, phasing and construction methodology of the proposed DART+ West project. It details the activities required for the construction of the DART+ West project following the structure set out in Chapter 4 of this EIAR, which divides the project into six different zones, from Zone A to Zone F. The zones are ordered from east to west and are defined in Figure 5-1.

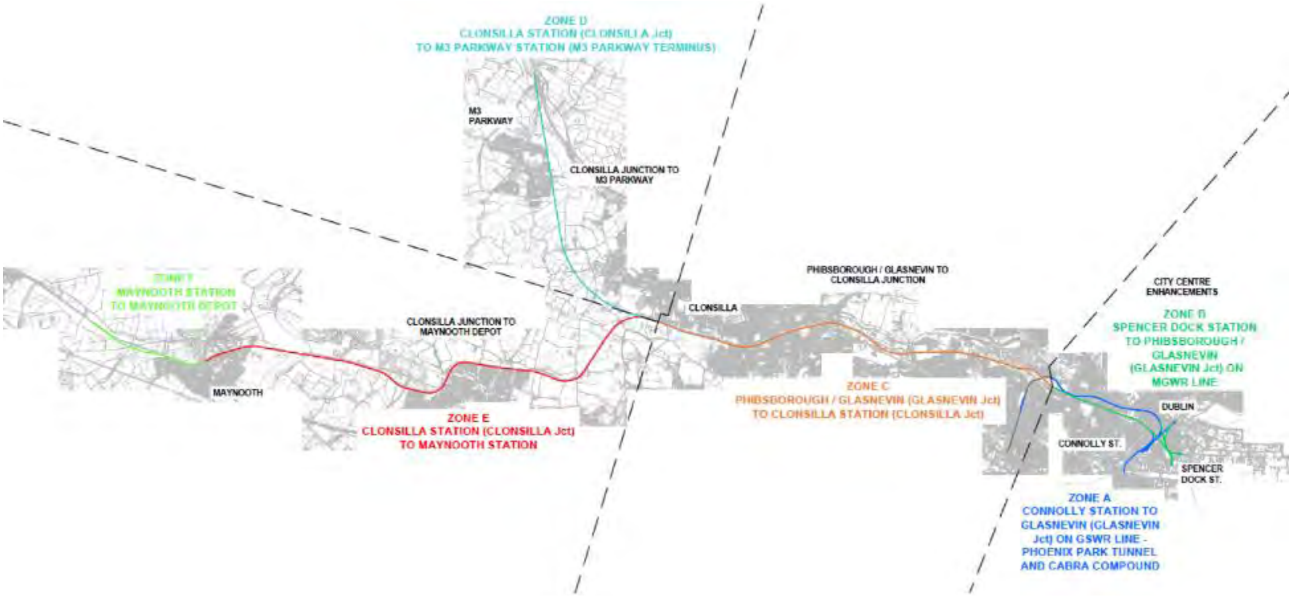


Figure 5-1 DART+ West geographical zones

The contents of the chapter are as follows:

- The construction programme and phasing of works.
- Description of project wide works and construction methodologies.
- Description of construction methodologies required within each of the zones described from east to west (Zones A-F).
- An overview of the Construction Environmental Management Plans required as part of the project.
- Testing and commissioning of the system.

5.1.1 Sustainable construction principles

Iarnród Éireann is committed to contributing to the achievement of the United Nations Sustainable Development Goals (SDGs) and together with the CIÉ Group of Companies has developed a Sustainability Strategy that coordinates actions that assist in addressing national economic, social and environmental challenges.

The key themes used as a focus while designing the project include:

- Avoid, mitigate and if not possible reduce the adverse effects on communities during the construction of the project.
- Reduce the carbon footprint of the project during the design, construction, and operation and encourage more sustainable transport modes.
- Support for cleaner energy and lower emissions through implementation of an electrically powered fleet.
- Facilitating population and sustainable development growth, and a low carbon climate resilient economy.

- Designing for resilience against future demand changes and climate needs.
- Minimising waste during construction of the project, while focusing on using sustainable and reusable materials and construction methods.

These key themes will be considered throughout the entire duration of the construction of the project using the following enabling measures:

- Ensuring a clear plan detailing goals related to each stage of the construction process beginning from the development stage and ending at the maintenance and ultimately, a renewal stage.
- Ensuring that sustainability precedes the construction process during the procurement process and the partners associated with that stage.
- Allowing and encouraging innovation during the construction process and ensuring sustainable measures are safely and efficiently implemented in the later stages of the project.
- Working with local communities and publicly sharing information regarding the project's sustainability measures while remaining open to accepting and implementing feedback.

5.2 Construction Programme

The Construction phase of the proposed development will be approximately 47 months in duration. The construction programme has been developed considering efficiency of works and to reduce the potential for environmental impacts. The approximate duration of the main activities are as follows:

• Spencer Dock	39 months
• Connolly Station	18 months
• SET	32 months
• Civil, Track and Building Works	29 months
• Depot	39 months

The high-level indicative construction programme is set out in Figure 5-2 below identifying the key construction phases and likely construction years.

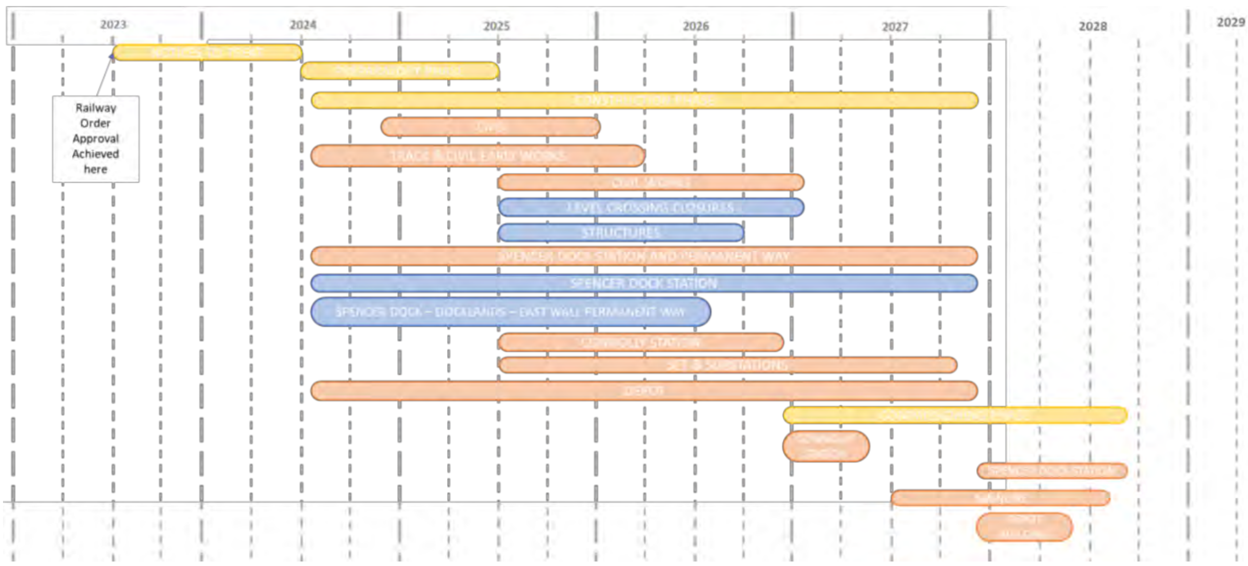


Figure 5-2 Indicative construction programme for DART+ West

5.2.1 Construction working hours

A key consideration in the design of the construction strategy and programme is the requirement to reduce the impact on the operation of the railway line and hence, to maintain rail services for passengers. The construction works range from those that are located outside of the railway boundary (thus, having no impact or minimal impact on train operations) to those that will require a temporary closure of a section of railway line normally during night-time works or weekend possessions to limit the impact on rail services.

The possession times may vary across the routes and the current IÉ Working Timetable should be followed at construction stage. The times listed below are indicative and the proposed working hours will be finalised at detailed design and construction planning stage.

The proposed construction working hours for the project are as follows:

Daytime:

- Monday to Friday: 12 hours. From 07:00 to 19:00.
- Saturday: 6 hours. From 07:00 to 13:00.
- Sunday/Bank Holidays: none except where agreed in advance with the local authority and CIÉ or as part of a possession/closure.

Night-time & weekend possessions (note hours indicate times when track is physically closed to allow for the works, but there will be additional time for mobilisation/demobilisation activities outside of the hours listed below):

- Night-time track possession (weekdays): 4-hours. From 01:00 to 05:00.
- Night-time track possession (Saturday nights): 6-hours. From 01:00 to 07:00.
- Full weekend track possession: 52 hours. Saturday 01:00 to Monday 05:00.
- Bank holiday weekend track possession: 76 hours. Saturday 01:00 to Tuesday 05:00.
- Total closure: 24 hours per day for a specified duration.

Any restrictions to construction working hours associated with major events in the area of works will be agreed with Local Authorities and An Garda Siochana. In addition, a Noise and Vibration Management and Control Plan will be included as part of the final CEMP and this will include for specific working hour and mitigation measures at sensitive locations.

Regarding the working hours of the construction compounds, these will be operational 24/7 in order to service the various worksites.

A schedule of indicative working hours and the corresponding construction location/activity is provided in Table 5-1.

Table 5-1 Schedule of working hours

Location/Activity	Working Hours
Stations	
Spencer Dock	Construction works are scheduled for daytime working hours over 5.5 days per week. Track works involving operational tracks will be performed during night-time possessions.
Connolly	Construction works are scheduled for daytime working hours over 5.5 days per week. The operations relating the structural openings will be carried out during night-time/weekend possessions. Track works involving operational tracks will be performed during night-time/weekend possessions.
Ashtown	Construction works are scheduled for daytime working hours over 5.5 days per week. Pedestrian bridgeworks over tracks will be performed during night-time/weekend possessions.
Coolmine	Construction works are scheduled for daytime working hours over 5.5 days per week. Pedestrian bridgeworks over tracks will be performed during night-time/weekend possessions.

Location/Activity	Working Hours
Permanent Way	
Changes to track vertical alignment	Full weekend possessions and total closure for some specific activities. • The proposal for the track lowering on the MGWR line (from OBD226 Newcomen Bridge to OBD221 Glasnevin Maintenance Bridge) requires extended closure of this railway section for 10 weeks. • The track work (including lowering of OBD227) from the west of OBD227 to the Structure C at Spencer Dock will requires 1 month closure. • The rail section from OBO36 (Ossory Rd) to the North Wall area: the proposed civil and track works are located on the railway and will require the closure of this connection. • The track lowering (except the one on the MGWR line previously mentioned), due to their localised extensions, can be executed during weekend track possessions. • Spencer Dock track realignment (both vertical and horizontal) will require an extended closure of the current connection to the GSWR line of 2.5 weeks (see Section 5.5.7 for further details). The remaining works can be completed during daytime working hours over 5.5 days per week if Safe Working Area (reference IE Rule Book) can be maintained. Where this is not possible, works will be completed during night-time/weekend possessions.
Changes to horizontal alignment	• Clonsilla Siding: Construction works are scheduled for daytime working hours over 5.5 days per week. Railway line is very close. If Safe Working Area (reference IE Rule Book) cannot be achieved, works must be carried out during night-time/weekend possessions. • Maynooth Siding: Construction works are scheduled for daytime working hours over 5.5 days per week. Railway line is very close. If Safe Working Area (reference IE Rule Book) cannot be achieved, works must be carried out during night-time/weekend possessions. • Maynooth Track Doubling: weekend possessions and night-time possessions. • New double track diversion at Jackson's Bridge: Construction working hours are scheduled for 5.5 days per week. • M3 Parkway: Construction works are scheduled for daytime working hours over 5.5 days per week. Siding is very close to the railway line. If Safe Working Area (reference IE Rule Book) is not achieved, works must be carried out during night-time/weekend possessions.
Retaining walls	Construction works are scheduled for daytime working hours over 5.5 days per week. If Safe Working Area (reference IE Rule Book) is not achieved, works must be carried out during night-time/weekend possessions.
Drainage	Construction works are scheduled for daytime working hours over 5.5 days per week/night-time possessions. Works on the track area are to be carried out primarily during night-time/weekend possessions. Works on the MGWR track area are to be carried out primarily during the 10 week closure for the track lowering on the MGWR line.
Fencing	Construction works are scheduled for daytime working hours over 5.5 days per week. If Safe Working Area (reference IE Rule Book) is not achieved, works must be carried out during night-time/weekend possessions.
Cable Management System	Construction works are scheduled for daytime working hours over 5.5 days per week and night-time/weekend possessions. Works on the track area are to be carried out primarily during the night-time possessions. At some locations such as the stations, works may be able to be carried out during construction working hours.
Electrification of the network	
Overhead Electrification System (OHLE) support	Night-time/weekend possessions (preparatory works to be performed 24 hours per day seven days per week at construction compounds).
Traction Power and Signals	Night-time/weekend possessions (preparatory works to be performed 24 hours per day, seven days per week at construction compounds).
Substations	Construction works are scheduled for daytime working hours over 5.5 days per week/Night-time/weekend possessions for some activities.
Other Electrical Buildings	Construction works are scheduled for daytime working hours over 5.5 days per week/Night-time/weekend possessions for some activities.

Location/Activity	Working Hours
Structures	The reconstruction/lift of overbridge decks will mean a localised impact on rail traffic for the works located on the railway. These tasks will be carried out during night-time or weekend track possessions.
Bridges	Construction works are scheduled for daytime working hours over 5.5 days per week. Bridge works over tracks to be performed during night-time/weekend possessions. Full line closures are required at some locations.
Parapets	Construction works are scheduled for daytime working hours over 5.5 days per week. For parapets heightening and OBD228 bridge reconstruction, the work will be carried out during daytime. For bridges with proposed new parapets above railway (OBG23A, OBG5, OBG11, OBG14, OBG9, OBG16), most work will be carried out during daytime and additionally some night-time possession work may be required.
Level Crossing Replacements	
Ashtown	Ashtown Road Realignment Works Main Works - Construction works are scheduled for daytime working hours over 5.5 days per week. Works in public carriageway – In accordance with Local Authority restrictions on working hours. Works on the underpass may be required to be completed during night-time possessions. Pedestrian and Cycle Bridge Works Construction works are scheduled for daytime working hours over 5.5 days per week. Pedestrian bridgeworks over tracks will be performed during night-time/weekend possessions.
Coolmine	Roadway and Junction Works Main Works – Construction works are scheduled for daytime working hours over 5.5 days per week. Works in public carriageway (requiring closure of lanes etc.) – in accordance with Local Authority restrictions on working hours. Pedestrian and Cycle Bridge Works Construction works are scheduled for daytime working hours over 5.5 days per week. Pedestrian bridgeworks over tracks will be performed during night-time/weekend possessions.
Porterstown	Roadway and Junction Works Main Works – Construction works are scheduled for daytime working hours over 5.5 days per week. Works in public carriageway (requiring closure of lanes etc.) – in accordance with Local Authority restrictions on working hours. Bridge Works Approach ramps - Construction works are scheduled for daytime working hours over 5.5 days per week. Bridge over rail line – Night-time possessions/weekend possession.
Clonsilla	Roadway and Junction Works Main Works – Construction works are scheduled for daytime working hours over 5.5 days per week. Works in public carriageway (requiring closure of lanes etc.) – in accordance with Local Authority restrictions on working hours. Bridge Works Approach ramps - Construction works are scheduled for daytime working hours over 5.5 days per week. Bridge over rail line – Night-time possessions/weekend possession
Barberstown	Roadway and Junction Works Main Works – Construction works are scheduled for daytime working hours over 5.5 days per week. Works in public carriageway (requiring closure of lanes etc.) – in accordance with Local Authority restrictions on working hours.

Location/Activity	Working Hours
	Bridge Works Approach ramps - Construction works are scheduled for daytime working hours over 5.5 days per week. Bridge over rail line – Night-time possessions/Weekend possession.
Depot and compensation storage area	Construction works are scheduled for daytime working hours over 5.5 days per week. Track connection works – Night-time possessions/weekend possession.

5.2.2 Indicative construction durations (installation rates) – main works

Indicative installation rates for repetitive/linear elements of the main works are summarised and described below. These durations are indicative based on similar projects and conditions.

Track lowering: The works on the double track lowering are scheduled to occur during planned weekend possessions. It will only be possible to lower one track at a time (per weekend possession) so that the remaining track can be utilised moving materials to and from the site. A single track can only be lowered to a maximum depth of 30-40 cm at a time so that the other track remains on stable footing. If a track section is required to be lowered more than 30-40 cm then the track lowering will take place over multiple weekend possessions, alternating between lowering one track by 30-40 cm one weekend, then lowering the other track by 30-40 cm the next weekend, and so on until the required lowering depth has been achieved. It is essential to optimise as many work teams as possible at either ends of the track works to maximise efficiency and reduce the number of possessions required.

The track lowering rates are:

- Installation of 150 – 200 m in a 48h per weekend possession (to a maximum depth of 30-40 cm).
- Installation of 75 – 100 m in a 24h-weekend possession (to a maximum depth of 30-40 cm).

Installation of new track (superstructure): Installation rate is approximately:

- 400 m per weekend from both sides of the track in a 48h weekend possession.
- 200 m per weekend from both sides in 24h weekend possession.

OHLE and HV installation:

- During night possessions and weekend possessions, the installation rate is approximately 150 – 200 m of OHLE per week.
- During total possessions, the rate of installation increases to approximately 750 m per week.

Substation: For the construction of all substations these will take place over approximately 8-month period (including enabling works), to include:

- Enabling works: 2 weeks
- Civil works and architecture: 18 weeks
- Equipment installation, cabling and connections: 12 weeks

Signalling and Comms (CMS and cable installation):

- Civil works (installation ducts): rates according to different type of CMS as per Section 5.3.7.
- Cable installation: 60-100 m per night. As the cable drums are bigger, the drums can be stored in the nearest SET compound or in the contractor’s facilities.
- Connection and configuration interlocking and site elements: 2-3 months (this time assumes a medium section of 5 km and several sections can be done in parallel, with different teams).

Railway fencing: The considered average installation rate is 20 m of fence per day per team.

5.2.3 Indicative construction durations - early works

Works that require to be carried out early in the construction programme in order to allow other works to commence will include, but are not limited to: structural surveys, ground investigations, site inspections to inform detailed design, structural condition surveys, tree surveys, application for licences as required i.e. derogation licence, archaeological surveys/monitoring, some key utility diversions, site clearance etc. Some of these potential activities are described in sections below.

Key early works include:

- North wall permanent facilities relocation to East Wall yard — 4 months
- Compound installation at Spencer Dock — 1 month
- Sheriff St. Access ramp — 4 months
- Key utilities diversions (see note below) — Various
- Track lowering (excluding MGWR line) — 15 months
- Cable Management System — 14 months
- Spencer Dock piling and earthworks — 7 months
- Depot access road works — 11 months

Utilities diversions that are included in the early works consist of significant diversions required to facilitate large-scale works such as those in the depot area and Spencer Dock area. Communication with utility providers and local authorities and non-intrusive surveys will also be carried out during the early works.

5.2.4 Construction programme assumptions

The structure of the construction programme is based on the following assumptions:

- Railway Order (RO) and construction tender documents preparation are simultaneous processes to be developed in 2022.
- The duration of the Construction contract award phase is estimated to be finalised in one year.
- An additional four month-period is allowed for to update the tender documents following RO approval by An Bord Pleanála.
- A unique contract award date has been considered for all the construction packages.
- As for the form of contract, all the packages are considered to be Design and Build contracts, apart from the track works which will be completed by Iarnród Éireann. However, some specific elements of the detailed design are planned to be completed ahead of contract award by a consultant appointed by IE to allow for construction works to commence soon after contract award to meet the proposed programme.

5.2.5 Construction programme constraints

The most relevant constraints that determine the duration of the works are:

- The construction working hours, defined in the previous section (the short period for night-time track works is particularly important, impacting on the development of the works).
- The need to construct the new OBG23A and a local road serving as depot access route to the construction of the depot.
- The long duration of the depot works.
- Navigation restriction for approximately four months over the Royal Canal. Generally, works can be undertaken in the canal from 31st October to 17th March.

Other significant constraints to the construction programme are as follows:

- The track lowering on the MGWR line (from OBD226 to OBD221) is proposed to be conducted during an extended 10 week closure of the rail traffic. Mitigation measures such as alternative timetables or bus connections are proposed for rail passengers.

- A second extended closure of 1 month is proposed for the track lowering at OBD227 and the connection of MGWR with the Spencer Dock area.
- Track works in the Spencer Dock area will require an extended closure of 2.5 weeks in the GSWR-East Wall yard connection.
- As for the new structures allowing the level crossing closures, two have a significant temporary impact on navigation on the following Royal Canal sections: the Clonsilla pedestrian/cyclist overbridge, with navigation closure estimated to be four months and the Ashtown underpass, requiring navigation closure for an estimated period of six months.
- Works at the junctions of Clonsilla Road/Diswellstown Road, Diswellstown Road/Porterstown Road and Castleknock Road/Park Lodge must be completed prior to the closure of the Coolmine level crossing and the Porterstown level crossing.
- The works at the Castleknock Road/Park Lodge junction should be undertaken at the same time as the closure of the Castleknock Bridge.
- The proposed Barberstown overbridge and approach roads should be completed and operational prior to the closure of the Clonsilla level crossing and Barberstown level crossing.
- Works for overbridge modifications present a constraint for the catenary installation on the section where they are located; although the OHLE masts positioned before and after the structure can be constructed independently from the overbridge works, the wire installation should be done after the deck reconstruction to avoid interference of the wires with the deck operations.
- The execution of the Glasnevin substation civil works will occur during the summer months to minimise the impact on St. Vincent's school and sports grounds.
- Site clearance including vegetation removal will take place between September and February inclusive to avoid nesting birds (if vegetation removal is required between March and August inclusive the area shall be checked by the Ecological Clerks of Works (ECoW); if nesting birds are found, the works will be postponed until the chicks have fledged, or alternatively advice will be sought from the NPWS).
- Considerations of changing from the existing SET systems to the new SET systems and the staging requirements involved in this process with need to be carefully considered.

5.3 Project Wide Construction Works and Methodologies

A description of the project is provided in Chapter 4 'Description of the Proposed Development' and is not repeated in this chapter. This section describes the scope of construction works that are either required in multiple areas (e.g. construction of substations, compounds, bridges etc.) or general linear works (e.g. Permanent Way, fencing, power systems etc.). The associated construction methodologies and indicative construction programme are included in this section for the following works:

- Surveys and licences.
- Site clearance.
- Construction compounds.
- The Main Storage and Distribution Centre (MSDC).
- Utility diversions.
- Permanent way (track works).
- Cable Management System (CMS).
- Bridges.
- Signalling, Electricity and Telecommunications (SET) systems.
- Fencing and boundary treatment.
- Vegetation clearance.
- Parapets.
- Drainage.

5.3.1 Surveys and licences

5.3.1.1 Structural survey

For existing bridges with bridge reconstruction and deck lifting solution, the following surveys will be required:

- Site inspection to check the condition of existing foundations (for corrosion, cracking, etc.).
- Site inspection to check the condition of existing structures, such as bridge decks, walls and abutments condition (for corrosion, cracking, etc.).
- Geometry and properties of materials of the existing structural elements (i.e. existing walls, bridges, etc.).

For existing bridges with track lowering solution, the following surveys will be required:

- Site inspection to check the condition of existing foundations (for corrosion, cracking, etc.).
- Geometry and properties of materials of the existing foundations.

For OHLE support structures to be installed on existing structures, the following surveys will be required:

- Site inspection to check the condition of existing foundations (for corrosion, cracking, etc.).
- Site inspection to check the condition of existing structures, such as bridge decks, walls and abutments condition (for corrosion, cracking, etc.).
- Geometry and properties of materials of the existing structural elements (i.e. existing walls, bridges, etc.).

5.3.1.2 Pre-construction surveys and licences

This phase of the construction stage will address any required pre-construction surveys, environmental pre-construction works surveys such as biodiversity, or archaeological mitigation measures detailed in this EIAR. Works requiring vegetation clearance or demolition works may impact on biodiversity. Ecological surveys consisting of invasive species surveys, and protected species surveys detailed in the mitigation measures included in this EIAR will be undertaken prior to construction, including any vegetation clearance, tree felling and/or other demolition works. Vegetation clearance should be programmed as far as reasonably practical to avoid bird nesting season.

5.3.1.2.1 Archaeological monitoring/ testing licence

Inappropriate excavation of a heritage site could result in damage to, or destruction of, the integrity, setting or historical context of the site, contrary to the public interest. Section 26 of the National Monuments Act 1930 (as amended) requires that excavations for archaeological purposes must be carried out by archaeologists acting under an excavation licence. Pre-construction geophysical surveys will be required under Licence from the Department of Housing Local Government and Heritage prior to construction works as recommended in the mitigation measures of this EIAR.

5.3.1.2.2 Tree surveys

A Site Arborist shall be appointed prior to the commencement of site construction works and will be responsible for the setting up and monitoring of tree protection, liaising with the relevant local authority Parks and Planning departments and providing feedback and advice to the design construction teams on issues relevant to trees. The Site Arborist shall be retained for the duration of construction works and should be appointed to carry out a post-construction tree survey/assessment.

5.3.2 Site clearance

Vegetation such as trees, climbing plants, shrubs or vines will require to be removed at some locations prior to the works commencing. Site clearance to remove any unwanted materials and equipment may also be required.

Before the site clearance starts, a survey of the area will need to be completed. Site clearance including vegetation removal will take place between September and February inclusive to avoid nesting birds. If vegetation removal is required between March and August inclusive, the area shall be checked by the ECoW. If nesting birds are found, the works will be postponed until the chicks have fledged, or alternatively advice will be sought from the National Parks and Wildlife Service (NPWS).

Machinery will vary depending on the location, but the following may be required:

- Chainsaws, axes, and hatchets can all be used to fell and remove trees.
- Stumps for trees that are removed can be ground down with stump grinders.
- Mulchers can be used to clear underbrush, small trees and leftover fencing; the contractor can either use a tracked or wheeled mulching machine or there are also mulching machines that can be used with equipment such as tractors or excavators (which can be road-rail for use on the railway).
- Bulldozers can be used for clearing large areas where leftover structures, boulders, standing trees and debris remain.
- Tractors with frontend loaders can be used to clear rocks, smaller trees, branches etc. and for levelling/grading the land.
- Backhoes and excavators can be used in small-scale land-clearing.
- A woodchipper may be required to turn trees into woodchips for easy disposal.

5.3.3 Construction compounds

The construction compounds are temporary facilities that support the construction of the different elements of the project. Construction compounds are required at specific site locations, such as at closures of level crossing and associated replacement works, or structure modification works. Compounds will also be distributed along the railway for linear works (mainly SET installation) to allow tasks to be performed.

Initial site clearance and establishment activities for the construction compounds include:

- Form the site entrances and exits.
- Clear the site as required.
- Install the site hoarding and gates to ensure that the site is secure.
- Install general site lighting.
- Carry out any necessary levelling.
- Strip topsoil and form the site haul roads.
- Lay down areas of hardstanding for material storage.
- Perform all the necessary connections to mains water sewage, power and communications.
- Install the site office and welfare facilities.
- Install site security facilities, goods received checking area, unloading and loading areas and wheel-washing facilities.
- Establish segregated pedestrian and vehicle routes to the working areas with clear, designated crossing points and establish areas for materials and waste storage.
- Establish power and water distribution and wastewater collection.
- Construct the agreed lorry holding area for each site.

The activities that will take place on these sites include:

- Material unloading, storage and loading.
- Erection of prefabricated sections for construction.
- Use of welfare and on-site office space.
- Personnel and machinery access to the railway.
- Parking space for personnel and work vehicles.
- Lifting of material/precast elements, especially in the compounds corresponding to modification of existing overbridges (for instance, OBG5), construction of new overbridges (OBG23A) and erection of buildings (new Spencer Dock station, stabling/workshop).

- Assembling of catenary cantilevers only in the SET compounds (the cantilevers consist of metallic bars that are connected by means of bolts).
- Heavy Goods Vehicles (HGV) and usual construction machinery movement.
- Staff vehicles movement.
- Installation and maintenance of Road-Rail Vehicles (RRV) access to track at the dedicated points set up for this purpose.
- Construction traffic on the access routes for the material/equipment supply by HGV.

5.3.3.1 Duration of the compounds

The compound duration is dictated by the full program of works. The life cycle of a construction compound ranges from several months (in the case of the building of substations or overbridge modification) to several years (for instance, those servicing the construction works for the proposed Spencer Dock station and the depot).

These compounds will be operational 24/7 in order to service the various worksites. Temporary lighting will be installed to facilitate works during hours of darkness, and new utility connections may be required to service the compounds.

5.3.3.2 List of construction compounds

Construction compounds that will support the construction of the proposed DART+ West project are listed in Table 5-2 below.

Table 5-2 Construction Compound summary

Compound Code	Zone	Location	Chainage	Compound Category	Primary Discipline Served	Road Rail Access Points	Level Crossing
CC-STA-S1-7800-B	A	Connolly Station	7+800	Satellite Compound	Station	New Road AP No Rail AP	No
CC-PW-S1-10300-B	A	Connolly Station	10+300	Satellite Compound	Permanent way	New Road AP New Rail AP	No
CC-PW-S3-33340-B	A	Glasnevin	33+340	Satellite Compound	Permanent way	Existing Road AP Existing Rail AP	No
CC-SUB-S3-33460	A	Glasnevin	33+460	Satellite Compound	Substation	New Road AP No Rail Ap	No
CC-SET-S3-00000-B	A	Cabra Road	00+000	Satellite Compound	SET	Existing Road AP Existing Rail AP	No
CC-SUB-S2A-20280	B	Spencer Dock	20+280	Main Compound	Substation	New and existing Road AP No Rail AP	No
CC-PW-S2A-20750-B	B	Spencer Dock	20+750	Main Compound	Permanent way	Existing Road AP Existing Track AP	No
CC-STA-S4-40230-B	B	Spencer Dock	40+230	Main Compound	Station	New and existing Road AP No Rail AP	No

Compound Code	Zone	Location	Chainage	Compound Category	Primary Discipline Served	Road Rail Access Points	Level Crossing
CC-STA-S4-40250-B	B	Spencer Dock	40+250	Main Compound	Station	Existing Road AP No Rail AP	No
CC-SET-S4-40280-B	B	Spencer Dock	40+280	Main Compound	SET	New and existing Road AP Existing Rail AP	No
CC-PW-S4-40380-B	B	Spencer Dock	40+380	Main Compound	Permanent way	New and existing Road AP Existing Rail AP	No
CC-PW-S4-43200-B	B	Glasnevin	43+200	Satellite Compound	Permanent way	Existing Road AP Existing Rail AP	No
CC-STR-S5-51480-B	C	OBG5	51+480	Satellite Compound	Structures	New Road AP No Rail AP	No
CC-SET-S5-51530-B	C	Reilly	51+530	Satellite Compound	SET	Existing Road AP No Rail AP	No
CC-SET-S5-52180-B	C	Reilly	52+180	Satellite Compound	SET	Existing Road AP Existing Rail AP	No
CC-SUB-S5-53600-B	C	Ashtown	53+600	Satellite Compound	Substation	New Road AP No Rail AP	Yes
CC-STA-S5-53660-B	C	Ashtown	53+660	Satellite Compound	Station	New Road AP No Rail AP	Yes
CC-LC-S5-53820-B	C	Ashtown	53+820	Satellite Compound	Level Crossing	New Road AP No Rail AP	Yes
CC-SET-S5-54750-B	C	Navan Road Station	54+750	Satellite Compound	SET	New Road AP New Rail AP	No
CC-STR-S5-56060-B	C	OBG9	56+060	Satellite Compound	Structures	New Road AP No Rail AP	No
CC-STR-S5-56130-B	C	OBG9	56+130	Satellite Compound	Structures	New Road AP No Rail AP	No
CC-STR-S5-56460-B	C	Castleknock	56+460	Satellite Compound	Structures	New Road AP No Rail AP	No
CC-SUB-S5-56500-B	C	Castleknock	56+500	Satellite Compound	Substation	New Road AP No Rail AP	No
CC-SUB-S5-57550-B	C	Coolmine	57+550	Satellite Compound	Substation	New Road AP No Rail AP	No
CC-STA-S5-57900-B	C	Coolmine	57+900	Satellite Compound	Station	New Road AP Existing Rail AP	Yes
CC-LC-S5-58670-B	C	Coolmine	58+670	Satellite Compound	Level Crossing	New Road AP Existing Rail AP	Yes

Compound Code	Zone	Location	Chainage	Compound Category	Primary Discipline Served	Road Rail Access Points	Level Crossing
CC-LC-S5-58800-B	C	Porterstown	58+800	Satellite Compound	Level Crossing	New Road AP Existing Rail AP	Yes
CC-LC-S5-60150-B	C	Clonsilla	60+150	Satellite Compound	Level Crossing	New Road AP Existing Rail AP	Yes
CC-PW-S5-59970-B	C	Clonsilla siding	59+970	Satellite Compound	Permanent way	New Road AP New Rail AP	Yes
CC-SUB-S8-101070	D	Hansfield	101+070	Satellite Compound	Substation	New Road AP No Rail AP	No
CC-PW-S8-101660	D	OBCN286	101+660	Satellite Compound	Permanent way	New Road AP New Rail AP	No
CC-PW-S8-104970	D	Dunboyne	104+970	Satellite Compound	Permanent way	New Road AP Existing Rail AP	No
CC-SUB-S8-105060	D	Dunboyne	105+060	Satellite Compound	Substation	New Road AP No Rail AP	No
CC-PW-S8-106950-B	D	M3 Parkway	106+950	Main Compound	Permanent way	New Road AP Existing Rail AP	No
CC-SET-S8-106950-B	D	M3 Parkway	106+950	Main Compound	SET	New Road AP Existing Rail AP	No
CC-SUB-S8-106950	D	M3 Parkway	106+950	Main Compound	Substation	New Road AP No Rail AP	No
CC-LC-S6-71100-B	E	Barberstown	71+100	Satellite Compound	Level Crossing	New Road AP Existing Rail AP	Yes
CC-SET-S6-70700-B	E	Barberstown	70+700	Satellite Compound	SET	New Road AP Existing Rail AP	No
CC-PW-S6-72830-B	E	OBG13	72+830	Satellite Compound	Permanent way	New Road AP New Rail AP	No
CC-STR-S6-74660	E	Leixlip	74+660	Satellite Compound	Structures	New Road AP New Rail AP	No
CC-SUB-S6-74680-B	E	Leixlip	74+680	Satellite Compound	Substation	New Road AP No Rail AP	No
CC-STR-S6-76470-B	E	Leixlip (Louisa Bridge)	76+470	Satellite Compound	Structures	New Road AP New Rail AP	No
CC-STR-S6-76540-B	E	Leixlip (Louisa Bridge)	76+540	Satellite Compound	Structures	New Road AP New Rail AP	No
CC-SUB-S6-78180	E	Blakestown	78+180	Satellite Compound	Substation	New Road AP No Rail AP	Yes
CC-SET-S6-78200-B	E	Blakestown	78+200	Satellite Compound	SET	New Road AP Existing Rail AP	Yes
CC-PW-S6-79950-B	E	OBG18	79+950	Satellite Compound	Permanent way	New Road AP Existing Rail AP	No
CC-SUB-S6-82260	E	Maynooth	82+260	Satellite Compound	Substation	New Road AP No Rail AP	No

Compound Code	Zone	Location	Chainage	Compound Category	Primary Discipline Served	Road Rail Access Points	Level Crossing
CC-STR-S7-91880-B	F	Millfarm	91+880	Main Compound	Structures	New Road AP No Rail AP	No
CC-PW-S7-92340-B	F	Millfarm	92+340	Main Compound	Permanent way	New Road AP New Rail AP	No
CC-SET-S7-92100-B	F	Millfarm	92+100	Main Compound	SET	New Road AP New Rail AP	No
CC-STR-S7-92850-U	F	OBG23A	92+850	Satellite Compound	Structures	New Road AP New Rail AP	No
CC-STR-S7-92900-U	F	OBG23A	92+900	Satellite Compound	Structures	New Road AP No Rail AP	No
CC-DEP-S7-93060-D	F	Depot	93+060	Main Compound	Depot SET	New Road AP No Rail AP	No
CC-DEP-S7-UP-93370-U	F	Depot	93+370	Main Compound	Depot Permanent way	New Road AP No Rail AP	No

New road rail access points will be constructed as identified on the relevant drawings (MAY-MDC-GEN-ROUT-DR-Z-0003-D). Construction of these access points may require site clearance, construction of access roads (Strail Units/rubber mats and hardcore) and fencing/gated access.

5.3.3.3 Maintenance of compounds and access points

As they will be heavily used, every construction compound will be subject to ongoing maintenance, ranging from surface repairs to fence repairs and including maintenance of gates and road and rail accesses. The access points shall be maintained to ensure safe and unimpeded passage for all plant and equipment necessary at each stage of the works. Upon completion of the works, the temporary accesses to the tracks shall be removed and any affected fences, boundaries or surfaces shall be reinstated.

Figure 5-3 Compound access point example

5.3.4 Main storage and distribution centre

A Main Storage and Distribution Centre (MSDC) will be installed to supply materials to the construction compounds, reducing the required storage space for these compounds. The MSDC site is located in Co. Fingal, approximately 20 km north-west of Dublin City Centre and the port of Dublin and it covers an area of up to 25 acres – see Figure 5-4.

Figure 5-4 Main storage and distribution centre location

The planned activities to be carried out at the MSDC site will consist of material storage, the loading/unloading of material and the pre-assembly of material. The MSDC is required to be operational for approximately 39 months in order to service the SET construction activities. Activities will be carried out continuously, 24 hours a day, 7 days a week. A number of areas will be designated for these specific activities within the MSDC as follows:

- SET materials (including OLE masts, cantilevers and other OLE components; foundation materials, wiring) 27.675 m^2
- Welfare facilities 150 m^2
- Staff parking 480 m^2 (for 60 employees)
- Office 200 m^2
- Machine parking 1250 m^2
- Load and unload area 1250 m^2

Approximately 50-60 staff will be working on site per shift consisting of the following:

- Gate staff.
- Personnel for material reception/exit.
- Forklift personnel.
- Cleaning staff.
- Personnel for material management.
- Personnel for storage and pre-assembly.

Construction methodology for the MSDC will be similar to that of the main construction compounds.

5.3.4.1 Haulage routes from MSDC to compounds

The haulage routes to different compounds have been proposed via road. An access route to the N2 national primary route has been proposed as per Figure 5-5.

Figure 5-5 Haulage routes for the MSDC

5.3.5 Utilities diversions

The scope of utility diversions and protection is dependent on the size, number and nature of the utilities impacted by construction at the specific site. Specific utility diversions have been described in Chapter 18 and this section describes the general construction methodologies for these utility diversions.

Due to the urban location of a large section of the proposed project, there are a large number of utilities and services located along the public road, adjacent to carriageways and in footpaths along the alignment. Existing utilities and services that require to be diverted include:

- Surface water, foul and combined sewers.
- Watermains.
- Electricity supplies.
- Overhead and underground ESB cables.
- Gas mains.
- Telecommunication and cable services including fibre optics.

Temporary protection measures for utilities that will remain in the zone of influence of the works will be completed prior to starting work.

Utility diversions and protection measures are planned, agreed and undertaken in cooperation with the relevant utility stakeholders (and relevant agencies). Relevant approvals will be in place prior to any work commencing on a utility or service.

5.3.5.1 Utility pipe installation

The following construction methods are typically applied during the construction of a pipe installation:

1. Pipes (and other material) will be delivered into the compound area and offloaded using, for example, a HIAB crane.
2. Trial pits are excavated to confirm the locations of existing services.
3. The main bulk excavation to the trench is undertaken.
4. Temporarily support the trench throughout the pipe installation works.
5. Lift pipe into position. Import bedding material by dumper.
6. The pipe is then backfilled up to the required level.

Stages 1 to 6 are repeated until the required length of pipe is installed.

5.3.5.2 Gas mains installation

In installing new gas mains, the following construction methodology is proposed to be followed:

1. Trenches to be prepared, and sand bed shall be placed.
2. Gas services to be laid at right angles to the main in as short a route as possible.
3. Sand surround shall be placed around the gas main immediately after installation.
4. Two layers of free issue marker tape shall be placed over the main. Marker tape must be extended past the width of the mains.
5. Where a valve and riser are installed, fencing shall be provided around that valve until either adequate temporary reinstatement is provided to protect the valve and chamber, or permanent reinstatement is completed.
6. Concrete protection slabs to be installed above all tops tees on gas mains.

5.3.5.3 ESB high voltage cable installation

In trenching, ducting and cabling for ESB 38 kV networks, the following methodology shall be followed:

1. Excavate trench to required dimensions.
2. Lay in and level bedding layer of concrete.
3. Lay in, joint and trefoil HDPE power ducts using cable ties.
4. Lay in and thoroughly compact layer of concrete around and above ducts and install marker strips.
5. Install HDPE comms cable ducts. Use timber or other spacers to maintain the required spacing.
6. Install further layer of concrete and compact thoroughly.
7. Lay in another wide marker strip.
8. Lay in wide yellow warning tape and backfill the top of the trench.
9. Mandrel all ducts and install draw rope, then seal all ducts.

5.3.5.4 ESB high voltage transmission pylon installation

In erecting new transmission pylons or relocating existing pylons, the following construction methodology can be followed. Works on site will require 4-8 weeks. Where new pylons are assembled to replace existing pylons, assembly is performed prior to line outages.

1. Verify that all planning and environmental conditions have been satisfied.
2. Carry out pre-construction site investigations including access review and ground conditions.
3. An excavation of 1 m deep x 10 m long x 10 m wide with access ramp is required.
4. Cast the foundation.
5. Sheet piling method is applied in narrow spaces. Interlocking sheets of steel are pressed down at all four corners and the cast of the foundation starts step by step from there.

6. Where the ground does not have strong adhesion (e.g. sandy earth), concrete piles are thrust into the ground into approximately 10 metres of depth, leaving 1-2 metres above the ground.
7. The upper part of the concrete pile is then blasted off and the iron inside the pile bent into the top layer of the foundation.
8. Sufficient time is given to allow for casting the foundations.
9. Erect the structure.
10. Attach to the pylon the surge arresters, isolators and cable reels after preassembling them on site.
11. Meanwhile the cable-drum and winch sites are constructed and anchored appropriately.
12. The pilot ropes, pulling rope, conductor and earthing conductor are then hoisted up.
13. Cables are then adjusted to allow for adequate tension and sag.
14. Cables are then braced/clasped.

5.3.5.5 ESB medium and low voltage cable installation

In trenching and ducting for ESB LV/MV ducts, the following methodology shall be followed:

1. Excavate trench to required dimensions.
2. Lay in and compact a bedding layer.
3. Lay ducts and horizontal spacer on bedding layer.
4. Lay in and compact a layer of approved backfill above bedding layer.
5. Install ESB approved red marker strip.
6. Lay in and compact a layer of approved backfill maintaining the maximum depth.
7. Install ESB approved yellow marker tape.
8. Reinstate final layer of backfill.

5.3.5.6 ESB LV/MV pole installation

In locations where pole heightening is proposed for MV/LV lines, new poles of the required lengths are installed in close proximity to the existing poles. The following strategy is followed in excavating for the pole and planting the pole using a tracker excavator:

1. Line up excavator with existing pole. Start the dig a minimum of 150 mm from the existing pole.
2. The hole shall only be sufficiently large to accommodate the pole.
3. The pole erector is lifted, and the driver tilts the pole into the hole.
4. Lower the pole into the hole and raise it up.
5. The pole is twisted in place.
6. Backfill hole to a minimum depth with a long handled rammer.

ESB will then connect the electricity lines to the new pole and remove the existing pole.

5.3.5.7 General duct installation on bridges

In installing other ducts, conduits and voids on bridges, the following shall be taken into consideration:

1. Rigid conduits shall be bent only with a standard conduit bender.
2. Ducts, conduits and voids shall be firmly secured during casing to prevent floating.
3. Where required, continuous pull wires shall be installed in all service ducts and conduits. Pull wires shall be galvanized steel, unspliced, extending with a tight fit through the duct end caps and terminating beyond the end of the duct.
4. Where pull wires are not used, a mono-poly, unspliced rope or equivalent may be substituted. The rope shall be longer than the duct and coiled up inside the duct with the end caps secured in place.

5.3.5.8 Pipe jacking using automatic tunnelling machine

Where trenchless utility diversions are required, the following pipe jacking with automatic tunnelling machine strategy could be used:

1. Road surface level shall be taken along the pipe jacking route at regular intervals.

2. The launch pit and target pit shall be constructed.
3. A thrust wall shall be constructed to provide a reaction against which to jack.
4. At the mouth of tunnelling, a concrete wall shall be casted to avoid soil collapse and smooth jacking of pipe.
5. Hydraulic jacks shall be positions on a support frame against the thrust wall parallel to line and gradient and driven by a hydraulic power jack.
6. A thrust ring shall be placed between the steel pipe and jacks to distribute the jacking force onto the pipe to prevent it from buckling.
7. The soil shall be excavated at the face by using air compressor and jack hammer.
8. If water is encountered during excavation, dewater accordingly.
9. The pipe shall be jacked forward as the excavation proceeds in reception pit.
10. When the pipe has been pushed to the limit of the jack's stroke, the jack will be retracted, and a spacer block placed between the jack and thrust ring. Jacking then continues until the pipe is fully pushed in and the drive has reached the target pit.
11. After casing pipe has been installed, the carrier pipe shall be laid to line and level.
12. Once the carrier pipes are securely fixed in position and checked, a breather pipe will be placed at the soffit.
13. Thrust and target pits are backfilled layer by layer.

5.3.5.9 Temporary diversion strategy - bridges

In locations where bridge modification is needed, utilities within the bridge deck shall be temporarily diverted during the deck reconstruction or lifting works; those bridges are listed in the following table.

Table 5-3 Bridge intervention summary

Bridge	Intervention
OBD228 Sheriff Street Bridge	Arch deck reconstruction
OBG5 Broome Bridge	Arch deck reconstruction
OBG9 Old Navan Road bridge	Flat Deck Lifting
OBG11 Castleknock bridge	Arch deck reconstruction
OBG14 Cope bridge	Arch deck reconstruction
OBG16 Louisa bridge	Flat Deck Lifting

Temporary diversions in every bridge will be supported by the construction of scaffolding that will run parallel to the original deck, separated by a safe margin to ensure it remains intact during the reconstruction process. The scaffold platforms, which shall be formed above the bridge soffit level, will consist of a wooden board screwed down over netton mesh sheeting and returned vertically at the edge of the footboards, and they shall be formed above the bridge soffit level. In addition, scaffolding shall be fully enclosed with plastic sheeting, and boards shall be securely lashed together and tied down at each end. Working surfaces on the scaffold shall only be accessed by site personnel.

Figure 5-6 Scaffolding for temporary diversion

By means of the scaffolding, the affected utilities can be diverted from one side of the track to another by a temporary conduit laid on the scaffold platforms. Prior to connection to the temporary conduit, the affected utilities must be cut off behind the abutments.

Figure 5-7 Temporary diversion along scaffolding

In general, the disruption time of the service is mainly due to the connection of the temporary diversion. This is expected to be hours, but it will depend on the utility, the intervention and the location. To minimize the disruption time, the temporary diversion, ducting and the connections must be planned properly.

5.3.5.10 Utilities protection strategy

In areas where track lowering works are planned, and where utilities diversions are not required, the protection of utilities underneath the track will be necessary as agreed with utility providers.

The proposal for this protection consists in laying a reinforced concrete slab above the affected utility conduit, so that the loads from the railway are not applied directly on the conduit. The precast reinforced concrete slab spreads the loads into the soil with no risk for any utility. The thickness of the slab will vary depending on the utility to be protected and will be analysed in a further stage during the detailed design. An example of this solution is shown below in Figure 5-8.

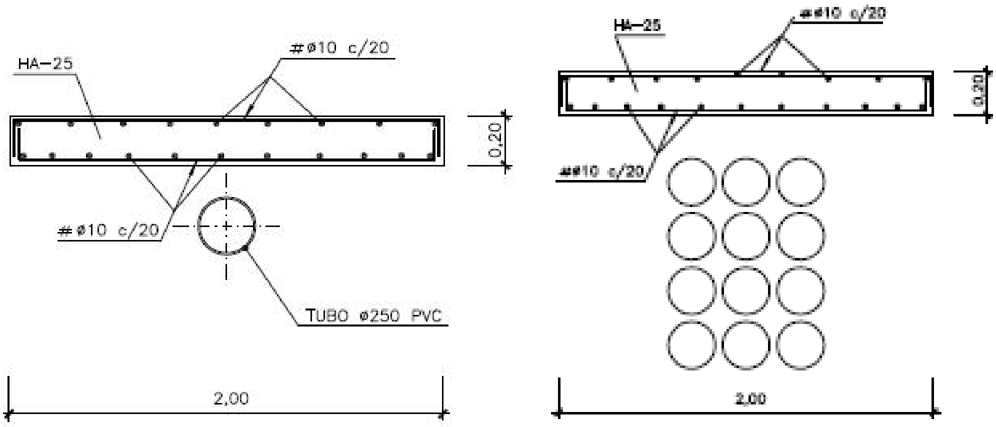


Figure 5-8 Slab based utilities protection.

For its placement, this slab will be lifted from different hooks embedded in the concrete as shown in Figure 5-9.

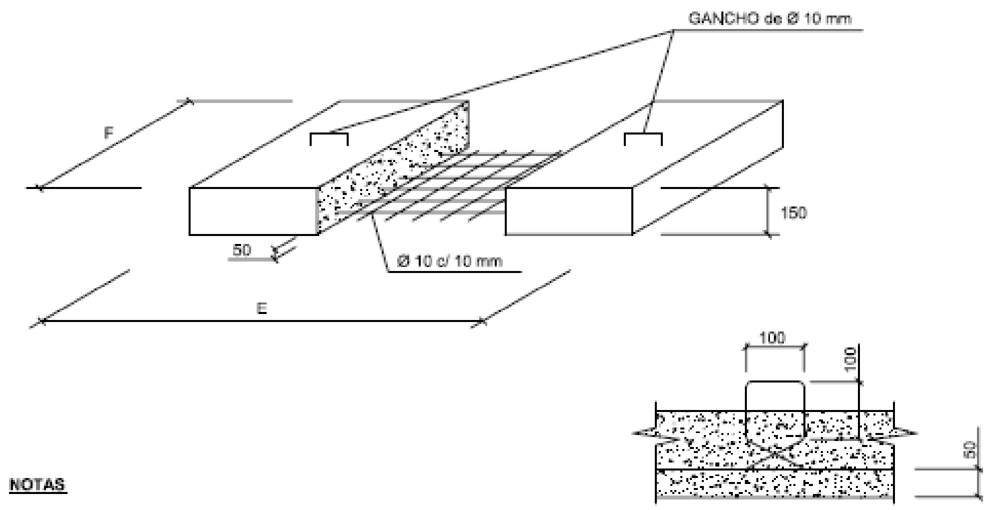


Figure 5-9 Precast slab with embedded hooks.

Before any slab placement, the excavation works above the utilities must be carried out considering the conduits depth. If utilities to be protected are located less than 1 m depth from ground surface, excavation must be done with hand tools, avoiding any excavator.

5.3.5.10.1 Utility protection strategy for foul pipes at OBO36

Three foul pipes by Ossory Road Bridge (OBO36) are to be protected according to the following strategy prior to track lowering works due to their material/size/age.

Due to the proposed track alignment design in Spencer Dock, part of the proposed track systems in this area are lower than the adjacent ground levels. Therefore, precast concrete cantilever walls have been proposed along the S2A UP and S2A DN tracks between Chainage 20+512 and 20+555 to laterally support soil. However, two existing utilities are crossing below the proposed cantilever walls, shown below. Therefore, a structural solution of cantilever wall on piles has been proposed at these crossing points to avoid any loading transmitting to existing utilities. The proposed piles are located at least 1.5 m away from the utilities to mitigate any impact during the construction work.

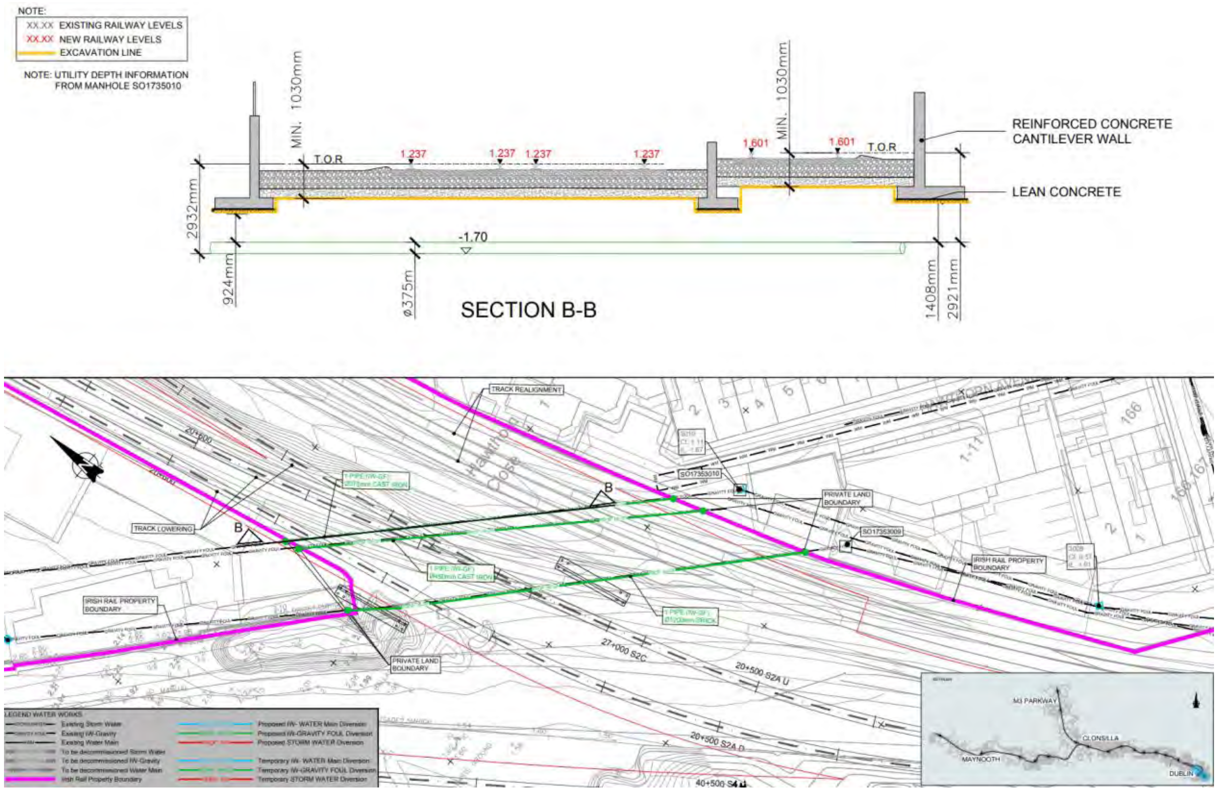


Figure 5-10 OBO36 structural protection Section B-B

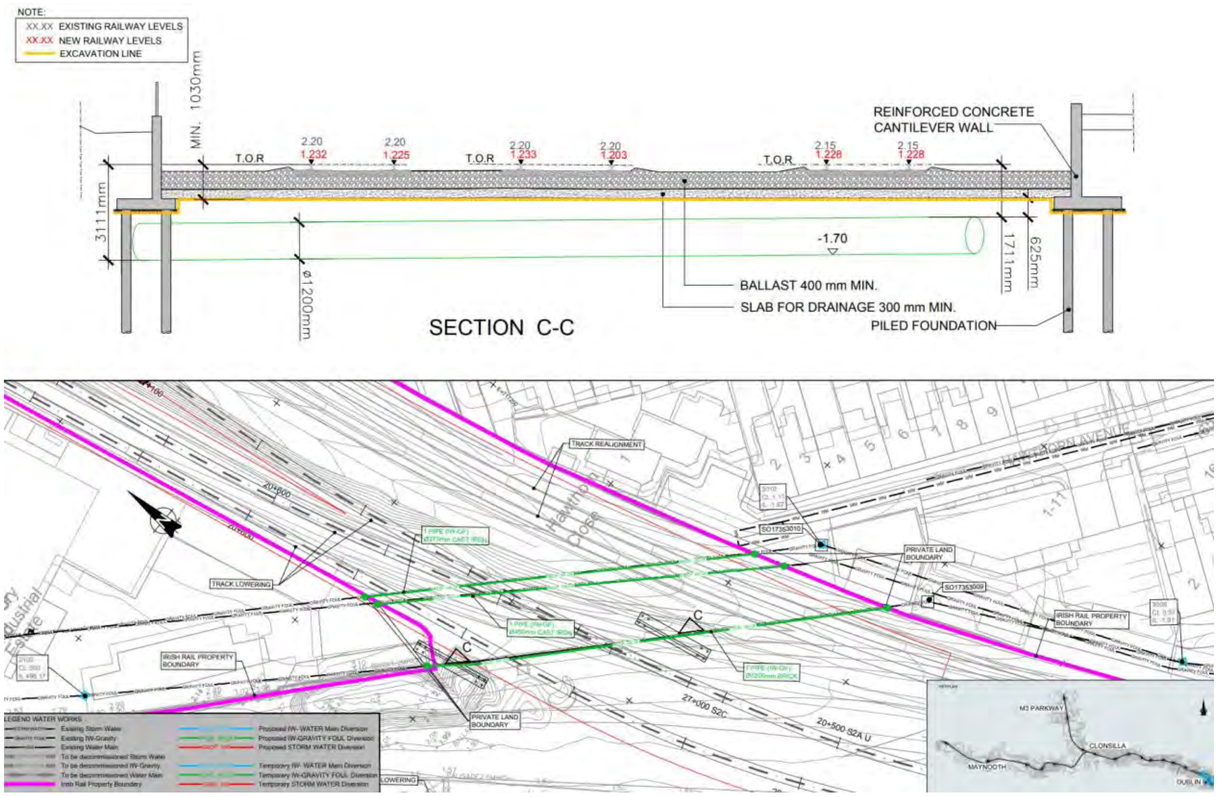


Figure 5-11 OBO36 structural protection Section C-C

5.3.6 Permanent way

5.3.6.1 Changes to vertical alignment (track lowering)

To construct the Overhead Line Equipment (OHLE) below some of the existing bridges along the project extents, it is necessary to lower sections of the existing rail track for specific lengths.

Track lowering beneath specific bridges, namely OBO11, OBG7A, OBG13, OBCN286, OBCN290 and OBG18, will be carried out in advance of the OHLE installation. All of this work will be performed during night-time or weekend possessions, or extended closures, and are to be executed sequentially. Based on the assumption of working at two fronts, the six track lowerings will take around 5 months to complete. That duration corresponds to a 150-200 m per weekend per front (maximum lowering depth of 30-40 cm per track at any one time – reference Section 5.2.2).

The length of the track lowering, and the depth of lowering will vary depending on the location of the works to achieve the minimum OHLE clearance required.

Track lowering will involve the following typical sequence of works:

1. Enabling works such as: installation of facilities and storage areas; bringing machinery and materials on site; utilities diversions (including the relocation of existing signalling and telecoms cables); railway operation safely cut etc. Enabling works will require the use of heavy goods vehicles (HGV), skip wagons, and jet-grouting machine. See Section 5.3.8.1.3 for description of structural intervention required for track lowering in some locations prior to works commencing.

Figure 5-12 Enabling works

2. Rail cutting of the existing track (separate track panels of 18 m length) using a rail cutting machine.

Figure 5-13 Rail cutting

3. Removal of old track panels using road-rail vehicles (vehicles capable of running on both road and rails), excavators, crane on truck and other necessary engineering equipment.

Figure 5-14 Track panel removal

4. Removal of degraded ballast by means of road-rail vehicles, excavators and other engineering equipment that will load the materials into an articulated dump truck. This will be taken offsite and disposed of in line with the Construction Demolition Waste Management Plan (CDWMP).

Figure 5-15 Ballast removal

5. Excavation of the track formation until the required level by means of road-rail vehicles, excavators and other engineering equipment that will load the materials into an articulated dump truck. Extension and compaction on the subgrade using a compactor and extension of the geotextile.

Figure 5-16 Platform excavation

6. Execution of track formation, levelling and compaction, which would employ the use of road-rail excavators, wheel loads, graders, medium rollers and articulated dump trucks.
7. Placement of the longitudinal drainage, using trucks, mini diggers and plate compactors.
8. Extension and compaction of the sub-ballast layer, using wheel loader, trucks and compactors.
9. Extension of first ballast layer, levelling and compaction using wheel loader, trucks and compactors.

Figure 5-17 Ballast laying

Figure 5-18 Ballast compaction

10. Laying of preassembled track panels and connecting with the provisional joints utilising road-rail vehicles and truck mounted cranes.

Figure 5-19 Track panel installation

Figure 5-20 Provisional track panel joint

11. Extension of second ballast layer, tamping and dynamic stabilisation utilising road-rail vehicles, tampers and articulated dump trucks.

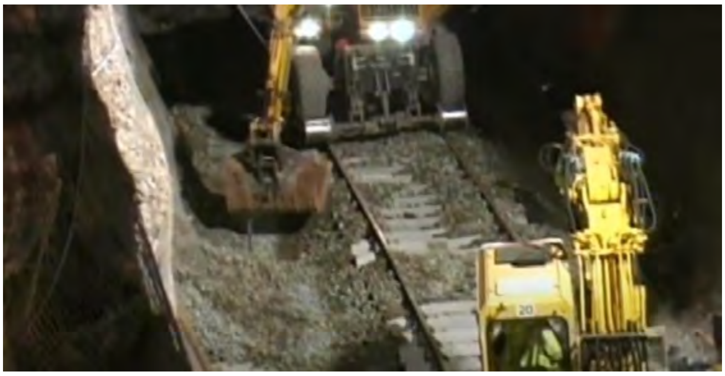


Figure 5-21 Ballast laying – second layer

Figure 5-22 Ballast tamping

12. Welding of joints and second stabilisation using welding and tamper equipment.

Figure 5-23 Rail joint welding

Figure 5-24 Tamper equipment

13. Rail destressing and track tampering using tampering equipment.

5.3.6.2 Changes to horizontal alignment

New track horizontal alignment is required mainly at the new track configuration consisting of:

- Double track from Maynooth to the proposed depot (Zone F) – this will require the modification of the existing ballast track to double track alignment until the depot.
- Spencer Dock-Docklands-East Wall (Zone B) – this will require the installation of a new slab track configuration.

5.3.6.2.1 Ballast track

Ballast track construction works, as part of the horizontal alignment modifications, will involve the following typical sequence of activities.

1. Enabling works, such as: installation of facilities and storage areas; bringing machinery and materials on site; utilities diversions; railway operation safely cut etc.
2. Rail cutting of the existing track (separate track panels of 18 m length) using a rail cutting machine (if required).
3. Removal of old track panels using road-rail vehicles (vehicles capable of running on both road and rails), excavators, crane on truck and other necessary engineering equipment
4. Removal of degraded ballast by means of road-rail vehicles, excavators and other engineering equipment that will load the materials into an articulated dump truck (if required). This will be taken offsite and disposed of in line with the Construction Demolition Waste Management Plan (CDWMP).
5. Preparation of the track formation until required level, using road-rail vehicle excavators.
6. Extension and compaction on the subgrade, using a compactor.

7. Extension of the geotextile.
8. Placement of the longitudinal drainage, using trucks, mini diggers and plate compactors.
9. Extension and compaction of the sub-ballast layer, using wheel loader, trucks and compactors.
10. Extension of first ballast layer, levelling and compaction using wheel loader, trucks and compactors.

Figure 5-25 Ballast laying and compaction

11. Laying of the sleepers with the fastening systems, using crane on trucks and excavators.

Figure 5-26 Sleeper laying

12. Laying of the rails and clamping the joints, using crane on trucks and excavators.
13. Extension of second ballast layer, tamping and dynamic stabilisation, using crane on trucks, excavators and a ballast tamper.

Figure 5-27 Extension of second ballast layer, tamping and dynamic stabilisation

14. Welding of joints and second stabilisation.
15. Rail destressing.

It is possible that temporary speed restrictions may be required to be implemented during these works. Any restrictions will be discussed and agreed with IÉ well in advance of implementation.

5.3.6.2.2 Slab track

Slab track is required mainly throughout the Spencer Dock-Docklands-East Wall area to deal with seepage or flotation (due to uplift forces from the water table to the structure). Due to the depth of track layout, the majority of slab track in this area is tied to retaining walls, which makes a U-shaped overall structure.

Slab track is also required at the OBD226 (Newcomen Bridge) Down track. This structure has a Top of Rail (TOR) to soffit clearance of 4210 mm that does not allow for any OHLE solution.

Twenty metres east of the OBD226, the Newcomen Chord crosses the Royal Canal via a lifting bridge (UBD233), limiting the options for track lowering of the Newcomen Chord and, in turn, the Down Track. For this reason, a slab track is proposed, which, by not requiring track tamping, allows an OHLE solution with less TOR to soffit clearance.

The two most common slab track systems are as follows:

a. Sleepers or Blocks Embedded in Concrete Slab.
b. Monolithic in-situ concrete slab track, with Direct Fastening System (DFS)

The sleepers embedded in concrete has been proposed as the slab track system.

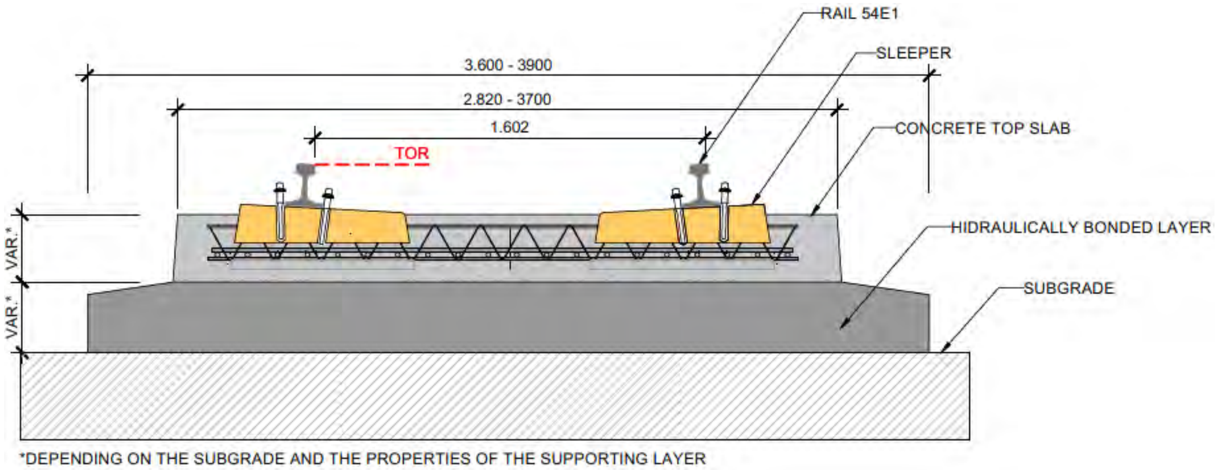


Figure 5-28 Schematic of concrete slab track (the concrete embedded sleeper solution shown is an example of the solution initially proposed in the report pending approval)

Indicative construction methodology for concrete embedded sleeper solution is as follows:

1. Sleeper placement on top of structural bottom slab and rail co-location on the sleepers.

Figure 5-29 Sleeper laying on top of structural slab

2. Sleepers and rail levelling (placement of steel bars for reinforced concrete slab track).

Figure 5-30 Rail and sleeper levelling

3. Final adjustment of the track prior to concreting. Topographical control.
4. Concrete placement and topographic monitoring supervision.

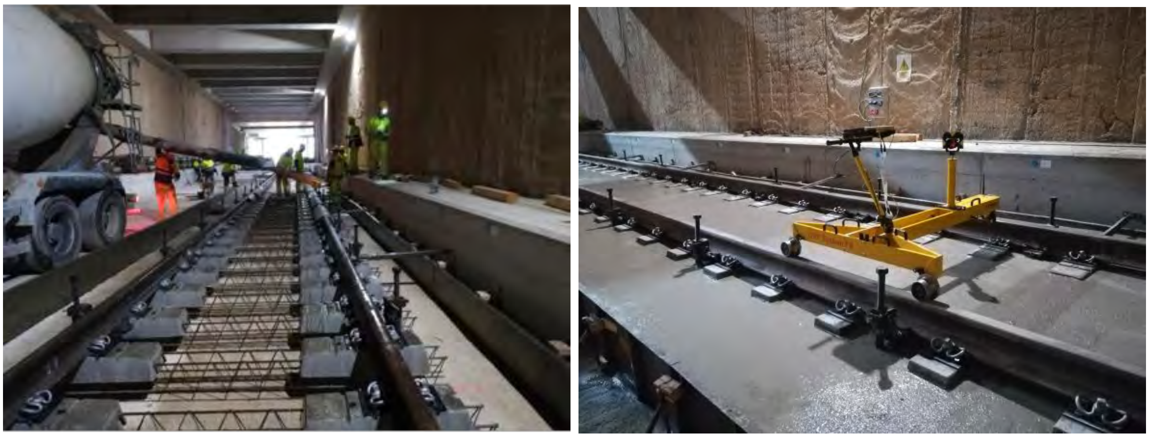


Figure 5-31 Concreting of the track (left) and topographical checks (right)

5. Concrete curing and recover of auxiliar elements for sleepers and rail levelling.

Figure 5-32 Concrete curing

6. Joints: execution of the constructive joints as stipulated.
7. Rail fastening system and rail.
8. Rail welding.

Plant to be used on the track laying will be multi use mobile gantries, diesel trains to deliver concrete and flat cars to deliver the track and sleepers. Welding machines will be used and will be fitted to wheeled excavators converted to run on both road and rails, known as road-rail vehicles. There are different types of slab track that can be utilised. The slab track type defined in this section is most likely type to be used. The slab track type will be confirmed at detailed design stage.

5.3.6.2.3 Permanent way structures

In the Spencer Dock-Docklands-East Wall area, at sections along the Glasnevin Junction to Maynooth section of track (Chainage 90+095 to Chainage 90+165), in order to deal with seepage or flotation (due to uplift forces from the water table to the structure) the majority of slab track in this area is tied to retaining walls, which makes a U-shaped overall structure. Several types of retaining walls are required due to the groundwater table being higher than the track, or the required excavation levels.

The cantilever retaining wall is required in total for a distance of approx. 70 m along the tracks. Figure 5-33 is an example of the cantilever retaining wall solution:

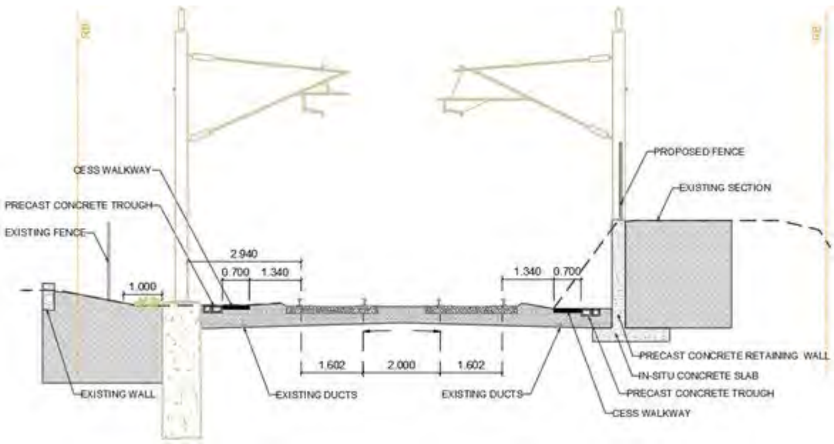


Figure 5-33 Example of cantilever retaining wall solution

Before the execution of the slab track, the U-shaped structure will be constructed by means of different retaining walls (piled walls, micro-piled walls or cantilever walls) depending on the location.

The construction methodology for the piled/minipile retaining walls is described below:

1. First, drilling will be carried out until the desired level by means of pile drill rigs, using bentonite slurries to prevent the borehole from collapsing.
2. Once the borehole is excavated and filled with bentonite slurries the drilling tool will be removed.
3. Then the reinforcement cage will be introduced with the aid of a mobile crane.
4. Then, the concrete will be placed from the bottom of the borehole to the top using a pressure pump, while the bentonite slurries are ejected through the top (slurries are to be collected and disposed of correctly).
5. Finally, the capping beam (made of reinforced concrete) will be constructed along the top of piled wall to construct a solid and monolithic wall (concrete vibrators will be necessary for the placement of the concrete).

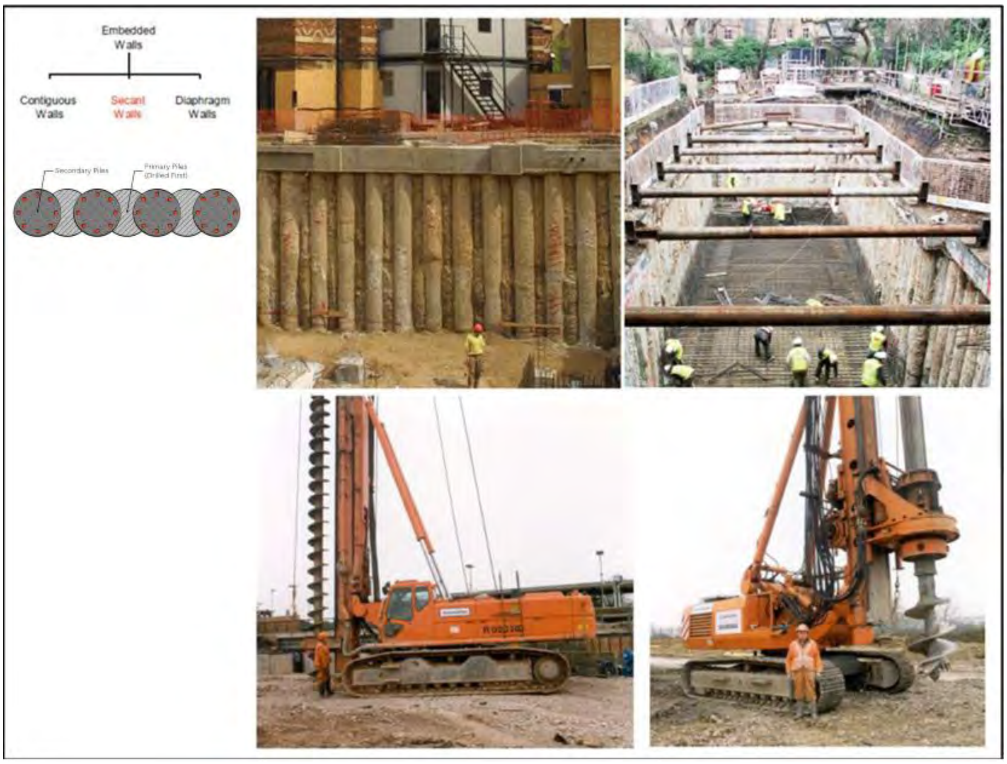


Figure 5-34 Typical plant required for secant piling

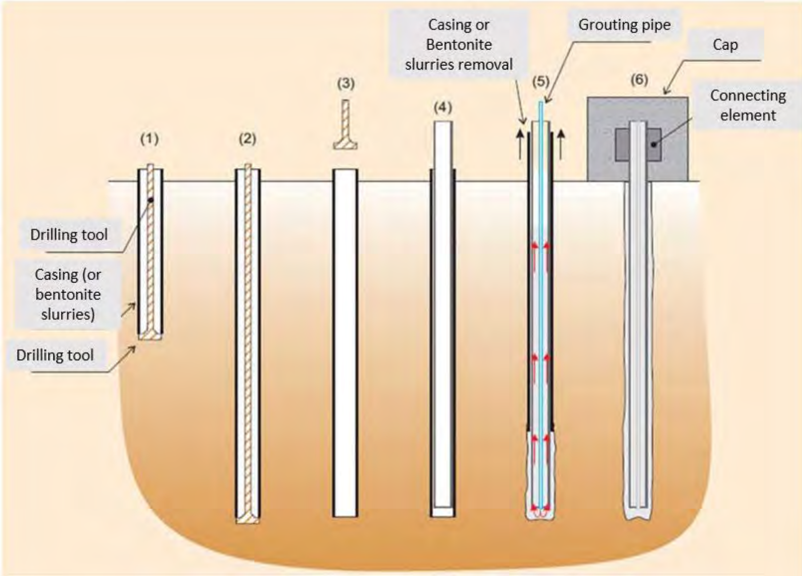


Figure 5-35 Execution process for micropiles

The construction methodology for the proposed cantilever retaining walls is described below:

1. Phase 1: Excavation and temporary dewatering with a pumping system during construction where there are potential flotation issues.

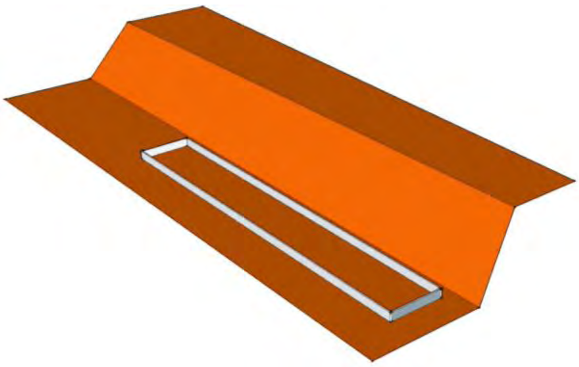


Figure 5-36 Preparatory work

2. Phase 2: Execution of the bottom slab.

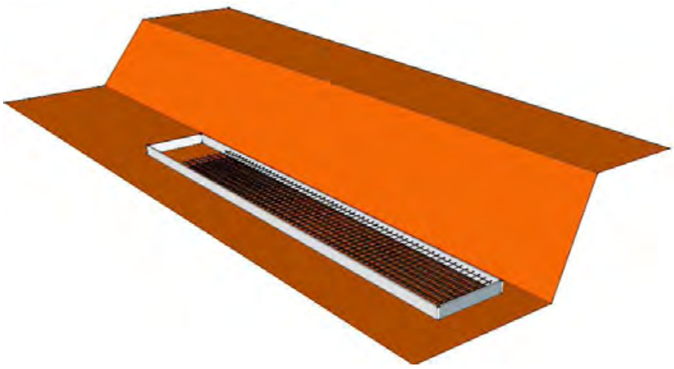


Figure 5-37 Reinforcement placing

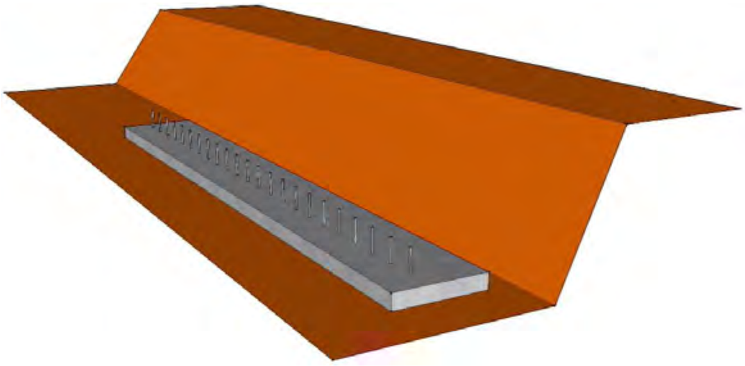


Figure 5-38 Bottom slab pouring

3. Phase 3: Construction of the vertical walls.

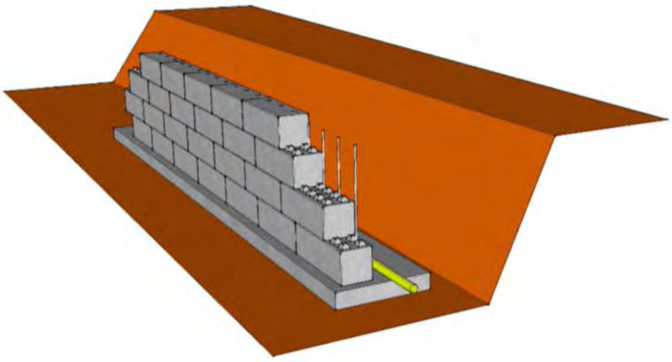


Figure 5-39 Vertical wall construction

4. Phase 4: Filling and compacting.

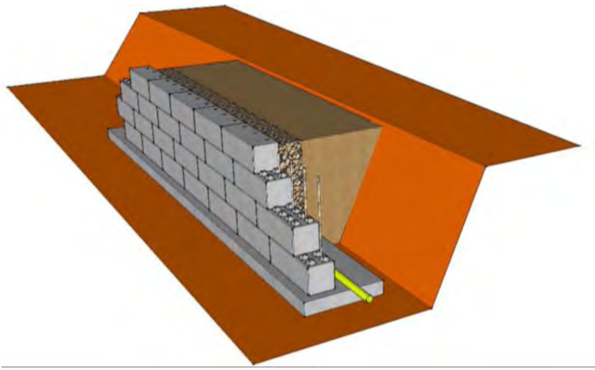


Figure 5-40 Backfilling

5.3.7 Cable management system

Cable management system (CMS) relates to the infrastructure required to distribute and protect the required cables for the signalling, telecommunications, low voltage power and catenary feeders.

Lineside cable routes are usually one of the following types:

- Concrete trough route.
- Buried PVC ducts.
- Elevated routes (metal trays).
- Elevated GRP (Glass Reinforced Plastic) troughing on posts.
- Catenary wire (supported by catenary system).

5.3.7.1 Concrete trough route

In general, a precast concrete trough solution has been considered as the most appropriate option to lay the cables along the majority of the project extents due to the shallow excavation required. This solution has been implemented wherever possible.

The construction sequence of the precast concrete troughing is the following:

1. Shallow trench excavation using a road-rail vehicle with excavator attachment and/or hand tools.
2. Installation of the sand/gravel bedding layer using a road-rail vehicle with excavator attachment.
3. Installation of precast concrete troughs using a road-rail vehicle crane/excavator with lifting attachment; troughs may be manually installed using Trough Clamps.
4. Backfilling of surrounds using a road-rail vehicle with excavator attachment.

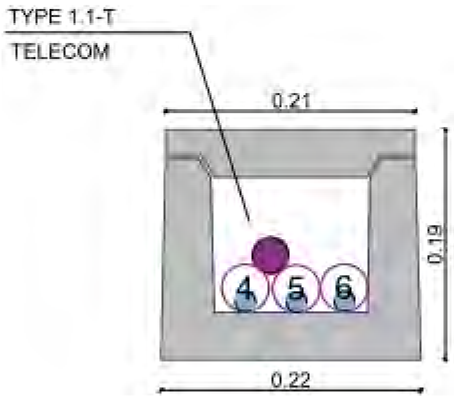


Figure 5-41 Example of precast concrete trough

The installation rate for precast concrete troughing is approximately 30 m per 8-hour shift and team.

5.3.7.2 Buried PVC ducts

Buried PVC ducts will be considered at stations and locations where there is not enough space to place either a cable trough or a metal cable tray. Ducts will be surrounded by concrete for protection or with a granular fill where applicable. Catenary feeders will always be placed in buried PVC ducts.

The construction sequence of the buried PVC ducts is the following:

1. Check area for existing utilities and divert as required.
2. Excavation of duct run including trench support as required (e.g. sheet piles).
3. Installation of the sand bedding layer.
4. Installation of PVC ducts with pipe spacer bracket to ensure correct spacing.
5. Pour concrete to secure ducts in place.
6. Backfilling of surrounds ensuring warning plate/tapes are installed as required.

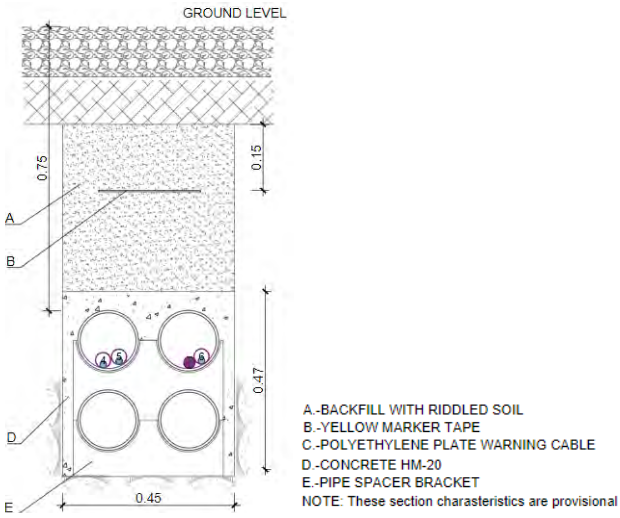


Figure 5-42 Example of buried PVC ducts

5.3.7.3 Metal cable trays

In areas where the available space is very restricted, such as overbridges, cables will be clamped to the walls/floor and protected with an omega profile. Installation of metal cable trays includes drilling and fixing to existing structures using handheld tools as per the design requirements.

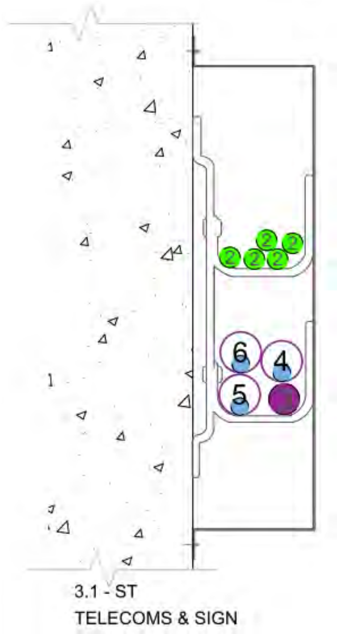


Figure 5-43 Example of metal cable tray solution

5.3.7.4 Elevated GRP troughing on post

When the available space next to the track does not allow the installation of a precast concrete trough, and metal cable trays are not feasible because of the structures/retaining walls, the use of elevated GRP routes on posts is considered as listed below:

- In some locations between Spencer Dock and Glasnevin (GSWR and MGWR).
- Clonsilla to M3 Parkway.
- Where the distance between the rail and the cutting is not enough for a precast concrete trough, an elevated GRP route on posts can be placed at the cutting slope.

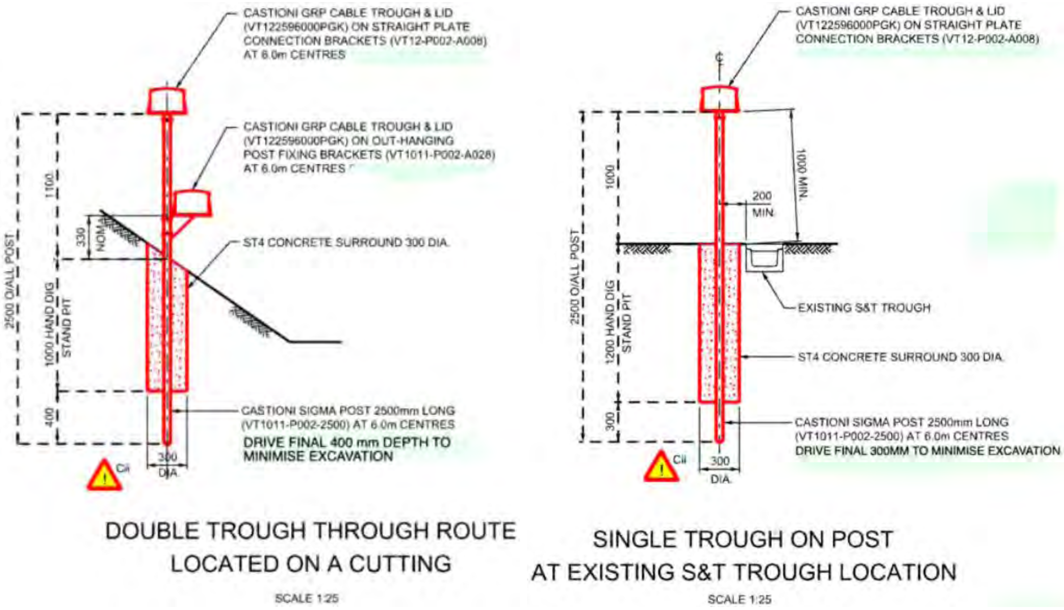


Figure 5-44 GRP elevated routes configuration examples

The elevated GRP trough is supported directly on posts, with a 6 m maximum span between them.

Depending on the local ground conditions, the post for the elevated GRP route system can be rammed, hole dug or embedded in post-mix, parallel to the railroad.

Ramming is the method of choice in new cables routes. In areas where there is a chance of cable strike or the ground is not considered suitable for rammed solutions, the posts are embedded in holes hand-dug or excavated by an auger and concrete backfilled.

A range of bracketry enables changes in height or direction to be accommodated easily and avoids obstacles and uneven ground. If required, the lids can be coloured with imprinted messages (yellow and “Danger High Voltage,” i.e. for HV cables). In vandalism areas, where additional security is preferred, stainless steel lid closer security straps are provided.

5.3.8 Bridges

5.3.8.1 Interventions at bridges

5.3.8.1.1 Arched bridges

5.3.8.1.1.1 Introduction

There are a number of existing arch bridges requiring deck reconstruction in order to increase the vertical clearance for the catenary system. These are listed below.

Rail bridges adjacent to protected structures – Masonry arch bridges:

- OBG5 Broome Bridge.
- OBG11 Castleknock Bridge.

Rail/canal bridge proposed protected structure:

- OBG14 Cope Bridge.

For works in the vicinity of these historic arch bridges, any modification works on the bridge must carefully consider the structures’ heritage potential, aesthetic and architectural changes. A solution of a precast arch deck has been selected as the optimal solution in terms of structural modification for all the existing arch bridges in the design. The contribution of a Grade 1 Conservation Architect has been an essential part of the design to achieve a sympathetic solution for the protected arch bridges.

The structural design for each bridge has been provided in Section 5.6.2 for OBG5, Section 5.6.11 for OBG11, and Section 5.8.3 for OBG14.

5.3.8.1.1.2 Overview of works required

The methodology for deck reconstruction for the three masonry arch bridges is very similar. The following figures (Figure 5-45 to Figure 5-47) provide further details of the structural design of OBG5 as an example.

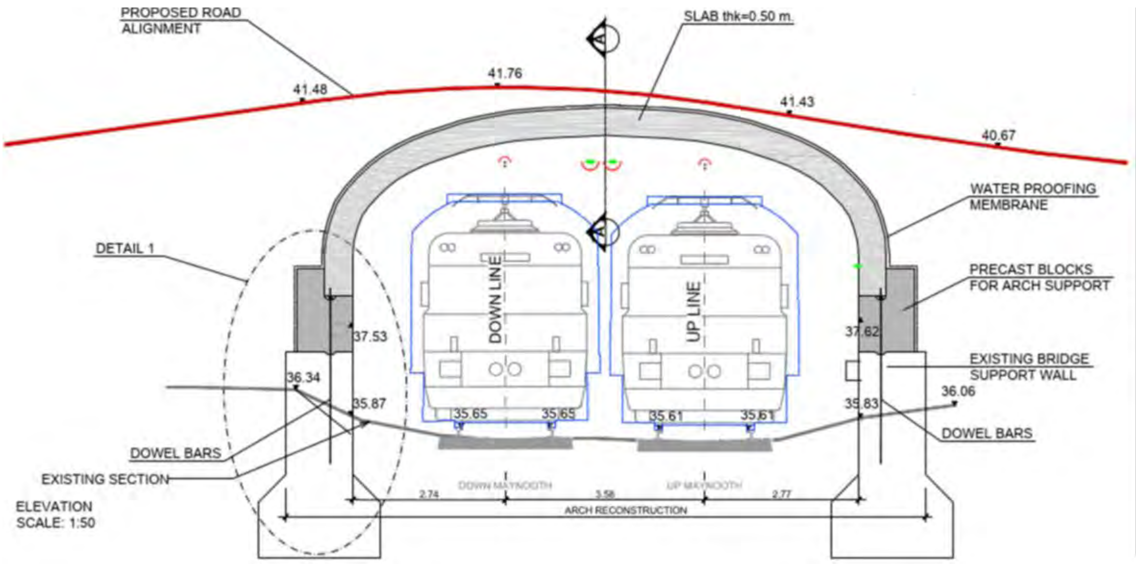


Figure 5-45 Structural elevation of OBG5

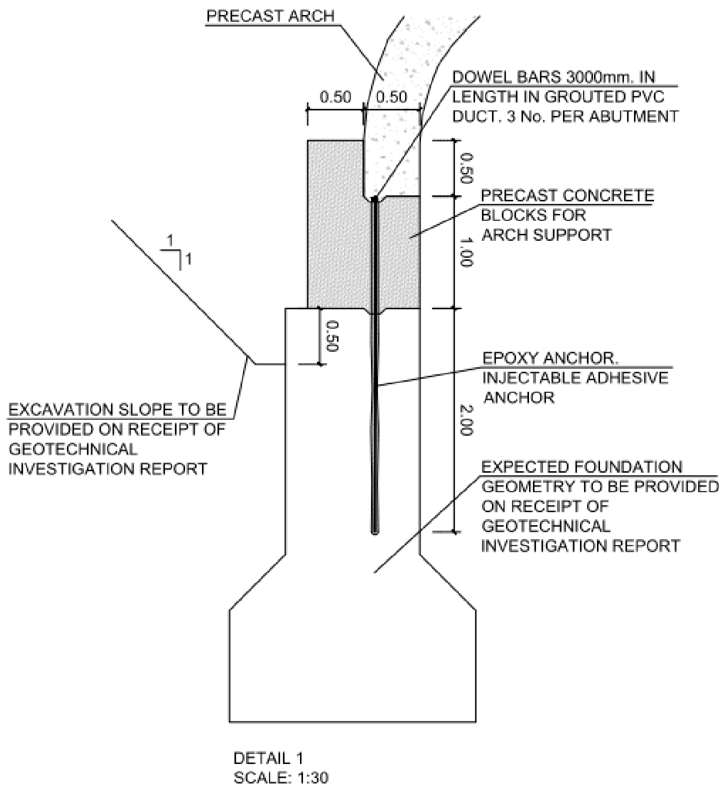


Figure 5-46 Connection detail between between existing foundation and new precast wall block

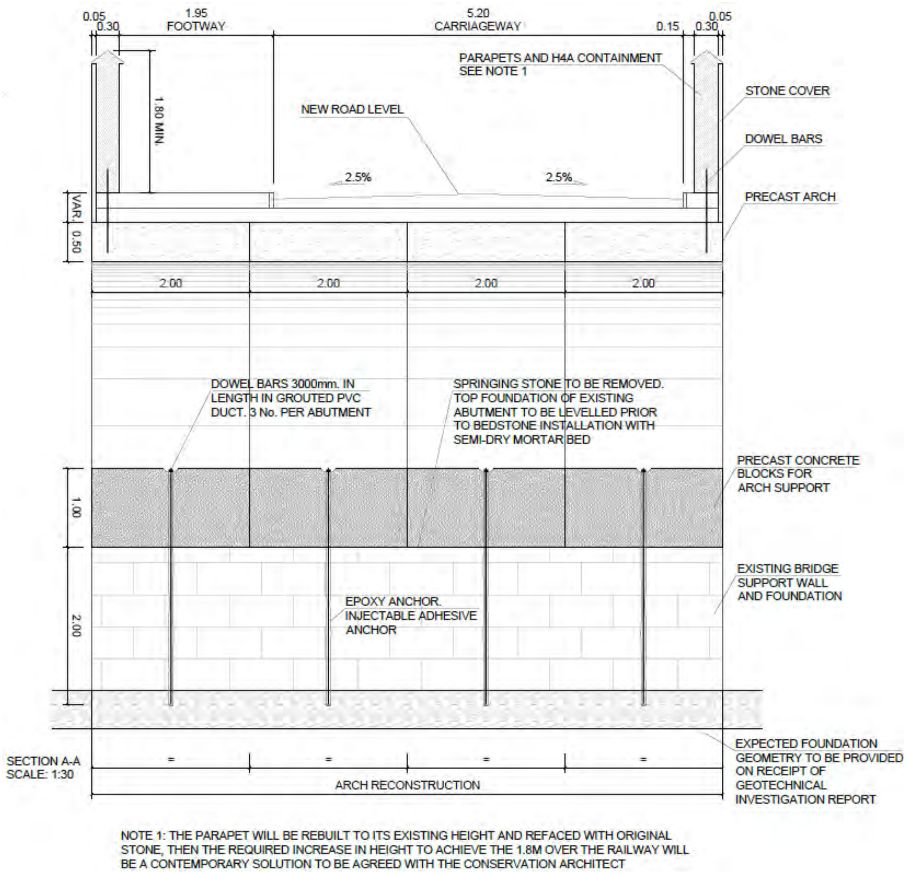


Figure 5-47 Cross section A-A through OBG5

5.3.8.1.1.3 Construction phasing

The construction phasing for these works is proposed as follows:

1. Traffic and utility diversions and enabling works shall be carried out before the arch deck reconstruction, including site setup, accommodation works, utility diversions, earthworks, and pavement works.
2. Soil improvement behind the existing wall using jet grouting, if required.

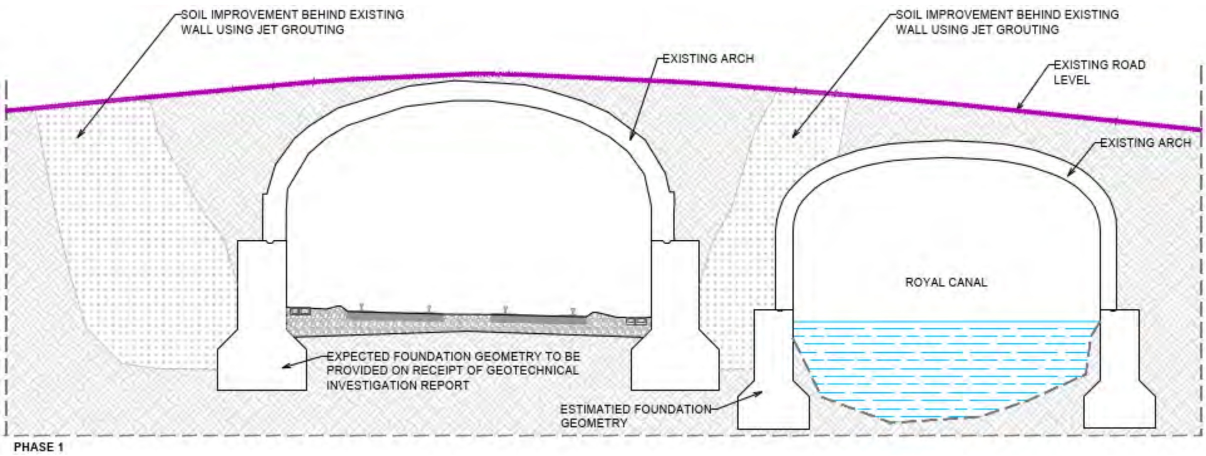


Figure 5-48 Soil improvement behind existing wall

3. Excavation, deconstruction of the surface of the existing arch (existing masonry to be reused for surfacing and finishing work) and demolish the inner upper part of the existing arch structure.
   3a. Underpinning of existing foundations using lateral micropiles to strengthen existing foundations, if necessary.

4. Placement of the precast concrete wall blocks for arch support and anchoring to the existing walls with dowel bars.

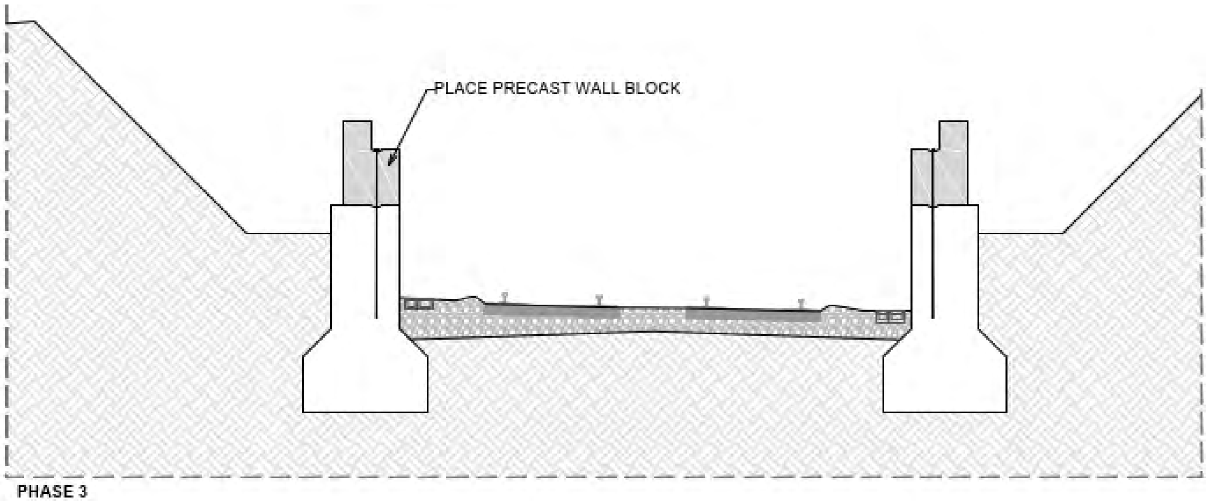


Figure 5-49 Placement of the precast concrete wall blocks

5. Placement of the precast concrete arch deck.

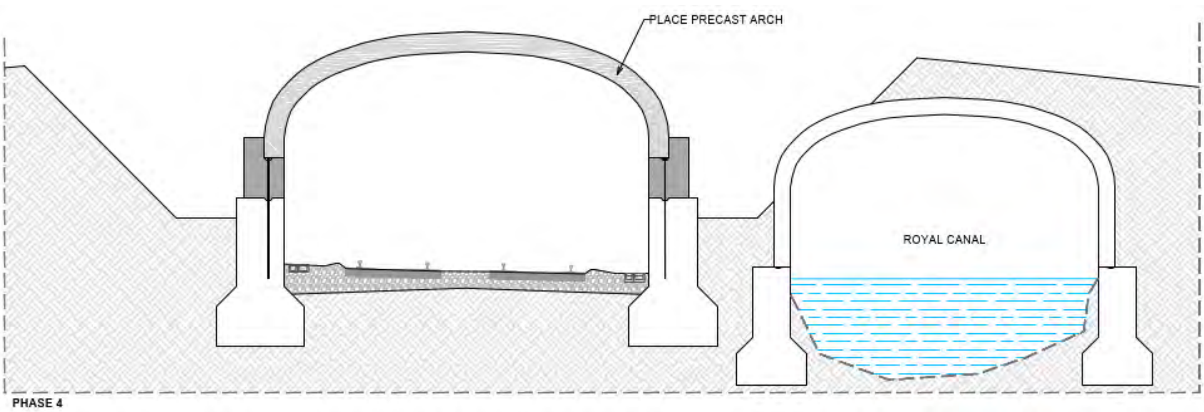


Figure 5-50 Placement of the precast concrete arch deck

6. Placement of waterproofing membrane on precast concrete arch deck and wall blocks.
7. Backfilling to bedstone behind the vertical walls to consist of semi-dry mortar not less than 750 mm in width.

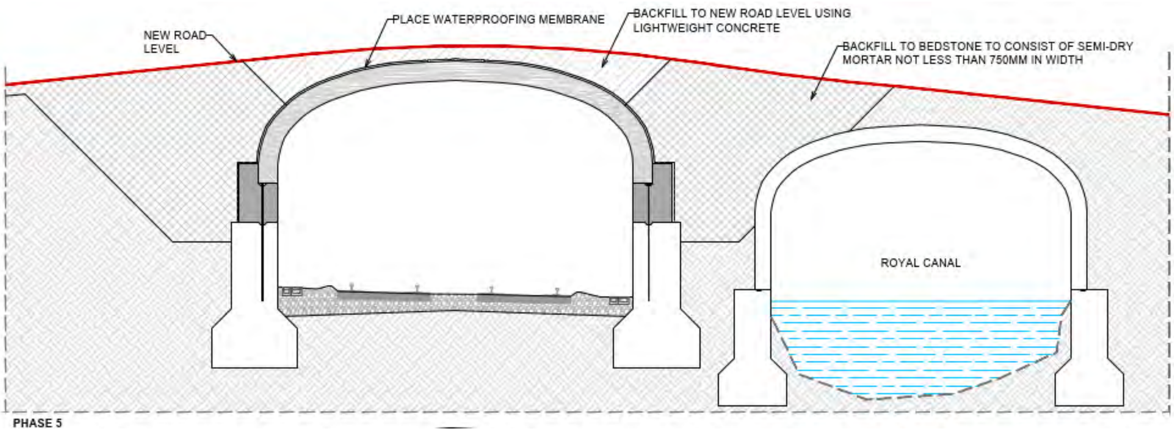


Figure 5-51 Placement of waterproofing membrane and backfill to bedstone behind vertical walls

8. Reconstruction of the road.

9. Restoration work along the deck to integrate aesthetically with the canal bridge.
10. Placement of temporary jersey barrier (or similar) in the carriageway to allow vehicles and pedestrians to cross, reinstallation of diverted utilities.
11. Repair of the pavements and parapets in accordance with conservation architects' requirements. Load test to be carried out on the adjacent canal bridge before allowing the road traffic to pass over.

To mitigate the impact on the historic structures as much as possible, the essential consideration in the process will be to ensure that the reconstruction sits comfortably alongside the remaining canal bridge. Due to the significant raising of the historic bridges and the requirement to install a precast concrete element to support the new span, it will not be possible or desirable to reconstruct the bridge to match the existing exactly. Instead, a contemporary solution using white cement concrete with timber slats shuttering will be designed between the two existing pillars to complement the proportions and style of the remaining canal bridge. The junctions between old and new bridges will be carefully considered, particularly the change in levels between the two spans and significant features such as the string course, arch voussoirs, stone coursing, and parapets.

Figure 5-52 Photomontage at Broome Bridge looking east

Figure 5-53 and Figure 5-54 are the example of OBG5 arch deck reconstruction.

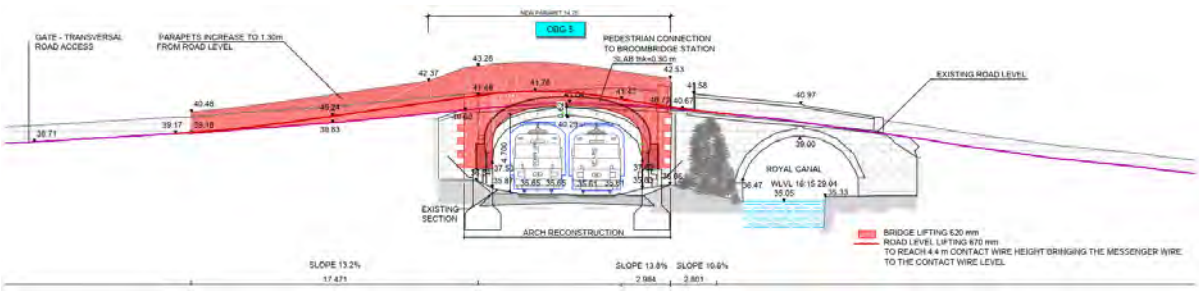


Figure 5-53 Elevation of OBG5 deck reconstruction

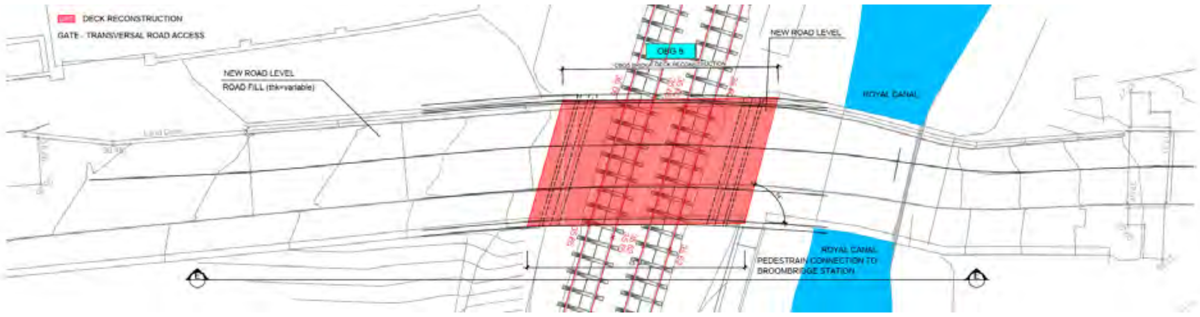


Figure 5-54 Plan view of OBG5 deck reconstruction

5.3.8.1.1.4 Construction duration

As shown in the following design chart, the total construction duration is estimated at approximately **40 weeks**. This includes:

- 15 weeks of total road closure.
- 19 weeks of partial road closure (one lane open).
- 13 weeks of total pedestrian closure (from 20th week the temporary jersey barrier or similar will be placed in the carriageway and in 20th and 21st weeks temporary pedestrian ramps will also be placed to allow pedestrian to cross).

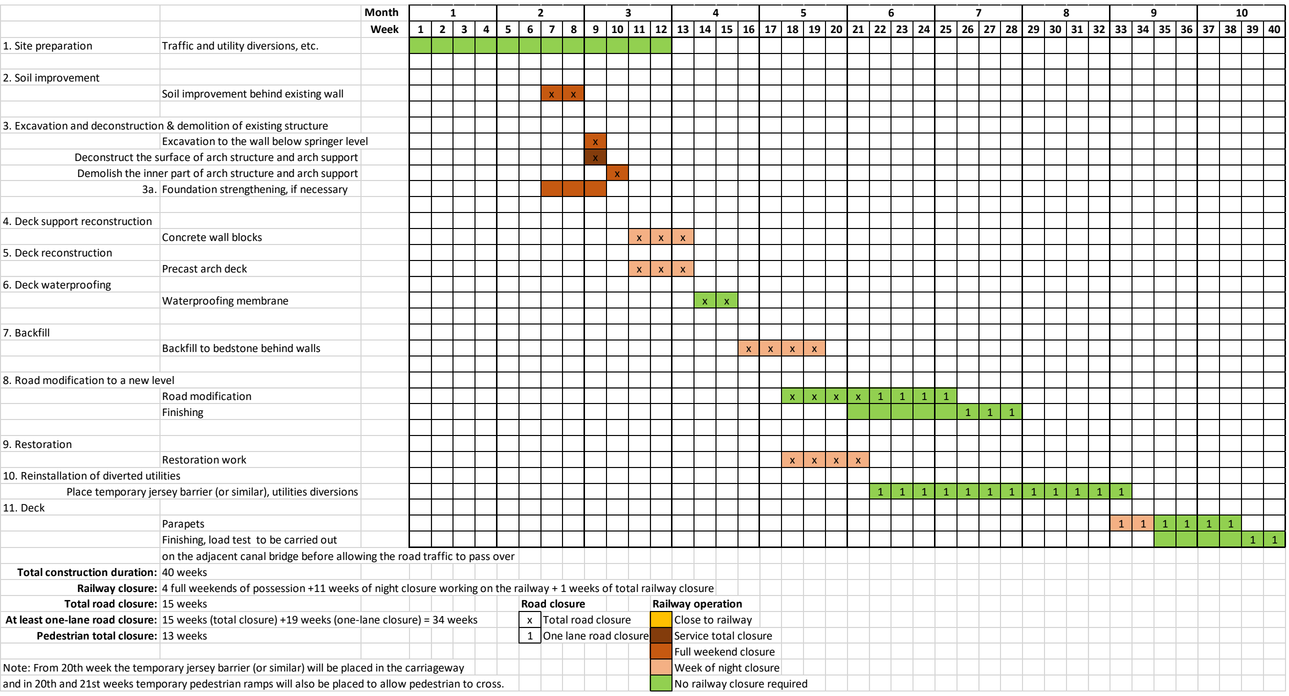


Figure 5-55 Construction duration of arched bridges

Note: as required by the conservation architect, the original stone at the surface of the existing arch should be carefully conserved during the arch reconstruction work. Therefore, it is proposed to dismantle the faces and particularly unstitch the stonework at the junction to the retained structure. The structure including the stonework will need to be carefully recorded and a stone accurate survey of the parapets before it is taken down. A one-week total railway closure is required for this phase (working 24h per day) for safety reasons. The protective element also needs to be installed to avoid any falling pieces to the track.

5.3.8.1.2 Flat deck bridges

5.3.8.1.2.1 Introduction

There are several existing flat deck bridges that require heavy deck lifting to increase the vertical clearance for the catenary equipment. These are listed below.

- OBG9 Old Navan Road Bridge.
- OBG16 Louisa Bridge.

For OBG16, the adjacent Canal Bridge is a proposed protected structure with historical value; therefore, it will be carefully protected during the heavy lifting works.

The structural design for each bridge has been provided in Section 5.6.10 for OBG9, and Section 5.8.7 for OBG16.

5.3.8.1.2.2 Construction phasing

The following construction strategy has been proposed for the two flat deck bridges (OBG9 and OBG16) regarding the heavy deck lifting work to increase the vertical clearance under the bridge:

1. Traffic and utility diversions and enabling works shall be carried out before the heavy deck lifting work, including site setup, accommodation work, service diversions, earthworks, and pavement works.
2. Road modification (excluding the bridge section) to a reach a new vertical clearance level (one lane).
3. Remove the pavement and infill within the bridge section to reduce the dead load (if required).
4. Excavate to the abutment level.
5. Place temporary deck lifting structure.
6. Vertical cut in the edges of the structural deck and horizontal cut between the piers/abutments and the deck.
7. Insert jacks and jack up the deck.

Figure 5-56 Standard bridge jacking system

8. Face of existing abutment work; place levelling layer and steel beam with anchor bolts to be cast into the new abutment extension.
9. Newly heightened deck support section must be connected with steel bars and connected to the existing steel reinforcement, and concrete should be poured to the new elevation.
10. Reconstruct the connection between the deck and abutments.
11. Remove temporary deck lifting structure.

12. Road modification to the new level.
13. Reinstallation of diverted utilities.
14. Repair the parapets, pavements and infill.

Figure 5-57 and Figure 5-58 are the example of OBG9 deck heavy lifting.

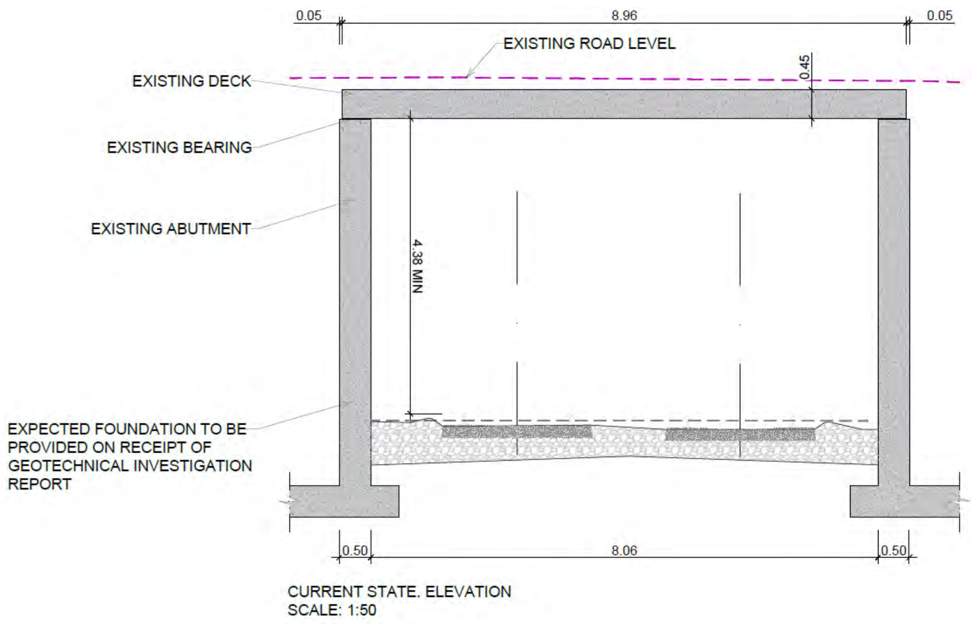


Figure 5-57 Elevation of existing OBG9

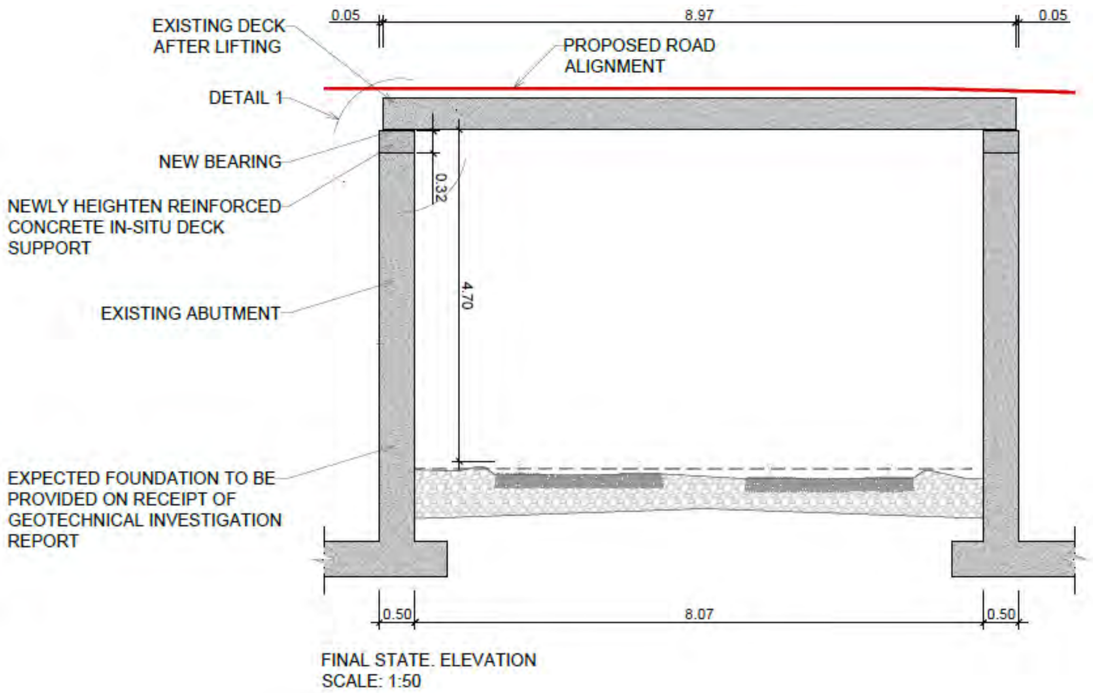


Figure 5-58 Elevation of OBG9 following deck lifting intervention

5.3.8.1.2.3 Construction duration

As shown in the following design chart, the total construction duration is estimated at approximately **42 weeks**. This includes:

- 9 weeks of total road closure.

- 25 weeks of partial road closure (one lane open).
- 7 weeks of total pedestrian closure (from 22nd week the temporary jersey barrier or similar will be placed in the carriageway and in 22nd and 23rd weeks temporary pedestrian ramps will also be placed to allow pedestrian to cross).

Most works will be performed during project construction working hours as set out in Section 5.2.1. Placement of temporary steel frame and deck jacking will be performed during railway weekend possessions. Connection to existing abutments, and placement of parapets will be performed during 6 weeks of night possessions on the railway. The proposed construction programme is shown in Figure 5-59.

Figure 5-59 Construction duration of flat deck bridges

5.3.8.1.3 Track lowering structural intervention at bridges

For all bridges where a track lowering solution to obtain sufficient vertical clearance is proposed, the following criteria regarding structural intervention will be followed.

Bridges where track lowering is proposed are: OBO11, OBG7A, OBG13, OBG18, OBO35, OBO35A, OBO36, OBCN286, OBCN290, OBCN290A, OBD221, OBD222, OBD223, OBD224, OBD224A, OBD225, OBD226 and OBD227.

The proposed depth of track lowering for all the above bridges is between 105 and 495 mm.

Three different types of structural interventions have been defined depending on the foundation level and the maximum excavation depth for track lowering:

- **Case 1**: No affect. The maximum excavation depth for track lowering is above the existing foundation level or the existing foundation is located at a sufficient distance away from the rail edge. No action on the existing structures is expected.
    - Applicable bridges: OBCN290A, and OBD227 (existing foundation is located sufficient distance from the rail edge).
- **Case 2**: The maximum excavation depth for track lowering is slightly below the existing foundation level.
    - List of affected bridges: OBO11, OBG7A, OBG13, OBG18, OBO35, OBO35A, OBO36, OBCN286, OBCN290, OBD223, OBD224, OBD224A, OBD225, OBD226 and OBD227.
    - The existing foundations are located below the proposed track lowering level; therefore, no significant structural impact is expected. However, soil improvement by jet-grouting or other

methods, according to geotechnical recommendation in the detailed design stage, is required before the excavation to protect the existing foundation.
    - Key design points:
        - Avoid affecting existing foundations: Soil improvement as detailed above is required before excavation. This work can be done from the railway without significant impact on existing structures.
- **Case 3**: The maximum excavation depth for track lowering is significantly below the existing foundation level.
    - Key design points:
        - Avoid affecting existing foundations: Soil improvement (as per case 2) shall be carried out around the existing foundation before excavation. This work can be done from the railway without significant impact on existing structures.
        - Ensure that the stability of existing foundations is not affected by the track lowering work: Precast concrete L-form retaining wall is required to mitigate the impact on the existing foundations.
    - List of affected bridges: OBD221, OBD222 and OBD225, see Section 5.5.9.7.1 for the construction phase, duration, and key machinery.

Construction sequence for soil improvement around existing foundations is as follows:

- Phase 1: Soil improvement around the existing foundation before excavation.
- Phase 2: Excavation to the required track lowering level.
- Phase 3: Place the track. Filling and compacting.
    - The total construction duration of the proposed soil improvement and track lowering will take approximately 3 months.

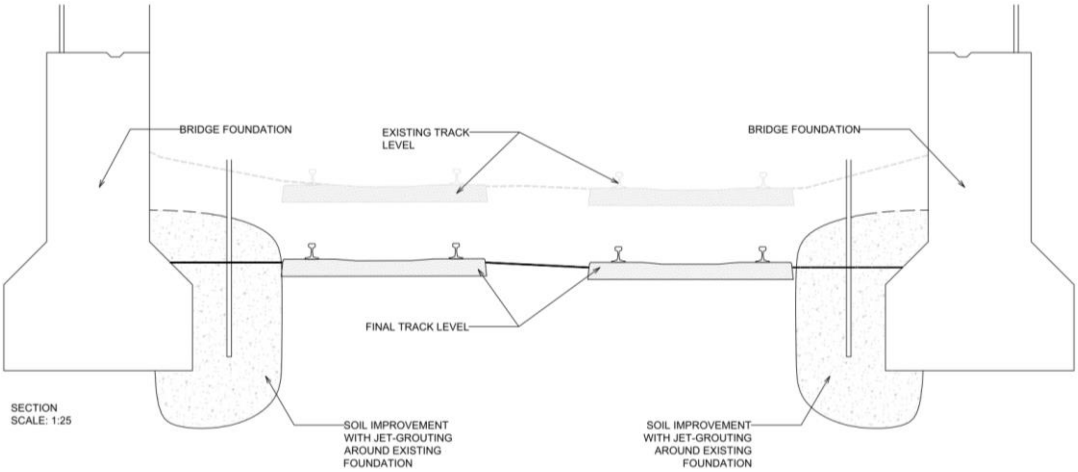


Figure 5-60 Soil improvement around existing foundation before excavation

5.3.9 SET systems

5.3.9.1 SET buildings and cabinets

As part of the DART+ West project works, new buildings or cabinets for SET (Signalling, Electrification, Telecommunications) are required along the line. The type of buildings/cabinets are described in the following sections of this chapter:

1. For HV substations, refer to Section 5.3.9.2.1.
2. For TPH, refer to Section 5.3.9.2.2.
3. For SEBs, refer to Section 5.3.9.4.1.
4. For PSPs, refer to Section 5.3.9.3.1
5. For ASPs, MV substations and DNOs, refer to Section 5.3.9.3.2.

6. For TERs, refer to Section 5.3.9.5.1.

Table below provides a breakdown of buildings/cabinets per zone (A-F).

Table 5-4 SET buildings/cabinets breakdown

Site description	Zone	38 kV HV substation (ESB + IÉ parts)	TPH	SEB	PSP	ASP	10 kV MV substation with customer switchroom	DNO	TER
Connolly	A			1	1			1	
Interface with DART+ Coastal North line	A					1		1	
Interface with DART+ Coastal South line	A					1		1	
Glasnevin	A	1		1	1		1	1	
Interface with DART+ SW line	A					1		1	
Spencer Dock (Abercorn Rd.)	B	1		1	1		1	1	
Spencer Dock (Ossory Rd.)	B						1	1	
North strand Junction	B							1	
Newcomen	B						1	1	
Broombridge	C								1
Ashtown	C	1				1		1	1
Navan Road Parkway	C								1
Castleknock	C	1							1
Coolmine	C	1							1
Porterstown	C								1
Clonsilla	C		1	1	1		1		
Hansfield	D	1							
Dunboyne	D	1				1			
M3 Parkway	D	1		1	1		1		
Leixlip Confey	E	1				1		1	1
Leixlip Louisa Bridge	E								1
Blakestown	E	1							
Maynooth	E	1		1	1				1
Depot entrance and CCE compound	F						1	2	
Depot	F	1							
Millerstown	F			1	1			1	
TOTAL		**12**	**1**	**7**	**7**	**6**	**7**	**14**	**9**

5.3.9.2 High voltage (HV)

5.3.9.2.1 HV substations

The HV substations will be constructed on-site with standard construction methods. The general procedure for construction will consist of the following:

1. Substation building:
    - Site clearance and earthworks.
    - Utilities diversion.
    - SET cabling diversion.

- Foundation and piles.
- Concrete slab.
- Facade and finishes.
- Pavement works.
- Boundary treatment.

2. Brickwork housing:
   - In-situ (fire resistant) concrete walls.
   - The installation of transformers.
   - Cable troughs and upstands cast into the floor, with the appropriate coverings.
   - All concrete surfaces will be cleaned and sealed to minimise dust generation.
3. MEP (Mechanical, Electrical and Plumbing) elements:
   - Building equipment (lights, fire detection, fire extinguishing, water, sewage, connection to Irish Water).
4. HV equipment (transformers, switchgear, auxiliary transformer, diesel generator, LV panels and UPS).
   - Delivered by road and installed using small cranes and cabling will be laid, then equipment will be electrically and mechanically installed.

Figure 5-61 Substation switchgear installed

Once the above activities are completed, the connection from the ESB to the new structure will be carried out (note as part of a separate planning application). Wherever practical, this will be carried out at the same time as necessary utility diversions to minimise disruption. The connection will require cables to be laid between the substation and the power station. ESB will have its own ESB room inside the IÉ traction substation. The HV cable connection between the ESB room and IÉ's substation is indoor. The external cabling connection (ESB network supply) from the ESB network to the ESB room (design and construction) is the responsibility of ESB. Figure 5-62 shows an existing IÉ traction substation to illustrate the components and their interconnections.

Figure 5-62 Traction substation connections

Once the feeder connection to OHLE is completed, the feeder cable routing will be placed in buried ducts that will connect the substation with the track. Road-rail vehicles with excavator attachments are necessary to carry out this excavation. The CMS is based on troughing constructed from precast concrete, so auxiliary cranes will be necessary. Final connections to the catenary poles will be carried out during night-time working hours, due to the proximity of the rail track.

Figure 5-63 Example of buried ducts for substation connections

Once the civils CMS works are finished, it is expected that the rate of work for laying the on live 1500 V DC feeder cables will be 40 – 60 m per 4-hour shift and team. Depending on the exact construction methodology adopted by the contractor, the construction time may differ. It is estimated that each substation will require a total of 8 months to be fully installed. The construction of substations requires constructing road access to connect into nearby existing roads.

5.3.9.2.2 Track paralleling hut

The erection of the track paralleling hut (TPH), although it is located near the rail track, will not affect its operation, so it is expected to be done during daytime project construction working hours as set out in Section 5.2.1. The construction, including the equipment installation, will include the following activities:

1. Enabling works and utilities diversions.
2. Land levelling and earthworks, which will consist in the contouring of the land in each location before the placement of the building. For that, it will be necessary to clear the land before any earthwork starts. The earthworks proposed are those necessary to generate the TPH footprint, such as:

removal or excavation, depositing of soil, or the execution of retaining walls when the surrounding area can't be occupied. At the same time, trenches will be excavated to construct the cable trough.
3. Lean concrete will be poured to form a foundation and a sand base will be extended.
4. After the foundation is complete, a prefabricated concrete building will be placed.
5. When the structure is finished, the equipment installation will be carried out, which consists of electromechanical equipment, electrical cabins, telecommunication and low-voltage equipment.
6. Finally, the feeder connection to OHLE will be completed, in a similar way as was explained in Section 5.3.9.2.1.

5.3.9.3 Low voltage (LV) supply

The works related to LV supply will consist firstly of the construction of technical buildings, and subsequently the execution of linear works.

5.3.9.3.1 Technical buildings

- **Principal Supply Points (PSP) and Medium Voltage (MV) substations.**

With regards to large technical buildings, the Principal Supply Points (PSP) and MV substations will be constructed next to the Signalling Equipment Buildings (SEB), and it will not be necessary to construct a separate compound as the area is small and the intervention is localised. The erection of the PSP and the MV substation, although it is located nearby the track, will not affect its operation, so it is expected to be done during daytime project construction working hours as set out in Section 5.2.1. The construction, including the equipment installation, will include the following activities:

1. Enabling works and utilities diversions.
2. Land levelling and earthworks, which will consist in the contouring of the land in each location before the placement of the building. For that, it will be necessary to clear the land before any earthwork starts. The earthworks proposed are those necessary to generate the PSP or MV substation footprint, such as: removal or excavation, depositing of soil, or the execution of retaining walls when the surrounding area can't be occupied. At the same time, trenches will be excavated to construct the cable trough.
3. Lean concrete will be poured to form a foundation and a sand base will be extended.
4. After the foundation is complete, a prefabricated concrete building will be placed.
5. When the structure is finished, the equipment installation will be carried out, which consists of electromechanical equipment, transformers and a diesel generator in each PSP and MV substation.

The MV substations will be a small building of approximately 7.05 m x 4.33 m and 2.6 m height, with one part for ESB and one part for IÉ (customer switchroom), that hosts the metering and main switch breaker. An example of an MV substation is shown below.

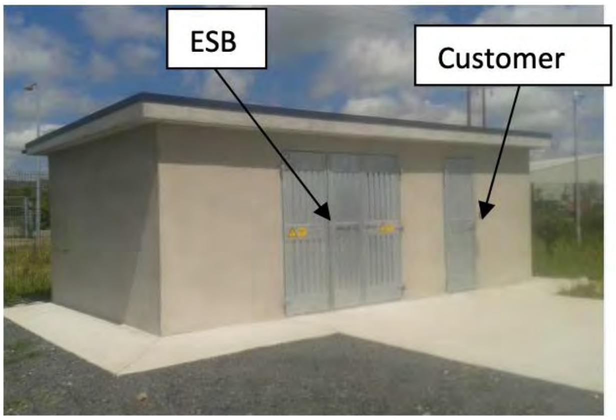


Figure 5-64 Example of MV substation

With regards to small technical buildings the construction, including the equipment installation, will include the following activities:

1. Land levelling and earthworks, lean concrete will be poured to form a foundation and a sand base will be extended.
2. After the concrete slab is complete, a prefabricated electrical panel will be placed.
3. When the structure is finished, then the equipment installation will be carried out, which consists of electromechanical equipment, transformers and electrical devices.

- **Auxiliary Supply Points (ASP)**

The Auxiliary Supply Points (ASP) will be small cubicles that constitute the secondary electrical supply for the Signalling/Telecommunications equipment. An example of an ASP is shown below.

Figure 5-65 Example of ASP

- **Point Heating Control Cubicle (PHCC)**

  The points heating cubicle will consist of a single enclosure that houses the controls, distribution and transformation for the points heating system. The cubicle will be a double door unit, with the control and distribution circuits located in the front and the step down and isolation transformers located in the rear. Its function is to control, step down, isolate and distribute the power supplies required for each point with track heating fitted (to be used when environmental and rail conditions are such that point heating is required). The Points Heating Control Cubicle indicative dimensions are shown in Figure 5-66.

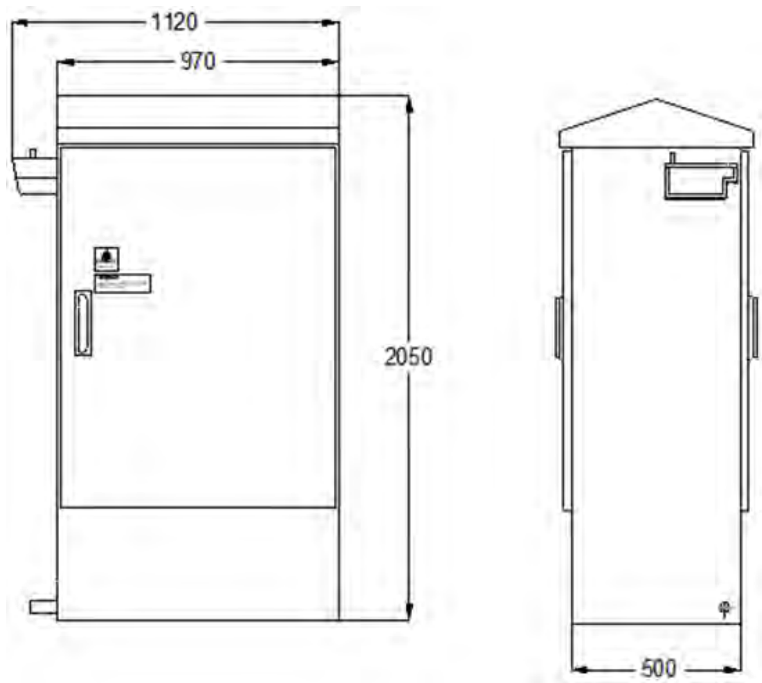


Figure 5-66 Points heating control cubicle indicative dimensions

- **DNO (Distribution Network Operator):** it is the interconnection boundary between the electrical company (ESB) and the end user (Iarnród Éireann) for low-voltage power supply connections. ESB extends its electrical network up to the DNO, where Iarnród Éireann receives the power supply. Note that ESB network extension is not covered in this chapter – to be delivered by ESB under a separate planning application.
  In locations where a new ESB connection is needed, the solution will be to install a double sided DNO/Distribution Cubicle in the fence line, as shown below.

Figure 5-67 Double sided DNO/distribution cubicle

A drawing of the double sided DNO/Distribution cubicle board is show in Figure 5-68.

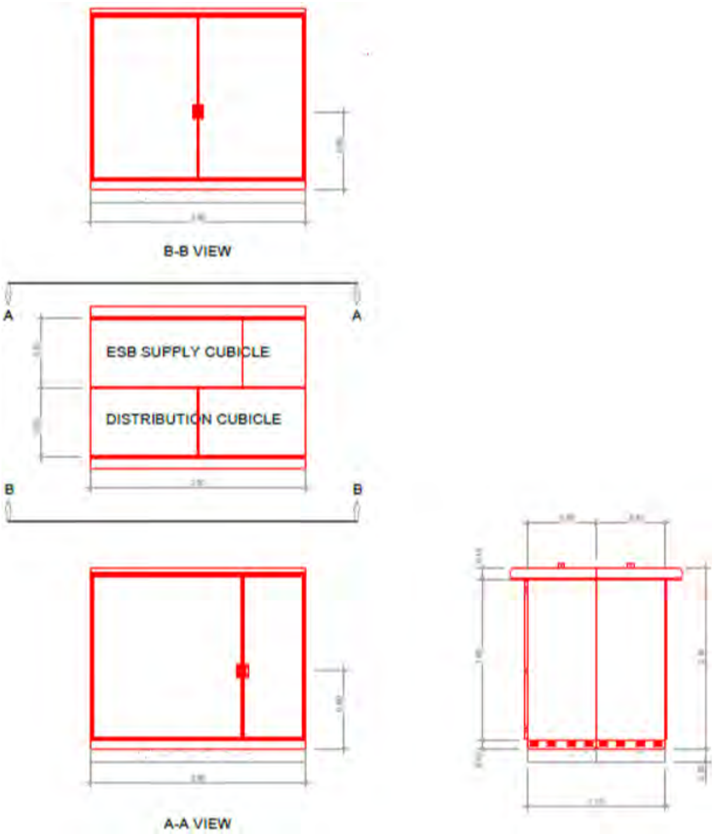


Figure 5-68 Double sided DNO/distribution cubicle board

5.3.9.3.2 *Linear works*

Linear works will consist of construction of the following elements:

- **Location Case (LOC):**
  The Location Cases (LOC) will provide housing for signalling, telecoms and low-voltage power supply assets (transformers, distribution board, etc.). The tracks surroundings (2 x 4 m^2) will be constructed during night-time possessions.
  An example of three LOCs is shown in Figure 5-69.

Figure 5-69 Example of three LOCs

- **LV cabling inside CMS:**
  Consists in the installation of the cabling from the large and the small technical buildings to the trackside CMS and from the CMS to the loads to be connected: LOC's, TER GSMR, Station TER, etc.
- **Points heater:**
  The system to be implemented will use self-regulating electric heater strips, so that as conditions become more severe, the heater increases output to maintain the rail above freezing point.
  The figure below shows a typical lay-out for a switch point equipped with 8 heater strips (four for TOE & 4 for HEEL) and 2 Clamplocks (at 2 of the TOE strips).
  The works to be carried out consists of the cabling from the PHCC to the junction boxes and the cabling from junction boxes to the heater strips and clamplocks, as shown in Figure 5-70.

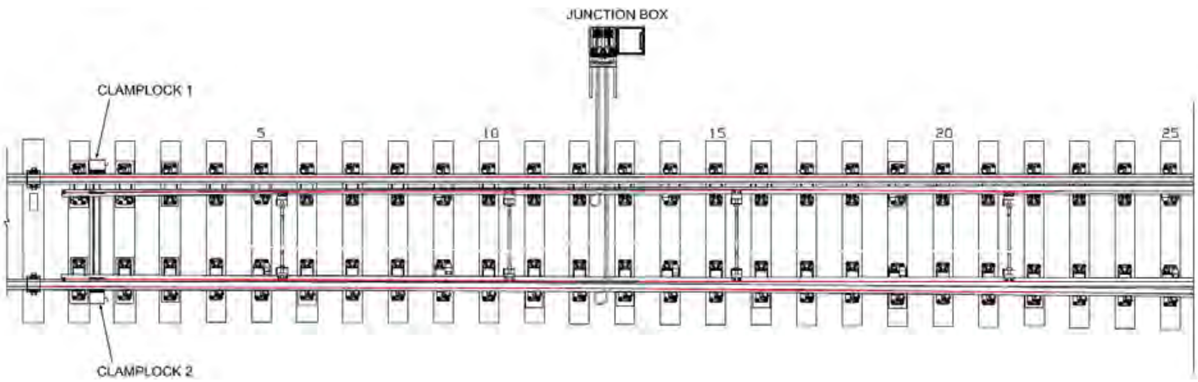


Figure 5-70 Typical heater strips & clamplocks lay-out

5.3.9.4 *Signalling*

The works related to installation of the signalling system will consist of the construction of technical buildings first, and then the execution of linear works. Signalling works also include updating the existing signalling system when required due to the permanent way works and the commission of the new system in different phases. These phases will enable the project to keep the train service running while performing the permanent way works.

5.3.9.4.1 Technical buildings

In the case of Signalling, technical buildings will consist of a Signalling Equipment Building (SEB). For its construction both the construction of new SEB and the refurbishment of existing ones is required. In the case of new SEBs, erection of a temporary construction compound is not required as they will be constructed as prefabricated buildings or because the buildings occupy a small footprint. The construction of the SEB will be done during daytime project construction working hours as set out in Section 5.2.1.

The construction phase of the SEB is described as follows:

1. Enabling works and utilities diversions as required.
2. Land levelling and earthworks, which will consist of contouring and clearing the land in each location before the construction of the building.
3. Then the earthworks will be carried out only within the footprint of the SEB consisting of: removal or excavation, depositing of soil, and construction of retaining walls if necessary.
4. At the same time, trenches will be excavated to carry out the cable troughs.
5. Lean concrete will be poured to form the foundations and a sand base will be placed from a truck.
6. After the foundation is complete a prefabricated concrete building will be placed.
7. When the structure is finished, the equipment installation will be carried out, which consists of electromechanical and signalling equipment.

In the case of the existing SEB, only the installation of new equipment within the buildings will be carried out.

Figure 5-71 Example of a SEB

5.3.9.4.2 Linear works

Linear works include the installation of the Location Cases (small cabinets of an approximate size: 1845 mm (height) × 1010 mm (width) × 535 mm (depth), the signalling cabling placed inside the CMS (cable management system) and finally, installation of the signalling equipment, namely signals, point machines, axle counters, balises, etc.

Figure 5-72 Typical LOC (location case)

The Location Case and signalling cabling installation may be carried out during daytime project construction working hours if feasible and working space allows. The signalling equipment must be installed during track possessions.

Much of the linear works will employ road-rail vehicles. Cable routes to station control rooms and offices will be installed as soon as the civil works have been completed and mechanical construction takes place.

The systems will be installed with dual redundant cabling infrastructure for both power and communications, and cables will be of suitably robust construction to withstand the environment and with appropriate physical separations from other services to prevent electromagnetic interference and other external effects.

The construction phase for the signal supports is described as follows:

1. Foundation excavation using auger boring machine.
2. Pre-assembled foundation rebar installed lifted in using crane.
3. Foundation concrete pour.
4. Mast installation using crane.
5. Gantry beam/cantilever beam installation (where necessary) using crane.
6. Signal installation.

Figure 5-73 Rail-road vehicle examples - pile boring machinery (left) and crane (right)

5.3.9.4.3 Signalling dependency on permanent way works

There are three typical dependencies between permanent way works and signalling:

- Works that can be done without affecting the existing signalling system and hence will be commissioned at the same time as the new signalling system is commissioned.
- Works that will require a modification of the existing signalling system.
- Works that will be done after the new signalling system is commissioned.

The following table summarises the different permanent way works that have an impact on the signalling system in each zone (Table 5-5).

Table 5-5 Signalling dependencies on Permanent Way works

Zone	Section	STAGE 2-3 Permanent Way Works with current signalling	STAGE 4 Testing of new signalling system	STAGE 5 Commissioning of new signalling system	STAGE 6-7 Final track configuration and associated changes in signalling
Zone A	Connolly - Glasnevin	• New crossover between East Wall Junction and Ossory Road Junction installed and blocked. No need to modify the existing signalling. • Interim connection between GSWR and East Wall lines modifying the exisiting signalling. In this area other trackworks will be performed when freight traffic is diverted through the interim connection. • Development of interfaces of the new CBI with Dublin North KRCF SSI and Dublin Central TTLD SSI. The boundary with DN KRCF SSI will be modified.	• Test of the new signalling system in Zone A, including the interface between the new CBI and Dublin North KRCF SSI at the new interlocking boundary and the interface between the new CBI and Dublin Central TTLD SSI.	• New signalling system commissioned with the following configuration: • New Crossover commissioned • Interim connection between GSWR and East Wall lines still in place • New interlocking boundary between the DN KRCF SSI and the new CBI	• Track works to remove the interim connection between the GSWR line and East Wall lines, with the associated changes in the new signalling system. • During these track works, freight trains will not be able to run through the GSWR line
Zone B	Spencer Dock - Glasnevin	• Track Access to Spencer Dock prepared but not commissioned. New signalling system installed to control the existing Docklands station. • MGWR line: Installation of new crossover and decommission of existing crossover modifying the existing signalling system. Commission of the new crossover. • East Wall lines: New crossover, new turnout and new trap points can be installed and blocked, without affecting the signalling system. • Development of the interface between the new CBI and Heuston SSI	• Testing of the new signalling system with Docklands station, new MGWR configuration and new crossover, trap points and turnout in the East Wall lines. • Testing of the new interface with Heston SSI.	• New signalling system commissioned with the new track configuration and Docklands station. • Spencer Dock station not in service yet.	• Commission of Spencer Dock, new track Access to Spencer Dock, decommission of Docklands and associated changes to signalling.
Zone C	Glasnevin - Clonsilla	• Modification of the existing signalling system to remove the level crossings atPorterstown, Clonsilla, Ashtown, and Coolmine . • Extension of Clonsilla siding: The siding can be extended without impacting the existing signalling system. The existing turnout will be replaced by a new one in the same location.	• Testing of new signalling system considering “no-level crossing” track configuration and full length of Clonsilla siding.	• New signalling system commissioned with no level crossings and with Clonsilla siding extended.	• No pending permanent way – signalling works
Zone D	M3 Parkway Branch	• New crossover at M3 Parkway station installed and blocked to work as the existing turnout, without modifying the existing signalling system. • Construction of the new siding at M3 Parkway station.	• Testing of the new signalling equipment with the new siding and crossover.	• New signalling system commissioned with the new siding and crossover.	• No pending permanent way – signalling works
Zone E	Clonsilla – Maynooth Station	• Modification of the existing signalling system to remove the level crossings at Barberstown and Blakestown.	• Testing of new signalling system considering “no-level crossing” track configuration.	• New signalling system commissioned with no level crossings.	• No pending permanent way – signalling works
Zone F	Maynooth Station – Maynooth Depot	• New crossover and siding at Maynooth station commissioned modifying the existing signalling. • New up track and new down track installed without the connection to the existing line. • New crossover installed but blocked. • New turnouts to access the depot installed and blocked until commissioning of the depot. • Development of the interface between the new CBI and the Sligo Line SSI.	• Testing of the new signalling system with the new crossover and siding west of Maynooth station and the existing single track from Maynooth to Sligo boundary.	• Commission of the new signalling system with the new crossover and siding west of Maynooth station and the existing single track from Maynooth to Sligo boundary.	• Permanent Way works to commission the double track. Associated changes in signalling to control the new double track section. • Accesses to the depot blocked until commissioning of the depot.

5.3.9.5 Telecoms

The works related with communications system will consist of the migration of the existing trunk cables first, then construction of technical buildings (station TER), and then the execution of linear works.

5.3.9.5.1 Technical buildings: Telecommunication Equipment Room (TER)

In the case of Telecoms, technical buildings will consist of new station Telecommunication Equipment Room (TER) installed at stations and a new TER for the Hot Axle Box Detector at Porterstown. For the installation of TERs, both the construction of new rooms and the refurbishment of existing ones is required. New TERs will be prefabricated buildings, therefore erection of a temporary construction compound is not required for their construction. The erection of the TER is expected to be done during daytime project construction working hours as set out in Section 5.2.1.

The construction phase of the TER is described as follows:

1. Enabling works and utilities diversions.
2. Land levelling and earthworks, which will consist in the contouring and clearing the land in each location before the placement of the building.
3. Then the earthworks will be carried out only within the footprint of the TER consisting of: removal or excavation, depositing of soil, and execution of retaining wall if necessary.
4. At the same time, trenches will be excavated to construct the cable trough.
5. Lean concrete will be poured to form the foundations and a sand base will be extended from a truck.
6. After the foundation is complete, a prefabricated concrete building will be placed.
7. When the structure is finished, the equipment installation will be carried out, which consists of electromechanical and telecom equipment.

At some stations the existing TER will be re-used, where only the installation of new equipment will be required.

Figure 5-74 Existing TER at Coolmine

5.3.9.5.2 Linear works: Cabling installed as part of the early works

Trunk cabling will be installed in the CMS as part of the early works. Trunk cables include both existing cabling (i.e. one to one replacement to avoid damaging these cables during construction works) and new cables.

Firstly, the replacement of the existing trunk cables will be done, including the cable routes and migration of services. No other works will start until this activity is completed.

Telecoms cabling will be carried out during planned night-time possessions unless there are full week or weekend possessions that can be utilised. There may be some sections where the cable laying can be done during daytime project construction working hours as set out in Section 5.2.1 with appropriate safety measures in place.

5.3.9.5.3 Linear works: Cabling not installed as part of the early works

The following activities will occur after the early works:

- All the new trunk cables will be connected to main DART+ West nodes/buildings (TER, SEB, substation).
- Subsidiary cabling will be installed to connect the specific DART+ West infrastructure (OHLE, Signalling and LV cabinets to the optical fibre).
- All new station infrastructure (optical fibre, copper, structured cabling and Station LOCs) will be installed in stations' yards and platforms.

Telecom cabling will be carried out during planned night-time possessions unless there are full week or weekend possessions that can be utilised. There may be some sections where the cable laying can be done during daytime project construction working hours as set out in Section 5.2.1 with appropriate safety measures in place (e.g. in stations).

Refer to Section 3.5.7 for information on installation of the Cable Management System.

5.3.9.6 Overhead Line Equipment (OHLE)

5.3.9.6.1 Utility diversion and OHLE topographical stakeout

Before catenary works commence, all the utilities that will be affected by the catenary works must be diverted. Some works can be done during the day depending on availability of a Safe Working Zone, but the connection works would be done during the night to avoid disturbance. Duration depends on the utility diversion proposed.

Figure 5-75 Example of buried utilities to be diverted

Figure 5-76 Aerial example of utilities to be diverted

5.3.9.6.2 Foundations

The foundations for the OHLE supports shall either be concrete bored piles, steel driven piles or shallow foundations such as concrete footings. The type of foundation selected will depend on the ground conditions or site constraints (e.g. locations where due to the existing utilities, a deep foundation cannot be installed, and a shallow foundation type could be required).

The construction of the foundations will require track possessions and will utilise road-rail vehicles such as piling rigs and concrete wagons; hence, the works will be carried out during night-time possessions in 4-hours shifts. Catenary masts will be located along the whole track at spacing of between 40 and 50 m.

5.3.9.6.2.1 Concrete bored piles

Installing a concrete pile starts with drilling a vertical hole into the soil using a rotary auger machine from track level. Alternative boring equipment can be outfitted with specially designed drilling tools, buckets, and grabs to remove the soil and rock. The drilling process may include driving a temporary steel tube, or sleeve, into the soil. This remains in place in the upper portion of the hole until the pile is poured with concrete.

Figure 5-77 Foundation drilling

Once the hole is drilled, a cage of reinforcing steel rebar is lowered into the hole; then, the hole is filled with concrete. The rebar cage shall be installed with suitable holding down bolts for future connection of the upper OHLE superstructure. The top of the pile may be capped with a footing or pier near ground level to support the structure above.

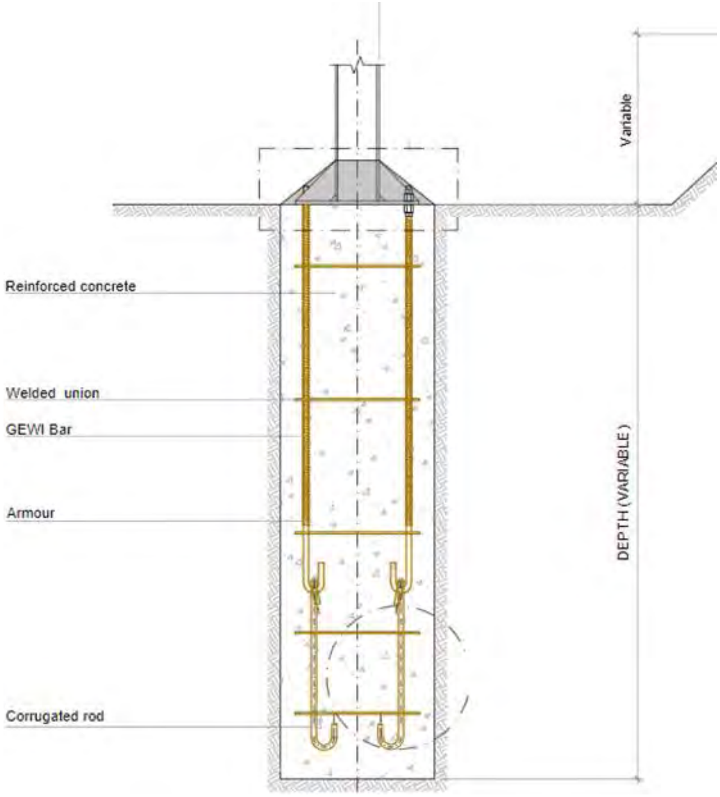


Figure 5-78 Standard OHLE foundation

5.3.9.6.2.2 Steel piles

In the execution of steel piles, cylindrical steel piles are driven deep into the ground by means of Rail-Road Vehicles that have an arm attachment. The arm is used to grip the hollow steel structures and vibrate or hit them until they are fully in the ground.

Figure 5-79 Installation of steel piles

In general, it is foreseen that piles are driven into the ground using the vibration method, however, in instances where this proves difficult, for example due to soil conditions, a hydraulically driven hammer will take over and hit the steel pile until it reaches the required depth.

5.3.9.6.2.3 Shallow foundations

A third option for the foundation of the catenary system are concrete footings, which might be used where soil upper layers seem to be strong enough. The construction methodology for these elements is listed below:

1. Excavation of the pad box by means of an excavator.
2. Pouring of a blinding concrete layer of about 50 mm thick in order to offer a clean and level surface for the reinforcement.
3. Correct placing of the foundation reinforcement by means of spacers.
4. Concrete pouring and vibration.
5. Concrete curing by appropriate techniques.

5.3.9.6.3 Mast bracketry

After the foundations are completed, OHLE support structures, including masts and cantilevers (previously assembled in compounds), shall be installed using rail-road vehicles. The works are to be carried out during the night-time and weekend possessions.

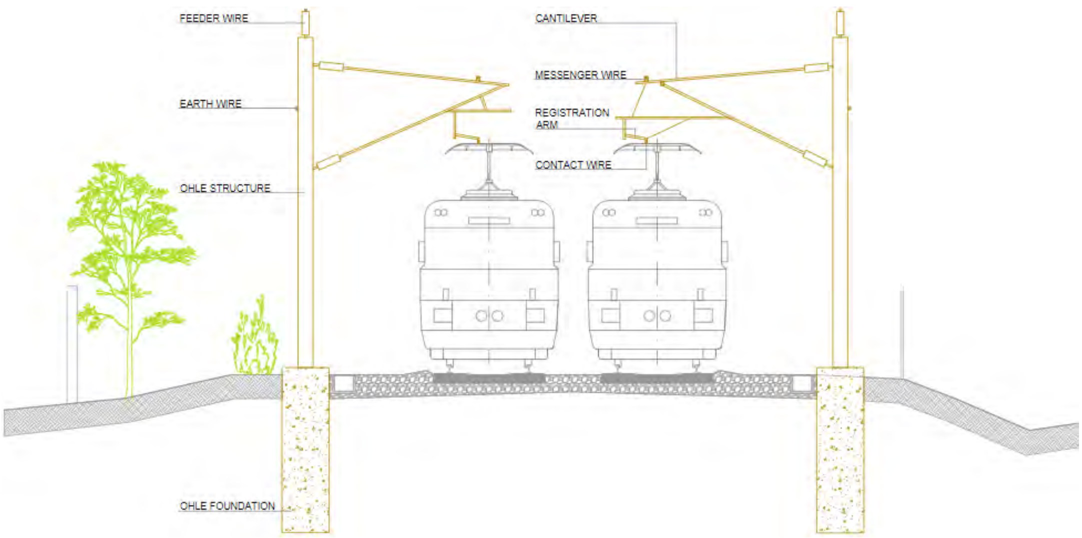


Figure 5-80 Standard OHLE structure

OHLE masts will be installed along the rail line with a spacing of 40 to 50 m. Where necessary, gantries will be installed to host the cantilevers. The installation of the masts will begin once the foundations have been installed.

The masts will be transported to the installation point using rail-road machinery with a boom crane. Track possessions will be required; hence this activity will be carried out during the night-time and weekend possessions.

Figure 5-81 Mast installation

Depending on the size of the gantry to be installed, more than one road-rail vehicle may be required to raise the structure.

Figure 5-82 Gantry installation

Masts will be installed on the anchors located in the foundation and locked in their correct position.

Figure 5-83 Foundation anchor for masts

Finally, the finishing of the anchorage will be done with mortar or other similar material required by the type of mast used.

5.3.9.6.4 Cantilevers

The cantilevers will be installed on the catenary poles along the entire length of the line.

Figure 5-84 Cantilever assembly

The cantilevers will be installed on the masts with the corresponding insulators and all other elements that are necessary for the laying of the OHLE wires. As with the previous elements, the cantilevers will be installed during night-time and weekend possessions.

5.3.9.6.5 Laying of the messenger wire

To install the contact wire, it will first be necessary to install the messenger wire. To avoid breakage and/or deformation of the messenger or contact wire during the installation works, appropriate road-rail vehicles will be used, such as platforms, reel carriers and wire laying trains. Later the contact wire will be installed, and some final adjustments will be checked for the OHLE system.

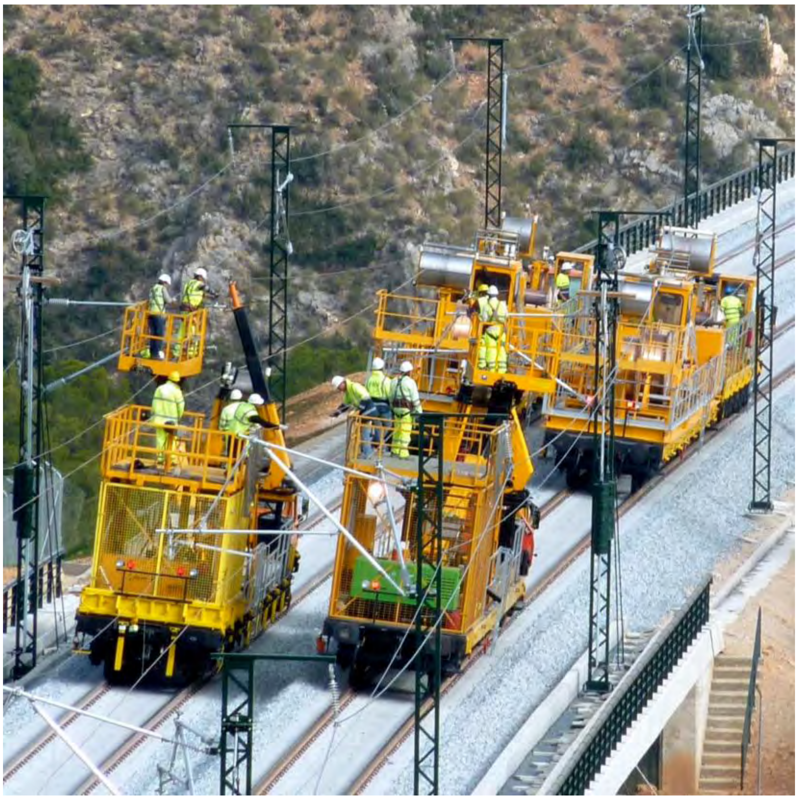


Figure 5-85 Wire installation track vehicles

Before laying the messenger wire, all the necessary equipment and machinery will be prepared on the track. The end of the cable reel will be anchored with the appropriate fastenings, then the laying of the wire will start.

A laying train will be used to lay the wire until the position of the next cantilever is reached. The wire is placed until the end point is reached, where the wire will be anchored. At this point the wire will be tensioned.

Once the over-tensioning period is finished, the wire will be removed from the pulleys located on the cantilevers and placed in its position. Finally, the excess wire will be cut off, completing the installation of the messenger wire.

5.3.9.6.6 Laying of the contact wire

The process of laying the contact wire is very similar to that used in the case of the messenger wire. The machinery and equipment required are the same.

In this case, in each span, to keep the wires elevated, they will be suspended from the messenger wire using copper hooks. Each wire shall be suspended on the same side, along the entire alignment, in such a way that there is no crossover or twists between them.

Once the end point of the laying section is reached, the wire will be anchored and over tensioned as prescribed, using same methods and elements used for the messenger wire.

The hooks placed in the spans will be replaced by temporary droppers until the definitive droppers are installed into place.

5.3.9.6.7 OHLE adjustments

After installing the contact wire, the correct position of the OHLE is checked and adjusted if needed. Special track equipment is required for this task. OHLE adjustments cover contact wire, messenger wire, feeder wire and cantilever bracketry. The OHLE structures or supports are not adjusted.

Figure 5-86 OHLE adjustment

5.3.10 Fencing and boundary treatment

5.3.10.1 Railway fencing

Railway fencing is to be installed in coordination with Permanent Way and SET works. The construction of the fence will be carried out, where possible, from the tracks to avoid any temporary land acquisition and disruption to stakeholders.

The requirements for the provision of fencing on the IÉ Network are set out in CCE-TRK-SPN-037 Fencing Specification. This document states different fence typologies that have been used for the proposed new fences. Even though the open mesh steel panel (Paladin fence) is not included in above mentioned standards, it is widely used along the line and has been approved by IÉ and the CCE.

The following railway fencing will be installed along the project extents:

- 2.4 m Palisade Fencing Security Purpose (SP) and General Purpose (GP).
- Open mesh steel panel for general purposes (Paladin fence).

5.3.10.1.1 Palisade fencing

5.3.10.1.1.1 Security Purpose (SP) fencing

Security Purpose (SP) fencing is required near stations, substations and other buildings to prevent trespass when security is required to prevent vandalism and intrusions.

The main characteristics of a Security Purpose (SP) fence are listed below:

- The type of fencing shall be 2.4 m (the top of the fencing pales shall be 2.4 meters above ground level).
- Pales shall be 3.0 mm thick corrugated with a ‘W’ profile. The maximum spacing of pales, centre to centre, shall be 155 mm. The minimum face to view (width) shall be 70 mm.
- The maximum centre of posts shall be 2.75 m. The posts shall be set in concrete in the ground to a minimum depth of 750 mm.
- Post (127x76x13 kg/m) shall be the minimum requirement of BS type SP30.
- A minimum of two number horizontal rails shall be installed.
- The fence should have a gap at the base, or alternatively and 300 mm x 300 mm gap every 50 m.

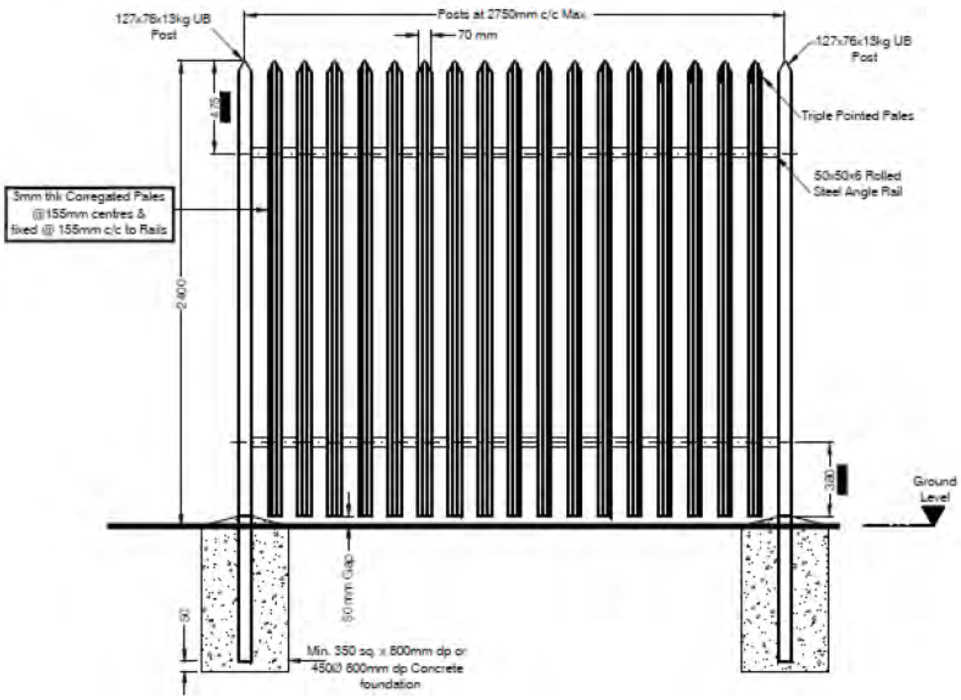


Figure 5-87 Security purpose (SP) fencing

5.3.10.1.1.2 General Purpose (GP) fencing

General Purpose (GP) fencing will be installed alongside the railway boundaries in locations which do not require Security Purpose (SP) fencing.

The main characteristics of a General Purpose (GP) Fence are listed below:

- The type of fencing shall be 2.4 m (the top of the fencing pales shall be 2.4 m above ground level).
- Pales shall be 3.0 mm thick corrugated with a 'W' profile. The maximum spacing of pales, centre to centre, shall be 155 mm. The minimum face to view (width) shall be 65 mm.
- The maximum centre of posts shall be 2.75 m. The posts shall be set in concrete in the ground to a minimum depth of 750 mm.
- Post (102 x 44 x 7.5 kg/m) shall be the minimum requirement of B.S. type GP24 for GP fences.
- A minimum of two number horizontal rails shall be installed.
- The fence should have a gap at the base, or alternatively and 300 mm x 300 mm gap every 50 m.

5.3.10.1.2 Open mesh steel panel for general-purpose

The open mesh steel panel fence BS 1722-14:2006 category 1 (Paladin fence) should be constructed in urban areas to avoid trespassing into the railway. It is used in urban areas where it is not necessary to specify an alternative type of fence (i.e. palisade).

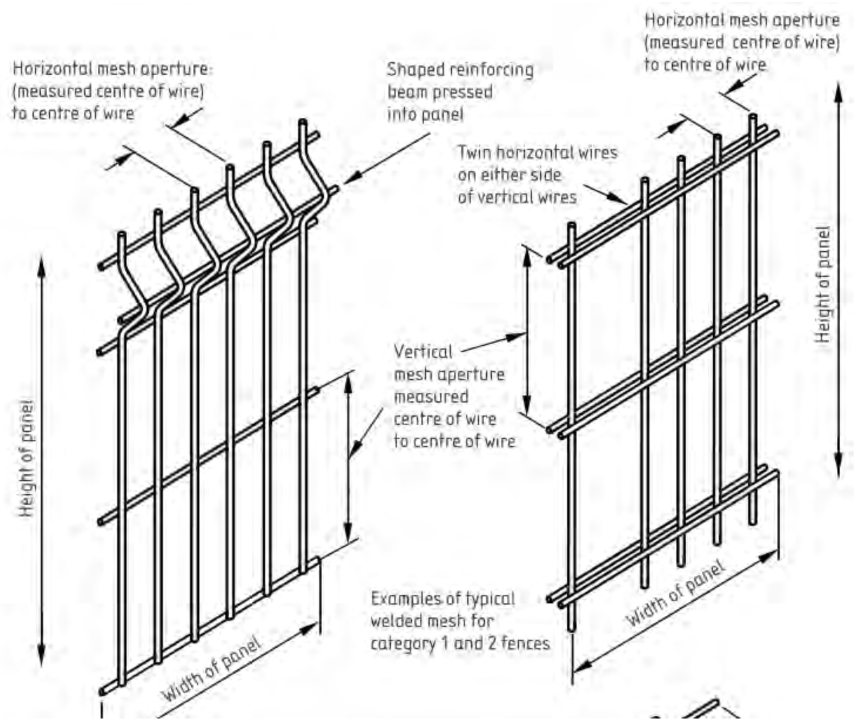


Figure 5-88 General purpose (GP) fencing

5.3.10.2 Construction methodology for fencing

Construction sequence for fencing works will vary depending on the type of fence required to be constructed. However, this will typically include:

1. Check ground for existing utilities and divert as required.
2. Excavate for foundations of fencing.
3. Install foundations as per design.
4. Install fencing, checking vertical and horizontal alignment.

Typical machinery includes mini digger, excavator with lifting equipment, concrete truck and dumper truck. If it is required to be constructed from the track, RRVs will be used.

5.3.10.3 Temporary fencing

All works zones will be fenced to secure the site against unauthorised access. Any works to be undertaken on the public road will be fenced to secure the site and prevent unauthorised access. Where works areas are adjacent to road traffic it is envisaged that H2 containment barriers will be erected. All traffic management will be designed and implemented to current standards and agreed with the relevant Local Authority prior to implementation.

5.3.11 Vegetation clearance

Vegetation is required to be cleared from the vicinity of electrified lines.

The construction of the fence will also require vegetation clearance.

Before the vegetation clearance starts, a survey of the area will need to be completed. Machinery will vary depending on the location, but the following may be required:

- Chainsaws, axes, and hatchets can all be used to fell and remove trees.
- Stumps for trees that are removed can be ground down with stump grinders.

- Mulchers can be used to clear underbrush, small trees and leftover fencing (the contractor can either use a tracked or wheeled mulching machine or there are also mulching machines that can be used with equipment such as tractors or excavators which can be road-rail for use on the railway).
- Bulldozers can be used for clearing large areas where leftover structures, boulders, standing tress and debris remain.
- Tractors with frontend loaders can be used to clear rocks, smaller trees, branches etc. and for levelling/grading the land.
- Backhoes and excavators can be used in small-scale land-clearing.
- A woodchipper may be required to turn trees into woodchips for easy disposal.

5.3.12 Parapets

This section describes the work methodology required for parapet construction works. The works shall be done in accordance with their respective technical specifications and parapets drawings.

All the parapets included in the project have been classified according to the structure they are being supported from: Bridges, Footbridges and Walls as described in sections below.

5.3.12.1 Parapets on bridges

This section describes the construction methodology for the parapet heightening solution proposed for bridges. Figure 5-89 shows the proposed solution, which is described in Chapter 4 in Volume 2 of this EIAR.

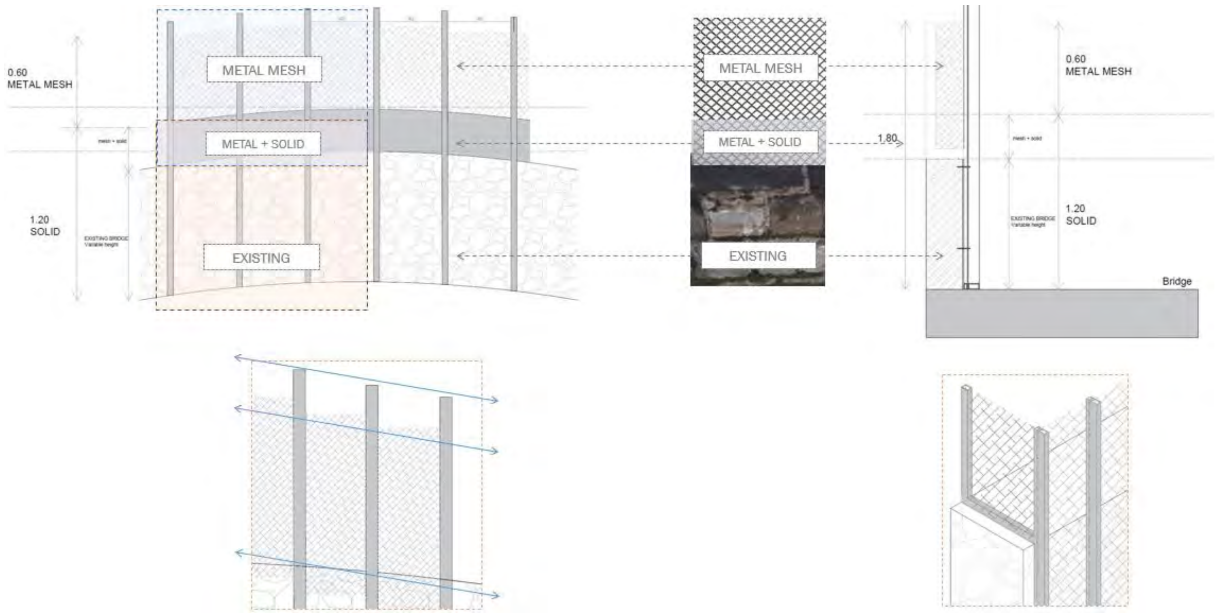


Figure 5-89 Design intent for parapet heightening on bridges

Construction sequence is proposed as follows:

1. Prepare the pavement surface for the footings (divert utilities if required).
2. Construct the foundations to support the vertical supports and the mesh structure.
3. Install the vertical supports and mesh structures, fixing into the mortar joints only (fixing into any historic stonework is not permitted).
4. Finishes and making good around the pavement.

5.3.12.2 Parapets on bridges with width restrictions

As detailed in Chapter 4, it is noted that OBG18 Pike Bridge and OBG13 Collins Bridge require an alternative solution due to width restrictions on the existing road/pedestrian walkway – reference Figure 5-90 below.

The alternative proposal places the parapet on top of the historic stone parapet with a structural support inserted through the stone parapet and founded in the deck at 2 m spacing. There will then be intermediate supports every 400 mm that will sit on top of the existing stone parapet. The support joints will be welded together, and the solid metal panel required up to a height of 1.2 m will also be welded to the upright supports. IP2X mesh will then be installed up to the required height of 1.8 m.

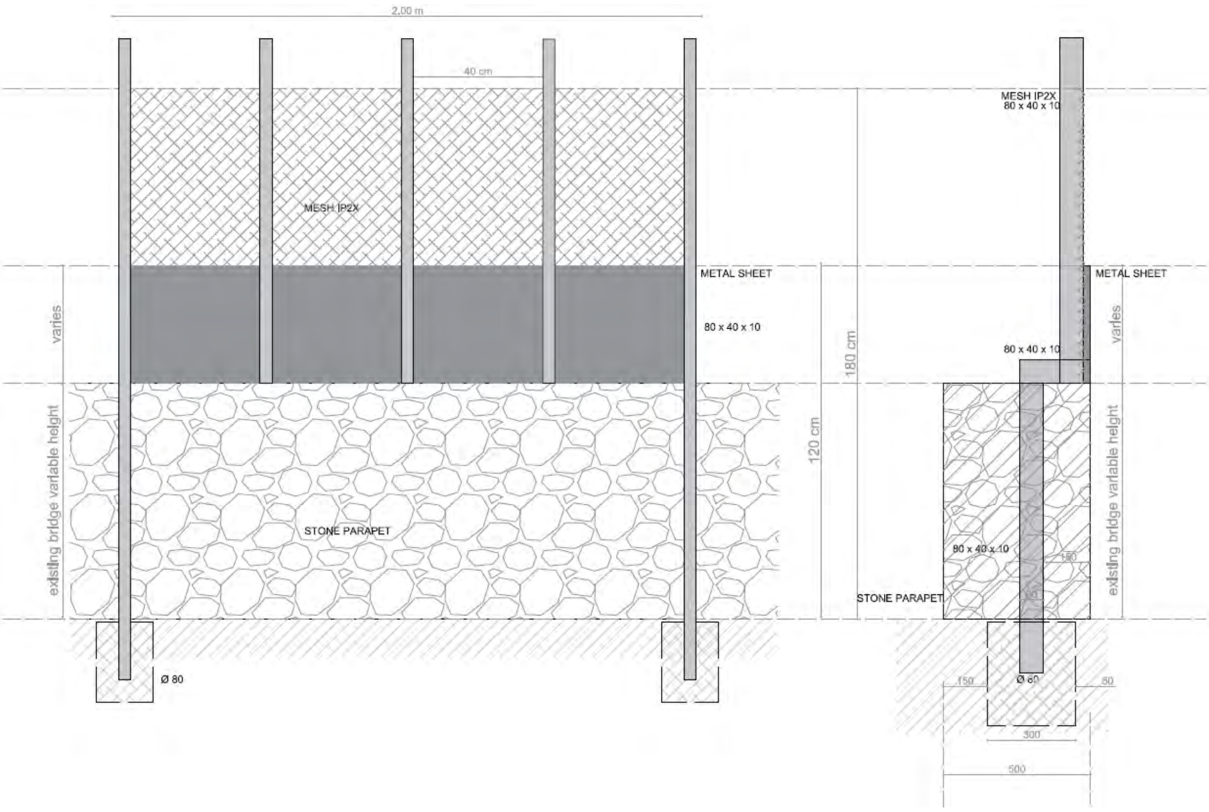


Figure 5-90 Alternative parapet heightening solution for bridges with width restrictions

The proposed construction sequence is as follows:

1. Close off the footpath/road section to provide sufficient working room.
2. Core through the stone parapet at 2m spacing, install vertical support and concrete footing as per design (welding of joints to be completed off site if possible).
3. Install metal sheet, IP2X mesh and intermediate supports, welding joints together as required (off site welding to be completed where possible).
4. Making good around stone parapets, in line with heritage considerations.
5. Finishes and making good around the pavement.

5.3.12.3 Parapets on footbridges

This section describes the construction methodology for the parapet heightening solution proposed for footbridges. Figure 5-91 shows the proposed solution, which is described in Chapter 4 of this EIAR.

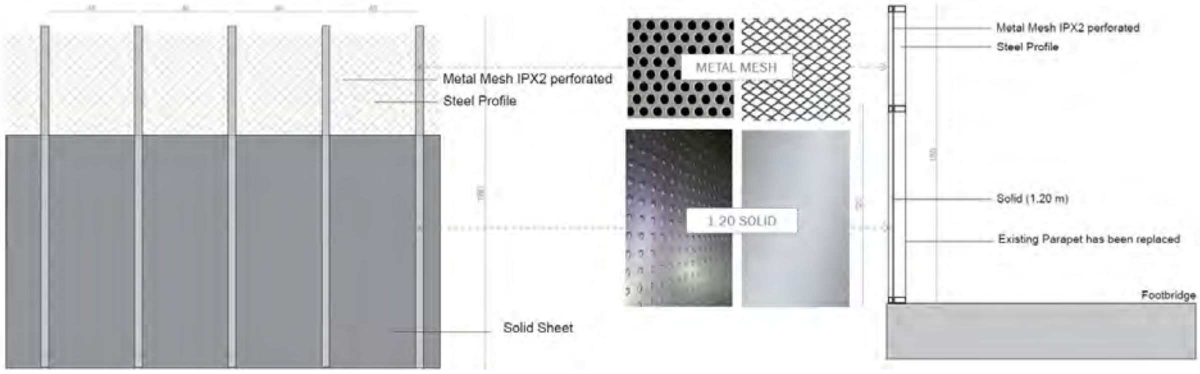


Figure 5-91 Design intent for parapet heightening on footbridges

Construction sequence is proposed as follows:

1. Prepare the pavement surface for the footings (divert utilities if required).
2. Construct the foundations to support the vertical supports and the mesh structure.
3. Install the vertical supports and mesh structures, fixing into the existing footbridge parapet with appropriate fixings.
4. Finishes and making good around the pavement.

5.3.12.4 Specific solution at OBG12 Clonsilla Station footbridge

A unique solution is required at OBG12 Clonsilla Station footbridge as described in Chapter 4.

Construction sequence is proposed as follows:

1. Prepare the surface of the bridge at the fixing locations.
2. Fix the low level polycarbonate panel as per design details.
3. Make good any defects on the existing bridge and around fixing locations.

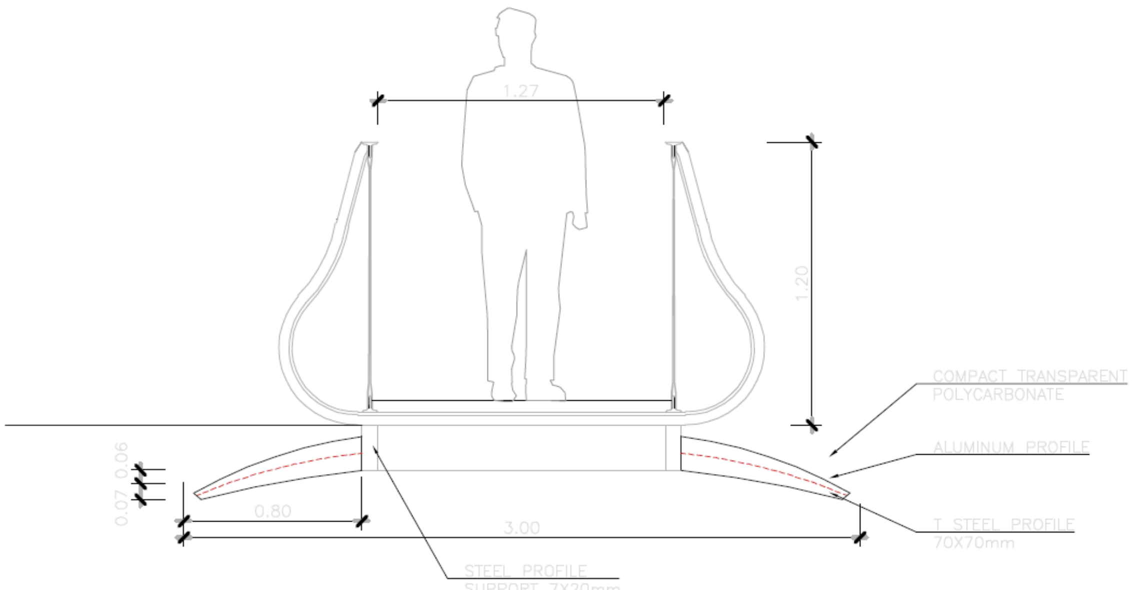


Figure 5-92 Proposed parapet solution at OBG12 Clonsilla station footbridge

A MEWP with RRV access to be used to access the underside of the bridge at the fixing locations. These works will need to be completed during night-time possessions.

5.3.12.5 Parapets on walls

This section describes the construction methodology for the parapet heightening solution proposed for walls. The image below shows the proposed solution, which is described in Chapter 4 of this EIAR.

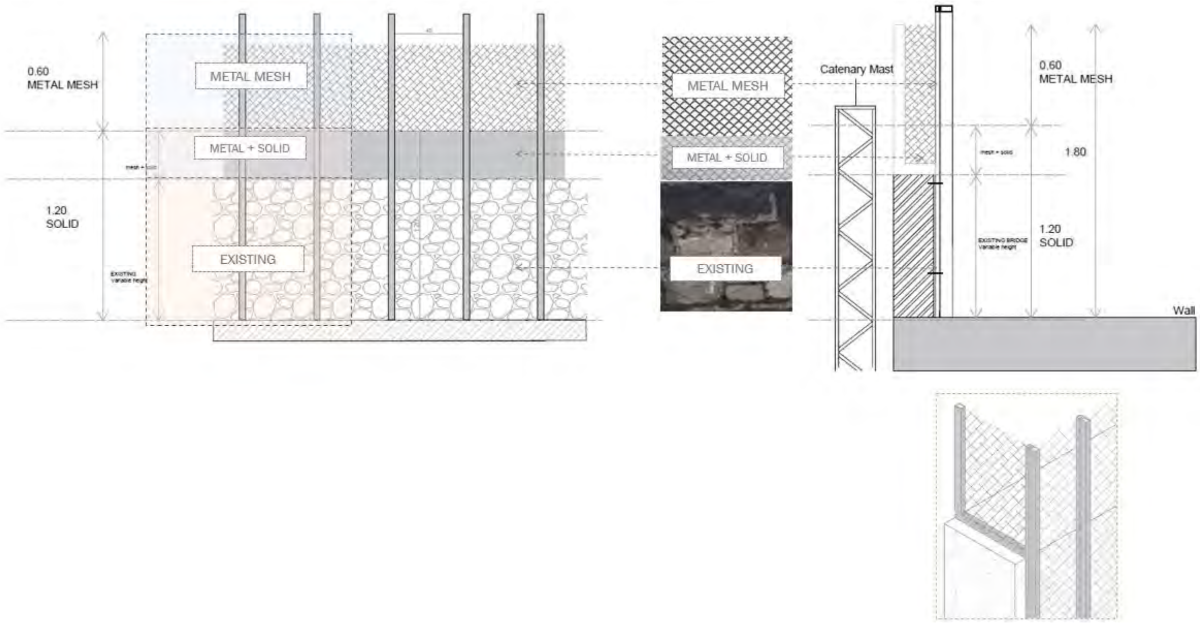


Figure 5-93 Design intent for parapet heightening on walls

The construction sequence for this is as per Section 5.3.12.1.

5.3.13 Drainage

The main elements of lineside drainage are the following:

- Channel drains.
- Piped collector drains.
- Piped carrier drains.
- Manholes.
- Pump Stations.
- Outfalls.
- Interceptors and silt traps.

The drainage works will be carried out simultaneously with the earthworks.

All track drains will generally be laid at a constant distance from the rail, with the centre line of the pipes located at about 1700 mm from the running edge of the nearest rail track.

5.3.13.1 Channel drains

Channel drains must be restricted to locations where only surface or shallow drainage, typically about 500 mm deep, is required. The invert level of a channel drain must be below the desired level of the free water surface. Channel drains of a constant depth may be used where the natural gradient is not flatter than about 1 in 1000 and there is a suitable outfall at the low end. The trench excavated for the channel units should be approximately 150 mm wider than the outside width of the units.

The construction sequence for the channel drains is as follows:

1. Clear the area and remove the hard surface.
2. Excavation of drainage trench using a mini digger/hand tools (trenches excavated for channel units should be approximately 150 mm wider than the outside of the units).
3. Install a sand and concrete base using concrete truck/mixer.
4. Install channel drain ensuring gradients are sufficient to allow flow of water.
5. Install the end cap and seal the joints with sealant and connect the drain into the underground drainage pipe.

6. Place the grating and pour concrete into the trench, and complete finishes (side spaces should be filled with porous materials such as small ballast, gravel or a filter medium if the ground conditions require this).

5.3.13.2 Piped collector drains

Piped collector or surface-water drains are suitable for use in all drainage work. Pipes must provide for water ingress by having open joints at frequent intervals. Pipes for general lineside drainage must be installed, whenever possible, at a self-cleaning gradient to minimise the accumulation of silt in the pipes.

The construction sequence for the piped collector drains are as follows:

1. Clear the area and remove the hard surface.
2. Excavation of area for the collector drain using a mini digger/hand tools.
3. Install piped collector drain ensuring gradients are sufficient to allow flow of water.
4. Install a sand and concrete base using concrete truck/mixer.
5. After the pipe is laid, the trench must be backfilled with porous material such as clean graded ballast or gravel (where personnel are required to walk, the backfill must be finished off with a blinding of chippings).
6. Install piped collector drain ensuring gradients are sufficient to allow flow of water.
7. To prevent backfill clogging the pipe collars or perforations, the pipe must be covered initially to a depth of 150 mm with an approved graded filter medium before completing the backfilling above (this fill must extend around the sides of the pipe to a width of 75-100 mm).

5.3.13.3 Pipe carrier drains

Piped carrier drains transport water. They are not required to collect water from the surrounding ground. They must be constructed from close-jointed, non-perforated pipes which may be of glazed earthenware, pitch fibre, plastics or concrete. The general construction sequence for piped collector drains also apply to piped carrier drains.

5.3.13.4 Manholes

The manholes are necessary to inspect the drainage system and to provide access to the operators. Manholes for both collector and carrier drains must be provided at:

- Intervals not exceeding 30 m on a straight run.
- Each sharp change of direction (greater than approx. 15 degrees).
- All pipe junctions.
- The junction of pipe drains and channel drains.

The construction sequence for the manholes is as follows:

1. Clear the area and remove the hard surface.
2. Excavation until specified level.
3. Install bed layer of concrete.
4. Install concrete walls of the manhole, the footrests and the connection pipes.
5. Plastering of the internal walls.
6. Install the manhole top cover and all the finishes.

5.3.13.5 Pump stations

The construction sequence for the pump stations is as follows:

1. Site clearance including vegetation removal as required using excavator/dump truck.
2. Excavation of pump station area, including use of temporary works to support the excavation as required (e.g. sheet piles) using excavator/sheet piling rig (note during excavation it may be required to use a temporary pumping system for removal of ground water).

3. Concrete blinding layer poured using concrete truck/pump and vibrators.
4. Reinforced concrete foundations poured as per design and area around foundation backfilled using subsoil using concrete truck/pump, vibrators and excavators.
5. Pump house building structure constructed as per design using scaffolding, crane, forklifts, pumper trucks.
6. Pipework fitted in the foundations to connect through the pumps; all equipment is then installed within the building using pallet trucks/lifting gantry.
7. Landscaping, fencing and access routes installed around the building.

5.4 Description of Construction Works in Zone A – Connolly Station to Glasnevin Junction

Zone A runs east to west from the Loop Line north of the Liffey River and Connolly station to Glasnevin junction in Dublin City along the GSWR line, together with a short section in the branch to the Phoenix Park around Cabra for the location of a temporary construction compound (Figure 5-94). The zone is approximately 4.65 km in length (without considering Cabra Compound – CC-SET-S4-00000-B). It also includes the Northern Line section between Connolly Station and the Tolka River in the north (1.15 km in length). Zone A is identified in colour blue in Figure 5-95 below.

GSWR consists of two tracks, the UP track being the northern track with trains running from Glasnevin to Connolly Station and the DOWN track being the southern track with trains running from Connolly Station to Glasnevin.

Works in Zone A will include:

- Modifications in Connolly station.
- Parapet heightening in OBO14A footbridge.
- Parapet heightening in OBO12A footbridge.
- Track lowering and parapets heightening below the OBO11 road bridge.
- Construction of a new substation at Glasnevin.
- SET installation (as described in Section 5.4.6).

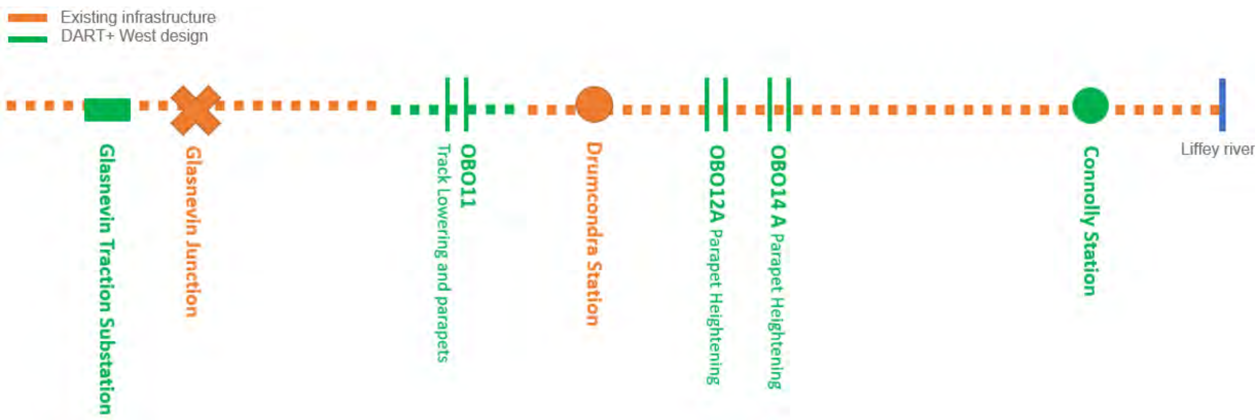


Figure 5-94 Schematic of DART+ West construction activities in Zone A

Early works for Zone A will include compound installation for track lowering and other works, and utilities diversions. Due to the linear nature of these works, utility diversion works have been identified in Zone A (described in Chapter 18) and will require temporary traffic measures. The typical construction methodology used for utility works has been detailed in Section 5.3.5, whereas the general principles of the traffic management measures required during the construction phase are outlined in 5.12.3 Construction Traffic Management.

The construction compounds required to carry out the construction works falling within Zone A are identified in Table 5-6 and shown in Figure 5-95.

Table 5-6 Construction compounds in Zone A

Compound code	Chainage	Reference	Discipline
CC-PW-S1-10300-B	10+300	Connolly Station	Permanent Way
CC-STA-S1-7800-B	7+800	Connolly Station	Stations
CC-SET-S3-00000-B	10+000	Cabra Road	SET
CC-PW-S3-33340-B	33+340	Glasnevin	Permanent Way
CC-SUB-S3-33460	33+460	Glasnevin	Substations

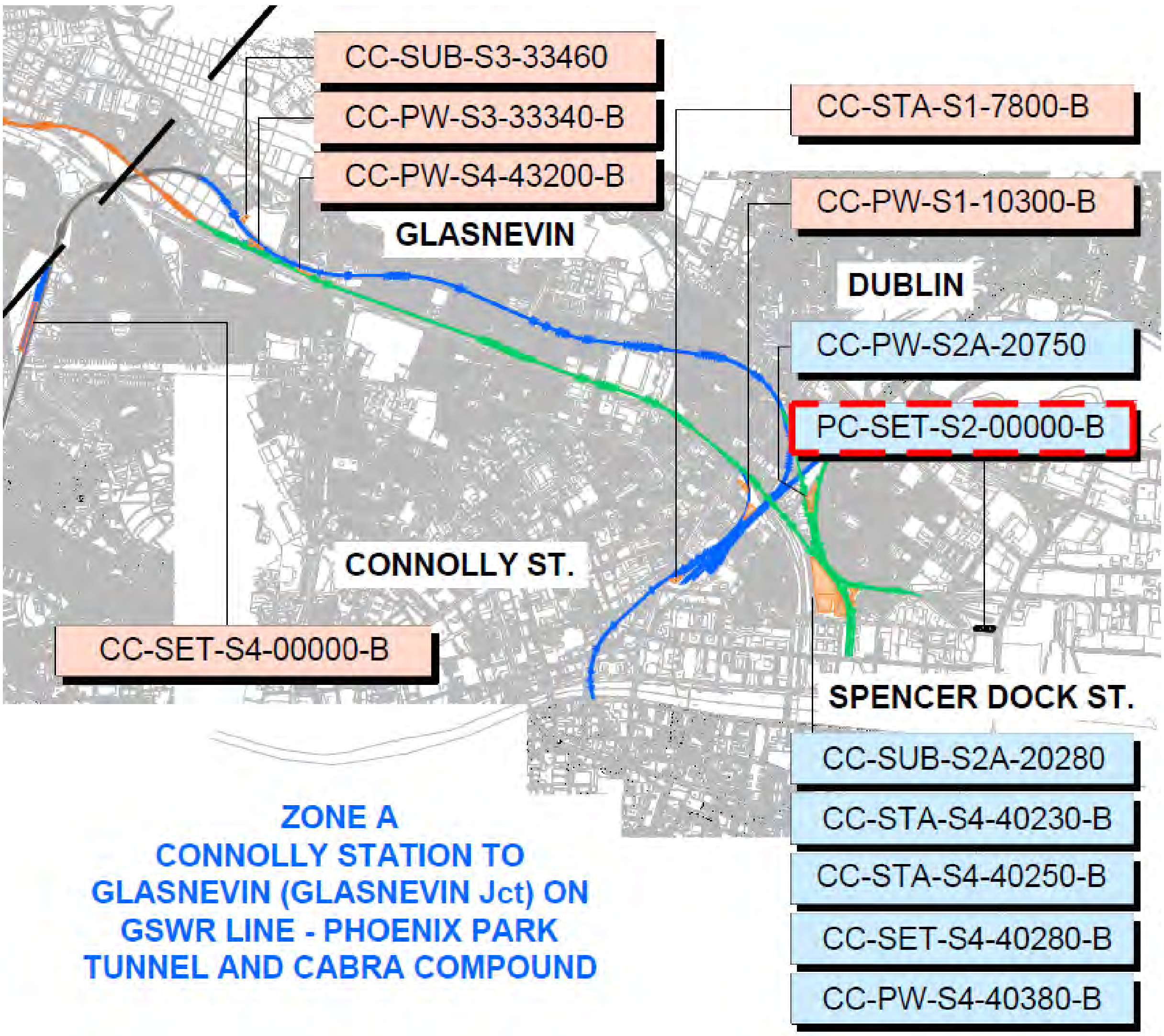


Figure 5-95 Zone A construction compounds

All works proposed in Zone A have been described in this section from east to west, following the structure established in Chapter 4 of this EIAR.

5.4.1 Works between Connolly and Liffey

Various upgrade works are required in the area of the railway between the River Tolka in the north and River Liffey in the south:

- Telecoms will require new cabling (fibre and copper) up to the northern and southern boundaries.

- Installation of new signalling LOCs.
- For LV power, new Auxiliary Supply Points (ASP) and DNO/Distribution Cubicles will be required at the northern and southern boundaries.
- CMS will be upgraded to support the above-mentioned SET cabling in the area.
- New crossover between East Wall Junction and Ossory Road Junction installed and blocked. This work does not need to modify the existing signalling system.
- Interim connection between GSWR and East Wall lines modifying the existing signalling system.
- Development of the interfaces of the new CBI with Dublin North KRCF SSI and Dublin Central TTLD SSI. The boundary with DN KRCF SSI will be modified.

Refer to the following sections for details on construction methodology and durations:

- Telecoms: Section 5.3.12.
- Signalling: Section 5.3.9.4.
- LV power: Section 5.3.9.3.
- CMS: Section 5.3.8.

5.4.2 Connolly Station

The works proposed at Connolly Station will increase the capacity of the access and egress infrastructure for the station to accommodate an increased passenger demand. New access and egress elements will be constructed at platform level, for which structural modifications must be carried out in the station vaults. In addition, a new entrance at Preston Street will be constructed.

5.4.2.1 Construction phases

As a general overview, the construction phases for works at Connolly Station are as follows:

1. Enabling works: vaults clearance, utility diversions, etc.
2. Vaults level excavation.
3. Foundations.
4. Structural openings for staircases and lifts.
5. Structural openings for escalators.
6. Platform repair.
7. Vault repair and waterproofing.
8. Escalators and lifts installation.
9. Architectural finishes and MEP fitout.
10. Landscaping and urban integration.

There are two main elements of works that have different methodologies: (1) the structural modifications related to the new access and egress points, and (2) the conservation of the vaults that must be treated carefully due to their architectural heritage value. The phasing of each of the works has some specific characteristics that are described in the following sections under the titles of 'Structural modifications' and 'Vault conservation'.

In addition, works to pedestrianize Preston Street will be required. These works will consist of the following:

- New granite pavement and kerbs, replacing the current asphalt and sidewalks.
- New drainage system for Preston Street and for the station access.
- Landscaping, mainly provision of five new trees.
- Installation of street furniture (benches and bins) and street lighting.
- New façade for the station entrance.

5.4.2.1.1.1 Structural modifications

Works at platform level consist of opening several voids in the platforms to connect the platform level with the vault area below. To achieve this vertical connection, the structure in the voids must be able to bear and transfer the horizontal loads of the arches, retain the fill between the arches and the platform, and support the stairs when needed.

Platform voids will be located where the staircases, escalators and lifts are to be located and will affect existing station platforms 5, 6 and 7.

Platform operation during the works – phasing

The works on platforms 6 and 7 are divided into two phases. One phase for the stairs and lift construction and another one for the escalators. The division of the works will enable the use of the platform by passengers during the works.

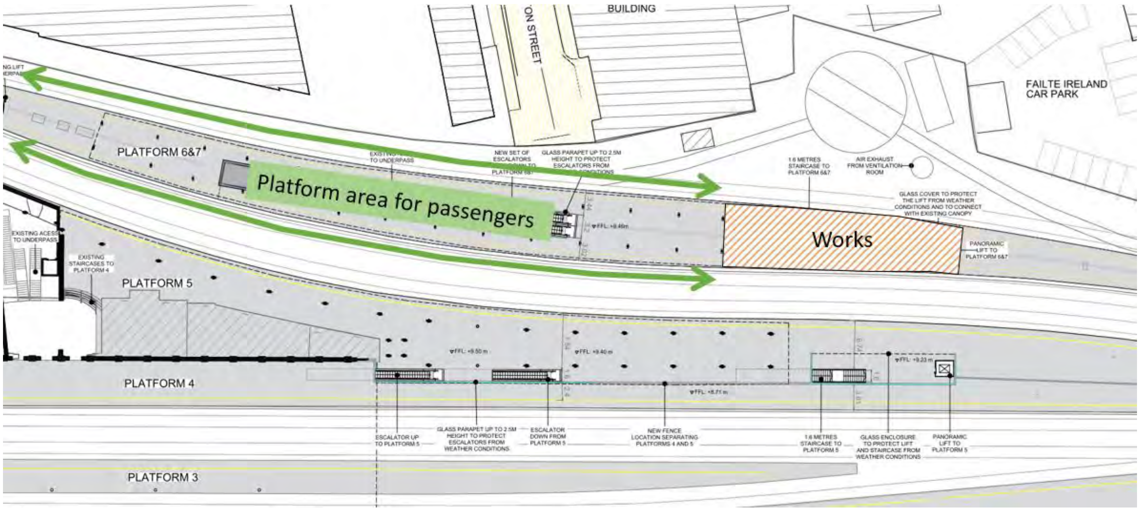


Figure 5-96 Phase one: works on stairs and lift

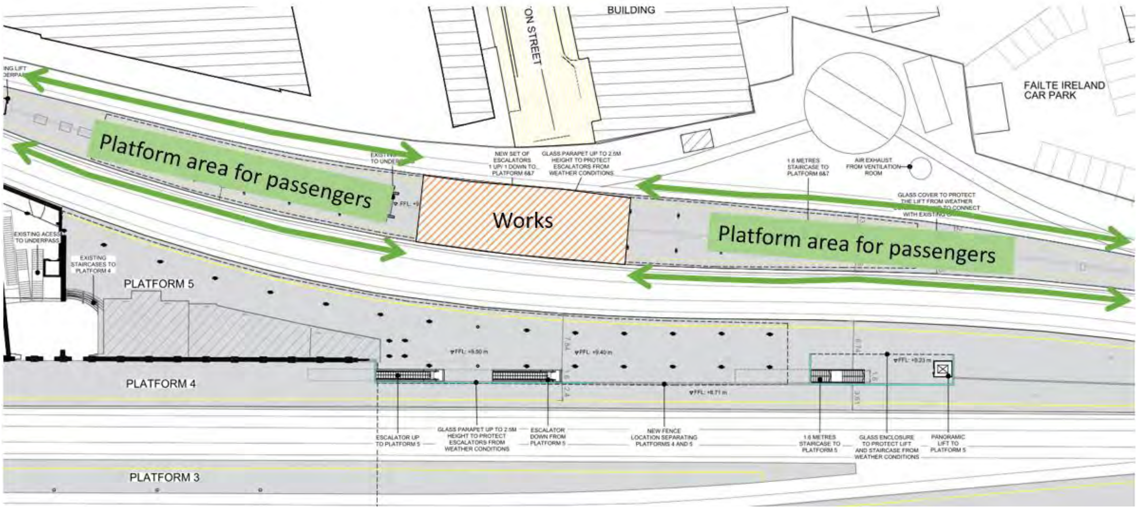


Figure 5-97 Phase two: works on escalators

The operation of platform 5 during the works is less intrusive due to the size of the works compared with the total size of the platform. The works can occur with the platform remaining operational.

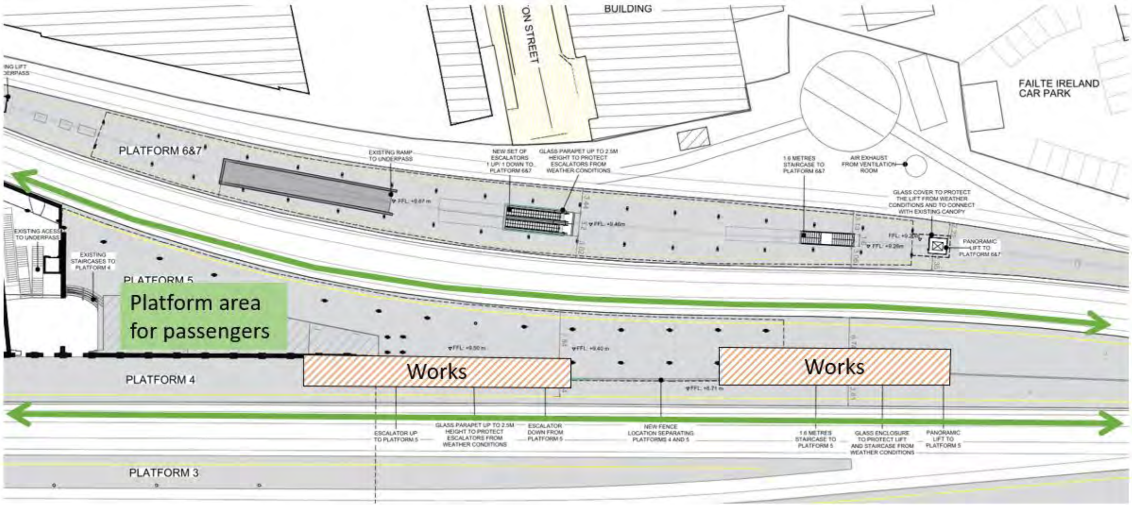


Figure 5-98 Simultaneous construction and operation on platform 5

Platform openings construction – phasing

The phasing of one of the openings (the one that corresponds to platforms 6 and 7 escalators) is described in detail below through a series of twelve steps.

STEP 1. In this phase, foundations for the new structure will be built using reinforced concrete pile caps with micropiles and micropiles inside the walls for the future columns. To carry out this phase, the micropiles will firstly be installed inside the core walls, in the location of the future columns. The excavation will then continue down to the lowest level of the pile caps, and the micropiles will be built. Once they have been installed, the surface will be poured with blinding concrete, and the pile caps and the tying between them will be completed.

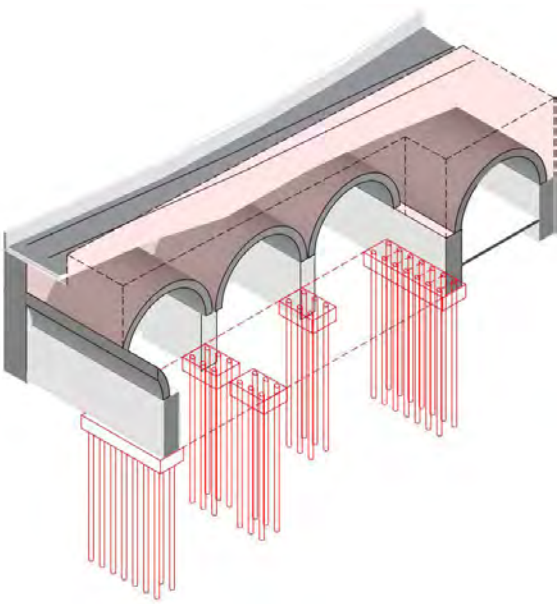


Figure 5-99 3D view of step 1 – foundation construction

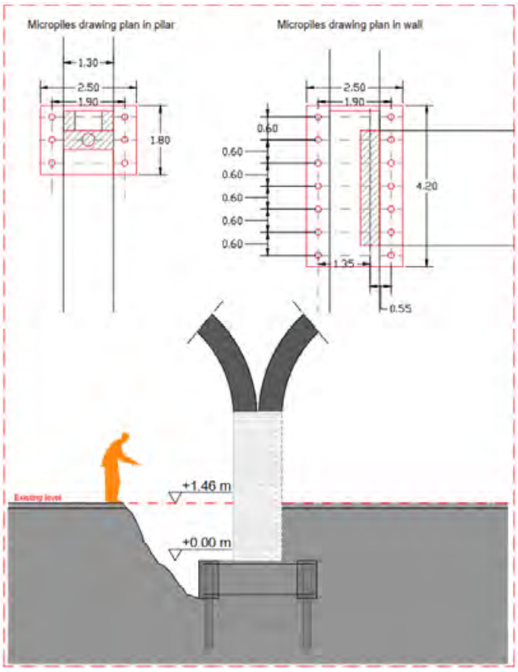


Figure 5-100 Elevation showing excavation to the base of the pile cap (below) and plan of two foundation types (above)

STEP 2. In this phase, the temporary shoring structure of the canopy is built, and the canopy structural columns are cut under the existing horizontal steel beam. Micropiles are built as foundations for the metal columns of this new temporary structure. These micropiles are built from a new concrete footing located below the platform level to the foundation level, passing through the brick walls. Once the structure is in place, the existing columns can be cut and dismantled.

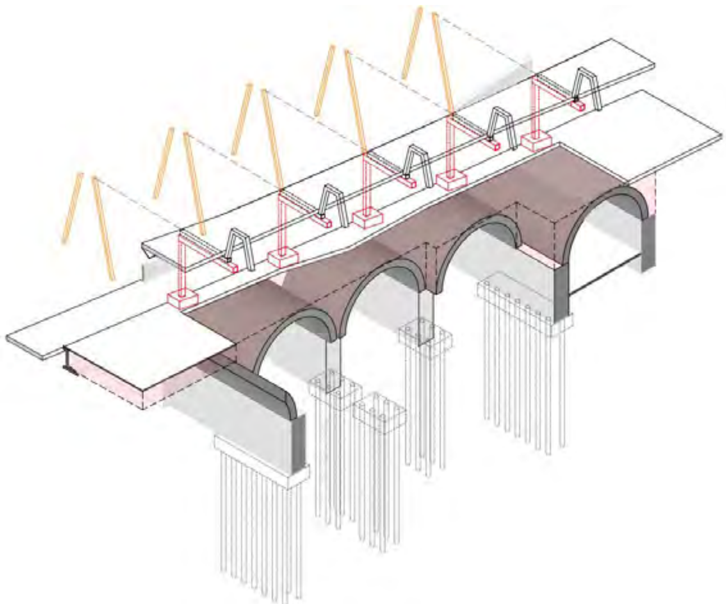


Figure 5-101 3D view of step 2 – construction of canopy shoring

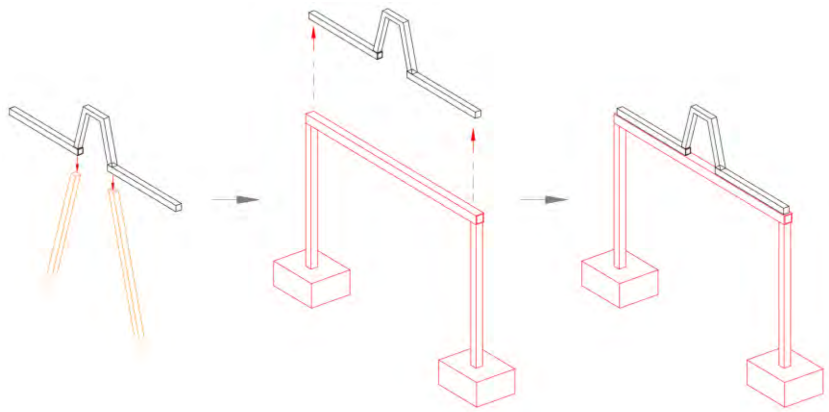


Figure 5-102 Removal of existing canopy structure and construction of new canopy and foundations

This phase will require two night-time rail possession for each of the portals. This will mean an eight-night rail possession for the construction of the staircases and lifts and an eight-night rail possession for the construction of the escalators. A total of sixteen night-time rail possessions are required to complete this work.

STEP 3. In this phase, the provisional falsework of the vaults is placed. This falsework will serve as a horizontal bracing system, as well as vertical shoring of the vaults. It will also work as formwork for the new structure.

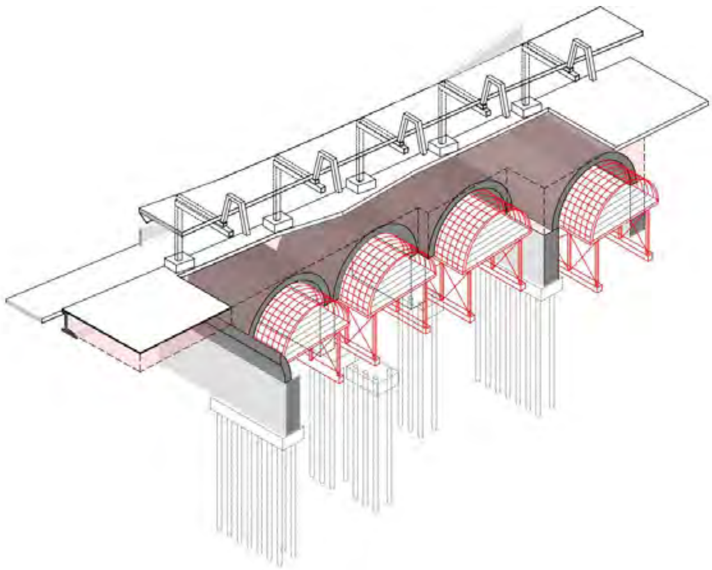


Figure 5-103 3D view of step 3 – erection of falsework

STEP 4. In this phase, the concrete columns are constructed near the edges of the shaft. These pillars will be built following a staged excavation procedure, surrounding the micropiles and building one side of the column first, and then the other one. Afterwards, the walls will also be built as a staged construction.

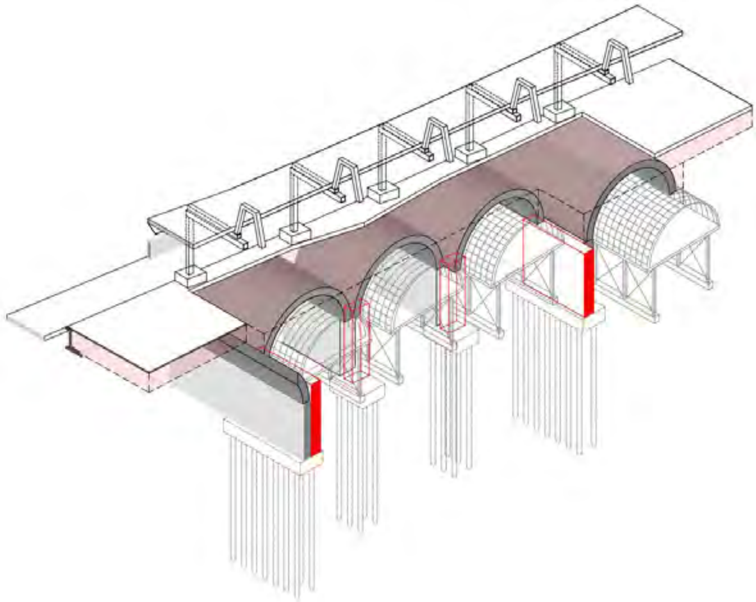


Figure 5-104 3D view of step 4 – construction of shaft columns

STEP 5. In this phase, the excavation will be carried out from the platform level down to the falsework in order to build the concrete arch beams.

Formwork modules will be placed to help contain the soil between the platforms and the exterior of the brick vaults.

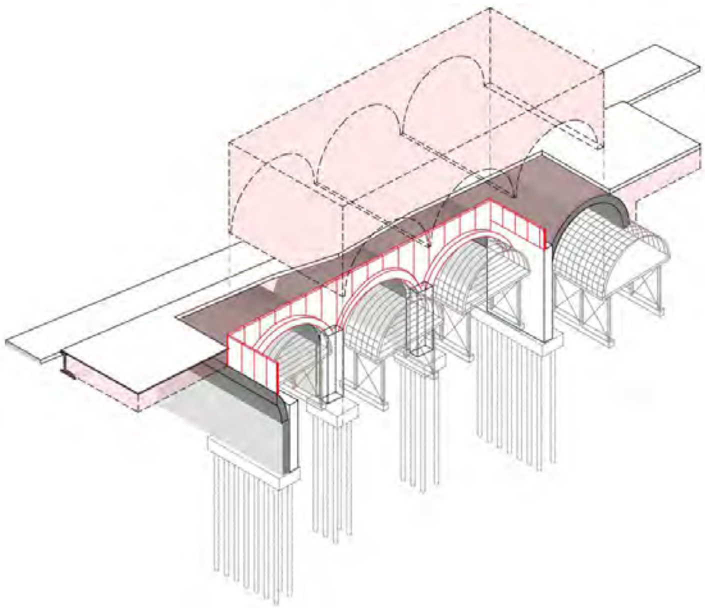


Figure 5-105 3D view of step 5 – excavation down to falsework level

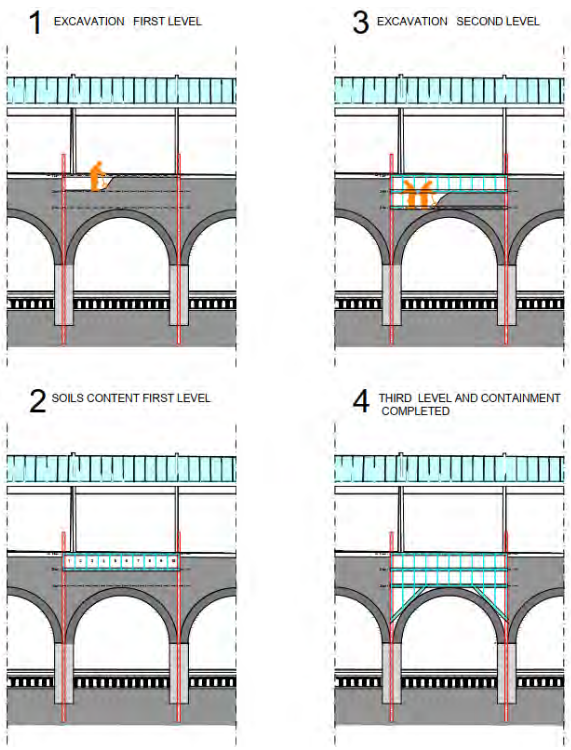


Figure 5-106 Excavation phases and containment of soil between platforms

STEP 6. In this phase, the construction of the vertical structure progresses from the level of the arches to the platform level.

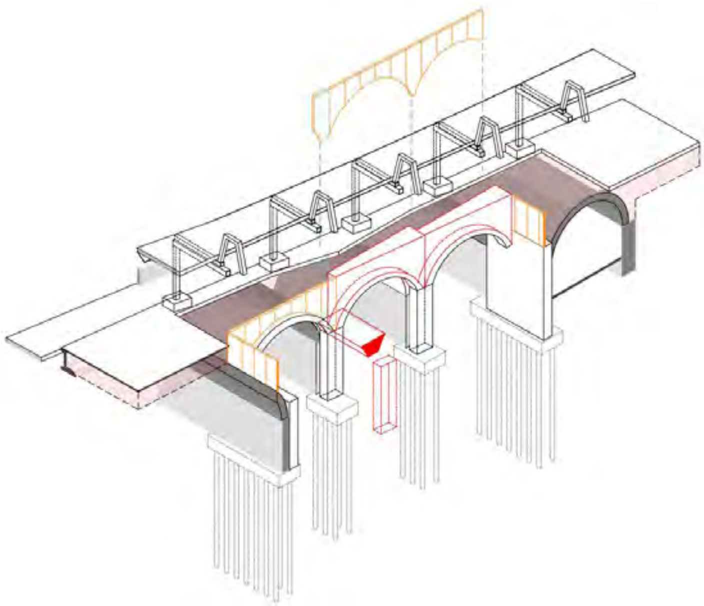


Figure 5-107 3D view of step 6 – construction of vertical structure

STEP 7. At this stage, the arched slab between the beam and the concrete wall is built.

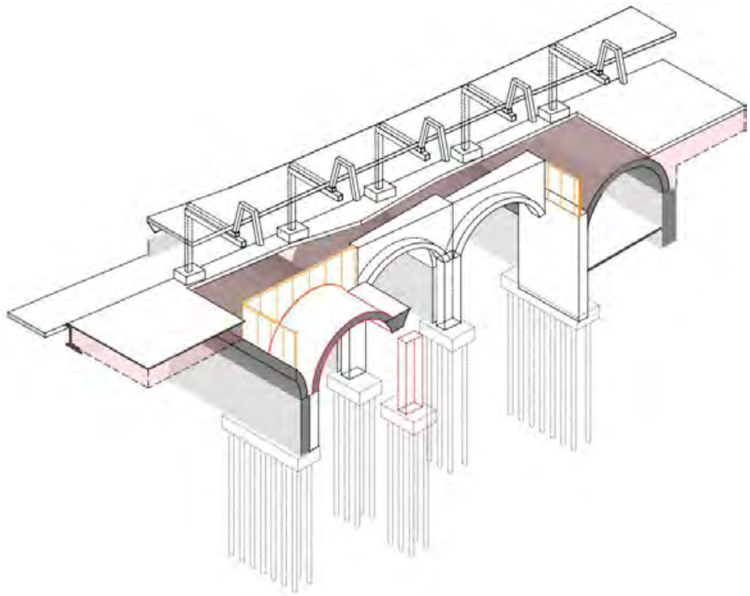


Figure 5-108 3D view of step 7 – arched slab construction

STEP 8. At this point, the remaining parts of the structure are constructed, including the beams and walls supporting the escalators, as well as the foundations for the escalator pits.

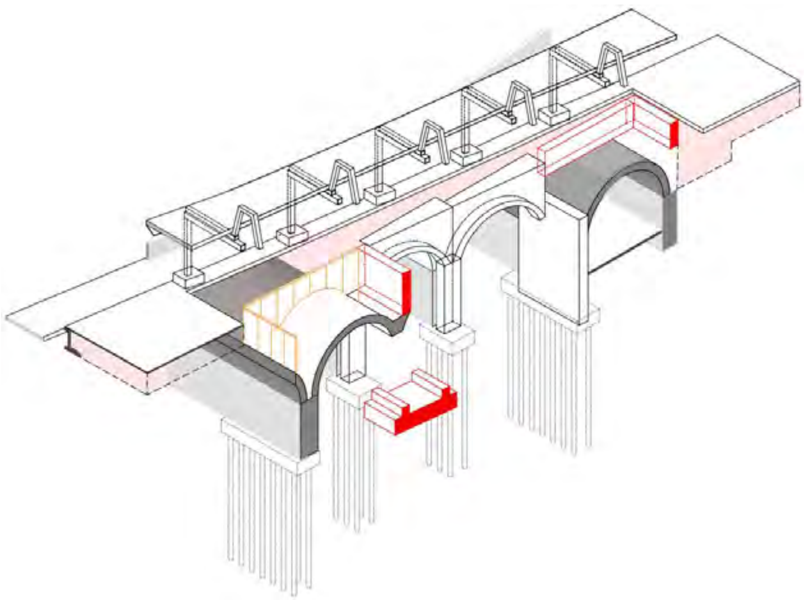


Figure 5-109 3D view of step 8 – escalator pit foundation construction

STEP 9. In this phase, the walls enclosing the shaft are built, together with the different layers up to the finished floor level.

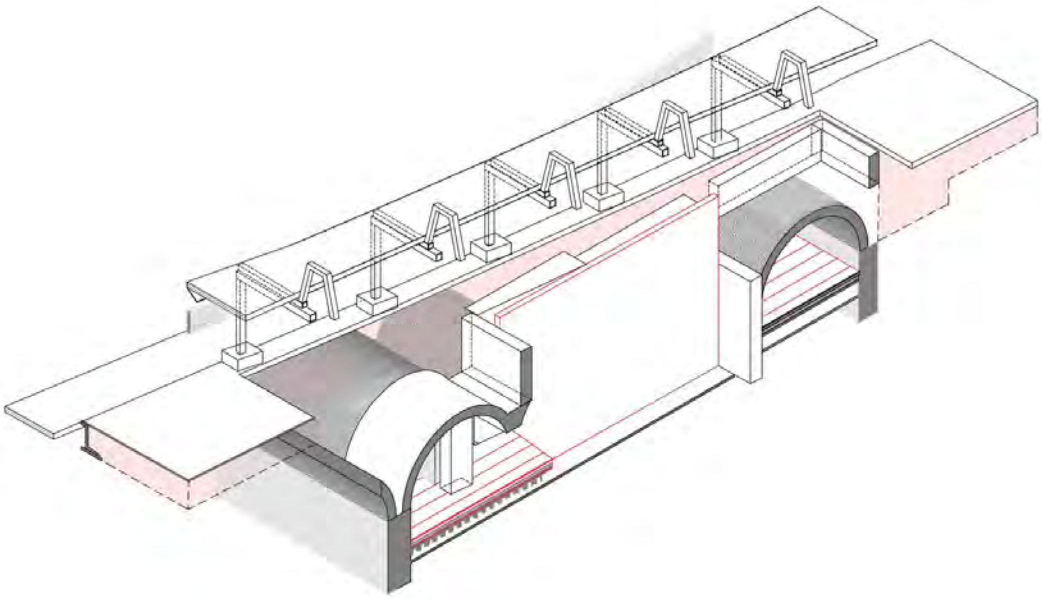


Figure 5-110 3D view of step 9 – escalator shaft construction

STEP 10. The escalator structure is assembled in two steps. The first section will be temporarily supported until it joins the second section of the escalators. The escalators will be resting over the pit and supported by the beam.

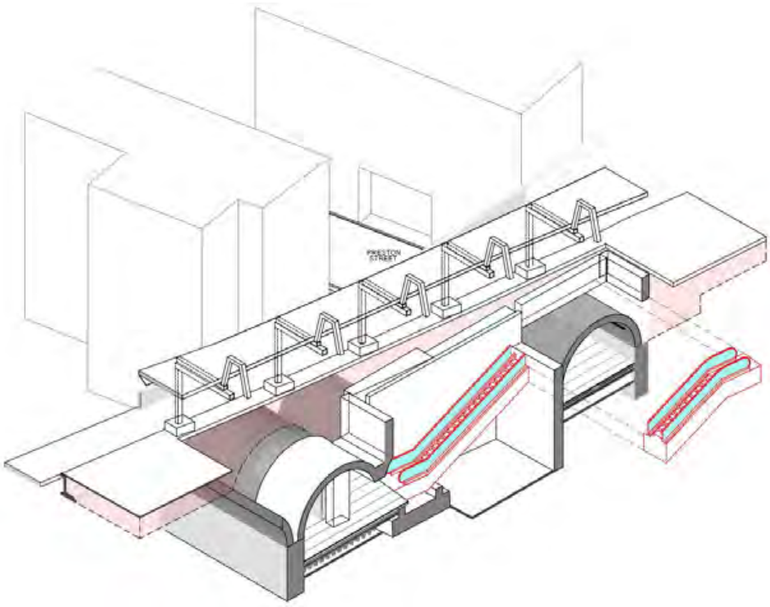


Figure 5-111 3D view of step 10 – installation of escalators

STEP 11. Once the assembly of the escalator has been completed, the soil can be backfilled to the lowest level of the canopy foundations, while the slab can be built to partially close the open shaft. Once this level has been reached, the definitive foundations and columns of the canopy will be constructed. After the canopy rests on the definitive columns, the provisional shoring structure will be dismantled. This operation will require one-night rail possession for every portal. A total of eight nights of rail possession for the staircases, lifts and escalators.

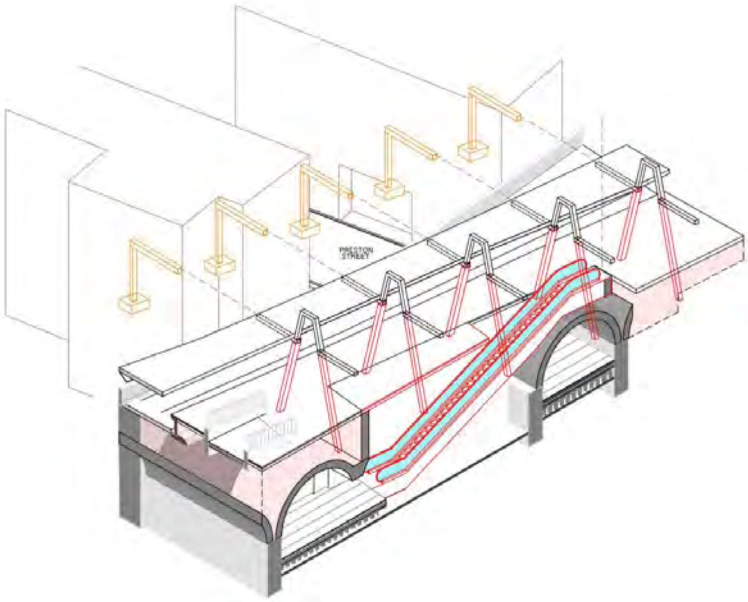


Figure 5-112 3D view of step 11 – construction of canopy support structure

STEP 12. Once the structural works have been completed, the shoring structure under the vaults is removed, and the finishing works can take place.

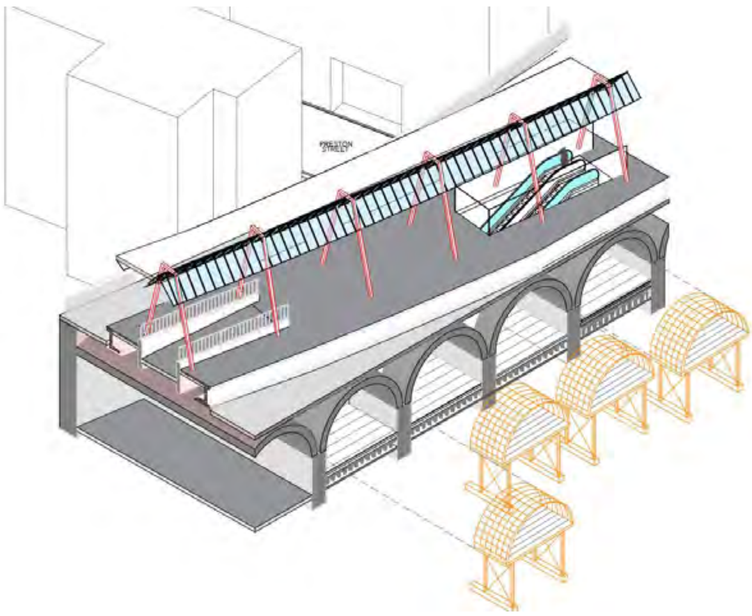


Figure 5-113 3D view of step 12 – removal of vault shoring structures

5.4.2.1.1.2 Vault conservation

The Connolly Vaults are protected structures as identified in the Dublin City Council Record of Protected Structures for Connolly Station (the 19th Century elements of the station). Therefore, cleaning, restoration and waterproofing strategies need to be carefully employed to avoid impacting the protected structures.

Cleaning strategy

The decision on how to perform cleaning in a historical building is one that should not be made lightly. Cleaning can have significant physical and aesthetic consequences, both positive and negative, on the building. The first step is to undertake a detailed investigation to determine the cleaning method that should be carried out. The characteristics and conditions of the masonry must be considered, including stone, brick and mortar, as well as the makeup of the soiling. The latter can include atmospheric depositions, paint, limewash and metal oxide staining. Each one requires a different approach. There is no single system or product that will safely and effectively remove all problems.

Different techniques for cleaning masonry can be utilised:

- *Air abrasive cleaning techniques:* These techniques are most effective on even surfaces and consistent surface texture and hardness. An air abrasive stream cannot, regardless of the abrasive used, differentiate between the removal of soiling and the removal of masonry. For brickwork, it is almost impossible to succeed in cleaning historic brickwork using abrasive blasts without causing any damage. Bricks are very intolerant to abrasive cleaning, and it is not a good choice for paint removal.
  Special attention should also be given to the effect of the cleaning process on the mortar, as traditional brickwork pointing mortars, which were based on soft mixes of lime and sand, are usually even softer than the bricks themselves.
- *Abrasive cleaning systems* are usually inappropriate for use on historic brickwork due to the nature and characteristics of the brickwork, even when the process is undertaken extremely carefully. These methods are unable to deal with the multiple variations that can be present in a brick wall. Abrasive cleaning is particularly inappropriate for paint or graffiti removal on brickwork.
- *Chemical cleaning techniques:* cleaning chemicals must be used at low strength, applied neatly, left for short dwell times and thoroughly rinsed at non-damaging pressures. Porosity also varies, and high absorbency may eliminate or stringently define the parameters of a chemical cleaning regime. Chemical cleaning methods are commonly the most suitable approach since they are able to accommodate variations in texture, condition and hardness, and it is undoubtedly the best method for paint removal.
- *Low Impact Vapor Blasting strategy:* This system is not as abrasive as sandblasting systems. This cleaning system uses a mixture of low-pressure air, small amounts of water and a safe, inert, fine aggregate such as calcium carbonate. It gently removes paint, dirt, carbon, bitumen, limescale, graffiti and biological matter from any building finish without damaging the substrate.

The cleaning of the vaults should start with the very least abrasive and move up from there until the most suitable solution is found. The level of cleaning should be considered in order to avoid bricks being damaged. An extensive cleaning test should be undertaken during the Detailed Design phase to further inform the extent of cleaning required.

Restoration strategy

For the restoration of brick vaults, it will be necessary to replace bricks that have fallen off or are defective. Since part of the vaults will have to be cut in order to create the access to Platform 5 and Platforms 6 and 7, the recovery and cleaning of the original bricks are proposed to be carried out along with the necessary brick replacement.

Special attention will be paid to the restoration process involving new mortars, brick replacement and the grouting of the joints.

- The new mortar will match the historic mortar in colour, texture and tooling
- The used sand will match the sand that is present in the historic mortar (the colour and texture of the new mortar will usually fall into place if the sand is matched successfully).
- The new mortar will have greater vapour permeability and be softer than the masonry units.
- The new mortar will be as vapour permeable and as soft as the historic mortar or softer.

Some necessary steps should be carried out before starting the waterproofing strategy:

- Structural interventions and repairs.
- Removal of contamination from bricks and joints.

- After this, the brickwork will be repaired where necessary and repointed using an appropriate lime mortar.
- Finally, it will be ready for waterproofing.

Waterproofing strategy

The proposed drainage system will not be completely effective or everlasting since the only fully effective solution would be waterproofing the vault structure from the upper side. The proposal aims to minimise the amount of water entering the vaults in an uncontrolled manner. The remains of the existing arch drainage system will be inspected and made good as far as is reasonably practicable. New downpipes will replace the existing ones, and the connections with the brick shafts will be made good.

The remaining water that the drainage system is not able to conduct will be stopped with two different waterproofing systems outlined below.

- ***Acrylic resin injections***

This system will be used for the vault of the concourse area, which includes the access vault (Preston St), the central corridor and its connection with the vertical communication elements (escalators, staircases and lifts).

A gel curtain system with injections of acrylic resins will be used to curtail this type of leakage from the back of the brick vault.

The process starts off by defining a grid of perforations with a diameter ranging from 12-14 mm, using the brickwork joints to reach the back of the vault. Nine injection points per square metre will be necessary, together with 1.5 litres of resin per injector.

Subsequently, injection packers are placed and used to pump the acrylic resin to fill the outer part of the vault.

This resin's viscosity is similar to water's viscosity, so it runs through any gap and, once hardened, it generates a waterproofing membrane. The packers are then removed, and the holes are sealed with mortar.

Figure 5-114 Injection of acrylic resin into vaults

- ***Sliding polycarbonate umbrellas***

This system will be used in the vaults housing retail units, back-of-house areas, and technical areas.

In these vaults, water penetration will be avoided by means of a system of sliding umbrellas made of polycarbonate. In this way, the water pressure in these vaults would not be increased since the water can seep through the bricks into the vault.

Interior protection for the vault will be designed based on a very light curved metal structure, following the vault's geometry, incorporating transparent polycarbonate protection. This new transparent vault under the existing one will be movable, fitted on simple rails supported on the metal structure, which would involve tactile inspection and low maintenance.

This approach is very respectful to the vault since there is practically no intervention in it (only the cleaning and grouting of mortar joints). The visual effect is enhanced by incorporating LED lighting in accordance with the desired architectural characteristics.

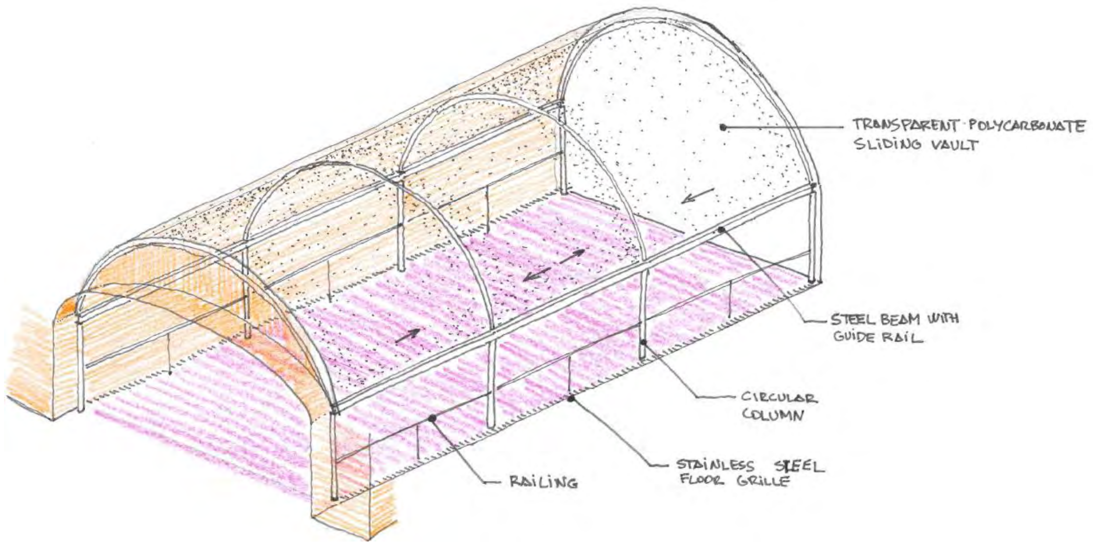


Figure 5-115 Sketch of transparent polycarbonate umbrella inside vault

This system is commonly used to cover swimming pools. It is broadly tested as many suppliers develop and provide it. It is an innovative application of the system with the confidence of a technically proven product.

Figure 5-116 Transparent methacrylate umbrella system covering a swimming pool

5.4.2.1.2 Construction duration

As shown in Figure 5-117 below, the total construction duration for construction works at Connolly Station is estimated at around **18 months.**

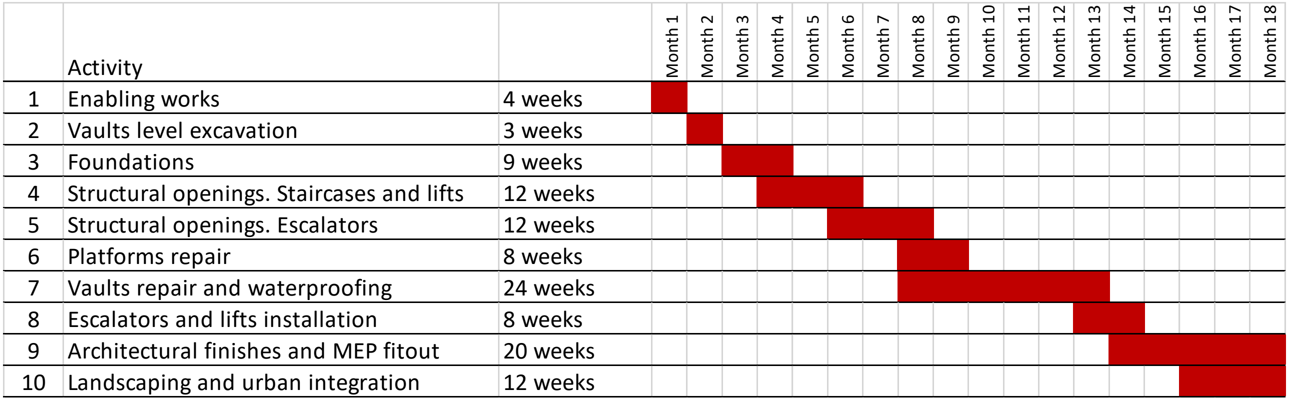


Figure 5-117 Duration of construction works at Connolly Station

All the works will be performed during daytime project construction working hours as set out in Section 5.2.1 except for the operation of replacing the structure portals of the canopy with temporary steel structure portals (step 2) and the works needed to reinstall the original portals back (step 11). See the table below for information on durations.

Table 5-7 Construction durations Connolly Station

Construction works at Connolly Station	Approximate duration of works		Rail Possession
Description of the activities required:	Day works (wks)	night works (wks)	Weekend/Night-time
Enabling works	4 weeks		
Vault level excavation	3 weeks		
Foundations	9 weeks		
Structural openings: staircases and lifts	12 weeks		12 nights rail possession
Structural openings: Escalators	12 weeks		12 nights rail possession
Platform repair	8 weeks		
Vault repair and waterproofing	24 weeks		
Escalator and lift installation	8 weeks		
Architectural finishes and MEP fitout	20 weeks		
Landscaping and urban integration	12 weeks		
Total Day/Night-time works	72 weeks		24 nights of rail possession
Total Construction Phase	**72 weeks (18 months)**		

5.4.2.1.3 Equipment required

The required equipment for each construction phase has been indicated below.

1. Enabling works: Trucks, forklifts, jackhammers and mini-crane.
2. Vaults level excavation: Excavator and trucks.
3. Foundations: Forklifts, micropiling rig, concrete mixer machines, vibrators, earth rummer and welding machines.
4. Structural openings (staircases and lifts): Road-Rail Vehicle (RRV) with crane and platform, concrete mixer machines, plate vibrators, welding machines and jackhammers.
5. Structural openings (escalators): Road-Rail Vehicle (RRV) with crane and platform, concrete mixer machines, plate vibrators, welding machines and jackhammers.

6. Platforms repair: End frames, mini-crane and trucks.
7. Vaults repair and waterproofing: Resin injectors, end frames, water pressure cleaning machines and forklifts.
8. Escalators and lifts installation: Forklifts and mini-crane.
9. Architectural finishes and MEP fitout: End frames, forklifts, mini-cranes and trucks.
10. Landscaping and urban integration: Trucks, mini-cranes, earth rammers, forklifts and telehandlers.

5.4.2.1.4 Construction compounds and haulage routes

Connolly Station modifications main compound (CC-STA-S1-7800-B) is located within the grounds of Connolly station. Two access points into this compound will be provided from Amiens Street/R105; one of them will be located at Preston Street, where the new pedestrian access to the station is to be constructed, and the other access will be constructed south of the first at the current station car park.

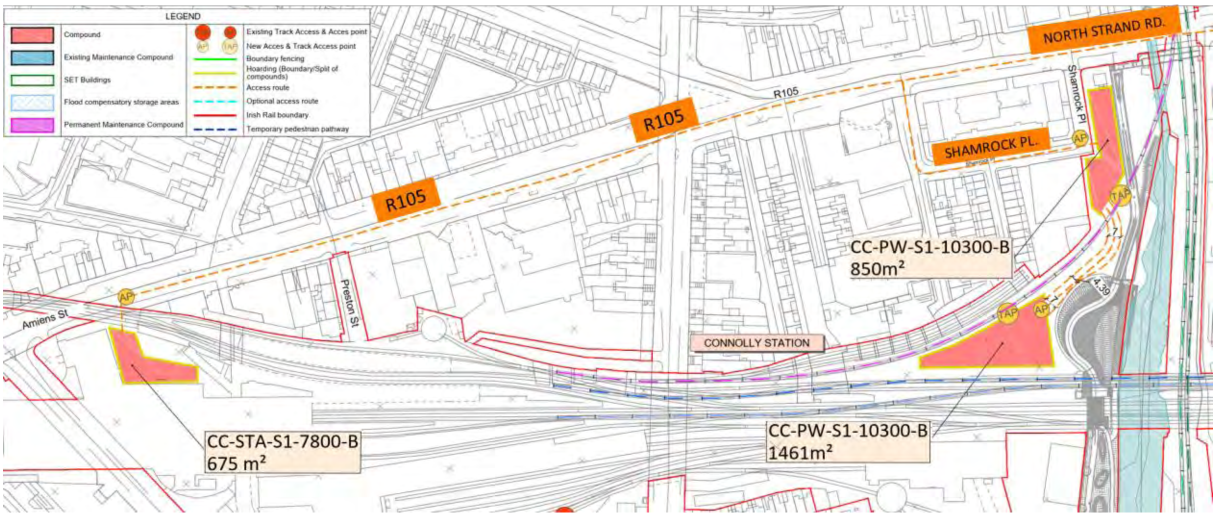


Figure 5-118 Connolly compound locations

For Permanent Way related works, another two compounds are required nearby the Royal Canal; these are referenced as CC-PW-S1-10300-B. In this case, the access point will be established at Shamrock Place, which can be accessed once again from R105 road. In addition, an access point to the track will be located where indicated in Figure 5-118 between the two compounds; from that point delivery vehicles or plants can access the nearby track works.

5.4.3 OBO14A Drumcondra Station and OBO12A Claude Road: parapet heightening

5.4.3.1 Overview of works required

OBO14A and OBO12A are two consecutive footbridges over the railway located in Phibsborough to the west of Drumcondra Station.

In order to protect users from the OHLE lines at OBO14A and OBO12A footbridges, parapets will be heightened.

5.4.3.2 Construction methodology

Construction of the aforementioned parapet heightening works on both footbridges will follow the construction methodology outlined in Section 5.3.12.3.

5.4.3.3 Construction compounds and haulage routes

As there is no specific compound for parapet heightening works and considering the minimal necessary area needed for the parapet heightening elements, the use of the Glasnevin Permanent Way Compound (CC-PW-S3-33340-B) as a parapet heightening compound if required.

5.4.4 OBO11 Prospect Road Bridge: track lowering and parapet heightening

5.4.4.1 OBO11 Prospect Road Bridge: track lowering

5.4.4.1.1 Overview of works required

The OBO11 is located on the GSWR line in Dublin city (Glasnevin area). A track lowering of up to 325 mm will be carried out below OBO11 along approximately 330 m of the track.

5.4.4.1.2 Construction methodology

The track lowering works will follow the construction methodology proposed in Section 5.3.6.1.

The general sequence of works will be as follows:

- On site offices and welfare facilities — 2 weeks
- Track lowering at OBO11 — 1 month

5.4.4.1.3 Construction compounds and haulage routes

OBO11 bridge track lowering main compound (CC-PW-S3-33340-B) is located in Glasnevin, west of Glasnevin junction. The haulage route for this compound is proposed through R135 road via the M50, as shown in Figure 5-119 below. The access to and from the compound is via the track, which needs to be managed in line with normal safety protocol.

Figure 5-119 Access route to Glasnevin Pway compound

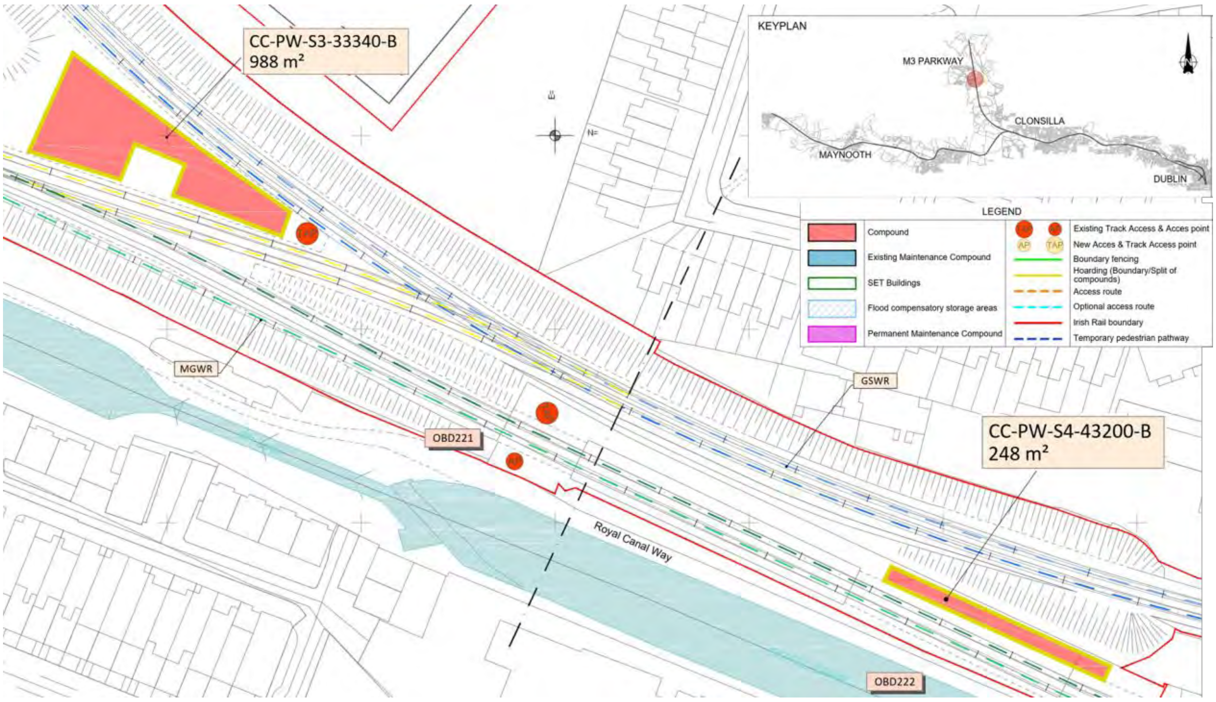


Figure 5-120 Glasnevin Pway compound location

5.4.4.2 OBO11 Prospect Road Bridge: parapet heightening

5.4.4.2.1 Overview of works required

OBO11 is located as described in the track lowering section above. Parapet heightening is required in order to protect the public from the catenary system.

5.4.4.2.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBO11 will follow the construction methodology set out in Section 5.3.12.3.

5.4.4.2.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the OBO11 bridge track lowering main compound (CC-PW-S3-33340-B) could be used as a storage area if required.

5.4.5 Glasnevin/St. Vincent's substation

5.4.5.1 Overview of works required

Glasnevin/St. Vincent's substation will be located west of Glasnevin junction within the playing fields of St. Vincent's School north of the Royal Canal Way, bordered by Clareville Ct. and Finglas Rd. This new substation will be constructed in order to provide power to the OHLE. The layout and work methodology and timing have been planned to minimise the impact on the school.

5.4.5.2 Construction methodology

Construction of the substation will follow the scheme outlined in Section 5.3.9.

The general duration of the works at this location will be as follows:

- Civil works at Glasnevin/St. Vincent's substation 3 months
- Equipment at Glasnevin/St. Vincent's substation 3 months

The site clearance in the area will begin within the school summer holidays in order to minimise the impact on the pitch operation. The works are planned to take place from May to September inclusive. Most of the disruptions will come from the civil works, whereas the installation of the equipment and the tests will be less disruptive for the school and Light-bellied Brent Geese, and hence can be completed into the autumn months.

5.4.5.3 Construction compounds and haulage routes

Glasnevin/St. Vincent's substation main compound (CC-SUB-S4-33460) is located in Glasnevin, west of the existing pitch.

Access into the Glasnevin substation compound will be through the Clareville Court off of R135 road via the M50, as shown in Figure 5-121. The access point to the construction compound will be constructed by opening the existing fence and removing existing vegetation (including removal of trees) so as to allow vehicles delivering to the site to enter the compound.

Figure 5-121 Access to Glasnevin substation compound

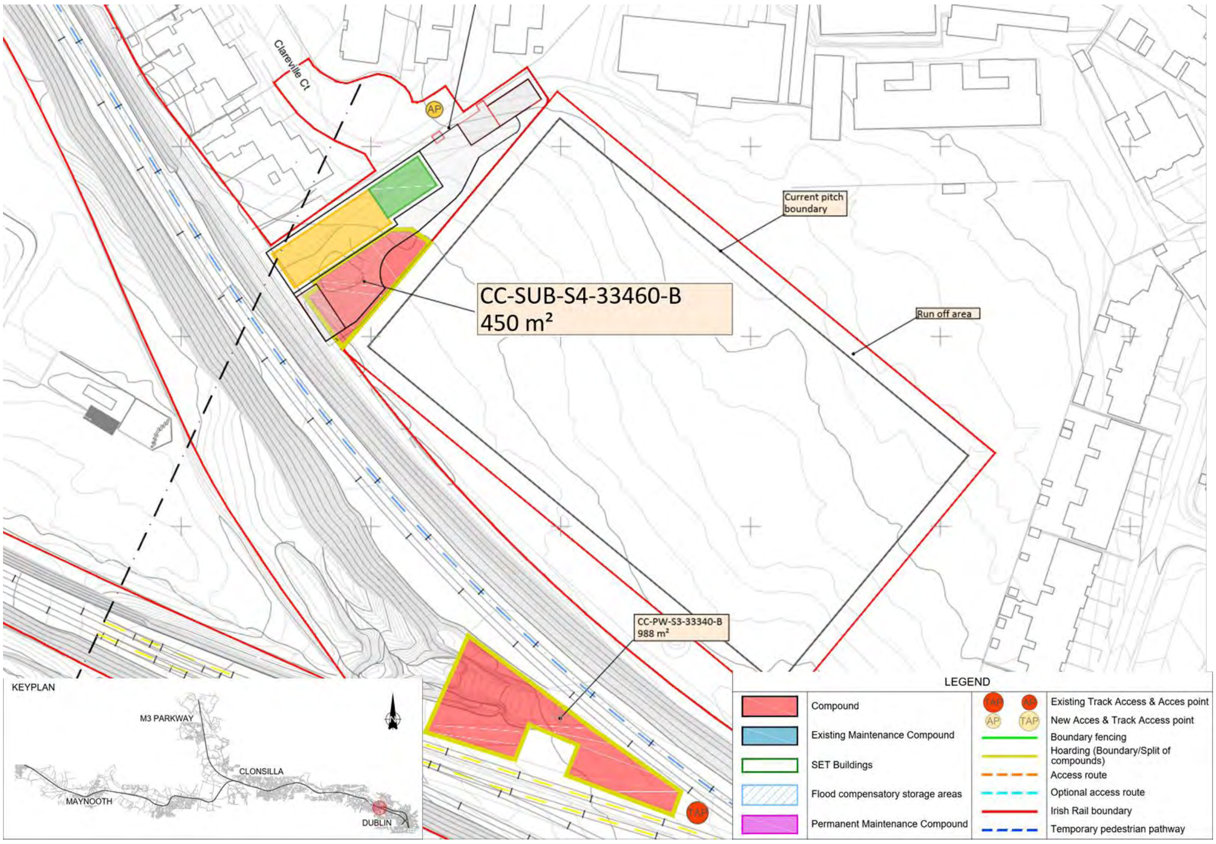


Figure 5-122 Glasnevin substation compound location

5.4.6 Other SET works

5.4.6.1 Signalling works

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling include:

- Ensure that the new crossover between East Wall Junction and Ossory Road Junction is blocked while the old signalling system is in service, and that it is put in service when the new interlocking is commissioned.
- The existing signalling system will need to be adapted to the new interim connection between GSWR and East Wall lines. The new signalling system will be commissioned while this interim connection is in service.
- The new signalling system will be modified to the final track configuration of this area.
- The new interlocking boundaries with the northern line (Dublin North KRCF SSI) and the southern line (Dublin North TTLD SSI) will be developed and commissioned with the new signalling system.

The specific signalling works for this area can be performed during night-time, weekend or extended possessions. Night services such as freight trains could be affected, especially during test periods.

5.4.6.2 LV power works

Apart from the general LV works described in Section 5.3.9.4, the specific works in this area for LV power works include:

- North Strand Junction. Installation of new PHCC and heater kits to existing P&S (Points & Switches). New electrical connections will be needed for the 3 new PHCC (NS-A, NS-B and NS-C) for the following existing points: 667A, 667B, 666B, 665B, 666A, 664B, 663A and 663B.

- Glasnevin. Removal of the existing connection from existing DNO/DC to the existing PHCCs. The existing PHCCs will be connected to the new DNO/DC. All of the existing PHCCs and Points heaters are going to be reused in this area.

These works will be performed during night-time possessions, having no impact on railway passenger services.

5.4.6.3 Telecoms works

The following construction activities will take place in Zone A:

- The new trunk cables will be connected to the new DART+ West nodes/buildings in this area, see details in Section 5.3.9.1 SET buildings and cabinets (i.e. Connolly TER, Connolly SEB, Glasnevin SEB and Glasnevin substation).
- The cabling will also be connected to the new DART+ West trackside LOCs and cabinets in this zone (OHLE, Signalling and LV cabinets) and other buildings (PSP).
- Telecoms equipment will be installed in the new TER, SEBs, PSPs and substation buildings. There will be no reconditioning of re-used TERs in this area.
- Telecoms equipment will be installed in new trackside LOCs and cabinets.
- New telecoms infrastructure (optical fibre, copper, structured cabling, Station LOCs) will be installed in Connolly station, including new station end points (e.g. CCTV cameras, CIS displays, PA speakers, etc.).
- Basic testing onsite without live railway interaction.

No impact on passenger services is expected, as these works will be carried out during night possessions (e.g. installation of new trunk cables), or during daytime (e.g. installation of new station elements).

5.4.6.4 Electrification works (HV/OHLE/SCADA/IESS)

The electrification construction activities that will take place in Zone A are listed in the following sections.

The specific electrification works for this section within Zone A can be performed during night possessions or when there is a longer possession (i.e. weekends), so additional impact on passenger services is not expected due to these electrification works.

5.4.6.4.1 Carriage sidings

Electrification of the Connolly Carriage Sidings tracks C, D, E and F will be required which are adjacent to the existing Valeting Depot as shown below.

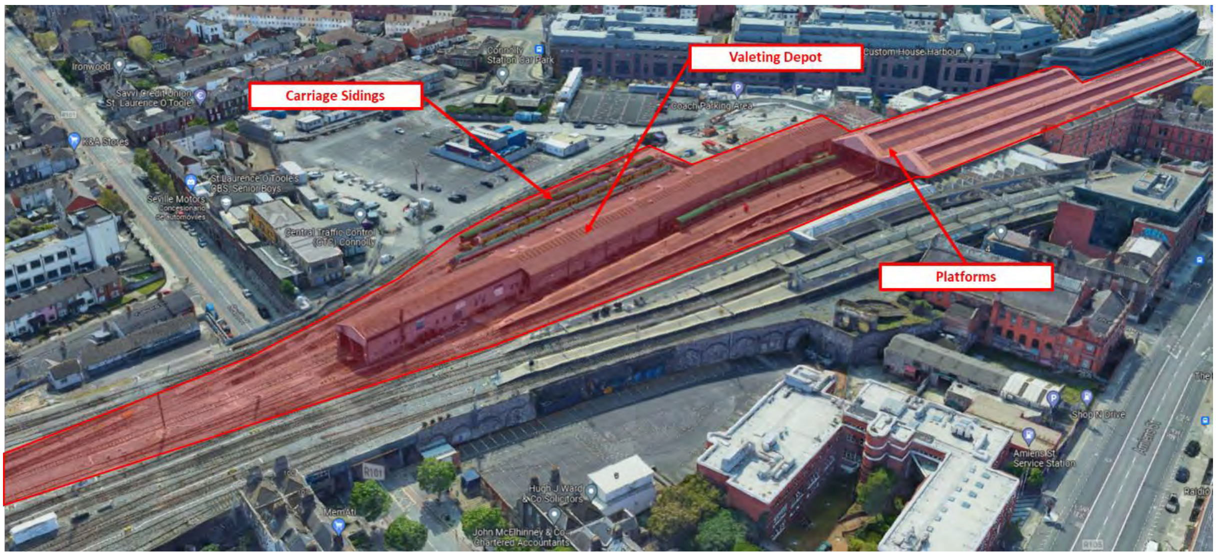


Figure 5-123 New electrified sidings at Connolly

5.4.6.4.2 Connolly platform area

Connolly station platforms 1, 2, 3 and 4 (already electrified) are built on brick arches and the OHLE will be provided with headspans to support the OHLE since it is the least visually intrusive solution for the station area. Part of the current OHLE headspans that are installed over platforms 3 and 4 will be replaced to accommodate the OHLE in platform 3.

Figure 5-124 Connolly Station

East Wall Junction: One of the main interfaces/connections between DART+ West and the existing electrification is at East Wall Junction in the Dublin City Area. This connection will link the coastal line with Spencer Dock. There are no regular passenger trains/services in this branch.

The interface between the new DART+ West OHLE and the existing electrification will take place in an overlap which area is identified in red in Figure 5-125.

Figure 5-125 East Wall Junction interface area

In this overlap two different OHLE wiring will coexist: the existing OHLE (Contact Wire 107 mm², Messenger Wire 70 mm^2 and 11 kN) and the new OHLE (Contact Wire 120 mm^2, Messenger Wire 95 mm^2 and 12 kN).

5.4.6.4.3 North Strand Junction

One of the other main interfaces/connections between DART+ West and the existing electrification is at North Strand Wall Junction in the Dublin City Area. This connection will link the GSWR line with Connolly.

There is an interface between the new DART+ West OHLE and the existing electrified railway OHLE. Figure 5-126 below shows this interface area in red.

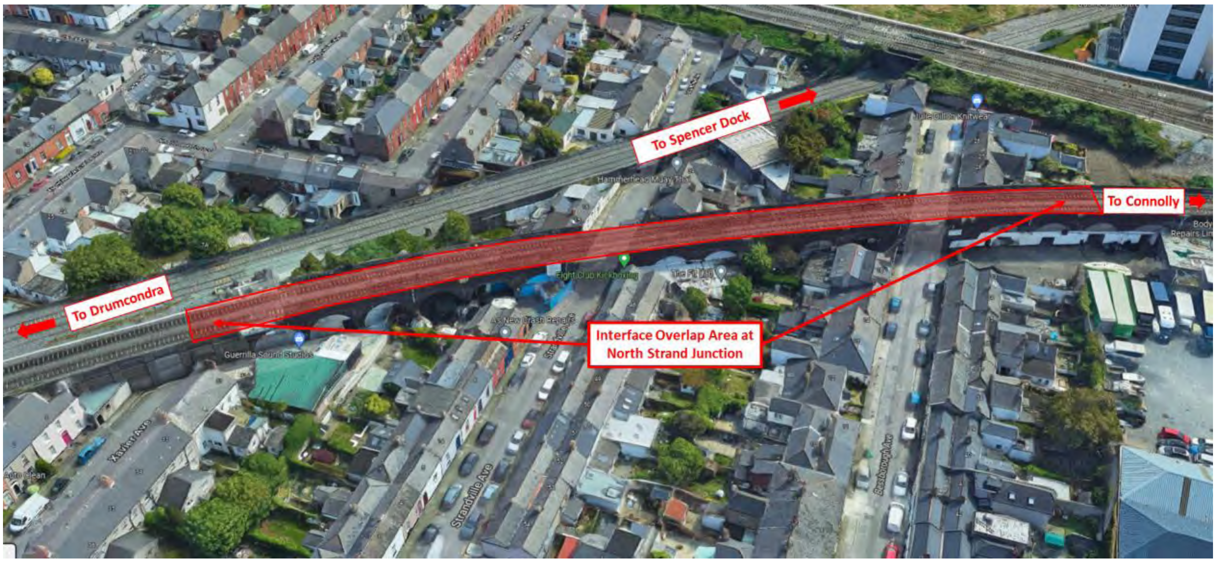


Figure 5-126 North Strand Junction interface area

In this overlap two different OHLE wiring will coexist: the existing OHLE (Contact Wire 107 mm², Messenger Wire 70 mm^2 and 11 kN) and the new OHLE (Contact Wire 120 mm^2, Messenger Wire 95 mm^2 and 12 kN).

5.4.6.4.4 New crossing in Connolly

The electrification of a new crossing between Tolka River and Connolly Station.

Figure 5-127 New crossing between Connolly and the Tolka River

5.4.6.4.5 GSWR

SET works on the GSWR line include the following:

- Installation of elastic bridge arms to support the OHLE, insulators to support the feeder wires and earth wire clamps at OBO11.
- In some particular locations, between Drumcondra and OBO35, where the railway is in an elevated overbridge and there is not enough clearance with the rolling stock to install the OHLE structures inside or on top of the walls, the solution required will be an external wall fixing which may require a temporary air space access for their installation.
- OHLE feeding connections and MOS installation from Glasnevin substation and mainline OHLE MOS.
- General electrification works for the OHLE installation (as described in Section 5.3.9.1 SET buildings and cabinets and Section 5.3.9.6) that will generally comprise single track cantilever structures (including twin track cantilevers, portals and wall fixings in some particular locations).

5.5 Description of Construction Works in Zone B – Spencer Dock Station to Phibsborough/Glasnevin Junction

Zone B runs east to west from Spencer Dock station to Glasnevin junction along the MGWR line, but connections to the Northern Line and the GSWR are also included. This zone is approximately 3.05 kilometres in length, from Ch 50+000 to Ch 53+050.

Works in Zone B around Spencer Dock Area include:

- New Spencer Dock Station.
- OBD228 Sheriff Street Bridge Reconstruction.
- Access ramp into Docklands' compound.
- New slab track configuration at Spencer Dock-Docklands-East Wall area.
- Track lowering and structural intervention at OBO36 Ossory Road Bridge.
- Parapet heightening at OBO36 Ossory Road Bridge.

Works in Zone B also include:

- General track lowering along the MGWR line.
- SET installation (as described in Section 5.5.10).

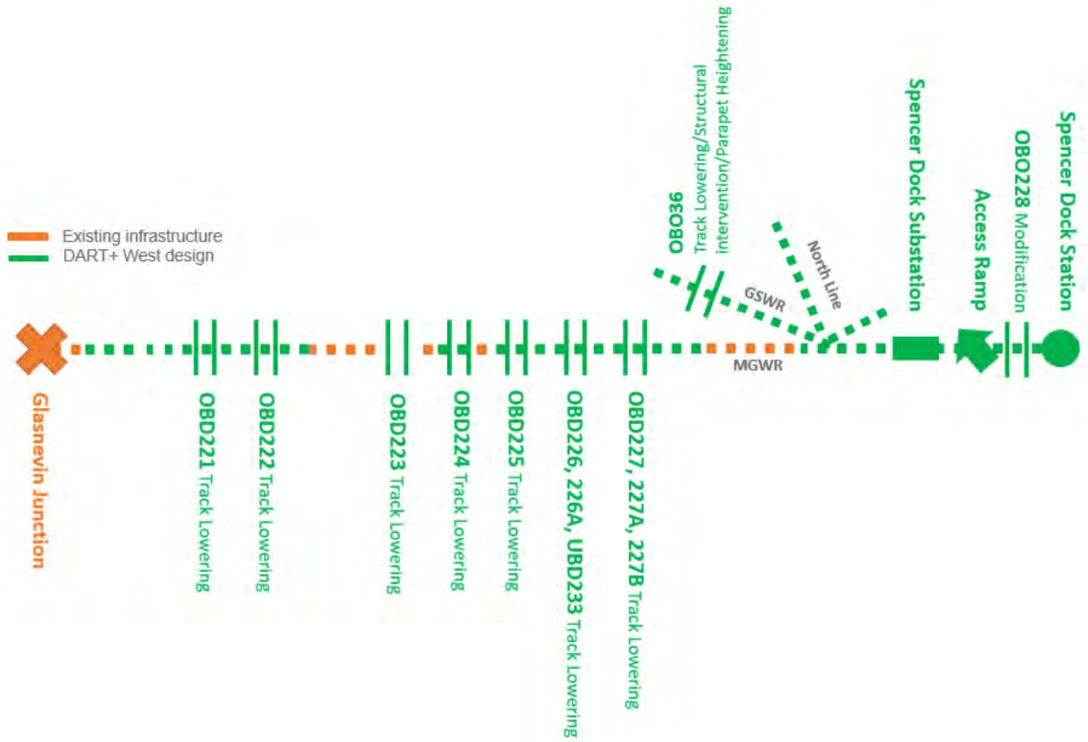


Figure 5-128 Schematic of DART+ West construction activities in Zone B

Early works in Zone B will include the following activities:

- North Wall Permanent Facilities Relocation.
- Construction of compounds.
- Sheriff Street Access Ramp.
- Utility Diversions.
- Spencer Dock piling and earthworks.

Utility diversions have been identified in Zone B (as described in Chapter 18) which will require temporary traffic diversions. The typical construction methodology used for utility diversion works has been detailed in Section 5.3.5, and the general principles of the traffic management measures required during the construction phase are outlined in Section 5.12.3 Construction Traffic Management. The remaining early works are described in the following sections.

5.5.1 Spencer Dock construction compounds and haulage routes

The construction compounds required to carry out the construction works within Zone B are outlined in Table 5-8.

Table 5-8 Construction compounds in Zone B

Compound code	Chainage	Reference	Discipline
CC-PW-S2A-20750-B	20+750	Docklands	Substations
CC-STA-S4-40230-B	40+230	New Spencer Dock Station	Stations
CC-STA-S4-40250-B	40+250	New Spencer Dock Attenuation Tank	Stations
CC-SET-S4-40280-B	40+280	New Docklands SET	SET
C-PW-S4-40380-B	40+380	Docklands Track	Permanent Way
CC-PW-S4-43200-B	43+200	Glasnevin	Permanent Way

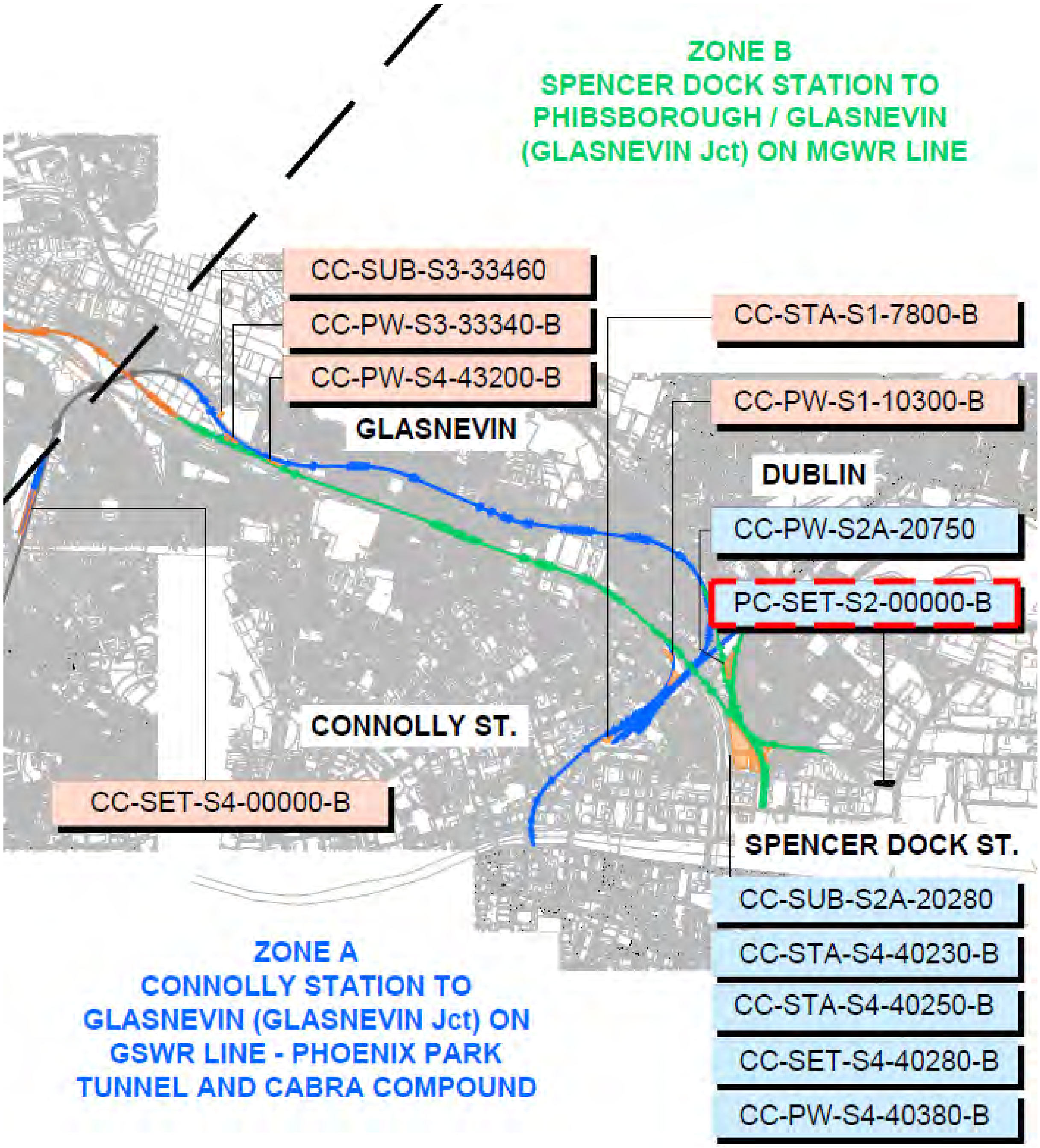


Figure 5-129 Zone B compounds

Spencer Dock construction compounds are located east of the existing Docklands train station. Three haulage routes have been proposed in order to provide access to these compounds, depending on the construction stage. All the routes arrive at Spencer Dock area using the R131 road to get to Sheriff Street Upper. From this point, access to the compounds may be by means of:

- Iarnród Éireann Track Domain (Dock Road).
- Abercorn Road.
- Sheriff Street Upper access ramp.

Since all these accesses are to be used during different construction stages, a phasing has been included below.

- Phase 1: The initial access route will consist of entering through the Iarnród Éireann Track Domain from East Wall Yard via Dock Road.

Figure 5-130 Access to compound via Dock Road

To safely access Dock Road from Sheriff Street Upper, works are required to allow the vehicles to turn safely into Dock Road. The removal of the concrete island in front of the access to Dock Road is necessary.

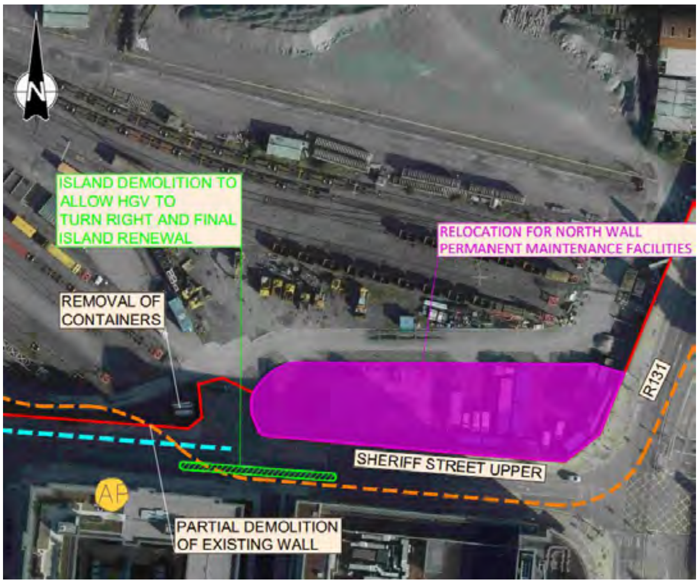


Figure 5-131 Traffic island demolition

Dock Road will be used as a one-way shuttle system road, due to its narrowness (narrowest section – approximate width of 3.4 m). Given the proximity of the road to the live rail line (see Figure 5-132) the construction of a fence between the road and the railway was considered, but this would further decrease the width of the road. Therefore, a safe system of work will need to be developed to ensure that train movements are coordinated with the vehicular use of Dock Road. Through discussions with IÉ it is understood that train movements are not significant on this section of the line; hence this was deemed an acceptable route. The detail of the traffic/train management required to safely use this route will be developed with IÉ during detailed design stages.

Figure 5-132 Dock Road showing live rail interface

When providing access via Dock Road, dust pollution must be taken into consideration. In order to reduce dust generated from the ground due to the truck's movements, a surface dressing for the road will be provided.

Regarding the width of the road (minimum 3.4 m approximately), the majority of machinery required to access the compound will be able to use this route; however, some wide load machinery might require accessing the compound area through Abercorn Road.

- Phase 2: When existing maintenance facilities in Docklands (to be relocated in East Wall Yard) are demolished, the access through Abercorn Road will be also available, which can be entered from Sheriff Street Upper.

Figure 5-133 Access to compound via Abercorn Road (Phase 2 and 3)

During Phase 2 both access routes via Dock Road and Abercorn Road will be accessible in parallel.

- Phase 3: The only access to the compound area during Phase 3 will be via Abercorn Road (see Figure 5-133). The use of Dock Road will not be possible during this phase due to the construction of Structure B.
- Phase 4: During this phase the access to the compounds will be provided via the Sheriff Street access ramp from Sheriff Street Upper. This route is only available after OBG228 Sheriff Street bridge has been reconstructed. In order to complete the construction of the permanent way works in the Spencer Dock area both of the routes via Dock Road and via Abercorn Road will be cut off at this phase. Works related to the access ramp are included in Section 5.5.2.2.

Figure 5-134 Access to compound via Sheriff Street Ramp (Phase 4)

When works in the new Spencer Dock Station area commence, access routes from the compound area to the new station area will be provided. As well as directly to the new Spencer Dock Station Area.

Figure 5-135 Location of compound and new station area

The new Spencer Dock Station site can be accessed from the compound area. This access is provided by passing under the existing Sheriff Street Bridge. The existing Dock Road access shown in blue in Figure 5-136 will not be available since reconstruction works will be performed in five spans of this structure (yellow limits). It is therefore required to provide access under an adjacent span where no works are planned to be carried out (orange limits).

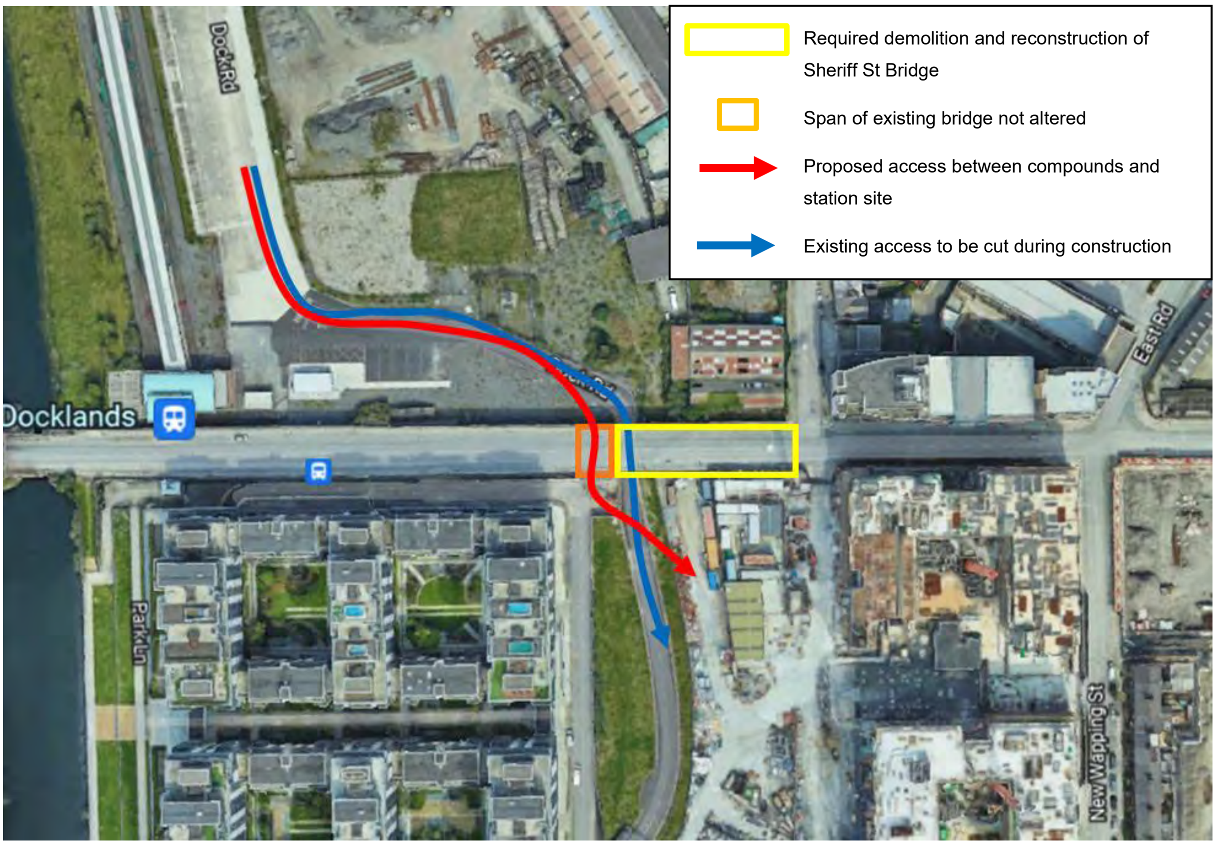


Figure 5-136 Access from compound to new station area

Due to the interference with the 'no parking' area highlighted in Figure 5-137, it is proposed that this area could be moved to the south. Additionally, traffic management would be put in place in case of emergencies. In case of emergency, the route for the construction vehicles would be closed temporarily in order for the public vehicles (e.g. fire truck) to access the area (Figure 5-138).

Figure 5-137 Exisiting 'No Parking' area

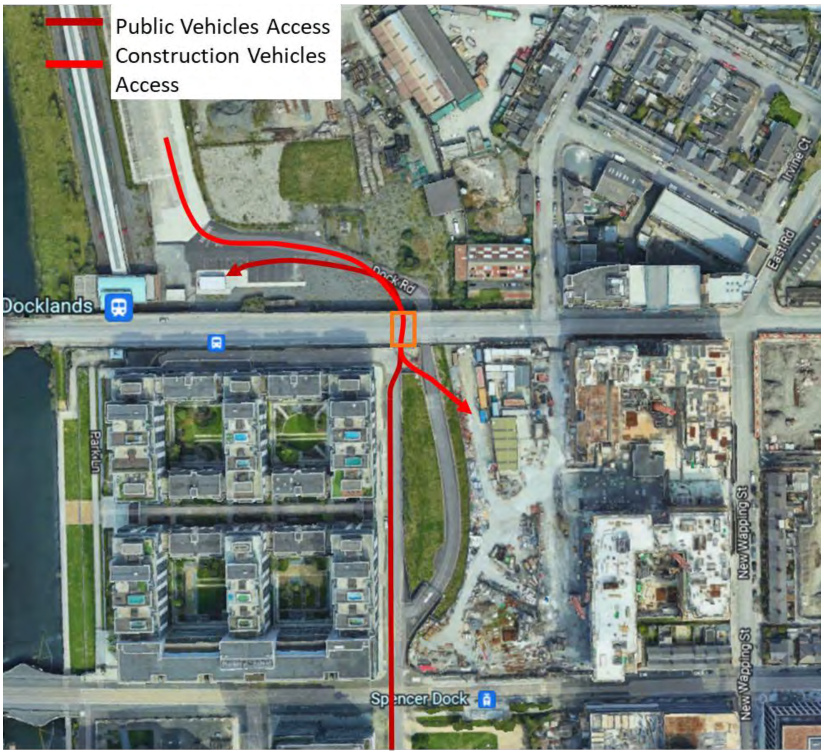


Figure 5-138 Public vehicle access in case of emergency

This route would be utilised for the duration of the project as a connection route between the main compounds and the Spencer Dock station area; however, interference with the Spencer Dock ramp must be taken into consideration.

To move in and out of the new station area the following route is proposed. The access route will consist of entering through a ramped road from Sheriff Street Upper into the site (Figure 5-139). This route provides direct access from Sheriff Street Upper. Due to the difference in levels, a temporary ramp may be required to be constructed.

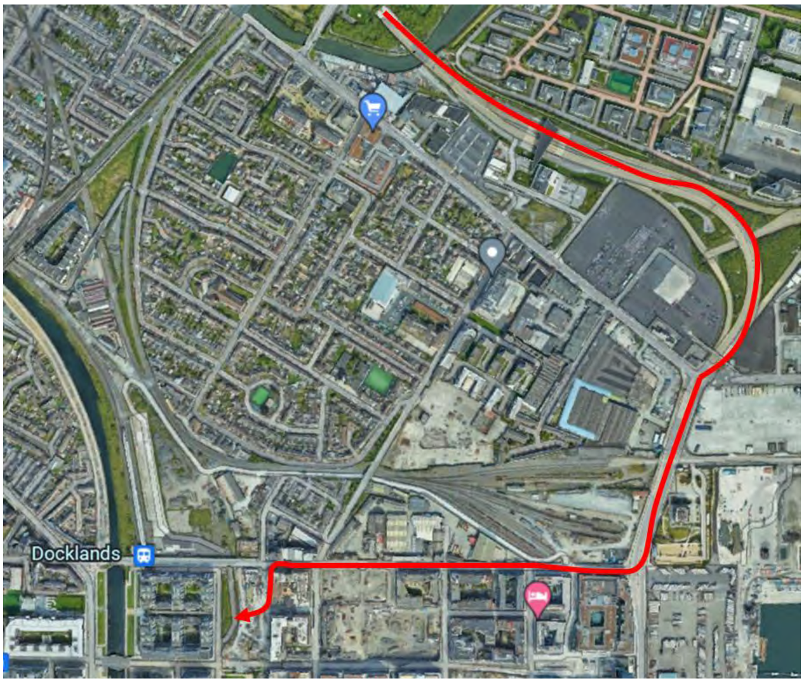


Figure 5-139 Spencer Dock Station area access route

Once Sheriff bridge is fully reconstructed (after week 84), the exit route from the site would be provided from Sheriff Street ramp directly onto Sheriff Street Upper as depicted in Figure 5-140.

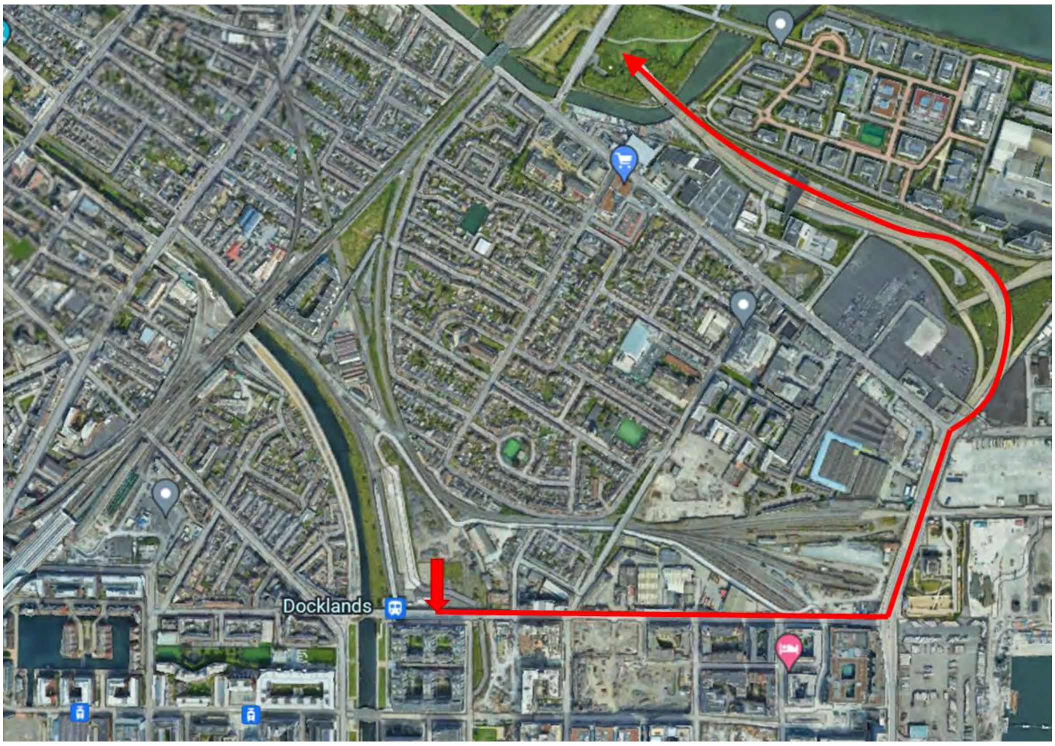


Figure 5-140 Egress route from compound area – second phase

5.5.2 Spencer Dock area overview of works required

The works required in the Spencer Dock area are listed below:

- Early works required as per construction programme
  - Construction of the compounds.
  - Construction of the access ramp to the Docklands compound.
  - North Wall permanent maintenance facilities relocation.
  - Utilities diversions for OBD228 Sheriff St bridge.
  - Spencer Dock area piling and earthworks.
- Spencer Dock Station
  - New Spencer Dock station construction.
  - Spencer Dock attenuation tank construction.
  - OBD228 Sheriff Street bridge reconstruction.
  - Spencer Dock substation.
- Spencer Dock-Docklands-East Wall Permanent Way
  - Maintenance facilities demolition.
    - Permanent way works.

All the main works contained in Spencer Dock area is shown in Figure 5-141.

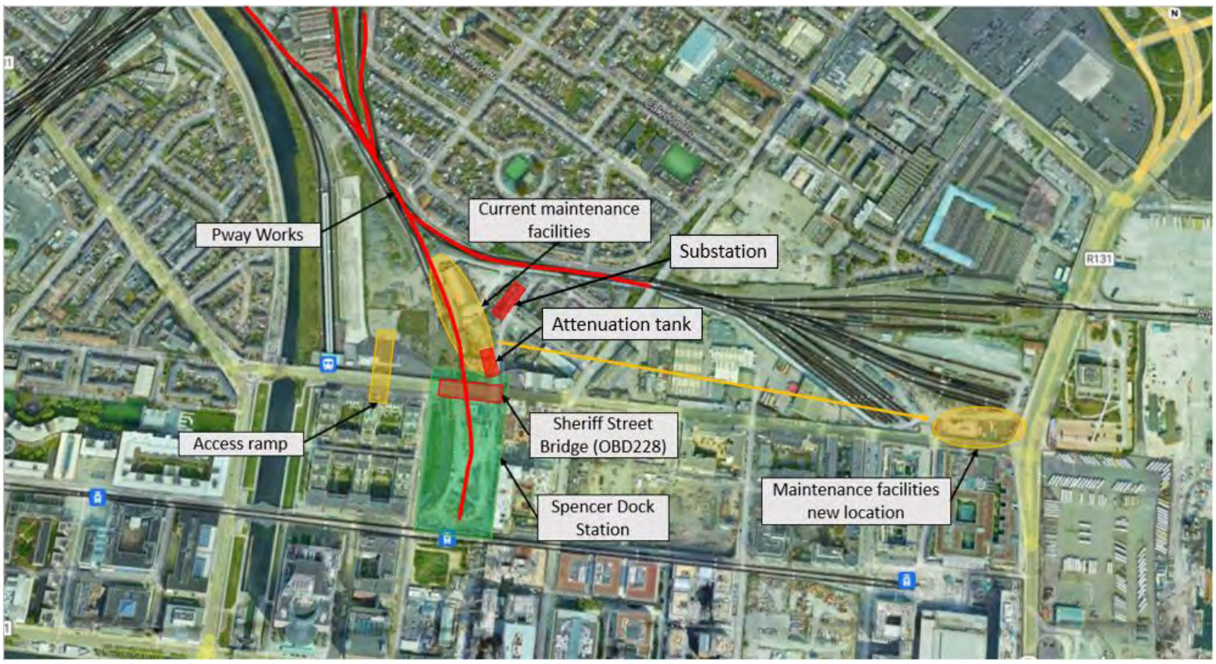


Figure 5-141 Proposed works within Spencer Dock area

For the permanent way works, three existing rail track branches will be affected, and a new connection to the northern line will be constructed. These are listed below and are shown in Figure 5-142.

- GSWR-Yard.
- MGWR.
- East Wall branch.
- Northern line connection.

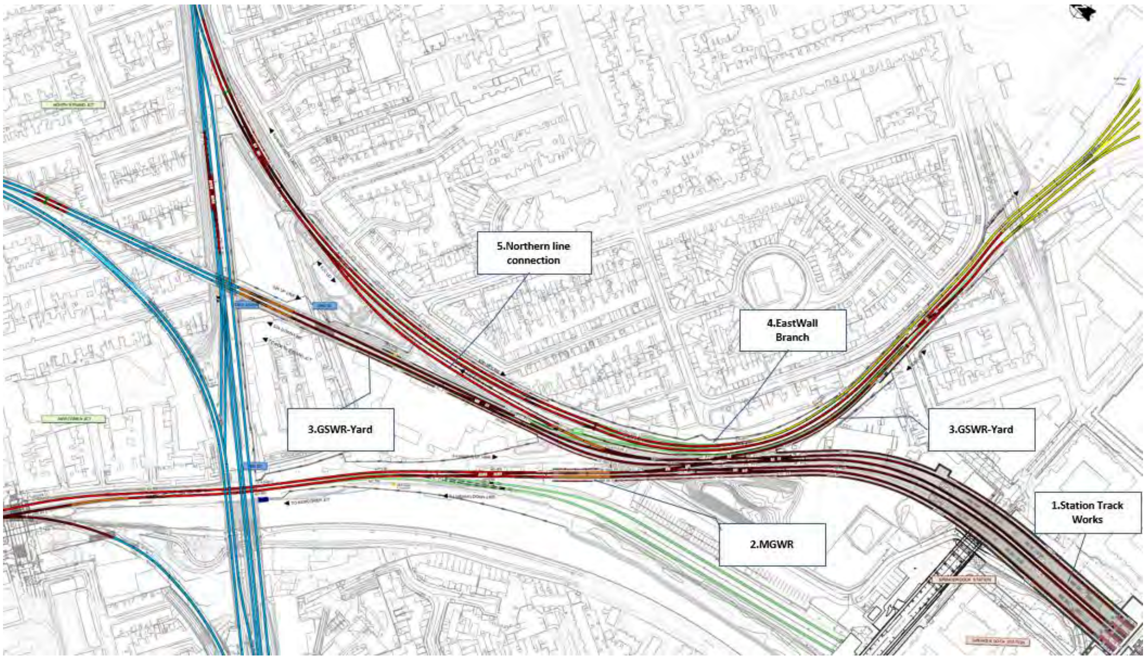


Figure 5-142 Lines affected by permanent way works

5.5.2.1 Construction strategy and works coordination

In relation to the construction strategy for the Spencer Dock area, the following points should be noted:

- The demolition of existing maintenance facilities will not start until their relocation has been completed.
- Prior to the demolition of Sheriff Street bridge, traffic must be diverted along the existing road network (details provided in Section 5.5.1.5).
- The reconstruction of Sheriff Street bridge is to be carried out together with the construction of the station.
- The permanent way works will involve the construction of a track slab and retaining walls in order to prevent flotation and minimise the impact on adjacent tracks.
- Track works in Spencer Dock, including inside the station, will not start until the U structure (bottom slab and retaining walls) is finished.

A construction phasing programme has been included below for the whole Spencer Dock area. The works related with Spencer Dock station have been highlighted in green, while the works relating to the permanent way are shown in yellow. The remaining works are highlighted in blue.

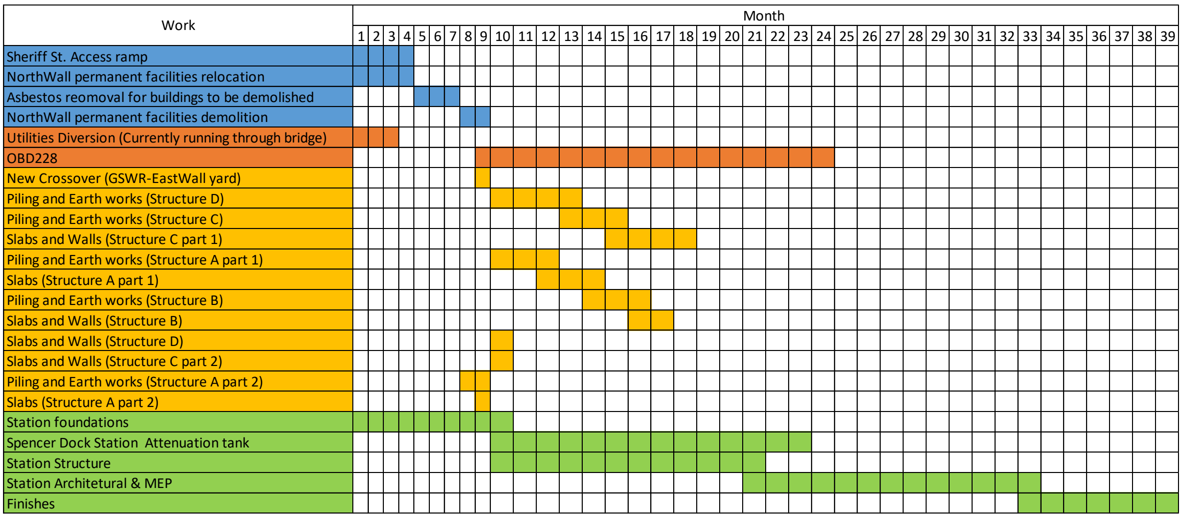


Figure 5-143 Construction programme for Spencer Dock area

5.5.2.2 Access ramp to Docklands compound

The access ramp to the Docklands compounds (CC-SUB-S2A-20280, CC-STA-S4-40230-B, CC-STA-S4-40250-B, CC-SET-S4-40280-B and CC-PW-S2A-20750-B) will allow construction vehicles to enter the compounds from Sheriff Street Upper (see MAY-MDC-ENV-ROUT-DR-Z-0001-C) when the Sheriff St Bridge has been reconstructed, as outlined in Section 5.5.1. The following section describes the anticipated construction sequence for the access ramp:

1. Topsoil removal (bulldozer, backhoe and trucks).
2. Laying and compaction of successive soil layers until the required surface level is reached (bulldozer, backhoe, trucks and compactor).
3. Execution of the required drainage (backhoe, crane, concrete mixer truck).
4. Pavement laying (asphalt paver, compactor, trucks).
5. Installation of the guardrails.

The total duration of the activities is foreseen to be 4 months, during daytime project construction working hours as set out in Section 5.2.1.

5.5.2.3 Permanent maintenance facilities relocation

The facilities located in North Wall are critical to both maintenance and renewals of IÉ assets along the DART line, so it is a requirement that these facilities remain in the same general area. There is a number of IÉ departments with individual facilities and shared facilities in this area. These facilities are required to be relocated as they clash with the proposed Permanent Way works.

Figure 5-144 Existing facilities in North Wall to be relocated

IÉ have proposed a space located in the south-eastern corner of the East Wall yard that is available for the relocation of the facilities.

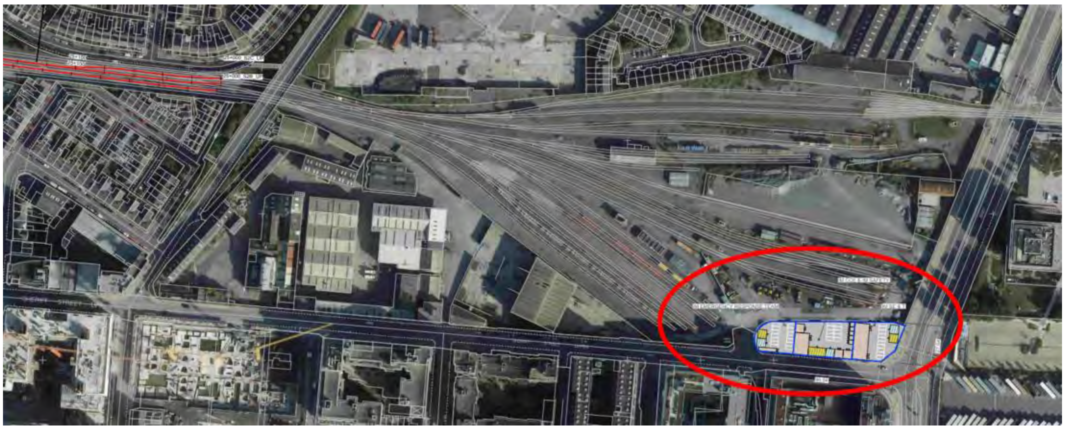


Figure 5-145 Proposed location for new facilities in East Wall yard

Below is a description of the proposed works at the East Wall Yard compound area:

- Main entrance to East Wall Yard is proposed through Sheriff Street Upper by means of an existing gated access. Once in this area, different entrances are provided to each of the fenced sections by means of an electric gate.
- The area is divided into three different sections which will be independently fenced.
- The general design criteria is to prioritise the access to the staff facilities and to storage areas. The area of buildings and storage containers is distributed along the perimeter, and the central area is left for parking.
- The area is completely flat and is at level +3 m.
- No utilities diversions are envisaged in this area. Watermain and sewage networks run parallel to the compound through Sheriff Street Upper.
- Each area is to be fenced off with its own electric gated entrance and a tarmac surface.
- Parking bays and walking routes will need to be clearly marked out.
- The project will have to facilitate the installation of lighting and security cameras for each of the three areas.

Figure 5-146 General layout of the new facilities in East Wall yard

The design of the different buildings has considered the requirement of installing porta-cabin buildings where new facilities are required.

Figure 5-147 Porta-cabin facility

The minor storages are mainly composed of containers of different sizes as below.

Figure 5-148 Storage container sizes

5.5.3 Spencer Dock Station

5.5.3.1 Station overview

The structure of the station is a continuous element with different structural solutions for each zone. All of the platform level is located below station entrance level and requires retaining walls. All of the structure at platform level will be constructed using reinforced concrete. The foundation of the station will be formed mainly by a raft foundation connected to the retaining walls. The raft is designed to compensate for the ground water pressure beneath the station.

The structure above platform level (mainly the main station entrance and retail area) will be formed by steel columns, composite deck slabs and a steel roof. For a better understanding of the structural design, the station has been divided into 6 zones as shown in Figure 5-149 and Figure 5-150.

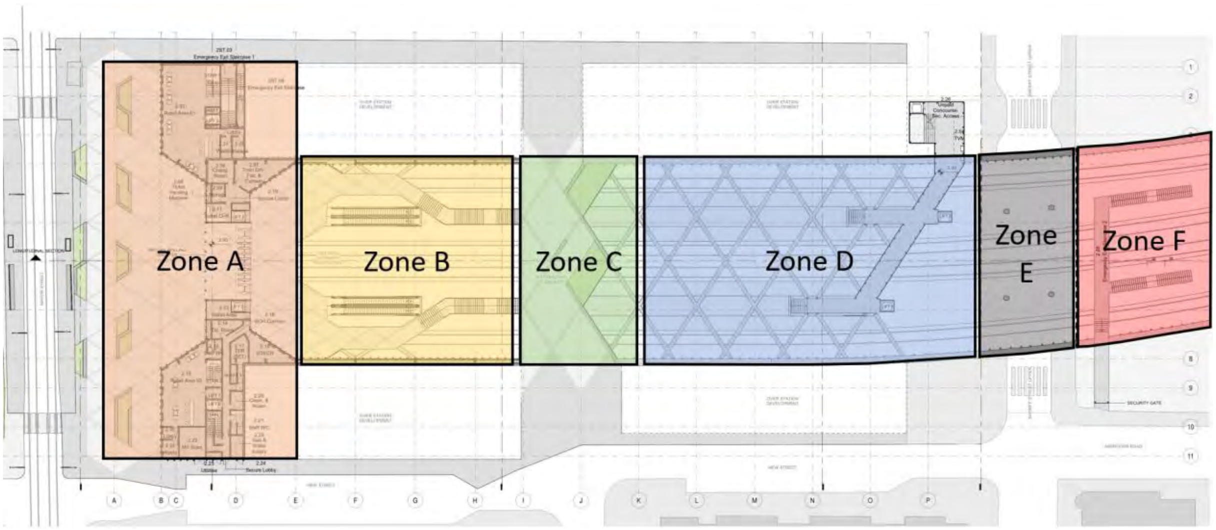


Figure 5-149 Plan of structural zones at Spencer Dock Station

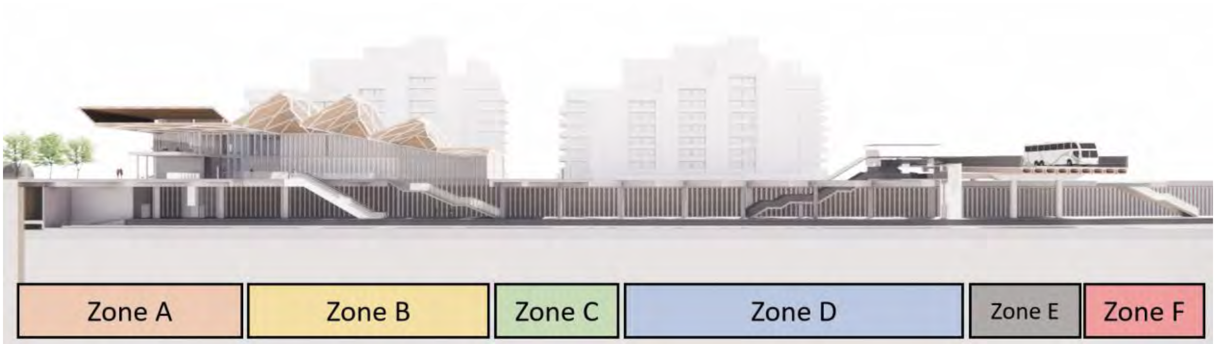


Figure 5-150 Section of structural zones at Spencer Dock Station

<u>Zone A</u>

Zone A is the main entrance to the station. This zone has 4 levels: platform level, street level, first floor level and roof level. All the vertical structure up to the street level is formed by reinforced concrete: central reinforced concrete (RC) columns rising from the foundation slab and a secant pile retaining system, which is designed for bearing gravity loads from above and internal RC walls. The pile walls are supported by the raft and the slab. The slabs are a mixture of one-way and two-way slabs on beams. The structure above the street level is formed by steel columns and composite deck slabs. The roof is a singular structure formed by two different typologies. T he roof over the retail area is formed by steel beams with composite deck and the roof over the public area is formed by steel trusses with lightweight cladding. The roof is only accessible for maintenance.

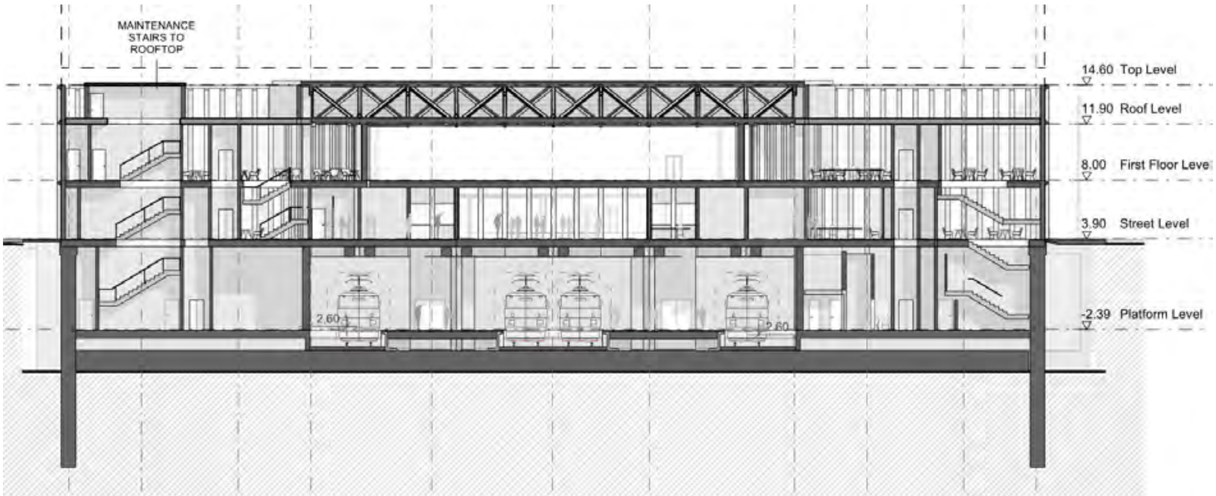


Figure 5-151 Section through Zone A

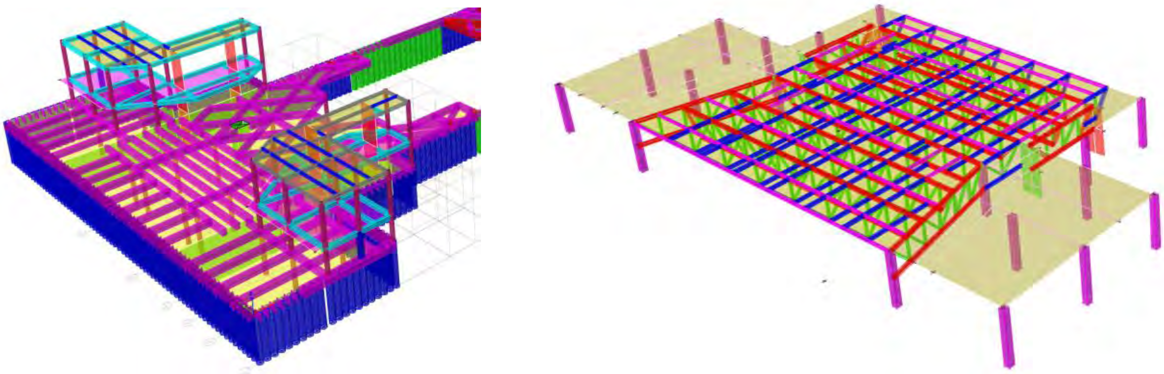


Figure 5-152 Numerical structural model of reinforced concrete structure (left) and steel roof structure (right)

<u>Zone B</u>

Zone B is the part of the platform under the roof of the station. This zone has three levels: platform level, entrance (street) level, and roof level. All the vertical structure is formed by steel columns: secant pile walls are constructed as the retaining system and columns rising from the raft foundation act as support for the stairs. The retaining walls are designed to work as a permanent cantilever structure. The slab at the entrance level is supported by cantilever beams, which are fixed to the retaining walls. The roof over the platforms is formed by steel trusses with lightweight cladding and glass only accessible for maintenance.

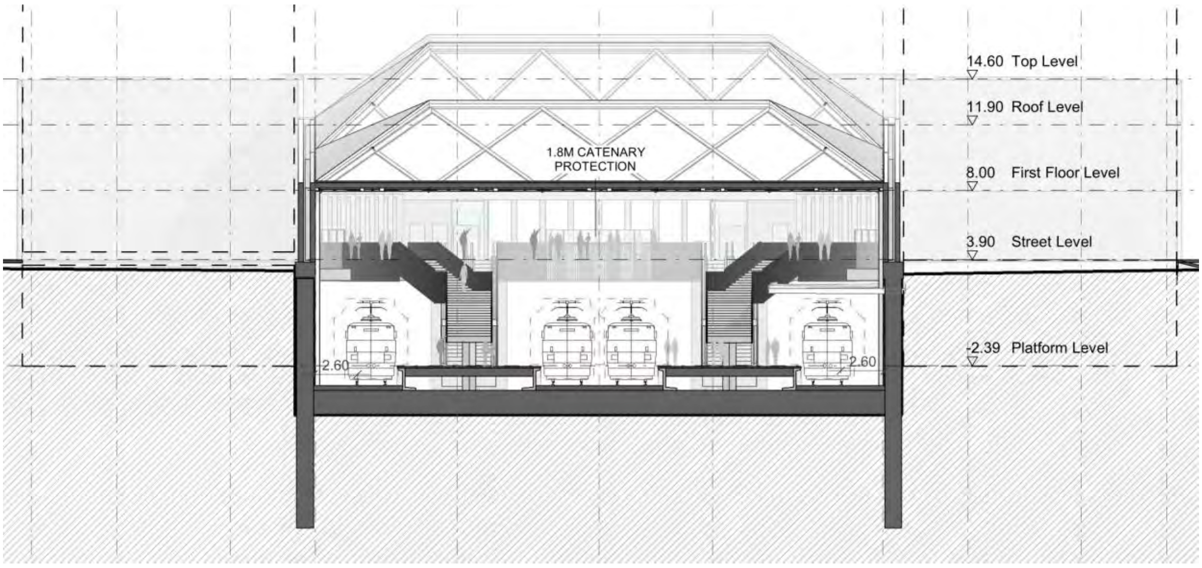


Figure 5-153 Section through Zone B

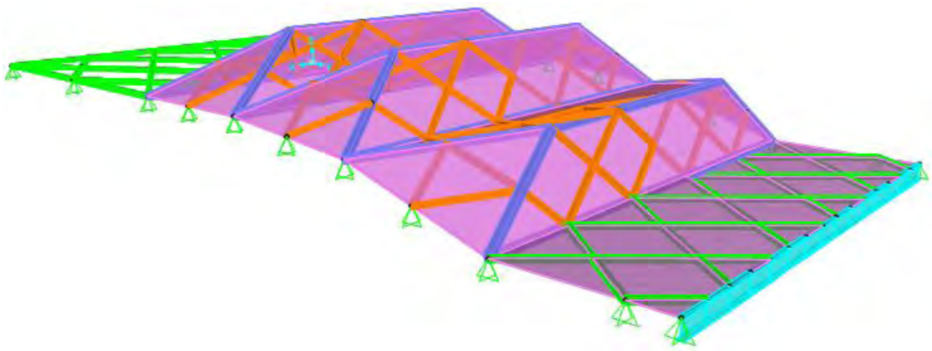


Figure 5-154 Numerical structural model of roof structure over Zone B

<u>Zone C</u>

This zone is the part of the platform with a pedestrian bridge over it connecting both sides of the station. This zone has only two levels: the platform level and the pedestrian bridge. All the vertical structure is formed by reinforced concrete: secant pile walls as retaining system and columns rising from the raft foundation. The retaining system is considered to have two support points: the raft foundation and the slab of the bridge. The pedestrian walkway is a two-way slab on beams supported by the retaining system and the columns.

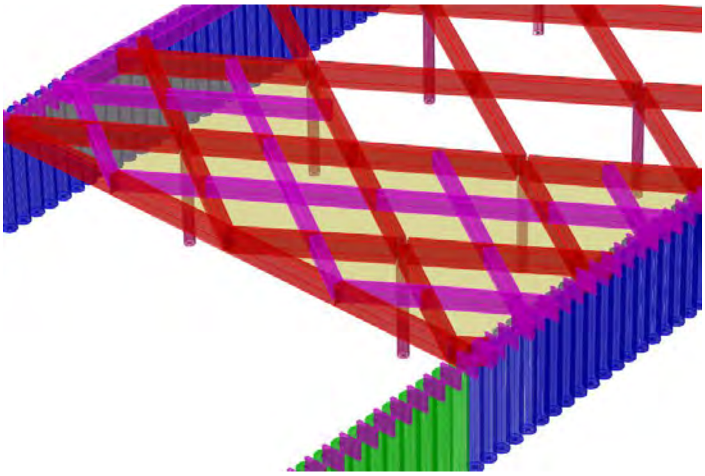


Figure 5-155 Numerical structural model of pedestrian bridge over Zone C

Zone D

Zone D is the largest zone and is located between the pedestrian walkway and the secondary building entrance. This zone has two levels: the platform and the beams working as shoring between the walls. All the vertical structure is formed by reinforced concrete: secant pile walls as the retaining system and columns rising from the raft foundation. The retaining system is considered to have two support points: the raft foundation and the shoring system formed by beams connected to the capping beams of the piles. The shoring system is supported in the columns. However, at the northern end of zone D, the retaining walls have a cantilever system.

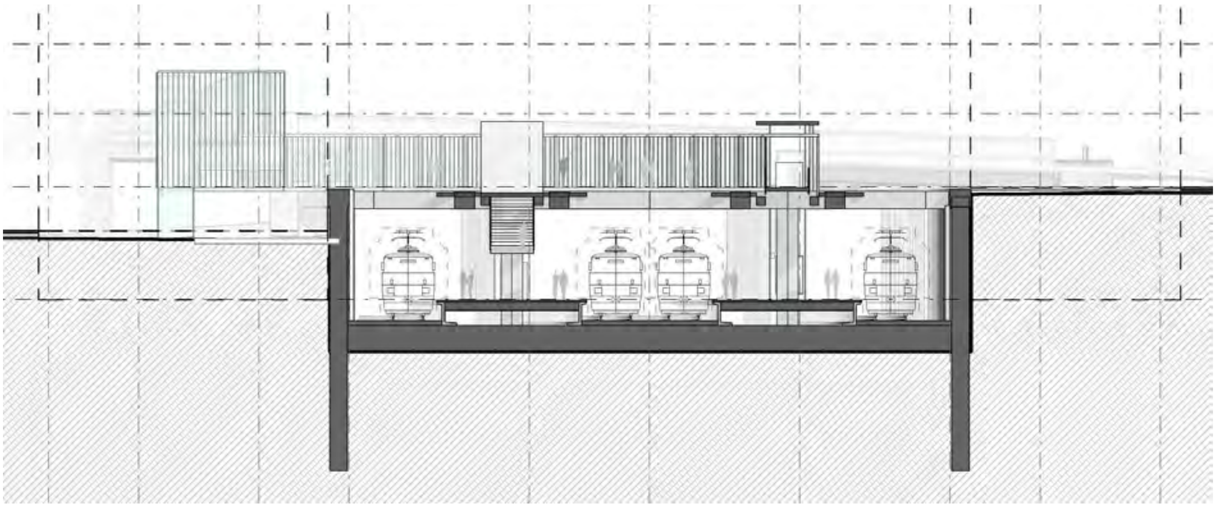


Figure 5-156 Section through Zone D

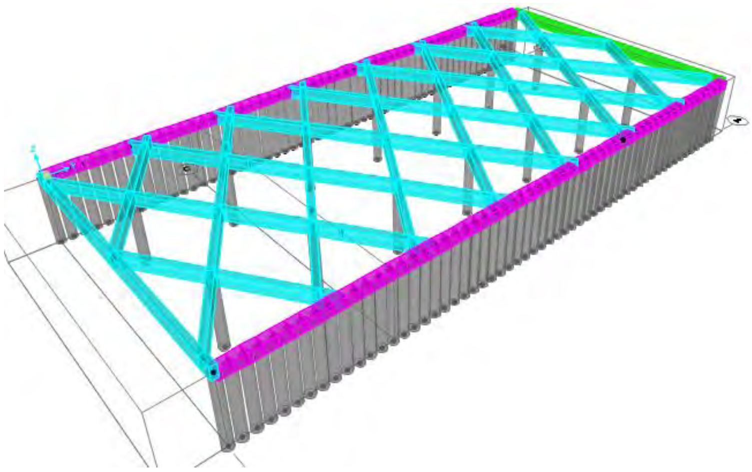


Figure 5-157 Numerical structural model of shoring system over Zone D

The secondary building entrance is also located in this zone. This building is designed as a reinforced concrete structure with steel columns rising from shallow foundations and from the shoring structure, two-way slabs on beams, and a steel roof.

Zone E

This zone is the part of the station where the Sheriff Street Upper bridge is located. This zone has two levels: the platform and the Sheriff Street Upper bridge. All the vertical structure is formed by reinforced concrete: secant pile walls as the retaining system and walls rising from the raft foundation. The retaining walls have a cantilever system, and the walls are used as supports for the bridge. The construction phases of the OBD228 Sheriff St. Bridge are described in Section 5.5.4.

Zone F

The last zone is located to the north of Sheriff Street Upper. The vertical structure is formed by the secant cantilever pile walls and is connected at the platform level by the raft foundation. The retaining structure of this zone is part of the Spencer Dock-Docklands-East Wall Permanent Way described in Section 5.5.7.

An emergency staircase is also included in this zone. The vertical structure is formed by reinforced concrete columns and the slabs and stairs are all steel elements. The staircase is supported on the retaining wall and the columns, which rise from the raft foundation.

5.5.3.2 Spencer Dock Station construction phases

As a general overview, for the new Spencer Dock Station, the construction phases are as follows:

1. Enabling works: Demolition of existing buildings and roads, site clearance, utility diversions, etc. (all zones).

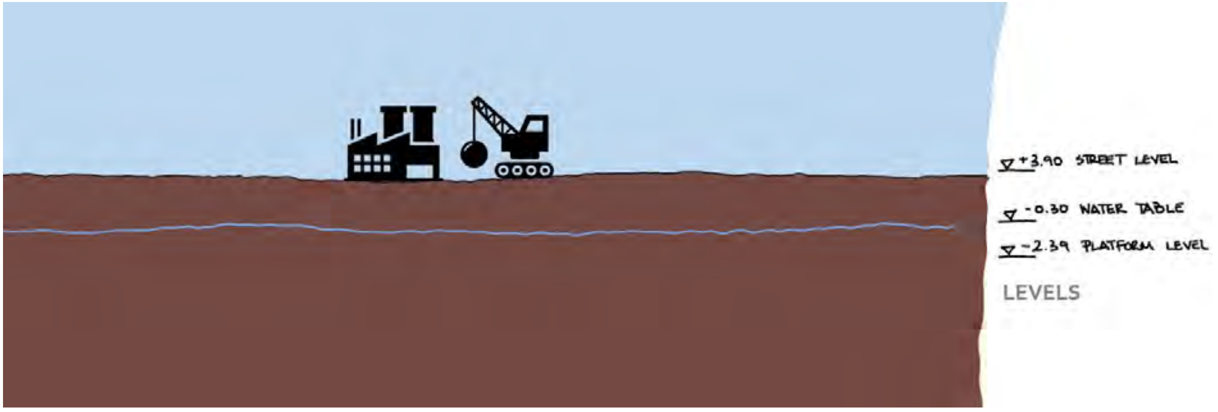


Figure 5-158 Construction phasing diagram - Phase 1

2. Execution of the secant pile walls. (all zones)

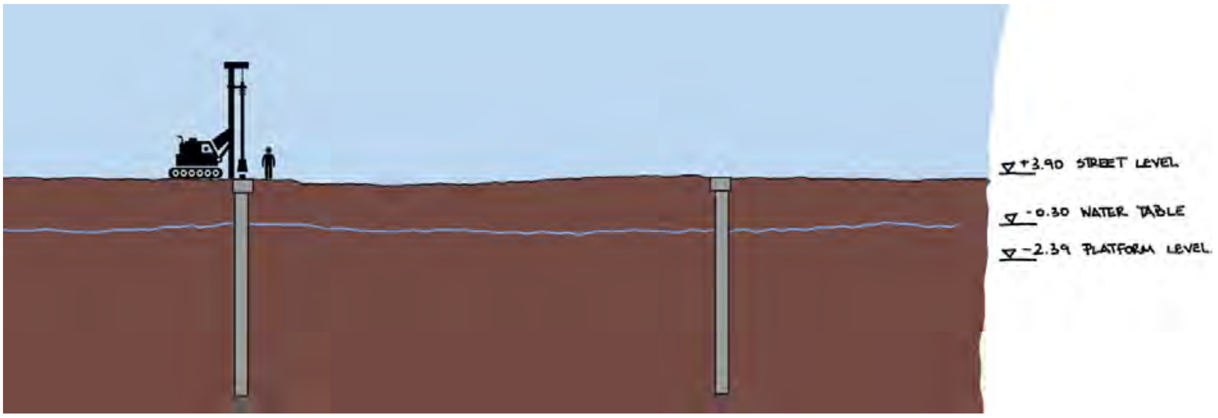


Figure 5-159 Construction phasing diagram - Phase 2

3. Excavation and disposal of soil between secant pile walls using temporary shoring such as sheet piles (zone A) or temporary anchorages (zones B, C and D). Groundwater inflow control is required during this phase see Section 5.5.2.5.6. Water pumps will be used to dewater the construction area at very low pumping rates.

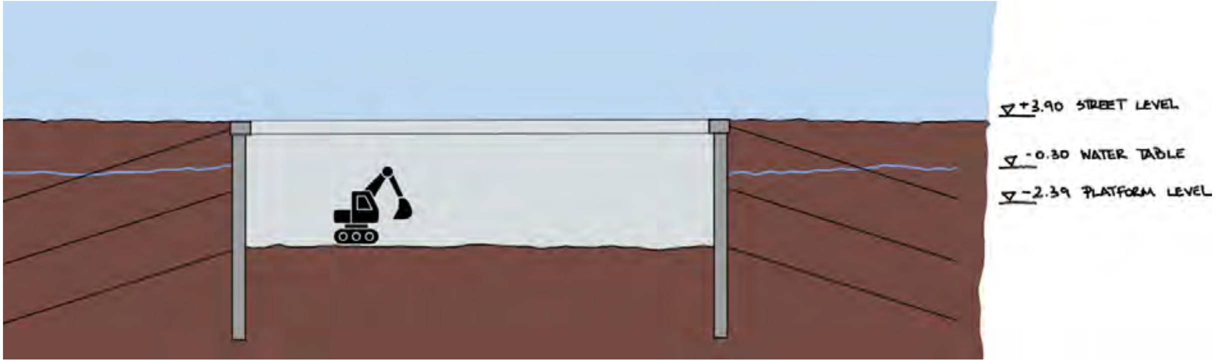


Figure 5-160 Construction phasing diagram - Phase 3

4. Execution of the lower sub-pressure slab (All zones).
5. Construction of the reinforced concrete columns and walls that will support the slabs and the permanent shoring structure (All zones).
6. Construction of the ground level slabs (zones A and C) and the permanent shoring structure (zone D).
7. Removal of the temporary shoring (zone A) and the temporary anchorages (zones B, C and D).

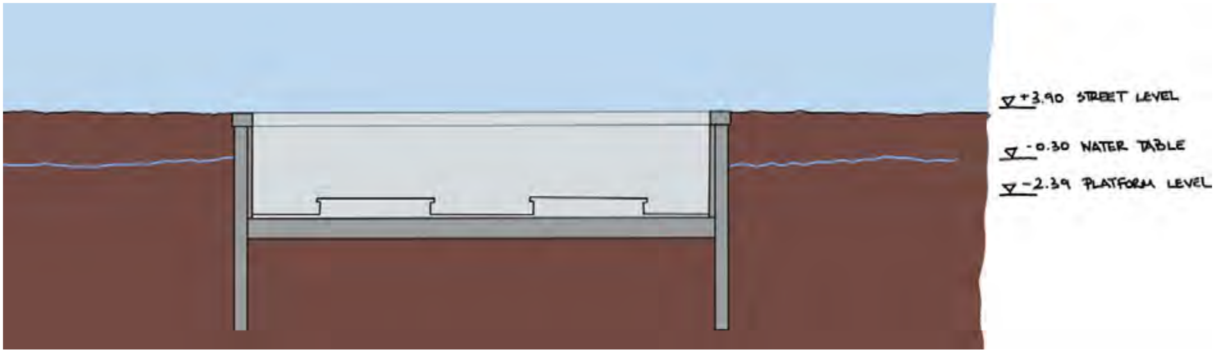


Figure 5-161 Construction phasing diagram - Phases 4 to 7

8. Construction of the steel structure including the installation of the roof steel truss. (Zones A, B, D and F).

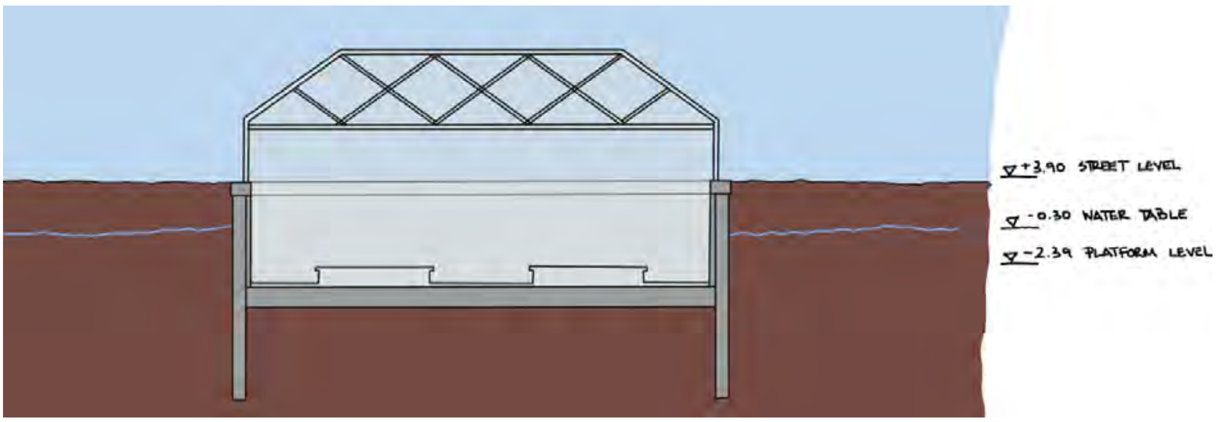


Figure 5-162 Construction phasing diagram - Phase 8

9. Architectural finishes and MEP fitout (All zones).
10. Landscaping and urban integration (Zones A, C and D).

The excavation and the retaining systems are different for each of the zones. The diagram below shows the system proposed for each zone. The construction phases of the Sheriff St bridge (zone E) are described in Section 5.5.4 and the phases for the retaining structure of zone F are included in Section 5.5.7.

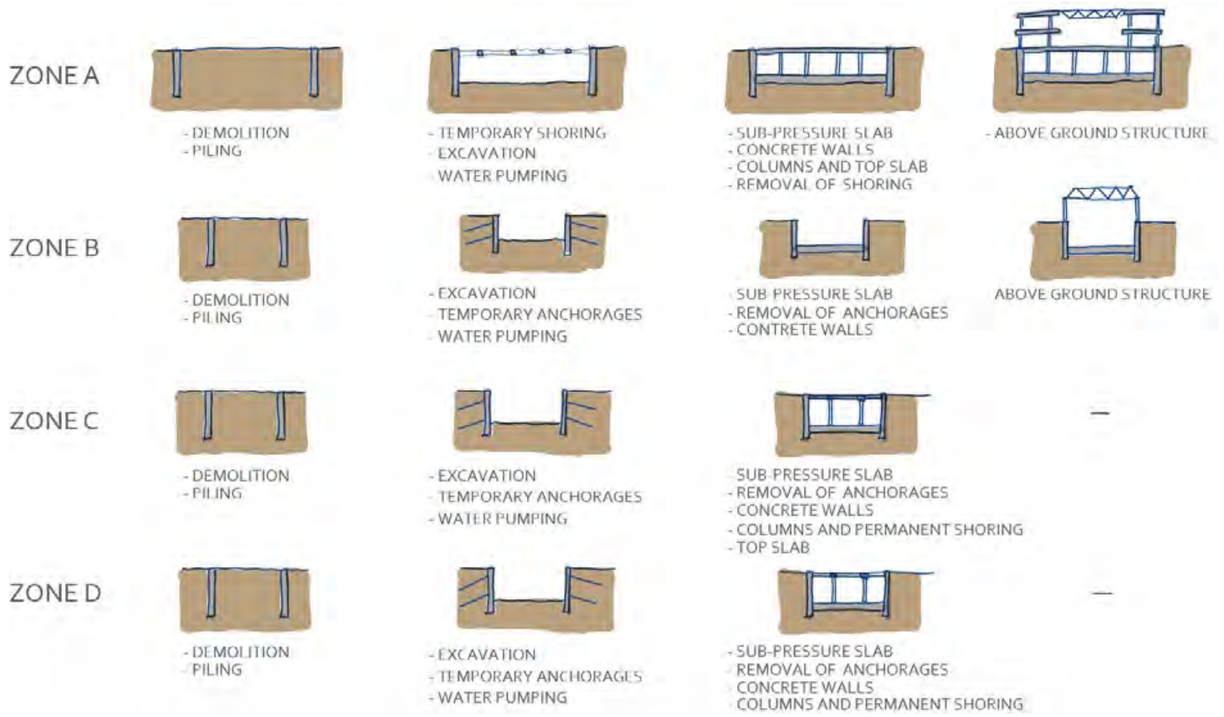


Figure 5-163 Schematic of Spencer Dock Station construction phases

5.5.3.3 Spencer Dock construction duration

The total construction duration is estimated at around **40 months.**

	Activity	Duration	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	Enabling works	Utility diversions and site set up	■																																							
	Installation of ground water management system	5 weeks	■																																							
2	Execution of the secant pile walls	19 weeks		■	■	■	■	■																																		
3	Excavation and disposal of soil	20 weeks				■	■	■	■	■																																
4	Execution of the lower sub-pressure slab	15 weeks							■	■	■	■																														
5	Construction of the reinforced concrete columns and walls	9 weeks											■	■																												
6	Construction of the ground level slabs and the permanent shoring structure	11 weeks												■	■	■																										
7	Removal of the temporary shoring and the temporary anchorages	2 weeks														■																										
8	Construction of the steel structure including the installation of the roof steel truss	28 weeks															■	■	■	■	■	■	■																			
9	Architectural finishes and MEP fitout	52 weeks																						■	■	■	■	■	■	■	■	■	■	■	■	■						
10	Landscaping and urban integration	23 weeks																																			■	■	■	■	■	■

Figure 5-164 Duration of construction works at Spencer Dock Station

All the works will be performed during project construction working hours as set out in Section 5.2.1.

5.5.3.4 Spencer Dock equipment required

The bullets below indicate the equipment anticipated to be required for each phase:

1. Enabling works: Demolition machines, dump trucks (Daytime).
2. Execution of the secant pile walls: Piling machines (2 or 3 machines), dumper trucks, bentonite plant, mobile crane and concrete mixer truck (Daytime).
3. Excavation and disposal of soil between secant pile walls using temporary shoring (zone A) or temporary anchorages (zones B, C and D): Excavators, bulldozers, backhoes, wheel loaders, compact machines, dump trucks, de-watering pumps and earth rammers (Daytime).
4. Execution of the lower sub-pressure slab: Trucks, tower cranes, plate vibrators and concrete mixer trucks (Daytime).
5. Construction of the reinforced concrete columns and walls that will support the slabs and the permanent shoring structure: Trucks, tower cranes and concrete mixer trucks (Daytime).
6. Construction of the ground level slabs (zones A and C) and the permanent shoring structure (zone D): Trucks, tower cranes, plate vibrators and concrete mixer trucks (Daytime).

1. Removal of the temporary shoring (zone A) and the temporary anchorages (zones B, C and D): Trucks, tower cranes and telehandlers (Daytime).
2. Construction of the steel structure including the installation of the roof steel truss: Telehandlers, forklifts, tower cranes, welding machines and trucks (Daytime).
3. Architectural finishes and MEP fitout: End frames, forklifts, telehandlers, tower cranes and trucks (Daytime).
4. Landscaping and urban integration: Trucks, tower cranes, earth rammers, forklifts and telehandlers (Daytime).

5.5.3.5 Disposal of material

The DART+ West construction strategy is currently based on the assumption (following a review of GI information) that 35% of the material excavated at Spencer Dock can be reused in the depot embankment construction. This would be transported to the depot from Spencer Dock by road.

Figure 5-165 Route for transport of spoil material from Spencer Dock to depot

Figure 5-166 Access points to depot

The remainder of the material that cannot be reused in the depot will need to be transported to a waste management facility also by road.

5.5.3.6 Groundwater management

Since the water table is close to the surface, it will be necessary to control ingress at excavation areas. Groundwater ingress is fundamentally controlled by the completeness and integrity of the secant pile wall and position with respect to bedrock. Therefore, very low pumping rates to keep the excavations dry during the construction phase are envisaged. A suitable monitoring plan and hydrogeological modelling would be required to assess any barrier effect in further stages of the project.

For pumping works in every excavation area, pumps will be used, and temporary pipes will be installed. Pumped water is to be treated in a settlement tank placed within the station working area before discharging into the network.

5.5.4 OBD228 Sheriff Street Bridge

5.5.4.1 OBD228 Sheriff Street Bridge overview

As part of the design and construction of the Spencer Dock Station, which will be located on the southside of the Sheriff Street Bridge, part of the existing bridge OBD228 must be demolished during the construction of the Spencer Dock Station and will then be rebuilt. Five spans of the bridge deck shall be demolished and rebuilt to their initial elevation to connect with the rest of the existing bridge sections. The bridge piers have been designed in line with the layout and design of the Spencer Dock Station.

The vertical clearance under the bridge is about 8.00 m from the bottom of the bridge deck to the TOR design level.

The proposed design solution is as follows:

- A precast concrete beam deck of 5 spans.

The total length of the bridge reconstruction is approximately 53.57 m, consisting of 5 spans. The beam depth required is approximately 0.8 m with a 0.2 m minimum depth of the top slab. The width of bridge is 16.24 m.

A piled foundation solution has been proposed to avoid any impact on the adjacent existing structures.

Figure 5-167 and Figure 5-168 show the current design of the bridge.

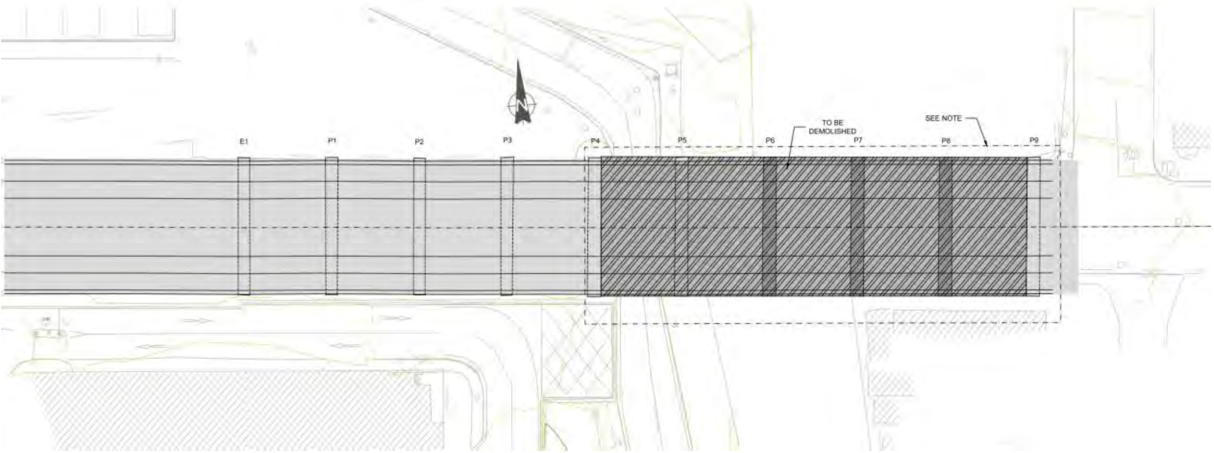


Figure 5-167 Plan of existing OBD228

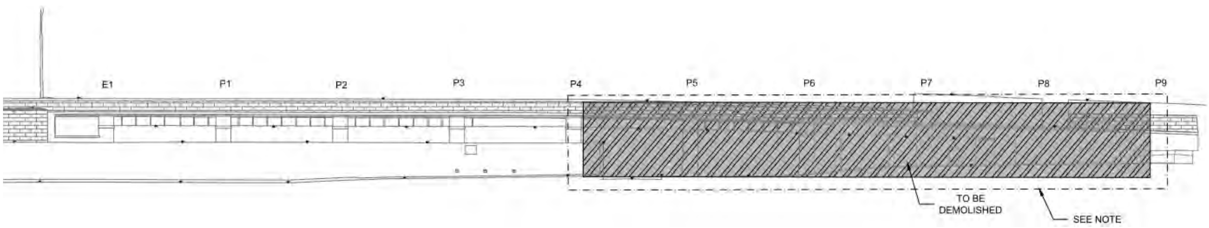


Figure 5-168 Elevation of existing OBD228

5.5.4.2 OBD228 Sheriff Street Bridge construction phase

The Sheriff Street Bridge construction phase is described as follows:

1. Site preparation.
2. Traffic and utility diversions (ESB, IW, GNI and Telecom need temporary utility diversions).
3. Demolish part of the existing bridge (five spans in total to be demolished).
4. Excavation of two foundations located at the edges of the platform (piled foundations have been proposed at these two supports but should be verified on receipt of the Geotechnical Investigation Report at detailed design stage; the other two supports will be placed on the platform - see Figure 5-169 below).
5. Construction of the reinforced concrete bridge piers:
    - One pier in the right edge of the platform.
    - Two piers in the middle of the platforms.
    - One pier between the existing pier (P4) and the edge of the platform.
6. Repair the connection to the existing structure.
7. Construction of the reinforced concrete pier caps and placing bearings.
8. Lifting of beams into position.
9. Casting of the top slab.
10. Installation of ancillary equipment, such as parapets and lightning columns.

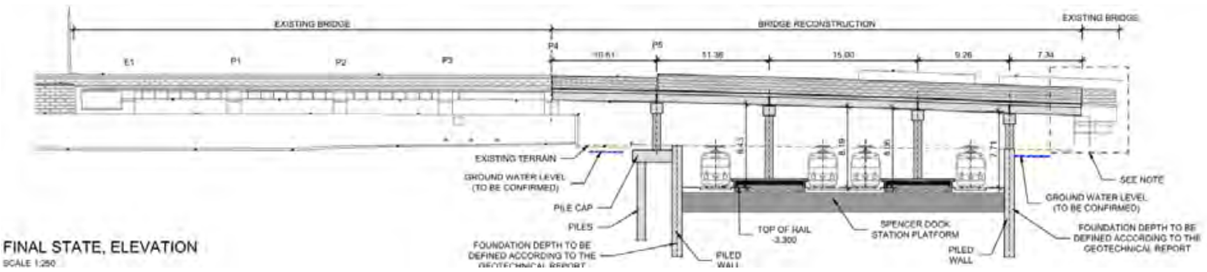


Figure 5-169 Elevation of reconstructed OBD228

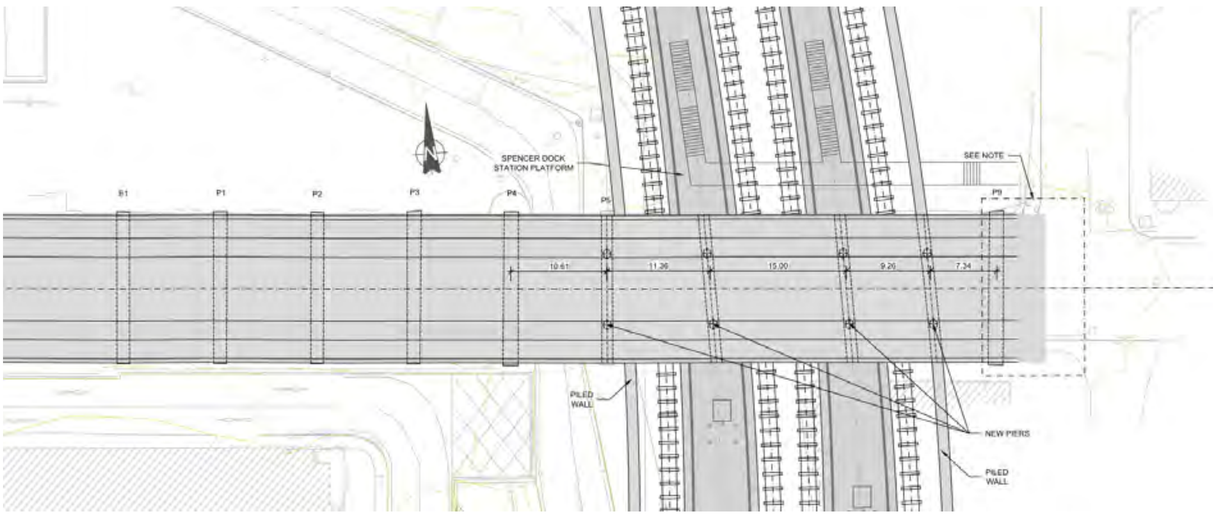


Figure 5-170 Plan of reconstructed OBD228

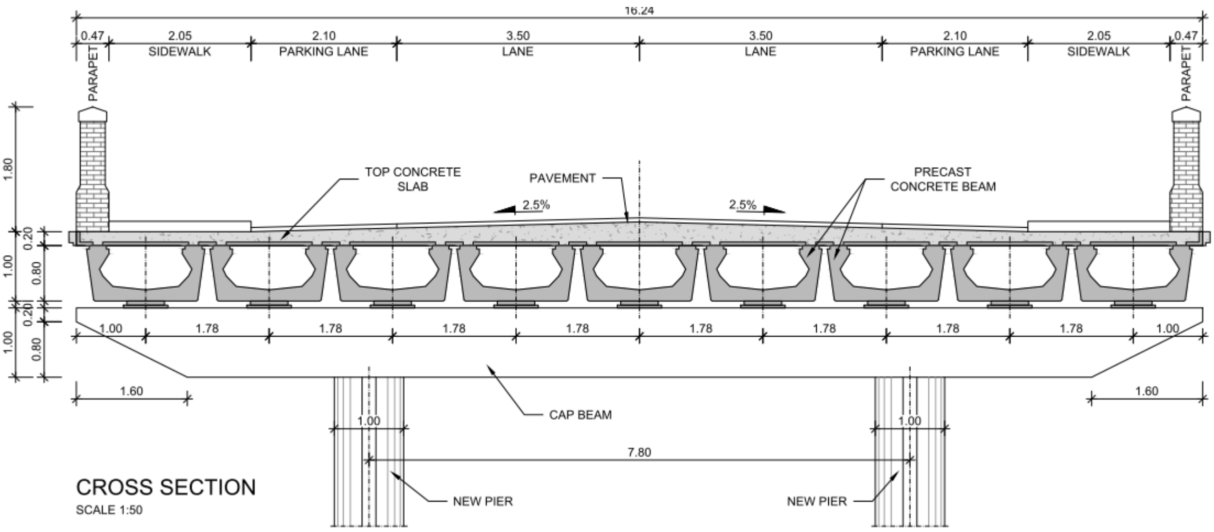


Figure 5-171 OBD228 - reconstructed cross section

5.5.4.3 OBD228 Sheriff Street Bridge construction duration

As shown in following table, the total construction duration (including utility diversions over the bridge) is estimated at around **80 weeks (1.5 years),** including 1.5 year total road closure and pedestrian closure during the whole reconstruction work of OBD228.

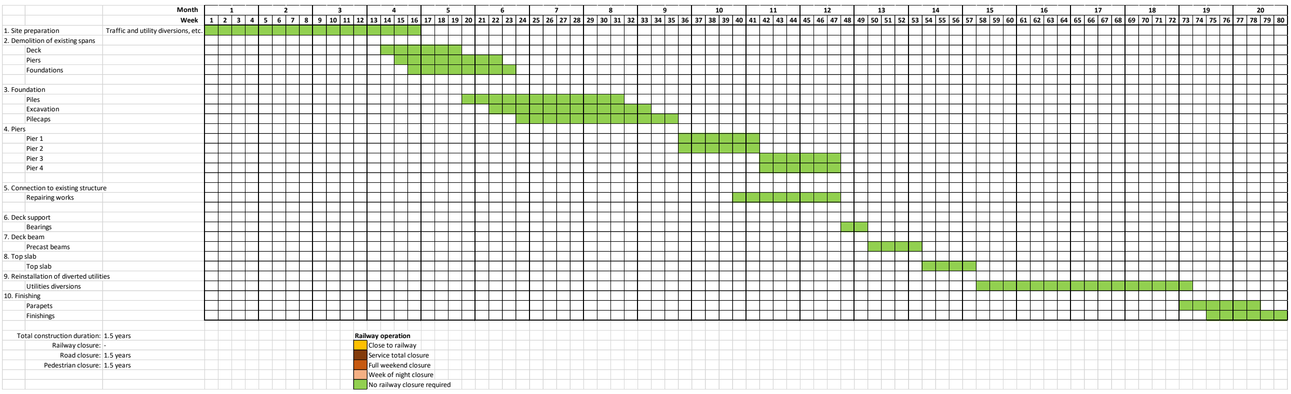


Figure 5-172 Construction duration details of OBD228

The works will be performed during project construction working hours as set out in Section 5.2.1.

5.5.4.4 OBD228 Sheriff Street Bridge equipment required

Equipment required for the construction of OBD228 Sheriff Street Bridge includes: demolition machinery; dump trucks; piling machines; bentonite; mobile crane; concrete mixer trucks; excavators.

5.5.4.5 OBD228 Sheriff Street Bridge traffic diversions

The traffic restrictions, closures and diversions are anticipated to be required during the time of reconstruction of the bridge (1.5 years). For the construction of the Sheriff Street bridge, the proposed road diversions are shown in Figure 5-173.

The temporary closure of part of Sheriff Street Lower during the reconstruction of OBD228, will be coordinated with the proposed BusConnects Dublin Ringsend to City Centre Core Bus Corridor Scheme, to ensure the availability of the planned diversion route along North Wall Quay.

Figure 5-173 Proposed road diversion for the OBD228

5.5.5 Spencer Dock attenuation tank

5.5.5.1 Attenuation tank overview

The Spencer Dock attenuation tank is designed to attenuate flows by storage so that the downstream watercourse is not exposed to flows that can cause flooding damage or environmental impact on the receiving drainage infrastructure. The pressure pipe will connect to the existing Newcomen pumping station.

The attenuation tank has a volume of approximately 2,590 m^3, allowing for climate change. As a design condition, the flow rate that can be pumped to the discharge point is 5 L/s.

5.5.5.2 Attenuation tank construction phase

The Spencer Dock attenuation tank will be constructed next to the permanent way and north of OBD228 Sheriff Street Bridge, adapting to the curve of the track layout (see Figure 5-174). The piled wall for Pway will be shared with the stormwater attenuation tank, whereas the rest of perimeter will be constructed with new piled walls.

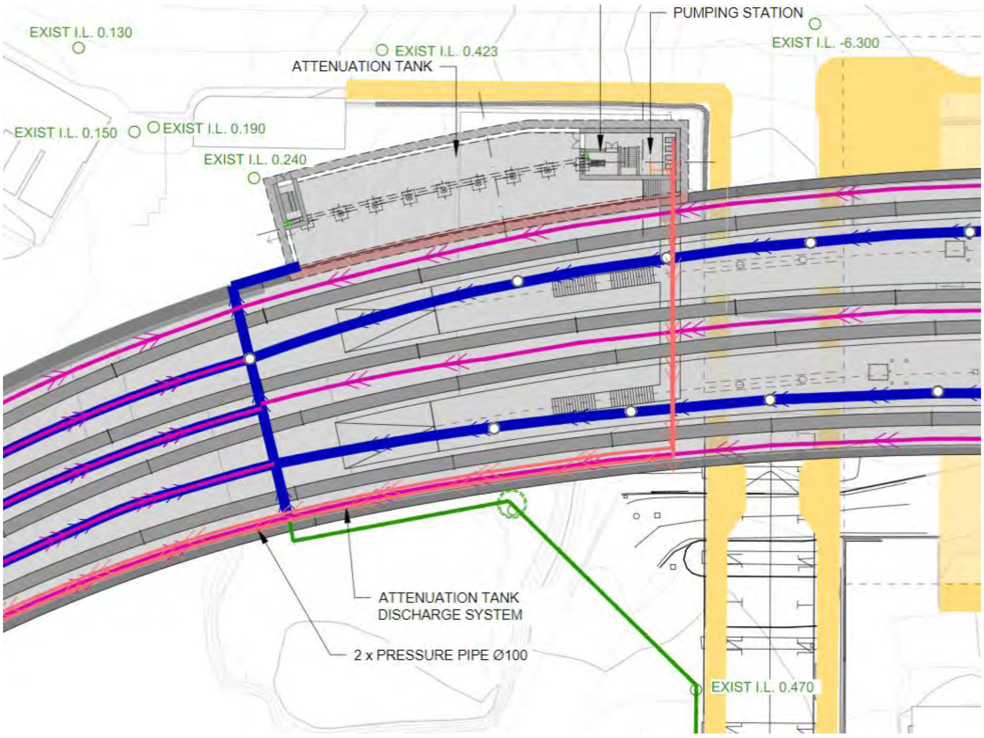


Figure 5-174 Piled wall between permanent way and attenuation tank

The construction sequence of the attenuation tank structure is as follows:

1. Phase 1: Site preparation and pre-excavation. Preparation of the work surface, traffic and utility diversions, demolition of existing buildings, etc. if required.
2. Phase 2: Construction of secant piled wall. Primary piles shall be constructed using a 'soft' cement-bentonite mix or 'firm' concrete. The secondary piles are formed in structural reinforced concrete. Temporary dewatering during construction where there are potential flotation issues. Structure A piled wall will need to be constructed before the attenuation tank is built as the Structure A piled wall will be shared with the tank, whereas the rest of perimeter will be executed with new piled walls.

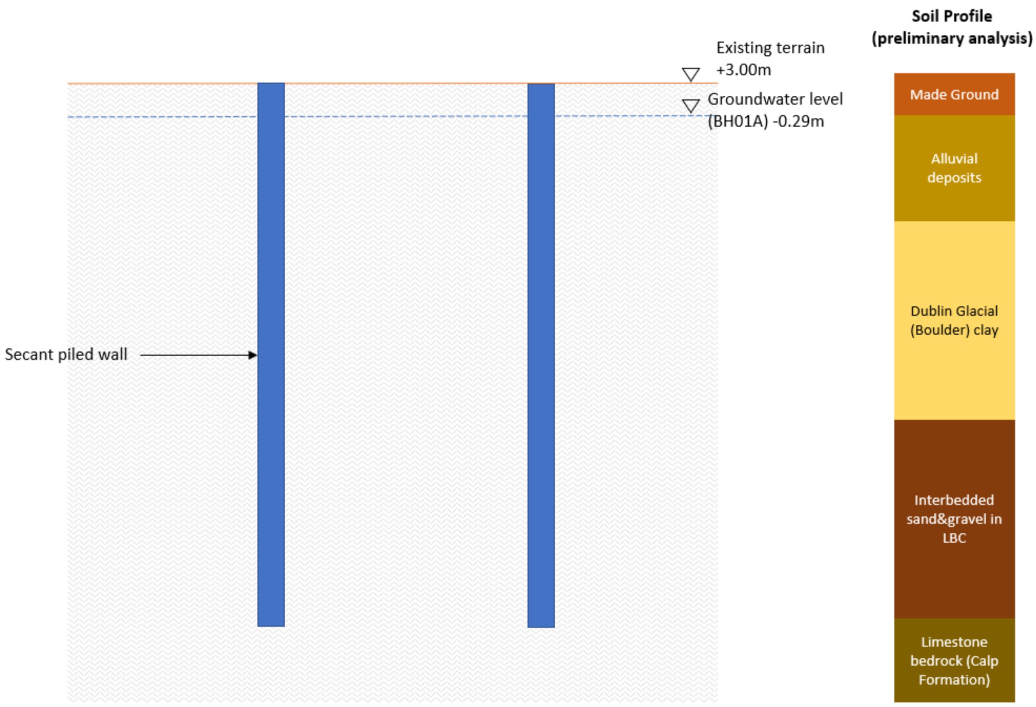


Figure 5-175 Phase 2 – construction of secant pile wall

3. Phase 3: Excavation to the top slab level and construction of pile caps. Install temporary structural supports (i.e. props) (Level 1 Props) at a level slightly higher than the top slab level. Temporary prop arrangement will be verified in the further stages of the project according to the geotechnical design report.

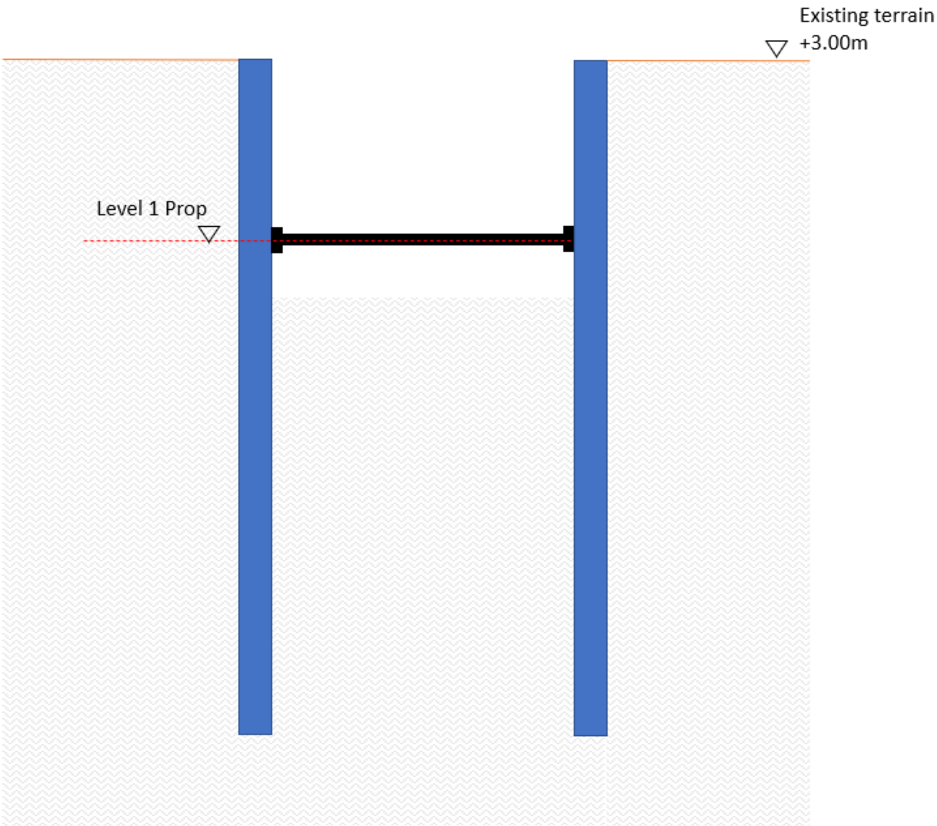


Figure 5-176 Phase 3 – excavation to top slab level

4. Phase 4: Excavation to the bottom slab level. Install temporary props (Level 2 Props) at a level slightly higher than the bottom slab level. Temporary prop arrangement will be verified in the further stages of the project according to the geotechnical design report.

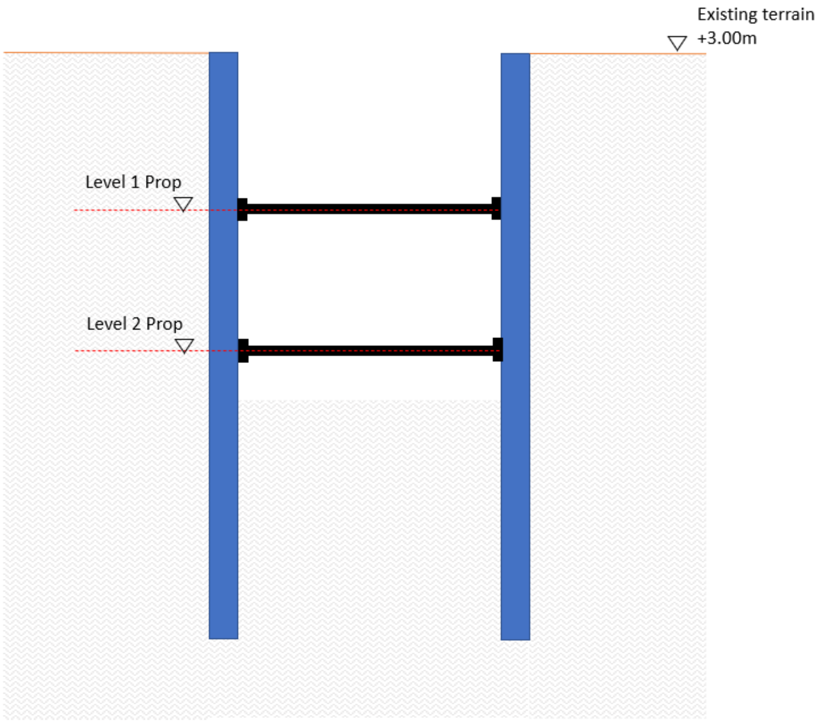


Figure 5-177 Phase 4 – excavation to bottom slab level

5. Phase 5: Execution of the bottom slab constructed using reinforced concrete (requires rebar installation, formwork, and placing of concrete), placement of waterproofing elements, and anchoring the bottom slab to the secant piled walls.

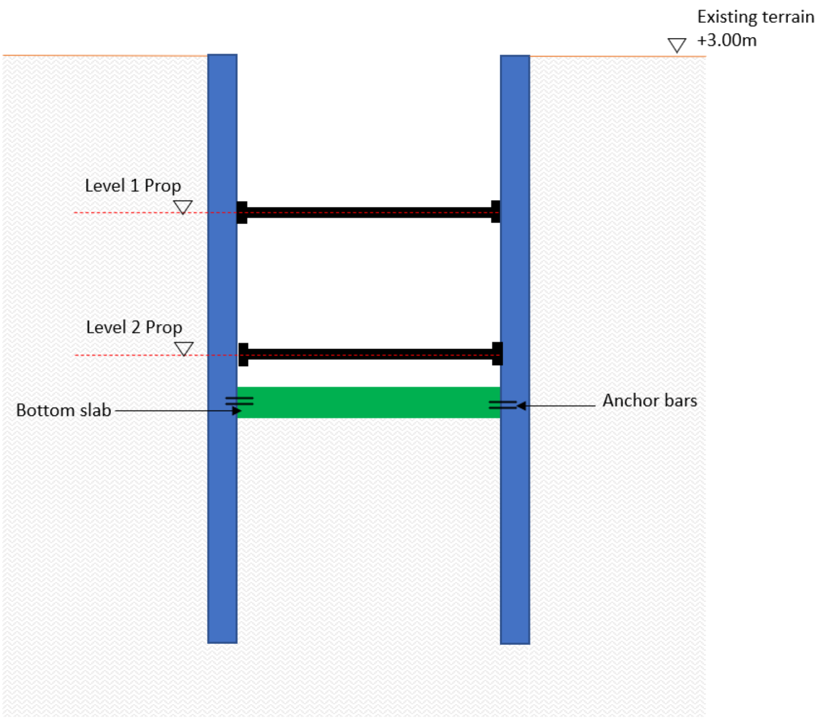


Figure 5-178 Phase 5 – construction of bottom slab

6. Phase 6: Remove Level 2 Prop.

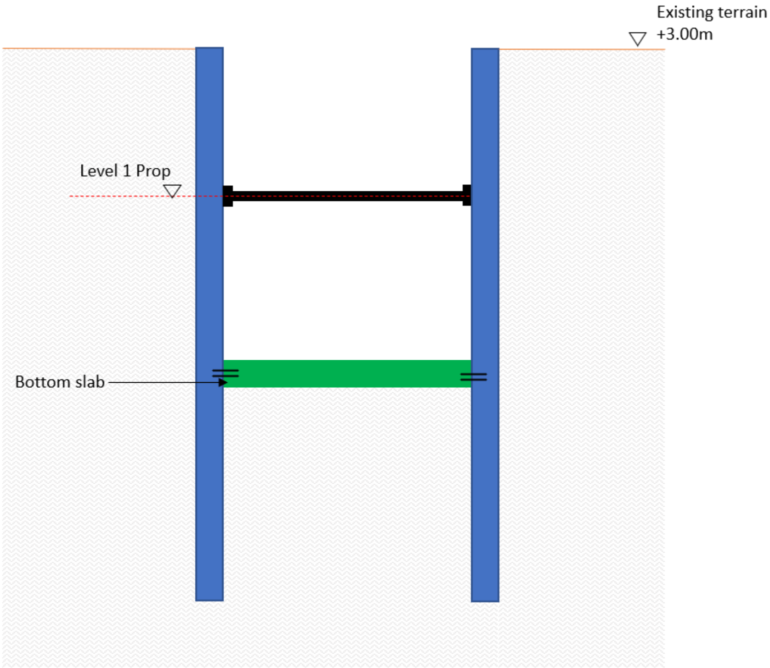


Figure 5-179 Phase 6 – removal of lower prop

7. Phase 7: Execution of the tank walls and columns constructed using reinforced concrete (requires rebar installation, formwork and placing of concrete), and anchoring the tank walls to the secant piled walls.

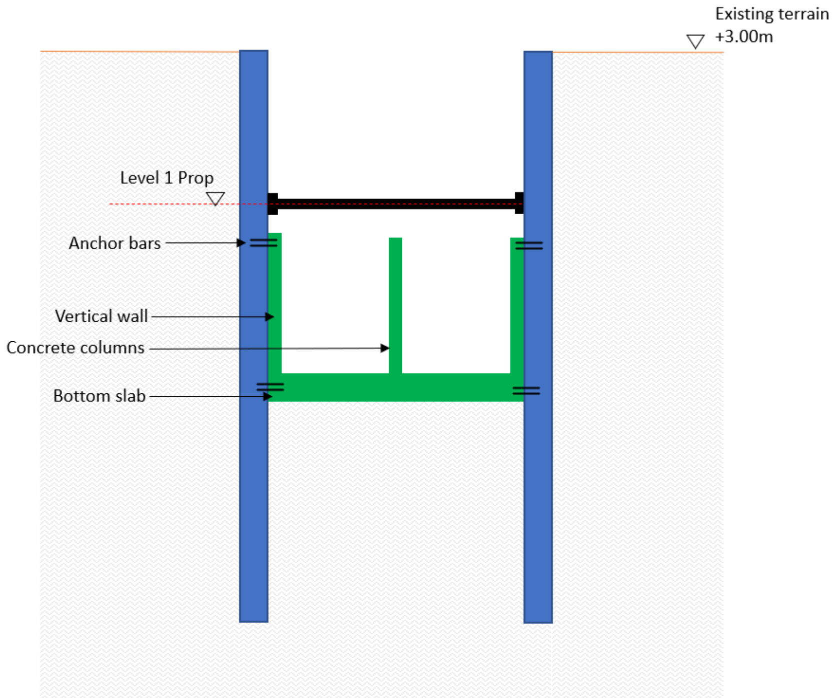


Figure 5-180 Phase 7 – construction of tank walls and columns

8. Phase 8: Execution of the top slab constructed using reinforced concrete (requires rebar installation, formwork and placing of concrete), and placement of waterproofing membrane.

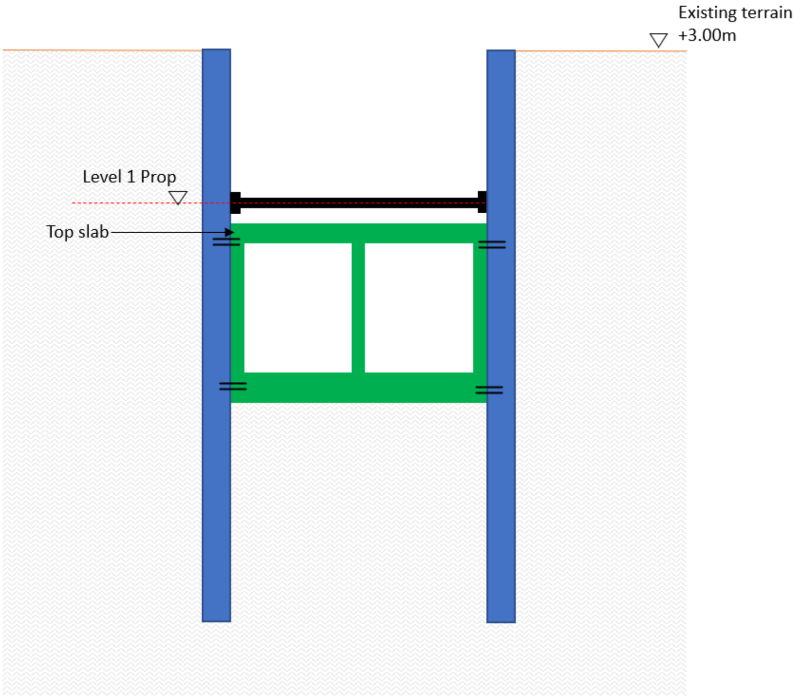


Figure 5-181 Phase 8 – construction of top slab

9. Phase 9: Remove Level 1 Prop.

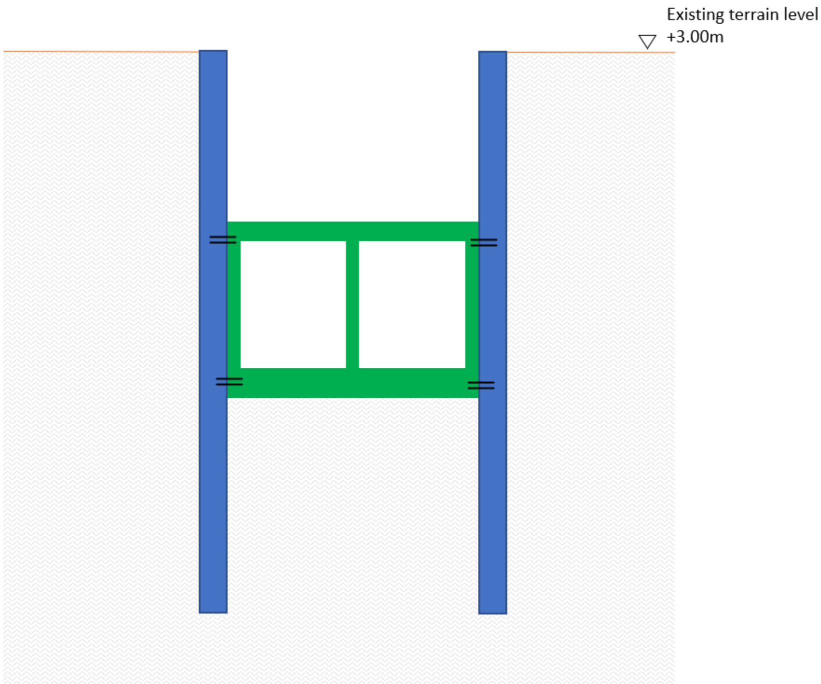


Figure 5-182 Phase 9 – removal of remaining prop

10. Phase 10: Backfilling, compacting, reinstallation of diverted utilities, and finishing.

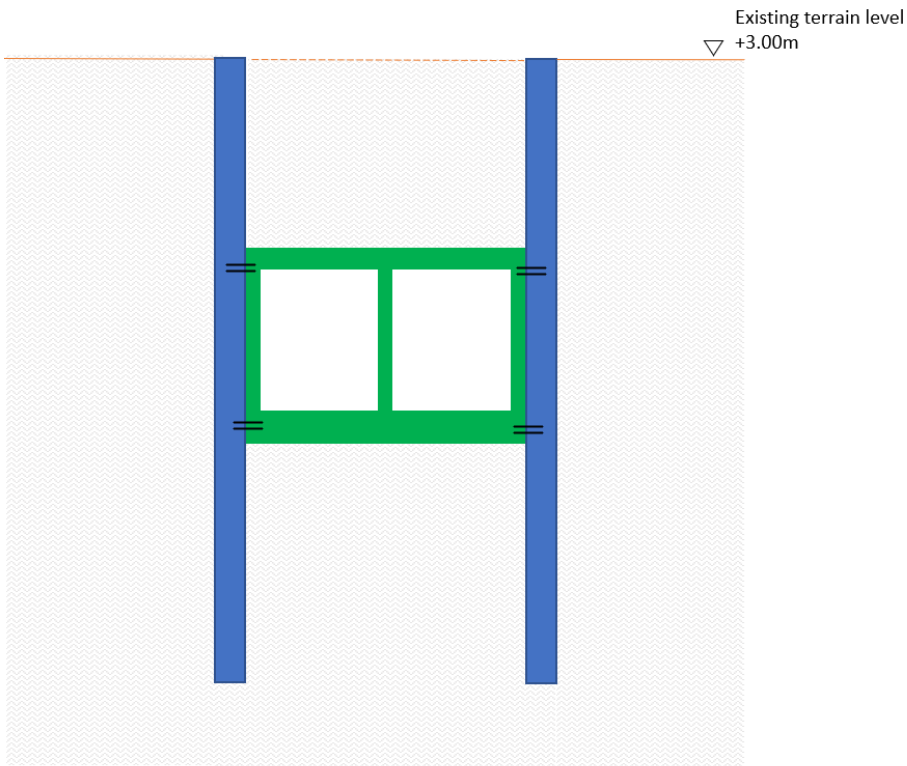


Figure 5-183 Phase 10 – backfilling and finishing

5.5.5.3 *Attenuation tank construction duration*

The total construction duration is estimated around **52 weeks**. The construction phasing and duration for each phase of this structure is shown in Figure 5-184.

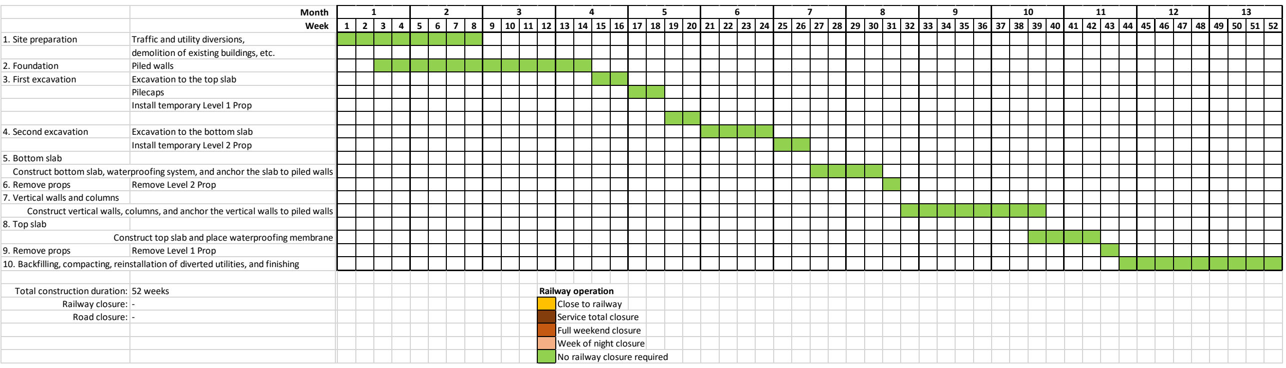


Figure 5-184 Construction phasing and duration

5.5.5.4 *Attenuation tank equipment required*

Equipment required for the construction of the Spencer Dock attenuation tank includes: demolition machinery; dump trucks; piling machines; bentonite; mobile crane; concrete mixer trucks; excavators.

5.5.6 Spencer Dock substation

The construction of the substation will not commence until after the maintenance facilities have been relocated. The general sequence of works at Spencer Dock substation will be as follows:

- On site offices and welfare facilities 2 weeks
- Civil works at Spencer Dock substation 18 weeks
- Equipment at Spencer Dock substation 12 weeks

Spencer Dock substation main compound (CC-SUB-S2A-20280) is located in Docklands at Ch 20+280, close to the proposed substation. Access into compound can be accommodated from both east and west. The principal access routes will consist of entering from Sheriff Street Upper to the Iarnród Éireann Track Domain, using R131 road to get to Sheriff Street, and the use of Abercorn Road (as outlined in Section 5.5.2.1).

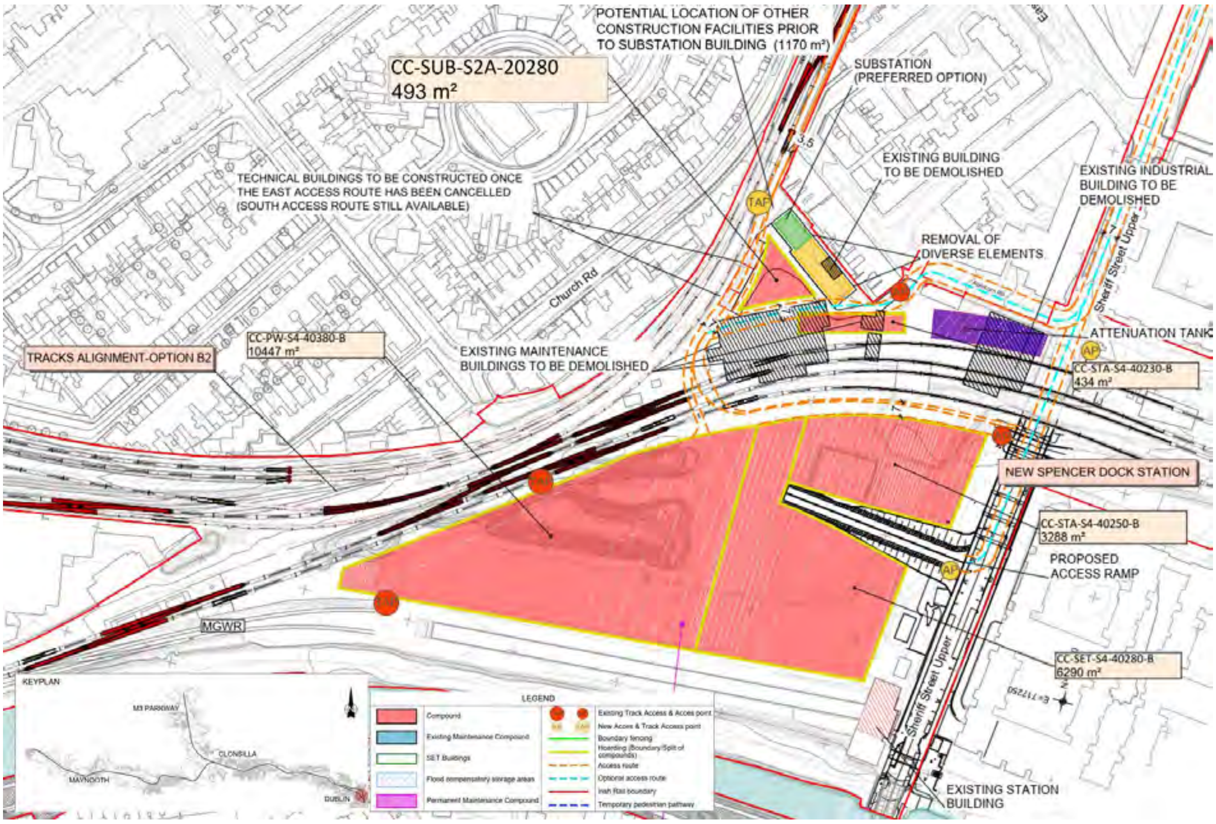


Figure 5-185 Spencer Dock substation compound location

5.5.7 Spencer Dock-Docklands-East Wall permanent way

Works included in this area require the modification of the horizontal and vertical alignment of different track works in the Spencer Dock-Docklands-East Wall permanent way, as well as the execution of a new track that will connect the new Spencer Dock station to the existing lines.

Due to the high groundwater level and the proximity to other railway tracks in the area, the area highlighted in grey in Figure 5-186 requires the construction of a slab track solution. This solution will consist of the construction of a bottom slab and different retaining walls (creating a U-shaped structure) in order to counteract the flotation issues and minimise the impact on surrounding tracks.

The area highlighted in red in Figure 5-186 will be a ballast track solution, including the new connection to the northern line. For this solution retaining walls are also needed to reduce the impact on adjacent tracks.

In addition, different slab to ballast transitions have been proposed where needed, see the orange section as per Figure 5-186 below.

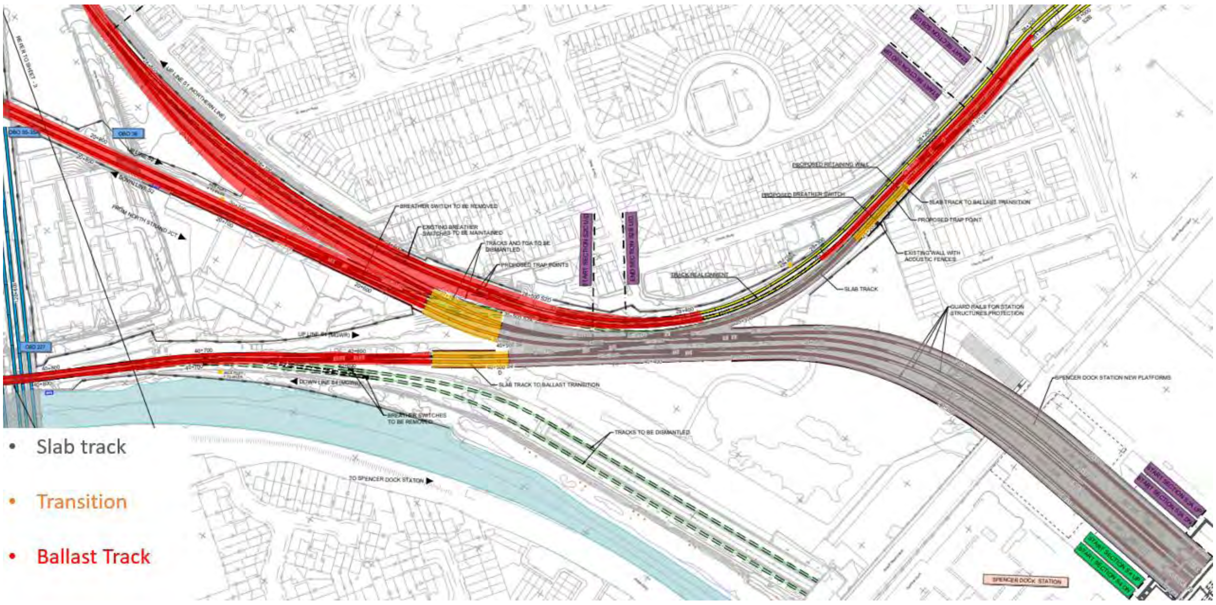


Figure 5-186 Ballast and slab track solutions in Spencer Dock area

As shown, permanent way works will affect the MGWR branch, GSWR-Yard branch, the East Wall branch and the connection to Northern Lines, as well as the Spencer Dock station.

The following sequence is anticipated for the principal construction elements at Docklands Permanent Way:

- Provisional GSWR-East Wall yard connection.
- North Wall Permanent Facilities Demolition.
- Earthworks and Piling.
- Slabs and Cantilever Walls.
- Spencer Docks Track.
- Connections Track.

On East Wall branch tracks (from Ch 28+870 to Ch 28+960), a new curved P15R-18.5 crossover (PT18 and PT19) allows the trains leaving the station to the northern lines to switch to the Up Track.

Currently, two trap points located on East Wall branch Up and Down tracks protect the uncontrolled entry of freight trains onto the Northern Line tracks.

The trap points, located at Ch 28+960 (0 m 585 yard), are moved south (towards the port) as these tracks are converted to running lines to give access to Spencer Dock station from the Northern Lines.

Approaching the East Wall yard, between the GSWR track and the East Wall branch Down track, a crossover is designed to allow for shunting on the yard sidings.

The construction of the ballast track will correspond to the methodology established in Section 5.3.6.2.1, while construction of slab track will follow the phasing indicated in Section 5.3.6.2.2. The construction strategy for slabs and retaining walls through the whole area have been included in Section 5.5.7.1.3.

Once the track works finish, the SET installation is carried out in this zone, in the following sequence:

- OHLE and HV foundations, masts and gantry/cantilever installation.
- OHLE and HV wiring system.
- Civil works at Docklands substation.
- Equipment at Docklands substation.
- CMS (Signalling, Telecom and LV).
- Cable installation (Signalling, Telecom and LV).

SET works involved in this area will be carried out in line with Section 5.3.9.

The Spencer Dock Pway compound (CC-PW-S4-40380-B) is located in Docklands at Ch 40+230 and has been described previously in Section 5.5.1.

5.5.7.1 Spencer Dock walls and protection slab

5.5.7.1.1 Introduction

As part of the Spencer Dock Station design, part of the tracks in the area near the station are below ground level and the groundwater table. Therefore, a retaining wall solution is required along this track area to support soil laterally, protect the track from groundwater, and against uplift pressure. The proposed structure type is a cantilever wall with a concrete slab for general cases and a secant piled wall for special cases. The secant piled wall solution is proposed due to the proximity to adjacent buildings, or nearby services, where cantilever walls may not be practical.

5.5.7.1.2 Overview of works required

Figure 5-187 and Figure 5-188 show the existing track alignment and the proposed track alignment in the Spencer Dock area.

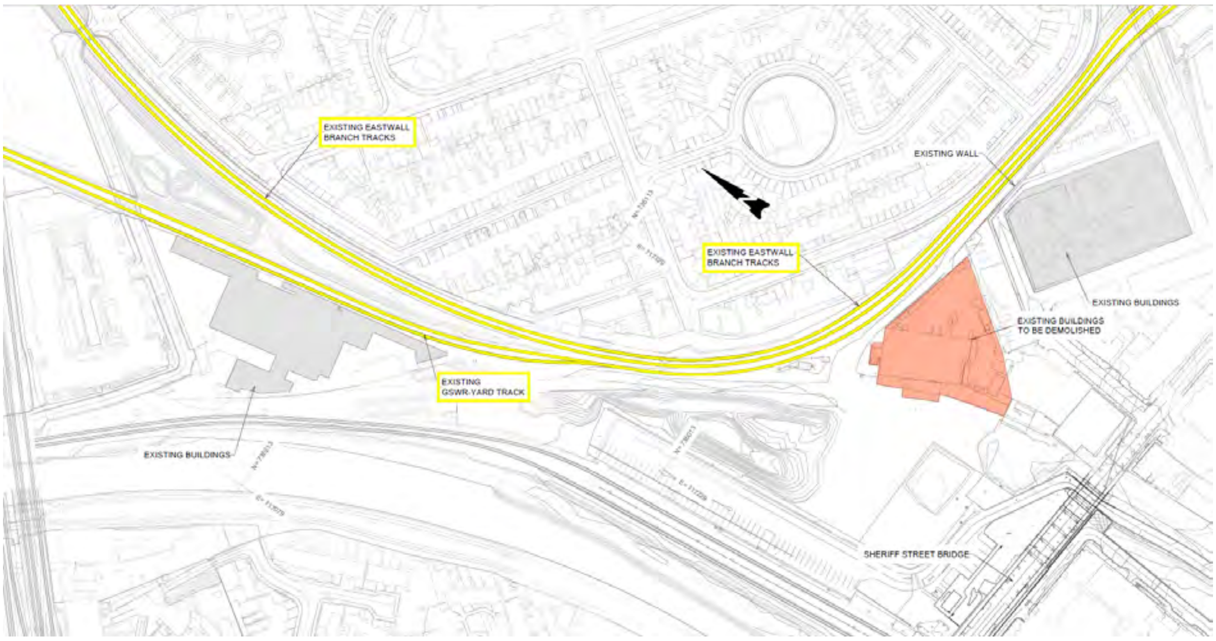


Figure 5-187 Spencer Dock existing situation

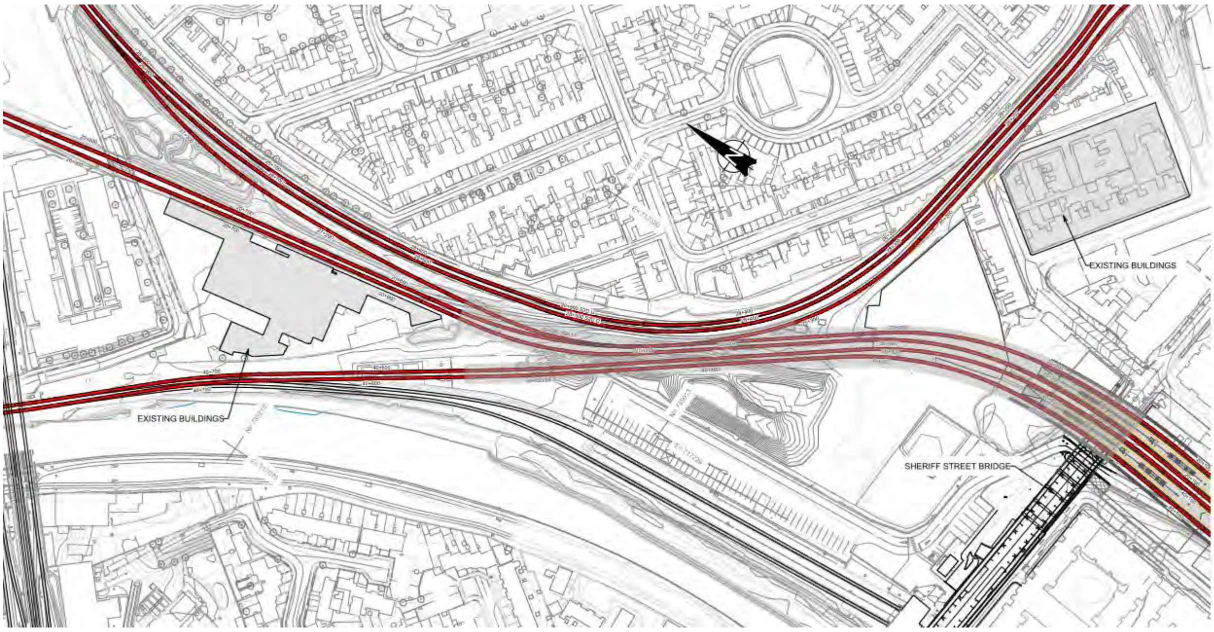


Figure 5-188 Spencer Dock proposed track alignment

Considering all the constraints in this area, the design has been grouped into four different types of structural solutions as noted in Figure 5-189 below.

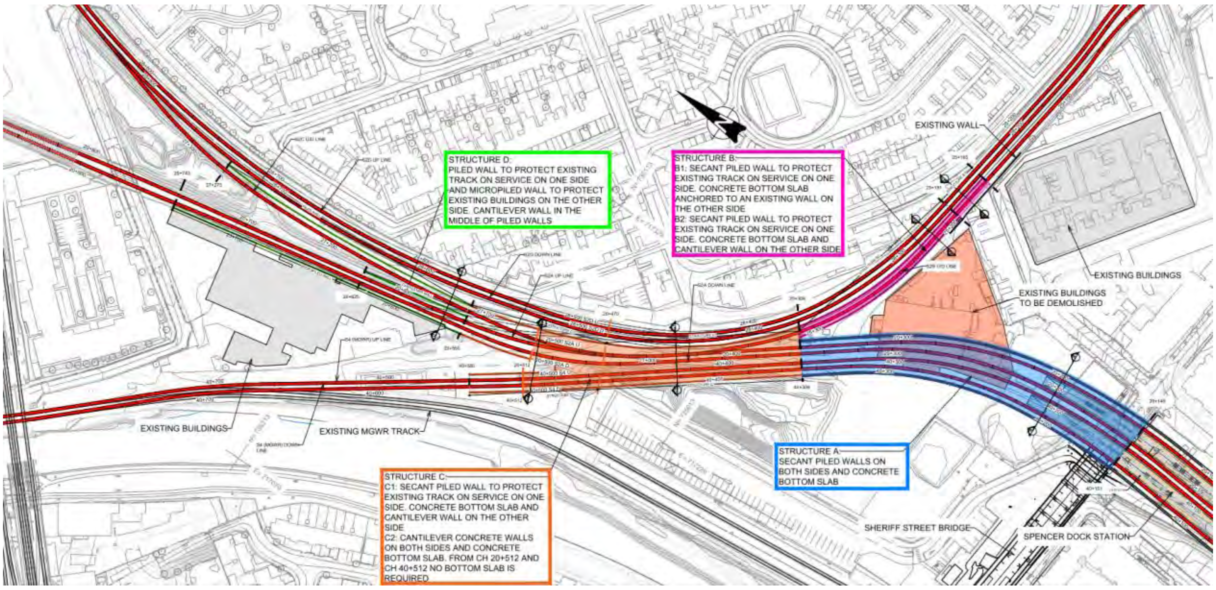


Figure 5-189 Spencer Dock proposed walls and protection slabs with the final track alignment

- Structure A: It comprises two lateral secant piled walls and a waterproofing bottom slab located near the Spencer Dock Station.

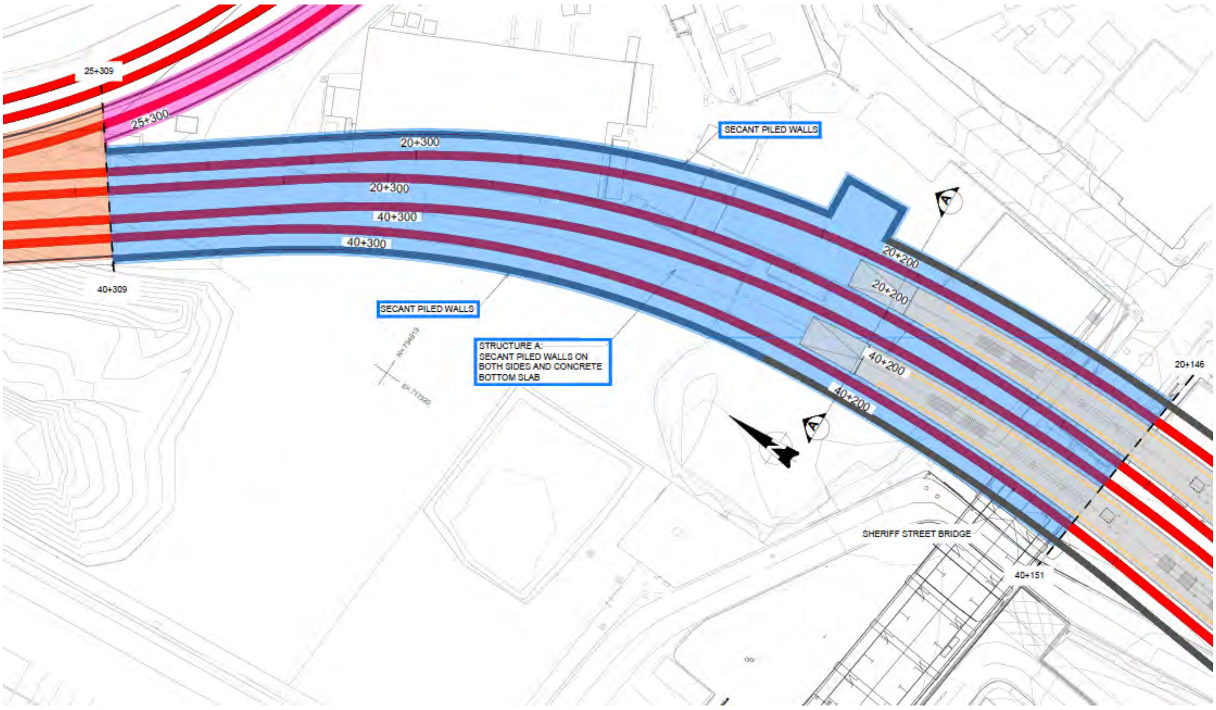


Figure 5-190 Spencer Dock proposed walls and protection slabs - Structure A

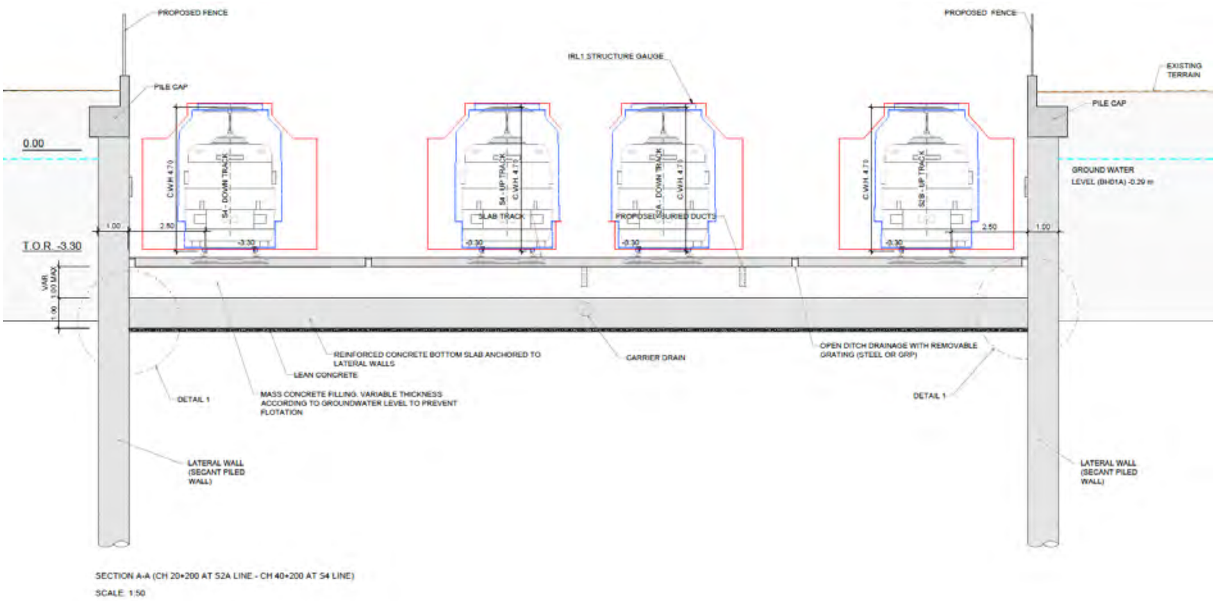


Figure 5-191 Structure A - cross section

- Structure B: It comprises a secant piled wall parallel to East Wall branch tracks (on service) and an in-situ wall and bottom slab at the other side of the track (see Figure 5-192). An existing retaining wall is adjacent to the track in the last 26 m Southside of the S2B U/D line (Chainage 25+191 to 25+165). Therefore, the bottom slab will be anchored directly to this existing retaining wall in this section, see Figure 5-193.

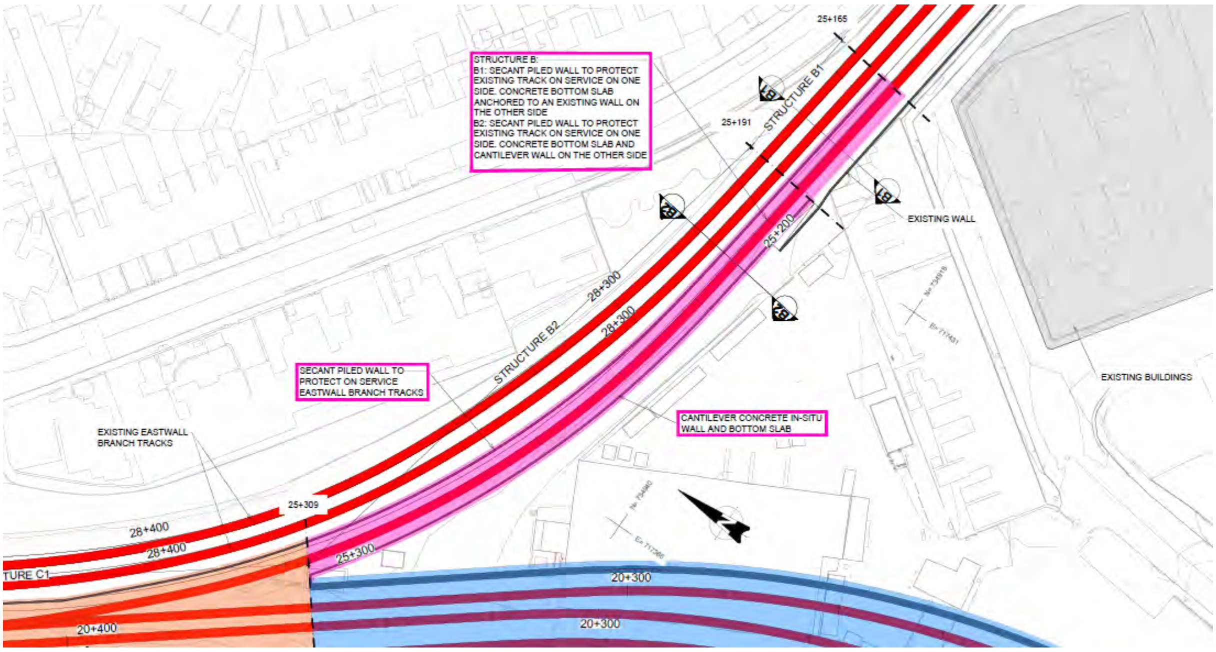


Figure 5-192 Spencer Dock proposed walls and protection slabs - Structure B

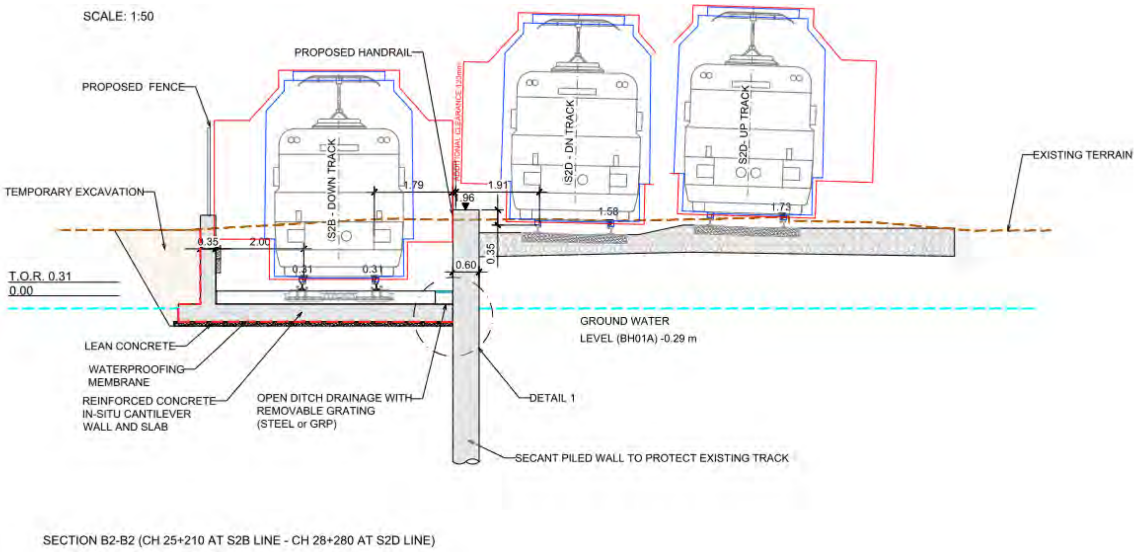


Figure 5-193 Structure B - section B2-B2

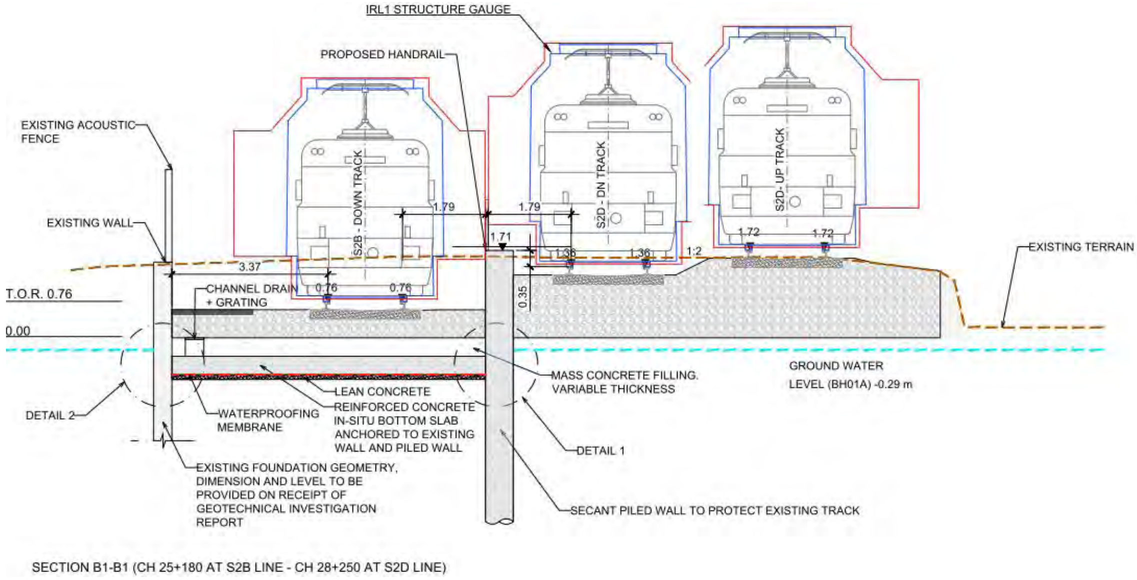


Figure 5-194 Structure B – section B1-B1

- Structure C: Between Chainage 20+309 and 20+470, it comprises a secant piled wall parallel to East Wall branch tracks (on service) and an in-situ wall and bottom slab at the other side of the track (see Figure 5-195). From Chainage 20+470 to 20+512, it comprises in-situ walls and bottom slab. From Chainage 20+512 to 20+555, no bottom slab is required, and it comprises precast concrete cantilever walls. Construction site access and egress have been proposed via new access to Sheriff Street Upper (same as Structure A).

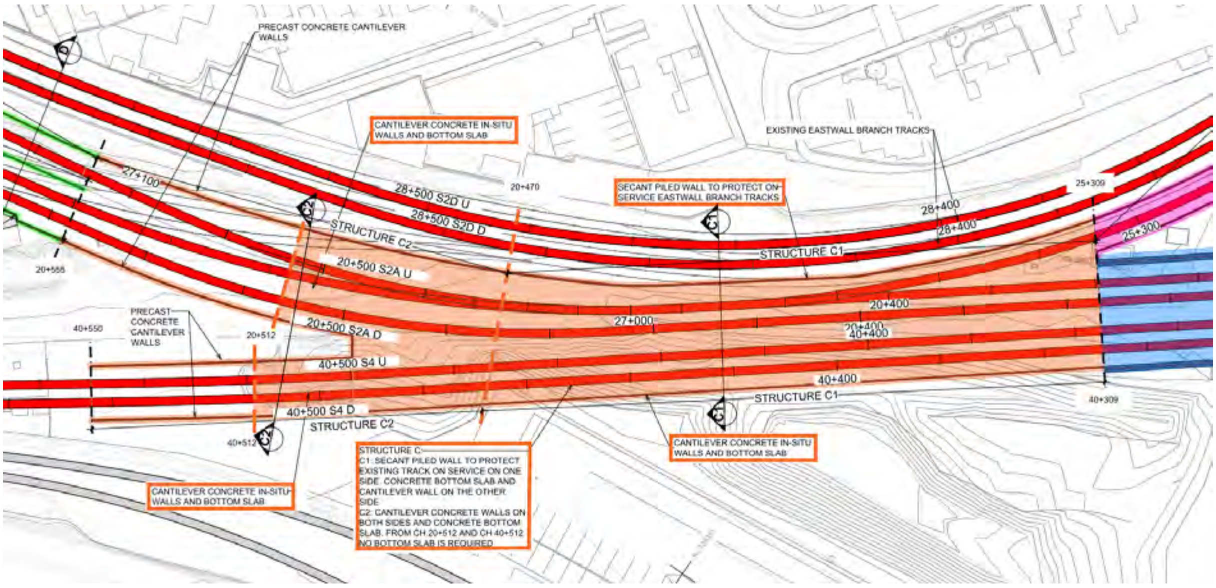


Figure 5-195 Spencer Dock proposed walls and protection slabs - Structure C

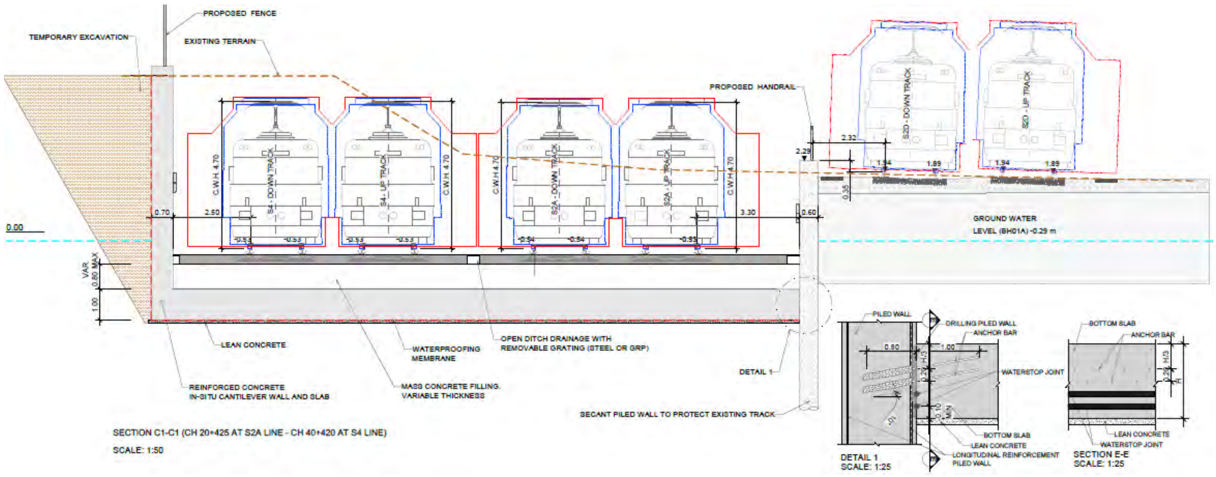


Figure 5-196 Structure C – section C1-C1

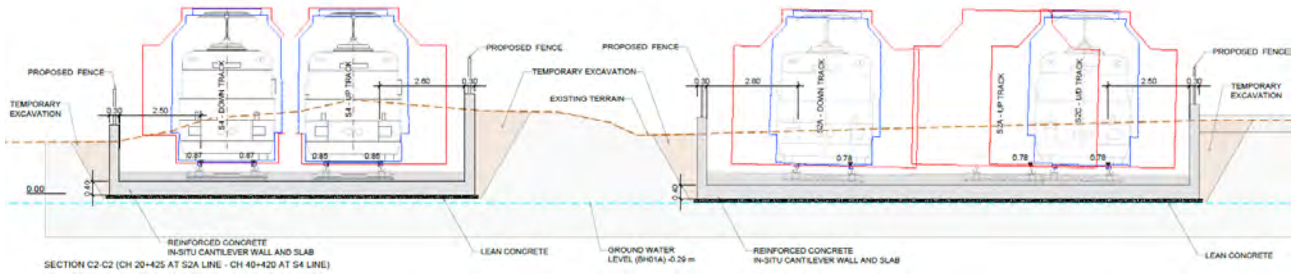


Figure 5-197 Structure C - section C2-C2

- Structure D: It comprises piled walls to protect East Wall branch tracks and micropiled walls to protect existing buildings. It also includes a central cantilever wall.

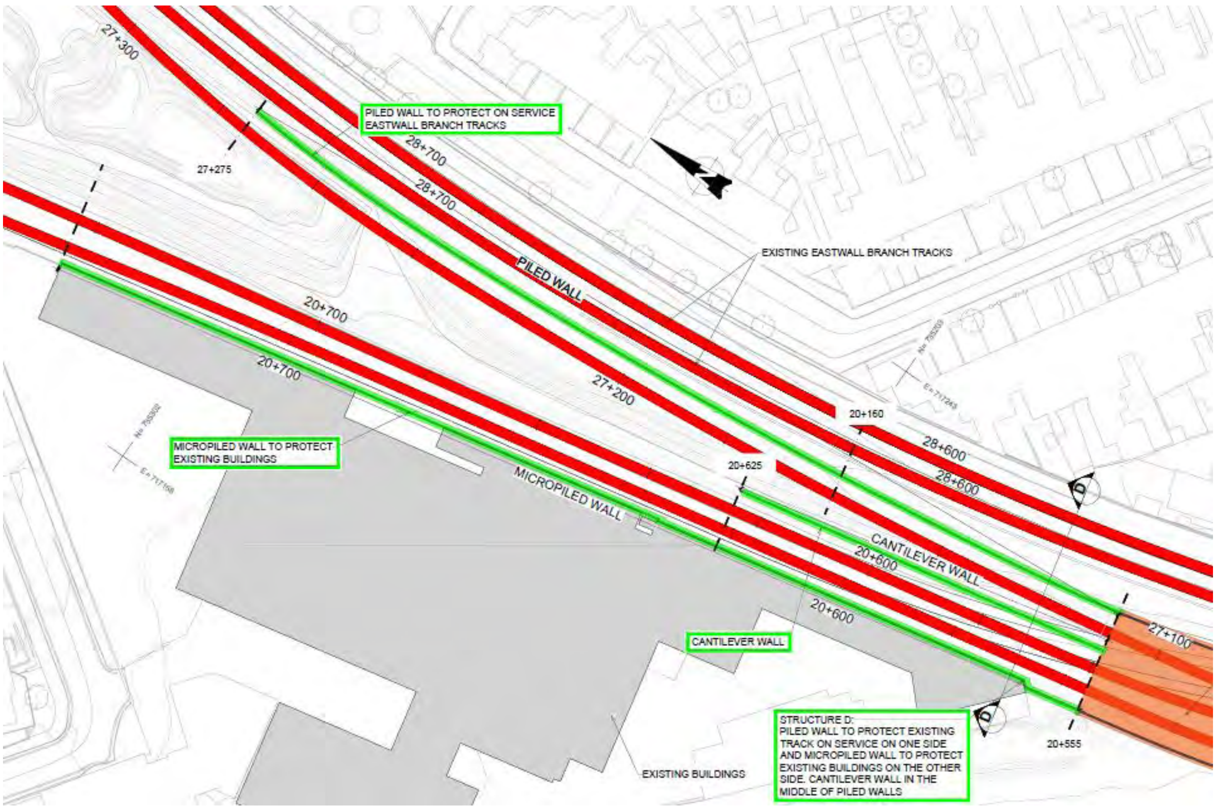


Figure 5-198 Spencer Dock proposed walls and protection slabs - Structure D

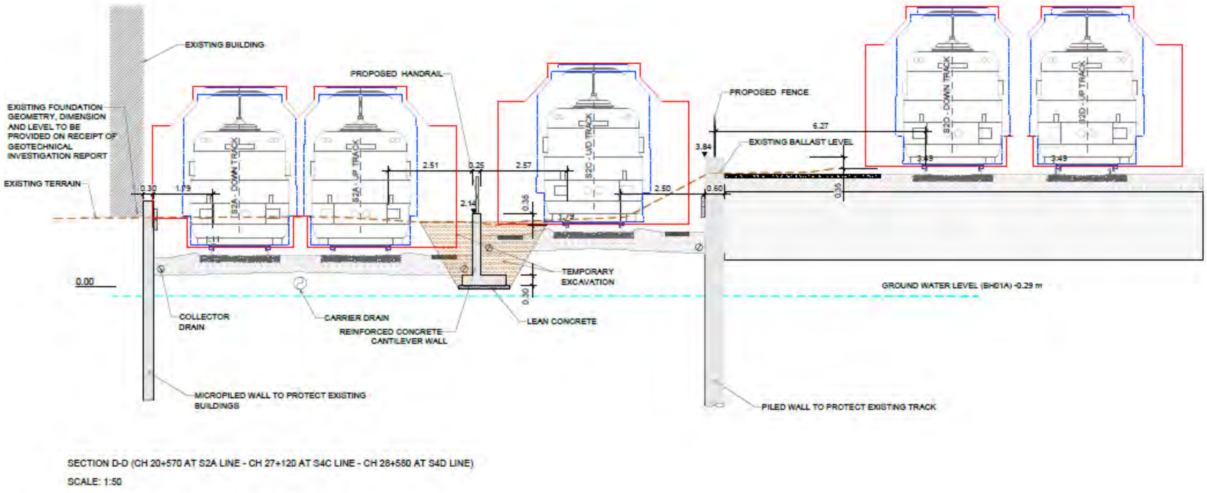


Figure 5-199 Structure D - cross section

5.5.7.1.3 Construction phase

The construction phases including the key machinery of the retaining walls in Spencer Dock:

- Phase 1: Construct a new provisional connection between GSWR and East Wall yard, as well as the execution of a new definitive turnout at East Wall as described in Section 5.5.7.2.
- Phase 2: Demolish the existing GSWR-YARD Tracks and existing buildings and road, if necessary.

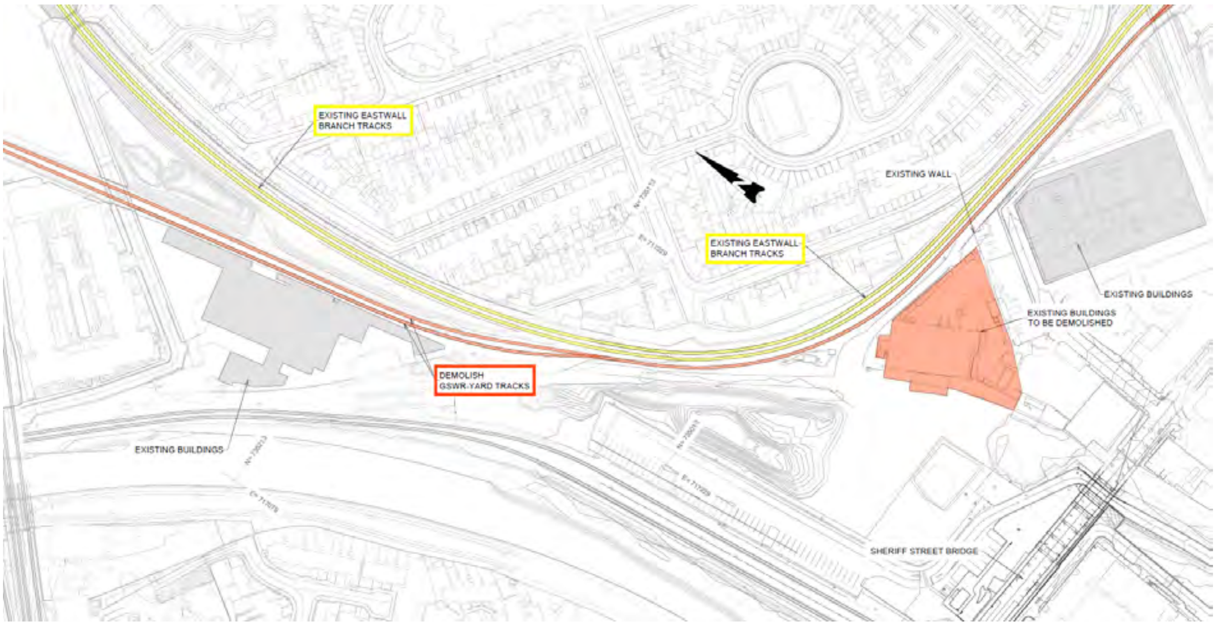


Figure 5-200 Phase 2 - demolition of existing tracks and buildings

- Phase 2: Pre-excavation. Preparation of the work surface and temporary dewatering with a pumping system during construction where there are potential flotation issues.
- Phase 3: Execution of secant piled wall. Install firm piles first and followed by hard secant piles.

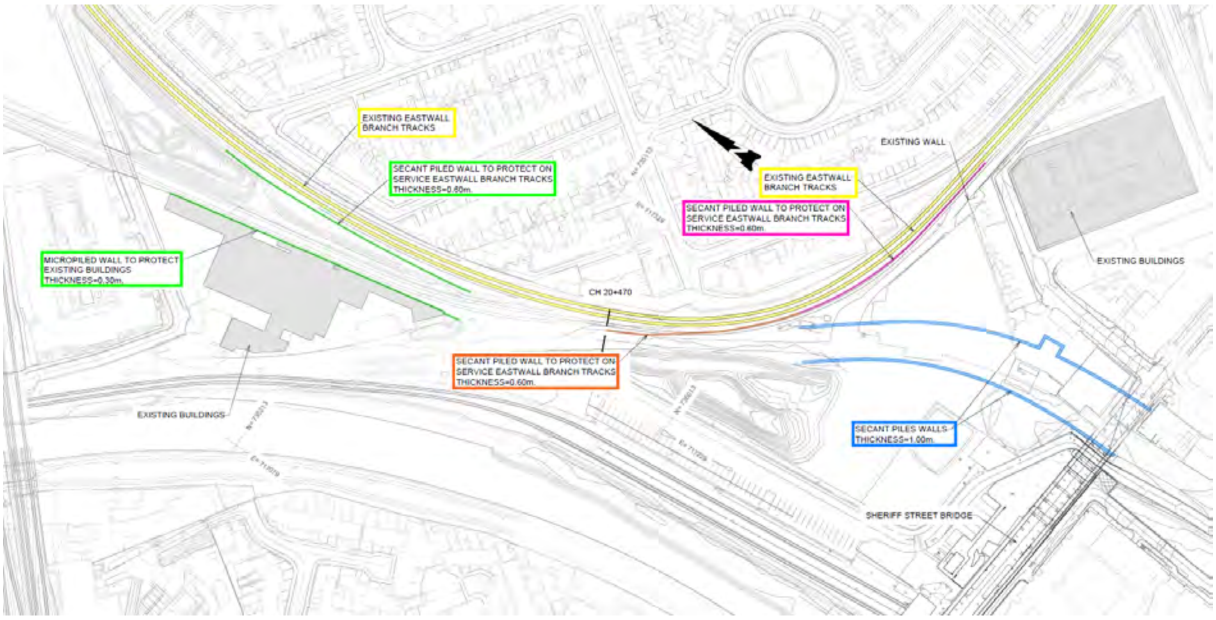


Figure 5-201 Phase 3 – construction of piled walls

For Structure A, a 158 m length secant piled wall is required on each side of the tracks (in total, 316 m). The piles required underneath OBO228 Sheriff St Bridge will be constructed before the overbridge OBO228 is reconstructed as the supports (columns) load path will be into Structure A. The piles that clash with the access route from Iarnród Éireann Track Domain and Abercorn Road will not be constructed until access to the compound is available via the access ramp from Sheriff St Upper – this is in order to maintain access to the construction compounds.

For Structure B, the secant piled wall is required for a total length of around 145 m parallel to East Wall branch tracks to protect the on-service tracks.

For Structure C, the secant piled wall is required for a total length of around 165 m parallel to East Wall branch tracks to protect the on-service tracks.

For Structure D, the secant piled wall is required for a total length of around 165 m parallel to East Wall branch tracks to protect the on-service tracks, and a micropiled wall with a total length of around 190 m on the Westside S2A Down Track Line to protect the existing buildings.

The total required length of the secant piled wall in Spencer Dock is estimated to be 981 m.

The typical plant required for secant piling includes the use of piling rig, concrete pump, mixer drum, compressor, jet washes, water bowser, crane suspended vibrator with a power pack, hand tools including power tools, 90-tonne crawler crane (or similar), backhoe excavator, tipper and remixer.

Figure 5-202 Piled wall example

- Phase 4: Excavation and execution of the bottom slab and vertical walls (auger drilling).

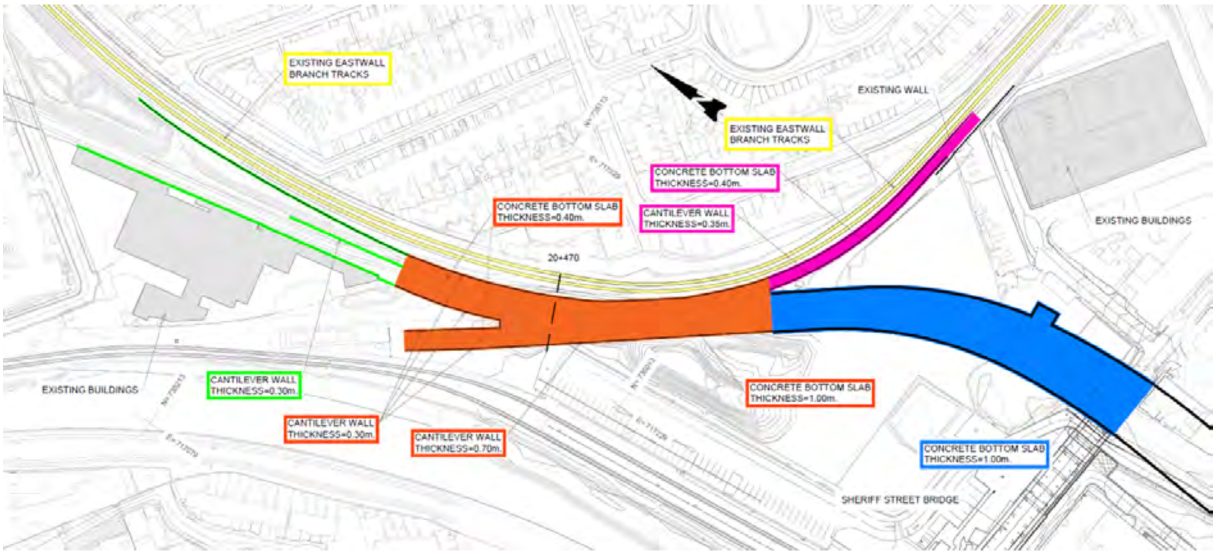


Figure 5-203 Phase 4 – construction of cantilever walls and bottom slabs

For Structure B, the cantilever retaining wall is required for a total length of around 100 m on the Southside of the S2B U/D Line with an in-situ concrete bottom slab to protect the track from groundwater.

For Structure C, the cantilever retaining wall is required for a total length of around 415 m with an in-situ concrete bottom slab to protect the track from groundwater and to retain soil at different levels on two sides.

For Structure D, the cantilever retaining wall is required for a total length of around 70 m in the middle of piled walls to retain soil at different levels on two sides.

The total required length of the cantilever retaining wall in Spencer Dock is estimated to be 585 m.

- Phase 5: Filling and compacting.
- Phase 6: Place new tracks.

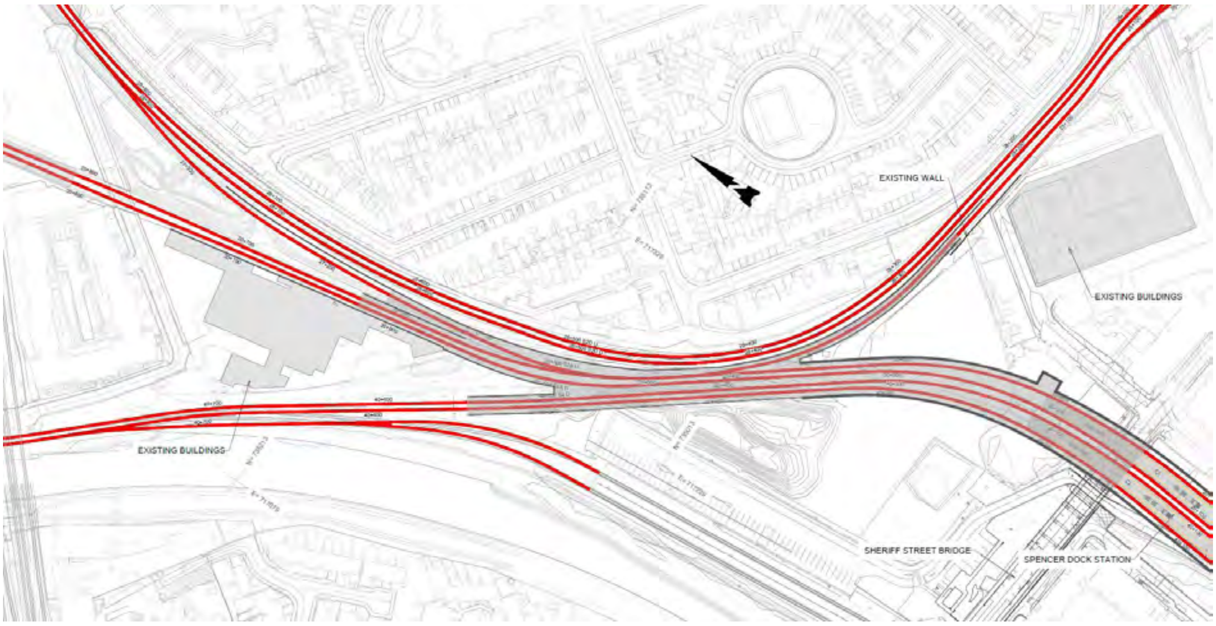


Figure 5-204 Phase 6 – placement of new tracks

The total construction duration for all the piled wall is estimated to be approximately **11 months** allowing for daytime construction working.

The total construction duration for all the cantilever walls and bottom slabs is estimated to be approximately **7 months** allowing for daytime construction working.

5.5.7.2 GSWR-East Wall yard provisional connection

5.5.7.2.1 Introduction

Due to the works to be carried out on the Spencer Dock area permanent way, the current connection between GSWR line and the East Wall yard will be affected. If no action is taken, this would result in an extended closure of 1.5 years for the line while the civil and track works are being constructed. The current connection impacted consists of a single track in the southern side of the existing layout and is shown in Figure 5-205.

Figure 5-205 Existing GSWR-East Wall yard connection

In order to avoid such an impact, a provisional connection has been proposed between the GSWR line and East Wall branch.

5.5.7.2.2 Overview of works required

Prior to the works commencing, the implementation of a provisional connection has been proposed consisting of two main elements:

- A temporary turnout is to be installed between the GSWR branch and the branch connecting to the Northern line.
- A new and definitive crossover is to be constructed next to the East Wall yard with the aim of preserving the existing connection between the Port and the yard (see Figure 5-206).

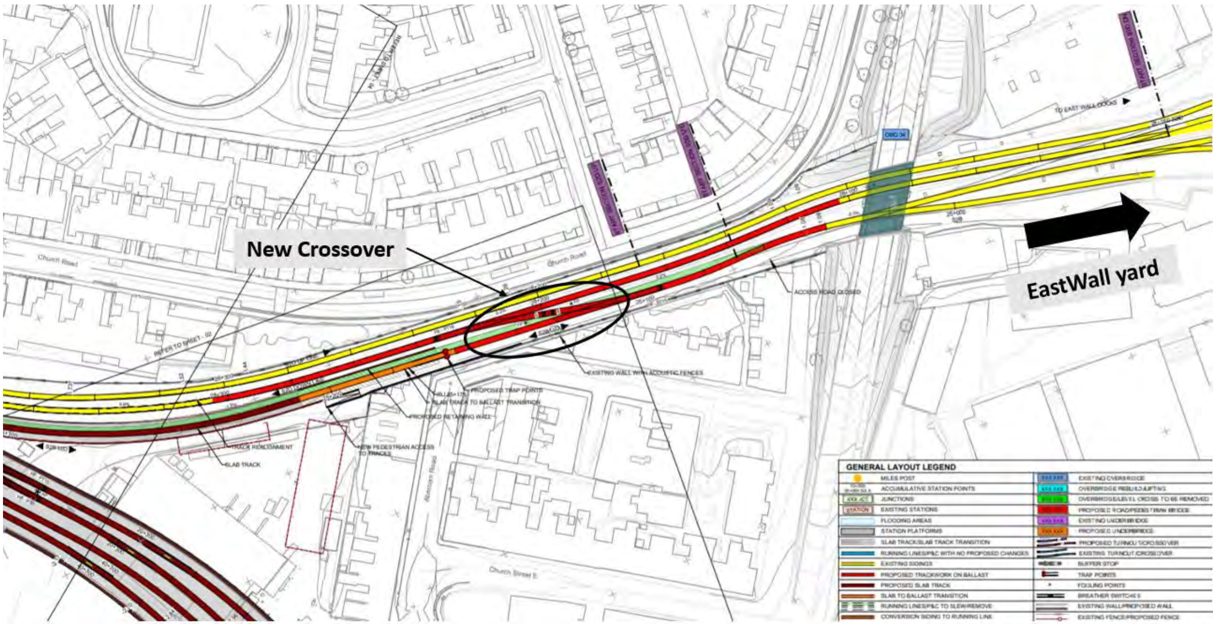


Figure 5-206 New permanent crossover next to the East Wall yard

The connection between branches will be carried out on a single track by means of two turnouts, constructed at each track to be connected. As a result, a compact connection has been proposed so as to mitigate the impact that nearby structures could have on it. Figure 5-207 refers to the layout prior to the start of the main PWay works, after the temporary connection between GSWR-East Wall yard (shown in magenta) has been constructed.

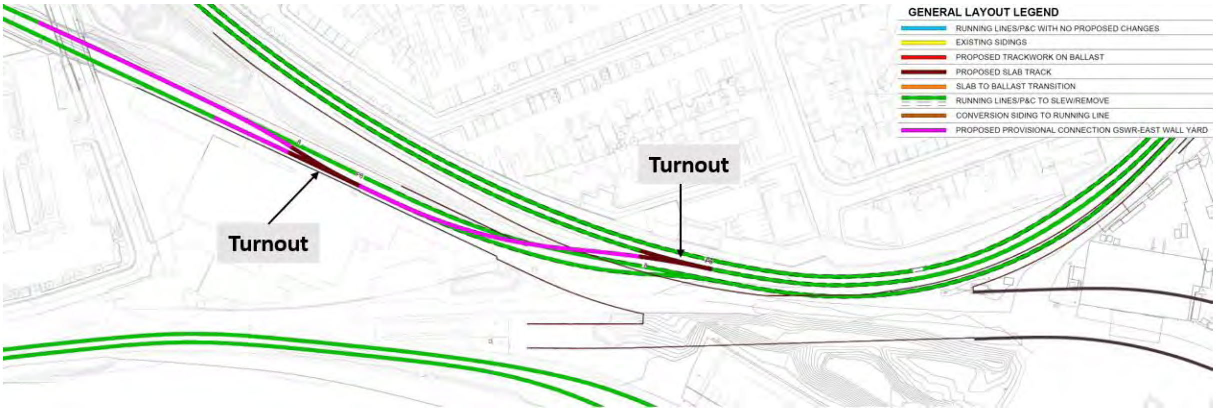


Figure 5-207 Provisional connection at GSWR branch

5.5.7.2.3 Construction phase

As outlined above, the temporary connection between the GSWR line and the East Wall yard will be constructed so as to allow a connection to the GSWR to continue during the main Pway works. However, even this temporary connection will be impacted for a short period when the works in this area need to be completed.

The following phasing is proposed with the aim of mitigating the closure period of the GSWR-East Wall yard by as much as possible:

1. Construction of a new temporary track connection (turnout) between GSWR branch and the connection branch with the northern line, and construction of the new permanent crossover between the East Wall yard and the new DART+ West lines.

The works are to be done during weekend possessions in both cases. Works for the crossover installation at East Wall yard are to be done in parallel with the works at the connection with the GSWR line. A construction phasing for these preliminary works is listed below:

- The installation of a new permanent crossover and the necessary alignment change at surrounding tracks shown in Figure 5-206. The track works will be done following the methodology included in Section 5.3.6.1 and Section 5.3.6.2.1 and during weekend possessions.
- The installation of two new temporary turnouts that would connect the GSWR line branch with the East Wall yard.
- The removal of the existing connection GSWR-East Wall yard that intersects with the layout of the future provisional connection track, as well as the construction of the new turnout. The works will be done according to the Section 5.3.6.2.1 during weekend possessions.

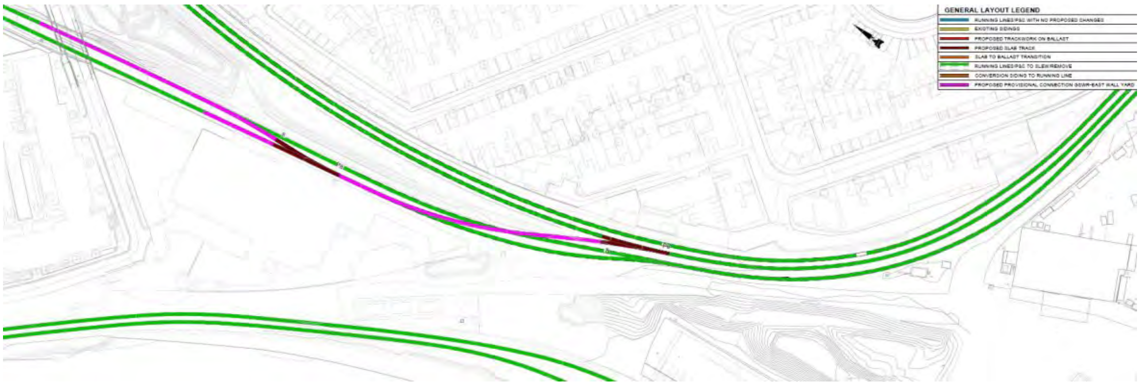


Figure 5-208 Existing layout after the provisional connection is constructed

2. Construction of the proposed structures for the modified and new Pway in all the area not affected by the provisional connection layout. These works involve the execution of the structures A, B and most of Structure C, as detailed in Section 5.5.7.1.2; as well as the construction of the superstructure on the Structures A, B and C.

   The transition track length between slab and ballast as part of the C structure zone will be carried out after removing the provisional connection.
3. Execution of the micropiled wall according to the Section 5.3.6.2.3, as part of the Structure D package included in the Section 5.5.7.1.2. The works will be done during daytime project construction working hours as set out in Section 5.2.1 making them compatible with operation of the line, since only about two trains/day flow is foreseen in the affected branch.

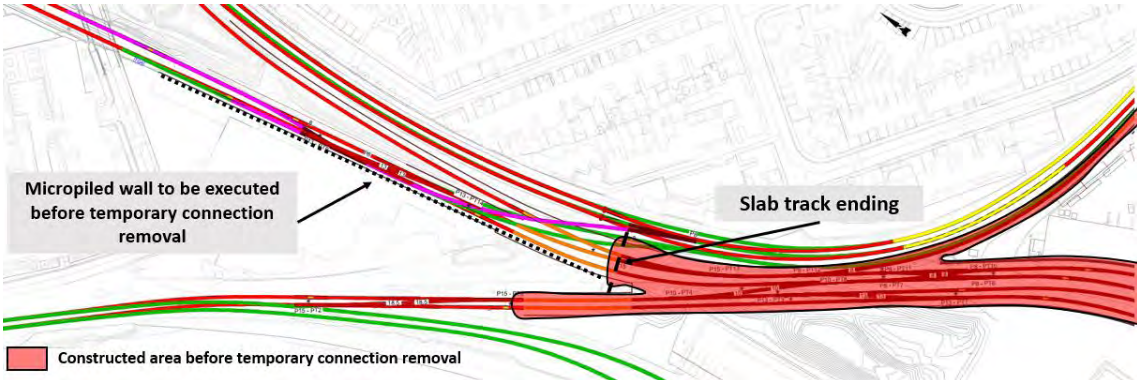


Figure 5-209 Area to be constructed before the provisional connection removal

Figure 5-210 Constructed Pway before the provisional connection removal

4. Removal of the previously executed provisional turnout shown in magenta in Figure 5-210. An extended closure strategy is proposed for the execution of these works, involving the shutdown of GSWR-East Wall branch connection for 2.5 weeks. Provisional track will be removed according to the stated in Section 5.3.6.1.
5. Construction of the remaining elements of Structures C and D (according to the naming in Section 5.5.7.1.2) and track in the remaining area included in the proposed Pway works in Spencer Dock area. During the works the studied connection will remain closed until the finalization of works at GSWR line branch.

Figure 5-211 Area to be constructed after the provisional connection removal

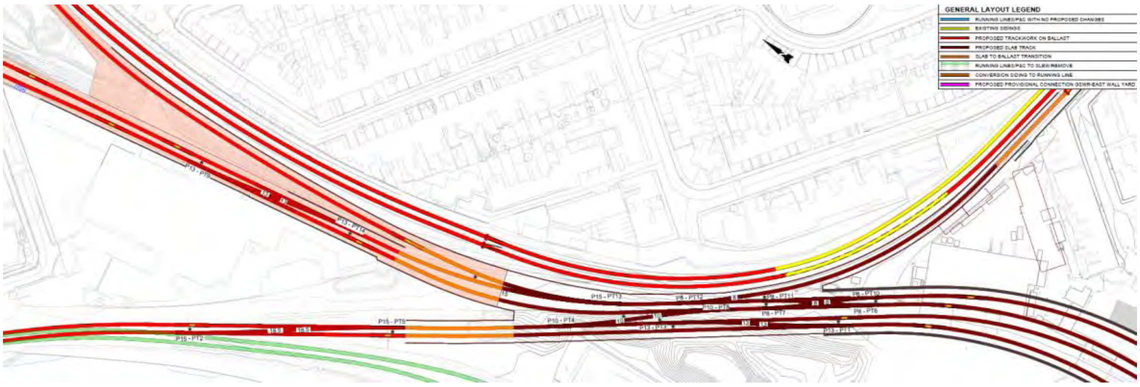


Figure 5-212 Constructed Pway after the provisional connection removal

All the works related with the constructed of the different structures and track are described in Section 5.5.7.

5.5.7.3 Demolition of Church Road signal box

Due to the proposed track alignment the existing Church Road signal box (a building of historic significance) will need to be demolished in order to construct the works. The signal box is shown in Figure 5-213 below.

Figure 5-213 Church Road signal box to be demolished

Following discussions with Grade 1 Conservation Architects (Blackwood's & Associates) the proposed course of action is to carefully record the signal box building both by survey drawings and photographically prior to demolition. Making the structure available for relocation is suggested as a possibility for heritage purposes should a heritage body wish to engage with IÉ on this option.

5.5.8 GSWR

5.5.8.1 OBO36 Ossory Road Bridge

OBO36 Ossory Road Bridge is located on the GSWR line, in Dublin City. It is an approx. 13.10 m wide, two-lane bridge with two footways. It is a flat deck bridge with two spans and central piers.

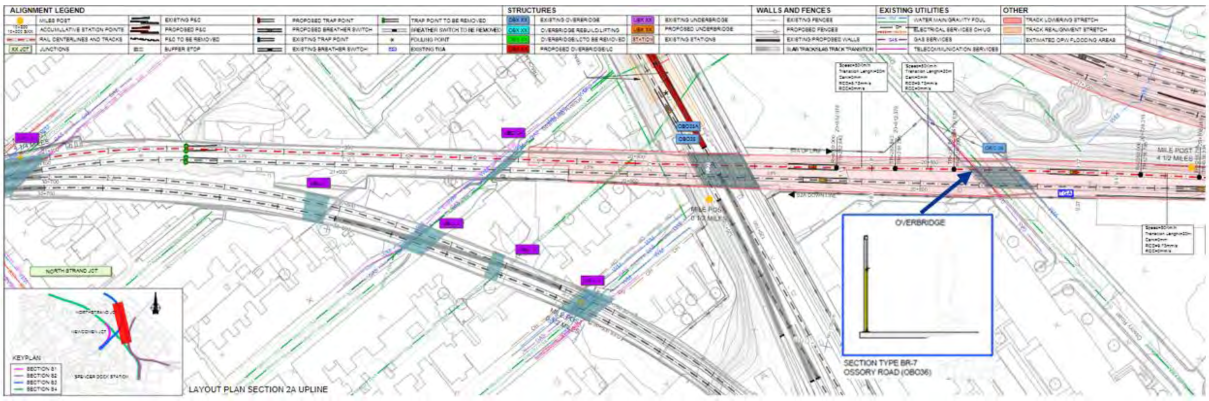


Figure 5-214 OBO36 location

5.5.8.1.1 Track realignment and lowering

The works planned for the section of track under OBO36 bridge involve both realignment and lowering of the track. The construction strategy proposed for this section will correspond to what is specified in Section 5.3.6.1.

5.5.8.1.2 Parapet heightening

In order to protect users from the OHLE, parapets on OBO36 footbridge will be installed according to the construction methodology defined in Section 5.3.12.3.

5.5.9 MGWR

There are a number of different interventions required on the MGWR line: the general track lowering, structural interventions (precast concrete retaining walls in OBD221, OBD222 and OBD225, soil improvement with jet grouting or other methods and UBD233 rail fastening system alteration), Cable Management System, drainage, and some minor civil works.

The general track lowering along the MGWR line includes track lowering under: OBD227, OBD227A and OBD227B, OBD226 and OBD226A, OBD225, OBD224, OBD223, OBD222 and OBD221. In order to protect all bridge foundations it is necessary that the soil is improved around the existing foundations by means of jet-grouting technology or other methods according to geotechnical recommendation in the detailed design stage. Jet-grouting will be carried out before the beginning of the lowering works. Additionally, OBD221, OBD222 and OBD225 will require a retaining wall below the track (see Section 5.5.9.7.1 and Section 5.5.9.4.1), which must be carried out at extended closure regime.

Due to the structural intervention works required at OBD221, OBD222 and OBD225, it is proposed that the MGWR line will require an extended closure for 10 weeks. During this extended closure all of the track lowering, and structural works required on this section of the line will be undertaken as far as OBD227. In addition, two additional months of night works for the rest of drainage and CMS interventions is required. The total duration of the works considered along MGWR line is approx. 18 weeks.

The MGWR track lowering main compounds (CC-PW-S3-33340-B and CC-PW-S4-43200-B) are located in Glasnevin at Ch 33+340 and Ch 43+200 respectively. Vehicles delivering to the site are expected to approach via IÉ Compound Road, which will be accessed from Royal Canal Way. The access to track will be established through the track access point indicated in the Figure 5-215.

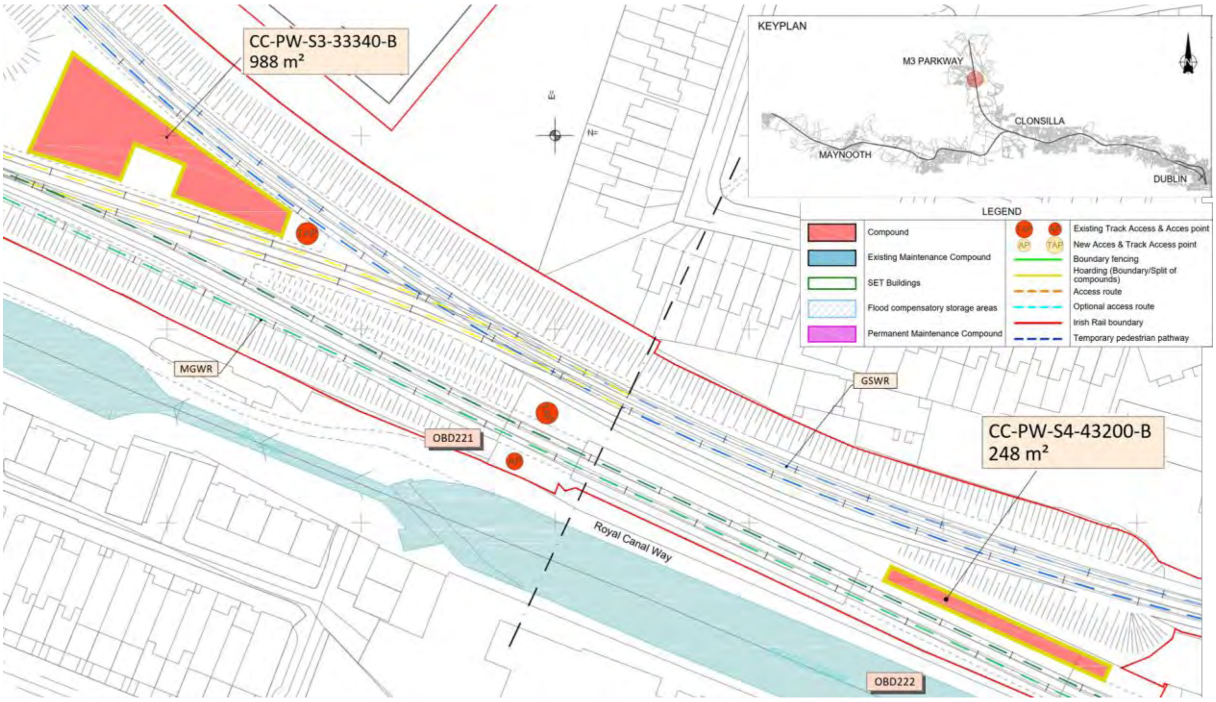


Figure 5-215 Glasnevin Pway compounds location

5.5.9.1 OBD227, 227A, 227B railway bridges

OBD227, 227A and 227B railway overbridges are located next to each other on the MGWR line. A track lowering of up to 406 mm will be carried out below OBD227 along approx. 180 m of track, following the construction methodology proposed in Section 5.3.6.1.

5.5.9.2 OBD226, 226A and UBD233 (Newcomen Bridge)

OBD226 is located on the MGWR line, next to OBD226A bridge. A track lowering of up to 385 mm will be carried out below OBD226 along approx. 235 m of track, following the construction methodology proposed in Section 5.3.6.1. The track lowering depth has been identified by considering the depth limitation set by UBD233. These works will be carried out during the 10 week closure of the MGWR line.

5.5.9.3 UBD233 structural intervention

An embedded rail system has been proposed to replace the current track design of rail supported by timber way beam on the existing steel underbridge UBD233 to obtain additional vertical clearance.

The existing timber way beam/wooden bearer rail shall be removed. The new steel L-profiles will need to be placed on the existing steel girders deck of UBD233, connected with a bolt connection solution. After placing the support structure of the L-profiles and placing the check rail with a bolt connection to the L-profiles, the compacting of fill and the running rail between the two L-profiles will be performed.

Figure 5-216 shows the proposed structural solution of the embedded rail system.

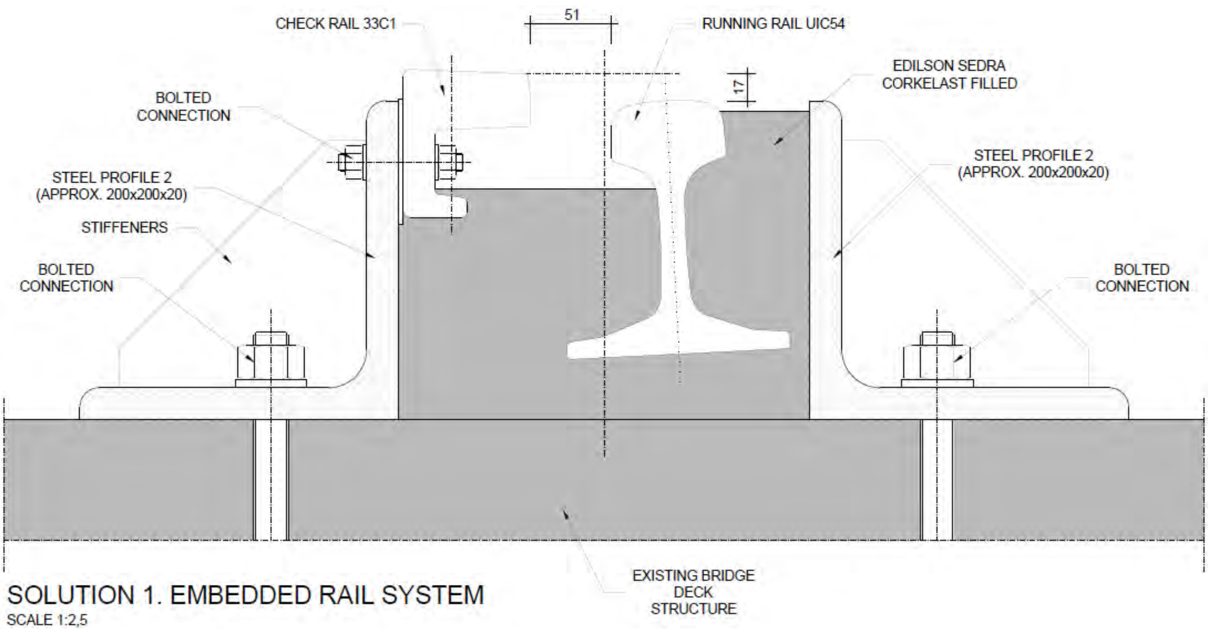


Figure 5-216 Solution 1 - Proposed embedded rail system.

The construction sequence of the support structure for each phase is as follows:

- Phase 1: Demolition of the existing superstructure based on wooden rail bearer.
- Phase 2: Install the support steel structures of the embedded rail.
- Phase 3: Compacted filling.

The total construction duration for the proposed solution is approx. 2 weeks during project construction working hours, as set out in Section 5.2.1, and will be performed during the 10 week closure of the MGWR line.

5.5.9.4 OBD225 Clarke's Bridge

The OBD225 is located on the MGWR line. A track lowering of up to 308 mm will be carried out below OBD225 along approximately 290 m of track, following the construction methodology proposed in Section 5.3.6.1 and after completing the soil improvement works required in the bridge foundation. These works will be carried out during the 10 week closure of the MGWR line.

5.5.9.4.1 Structural intervention

OBG225 is listed as a Case 3 structure as per Section 5.3.8.1.3. The construction sequence for Case 3 structures is as per Section 5.3.8.1.3.

The total construction duration for OBD225 is approx. **2 weeks**. These works will be carried out during the 10 week closure of the MGWR line. Further details of construction working hours for each construction phase have been provided in the table below.

	Month	1				2			
	Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Temporary utility diversions (if necessary) & soil improvement around existing foundation		Week of night closure							
2. Excavation under existing foundation level for the proposed track lowering work (20m)					Service total closure				
3. Construction of lean concrete (20m)					Service total closure				
4. Place the precast L-form retaining walls on the lean concrete (20m)						Service total closure			
5. Backfilling and compacting, and construction of track works						Service total closure			

Total construction duration:	2 weeks	
Railway closure:	1 week of night closure + 2 weeks	**Railway operation**
Total road closure:	-	Close to railway
Pedestrian total closure:	-	Service total closure
		Full weekend closure
		Week of night closure
		No railway closure required

Figure 5-217 Construction duration of OBD225

Figure 5-218 shows the proposed structural solution of the precast concrete L-form retaining wall at OBD225

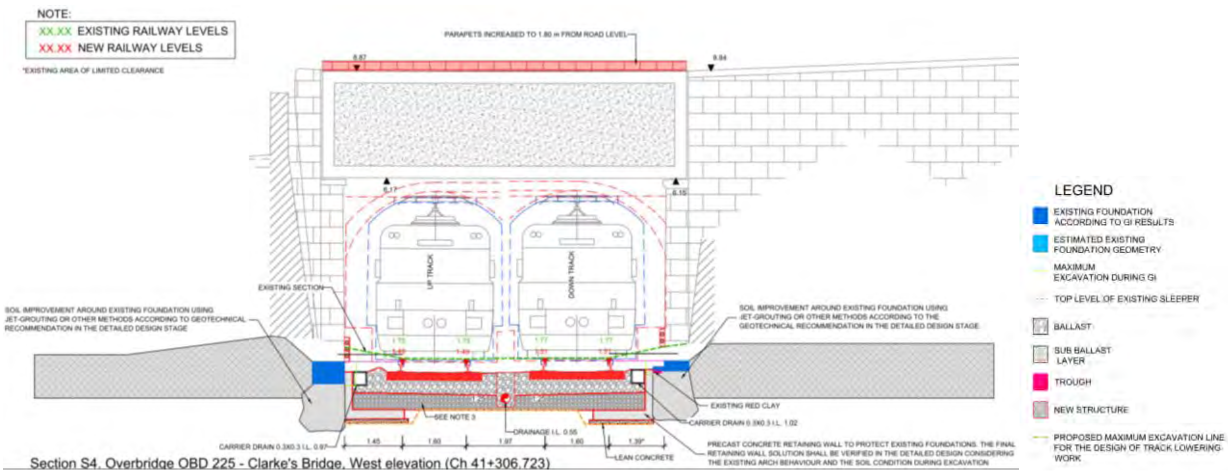


Figure 5-218 Section showing proposed L-form retaining walls at OBD225

5.5.9.5 *OBD224 Clonliffe Bridge*

The OBD224 is located on the MGWR line. A track lowering of up to 240 mm will be carried out below OBD224 along approximately 185 m of track, following the scheme proposed Section 5.3.6.1. These works will be carried out during the 10 week closure of the MGWR line.

5.5.9.6 *OBD223 Binns Bridge*

The OBD223 is located on the MGWR line. A track lowering of up to 603 mm will be carried out below OBD223 along approximately 315 m of track, following the construction methodology proposed in Section 5.3.6.1 and after completing the soil improvement works required in the bridge foundation. These works will be carried out during the 10 week closure of the MGWR line.

5.5.9.7 OBD222 Cross Guns (Westmorland Bridge) and OBD221 maintenance bridge at Glasnevin

The OBD222 is located on the MGWR and is a 171 m length overbridge/tunnel. OBD221 is located on the MGWR line (Glasnevin area) and is 20 m in length.

A track lowering of 410 mm will be carried out below OBD222 and OBD221 along approximately 575 m of track, following the construction methodology proposed in Section 5.3.6.1 and after completing the soil improvement works required in the bridge foundation. These works will be carried out during the 10 week closure of the MGWR line.

After the construction of the precast concrete retaining wall near the existing foundations, which will be executed according to the methodology included in Section 5.5.9.7.1, the new superstructure will be constructed.

5.5.9.7.1 Structural intervention

OBD222 is a protected structure masonry arch bridge and has numerous industrial buildings constructed over it. OBD221 is an arch bridge.

The track lowering solution that has been proposed for these two bridges to achieve a sufficient vertical clearance for OHLE installation is likely to have a significant impact on the existing foundations. A soil improvement shall be carried out around the foundation before excavation to protect the existing foundations.

OBD221 and OBD222 are listed as a Case 3 structure as per Section 5.3.8.1.3. The construction sequence for Case 3 structures is as per Section 5.3.8.1.3.

The total construction duration of OBD222 and OBD221 will take around **5 weeks**. These works will be carried out during the 10 week closure of the MGWR line. Further details of working hours for each construction phase have been provided in the table below.

	Month	**1**				**2**			
	Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Temporary utility diversions (if necessary) & soil improvement around existing foundation									
2. Excavation under existing foundation level for the proposed track lowering work (190m)									
3. Construction of lean concrete (190m)									
4. Place the precast L-form retaining walls on the lean concrete (190m)									
5. Backfilling and compacting, and construction of track works									
Total construction duration:	5 weeks								
Railway closure:	1 week of night closure + 5 full weekends	**Railway operation**							
Total road closure:	-		Close to railway						
Pedestrian total closure:	-		Service total closure						
			Full weekend closure						
			Week of night closure						
			No railway closure required						

Figure 5-219 Construction duration of OBD222 and OBD221

Figure 5-220 and Figure 5-221 show the proposed structural solution of the precast concrete L-form retaining wall at OBD222 and OBD221.

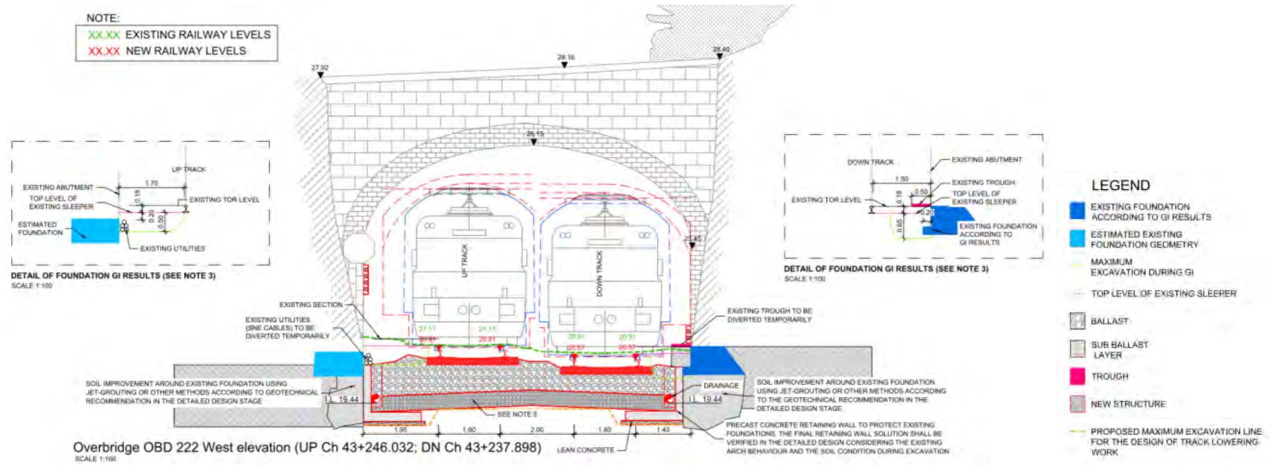


Figure 5-220 Section showing proposed L-form retaining walls at OBD222

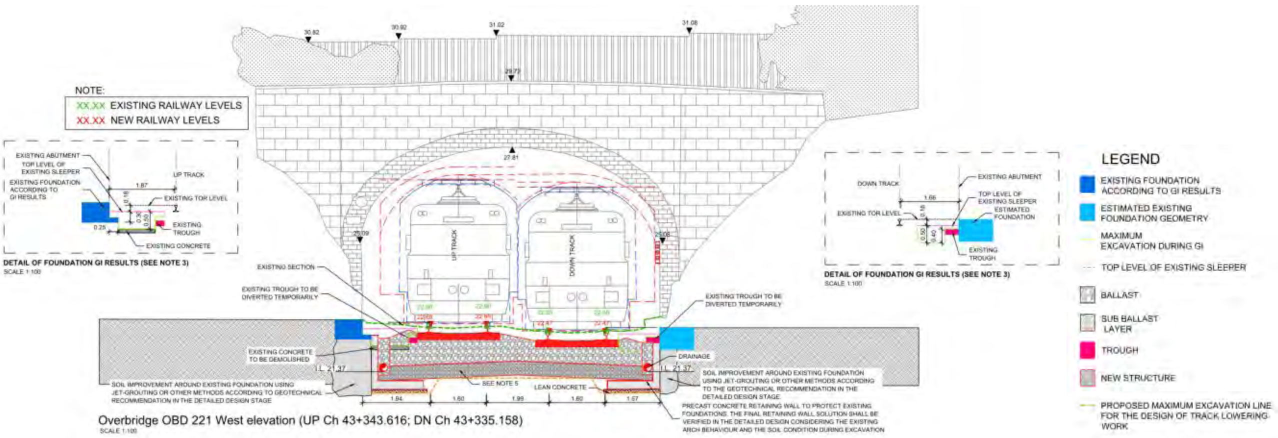


Figure 5-221 Section showing proposed L-form retaining wall at OBD221

5.5.9.8 Drainage MGWR

Construction of the drainage works along the MGWR will be coordinated with the rest of the activities due to the extended closure of this section. Construction methodology will be as per Section 5.3.13.

Duration of these works for the length of the MGWR is 10 weeks and will be constructed during the 10 week closure of the MGWR line.

5.5.9.8.1 OBD221- 222- 223

The drainage proposal consists of a gravity drainage from OBD221 outfalling to an existing connection at OBD223 to the Royal Canal.

Collector drains are provided at either side of the track from OBD221 and connect with an existing ditch located between OBD222 & OBD223 that runs along the Up track. At OBD223 the drainage is continued with collector drains that outfall to the Royal Canal at the existing discharge point.

5.5.9.8.2 OBD224-225-226-227

The proposal is a gravity drainage solution outfalling into an existing connection to the Royal Canal at OBD226.

From OBD224, collector drains are proposed on each side of the track and connect with existing open ditches at OBD225. Just past OBD225, when the existing ditches end, the drainage is continued with collector drains until OBD226. There, the water outfalls to the Royal Canal at the existing connection through gravity. When the level of the Royal Canal is higher than the level of the existing outfall point, the water is pumped and exits through the same connection point.

5.5.9.9 Signalling cabinet relocation

In the Docklands area there are three current technical buildings including a generator room and an SEB housing mostly axle counter assets. These buildings clash with the proposed permanent way alignment as per Figure 5-222 and Figure 5-223.

Figure 5-222 Existing technical buildings

Figure 5-223 Proposed permanent way alignment

At the end of the project, these three buildings will be decommissioned, because the IXLs (interlockings) will be centralized (NTCC/CTC). Docklands station will also not be in use, and there will be a new signalling/LV/telecom infrastructure to support the resignalling, with a new SEB and PSP in Spencer Dock Station.

However, the construction needs to be sequenced so that these buildings remain live until they are ready to be decommissioned. The following sequence is proposed:

1. New signalling assets installation while the current signalling is in service. These elements will be managed from the Spencer Dock SEB, but not put into service (still with current signalling), in conjunction with the signalling for the rest of the line.
2. New signalling is put into service for DMU for all the line.
3. The three buildings can be decommissioned.
4. In a window of approx. 2-3 weeks, access to Docklands station is suspended and the works in this area are finalized. During that time, the following activities are undertaken:
    - New track and P&C are installed.
    - Signalling updated (change of Docklands to Spencer Dock, all with the new signalling).
    - OHLE and EMU put in service, as in the rest of the line. Please note that these works are limited to the area that affects the access to Docklands station, because the works within the Spencer Dock station are made before.

5.5.10 Other SET works

5.5.10.1 Signalling works

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling include:

- The new crossover to be installed in the MGWR line and the decommissioning of the existing one will be done modifying the existing signalling system (see Section 5.5.9.2).
- New trap points, new crossover and new turnout on the East Wall lines can be installed and blocked, without modifying the signalling system. They will be later commissioned when commissioning the new signalling system. (see Section 5.5.7).
- The new interlocking boundary with the Heuston SSI will be developed and commissioned with the new signalling system.

The specific signalling works for this area can be performed during regular night possessions or when there is a longer possession due to track works, so additional impact on passenger services is not expected due to signalling works. Night services such as freight trains could be affected, especially during test periods.

5.5.10.2 LV power works

Apart from the general LV works described in Section 5.3.9.4, the specific works in this area for LV power works include:

- Newcomen Jct. Electrical power supply to the Pump Station from a new DNO that will be fed from a new MV substation located in Newcomen Junction Compound.
- Spencer Dock. Electrical power supply to the Attenuation Tank Pump Station from an existing DNO located in Spencer Dock compound.

These works are performed during night-time and will not impact on railway passenger services.

5.5.10.3 Telecoms works

The following telecoms works are required:

- The new trunk cables will be connected to the new DART+ West nodes/buildings in this area, see details in Section 5.3.9.1 (i.e. Spencer Dock TER, Spencer Dock SEB, Spencer Dock substation).

- The cabling will also be connected to the new DART+ West trackside LOCs and cabinets in this zone (OHLE, Signalling and LV cabinets) and other buildings (PSP).
- Telecom equipment will be installed in the new TER, SEB, PSP and substation buildings.
- Telecom equipment will be installed in new trackside LOCs and cabinets.
- New telecoms infrastructure (optical fibre, copper, structured cabling, Station LOCs) will be installed in Spencer Dock station, including new station end points (e.g. CCTV cameras, CIS displays, PA speakers, etc.).
- Basic testing onsite without live railway interaction.

There will be no impact on passenger services as these works will be carried out during night possessions (e.g. installation of new trunk cables), or during daytime (e.g. installation of new station elements).

5.5.10.4 Electrification works (HV/OHLE/SCADA/IESS)

The following electrification works are required:

- Installation of elastic bridge arms/OHLE supports to support the OHLE, insulators to support the feeder wires and earth wire clamps at OBO36, OBO35, OBD222, OBD224, OBD224A, OBD225, OBD226 and OBD227.
- Installation of earth wire clamps to support the earth wire to the structure at (and insulators to support the feeder wires where applicable) at OBD221 and OBD223.
- OHLE feeding connections and MOS installation from Spencer Dock and Glasnevin substations, and mainline OHLE MOS.
- General electrification works for the OHLE installation (as described in 5.3.9.1 SET buildings and cabinets and 5.3.9.6 Overhead Line Equipment (OHLE)) that will generally comprise single track cantilever structures (including twin track cantilevers, portals and wall fixings in some particular locations).

The specific electrification works for this section within Zone B can be performed during night possessions or when there is a longer possession (i.e. weekends), so additional impact on passenger services is not expected due to these electrification works.

5.6 Description of Construction Works in Zone C – Phibsborough/Glasnevin to Clonsilla Station

Zone C runs east to west from Glasnevin Junction to Clonsilla Junction. The section is approximately 10.1 kilometres in length, from Ch 60+000 to Ch 70+100. Works in this section will include:

- OBG4A, OBG6B, OBG6C, OBG11A, OBG11C, OBG12 and OBG12C Parapet heightening.
- OBG6D, OBG6C and OBG7A track lowering.
- OBG5 and OBG11 Arch deck reconstruction.
- OBG9 flat deck bridge modification.
- Ashtown, Coolmine and Castleknock substations.
- Level crossing closures in Ashtown, Coolmine, Porterstown and Clonsilla.
- Ashtown and Coolmine stations.
- Navan road compound.
- Clonsilla siding.
- SET installation.

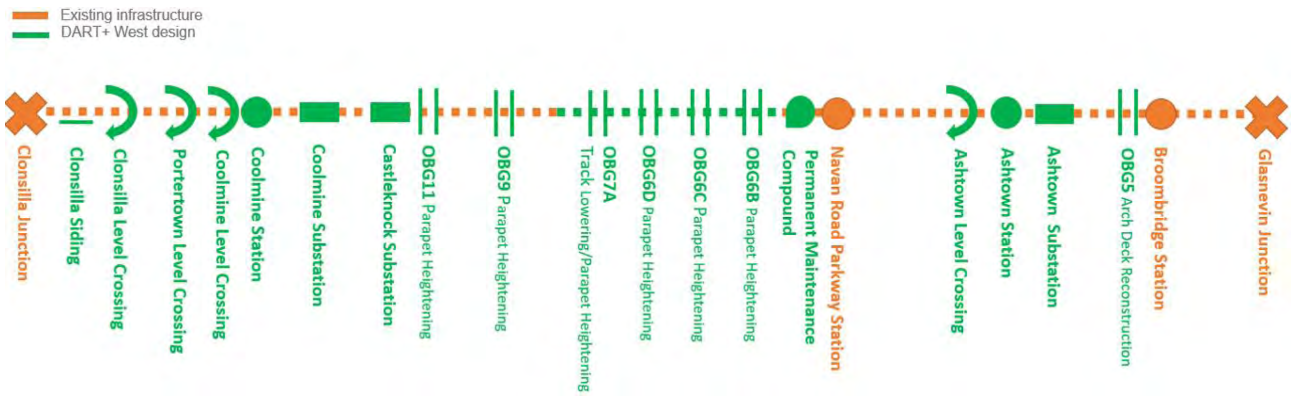


Figure 5-224 Schematic of DART+ West construction activities in Zone C

Early works will include compound installation for track lowering and other works, as well as utilities diversions. Due to the linear nature of these works, several utility diversions have been identified in Zone C (described in Chapter 18 of this EIAR) and will require temporary traffic measures. The typical construction methodology used for utility works has been detailed in Section 5.3, whereas the general principles of the traffic management measures required during the construction phase are outlined in Section 5.12.3.

The required construction compounds to carry out the construction works within Zone C are outlined in the following table.

Table 5-9 Construction compounds in Zone C

Compound code	Chainage	Reference	Discipline
CC-STR-S5-51480-B	51+480	OBG5	Structures
CC-SET-S5-51530-B	51+530	Reilly's SET Complementary	SET
CC-SET-S5-52180-B	52+180	Reilly's SET	SET
CC-SUB-S5-53600	53+600	Ashtown	Substations
CC-STA-S5-53660-B	53+660	Ashtown	Stations
CC-SET-S5-54750-B	54+750	Navan Road Station	SET
CC-STR-S5-56060-B	56+060	OBG9	Structures
CC-STR-S5-56130-B	56+130	OBG9	Structures
CC-STR-S5-56460-B	56+460	Castleknock	Structures
CC-SUB-S5-56500	56+500	Castleknock	Substations
CC-SUB-S5-57550	57+550	Coolmine	Substations
CC-STA-S5-57900-B	57+900	Coolmine	Stations
CC-PW-S5-59970-B	59+970	Clonsilla Siding Access	Permanent Way
CC-LC-S5-53820-B	53+820	Ashtown Level Crossing	Level Crossing
CC-LC-S5-58670-B	58+670	Coolmine Level Crossing	Level Crossing
CC-LC-S5-58800-B	58+800	Porterstown Level Crossing	Level Crossing
CC-LC-S5-60150-B	60+150	Clonsilla Level Crossing	Level Crossing

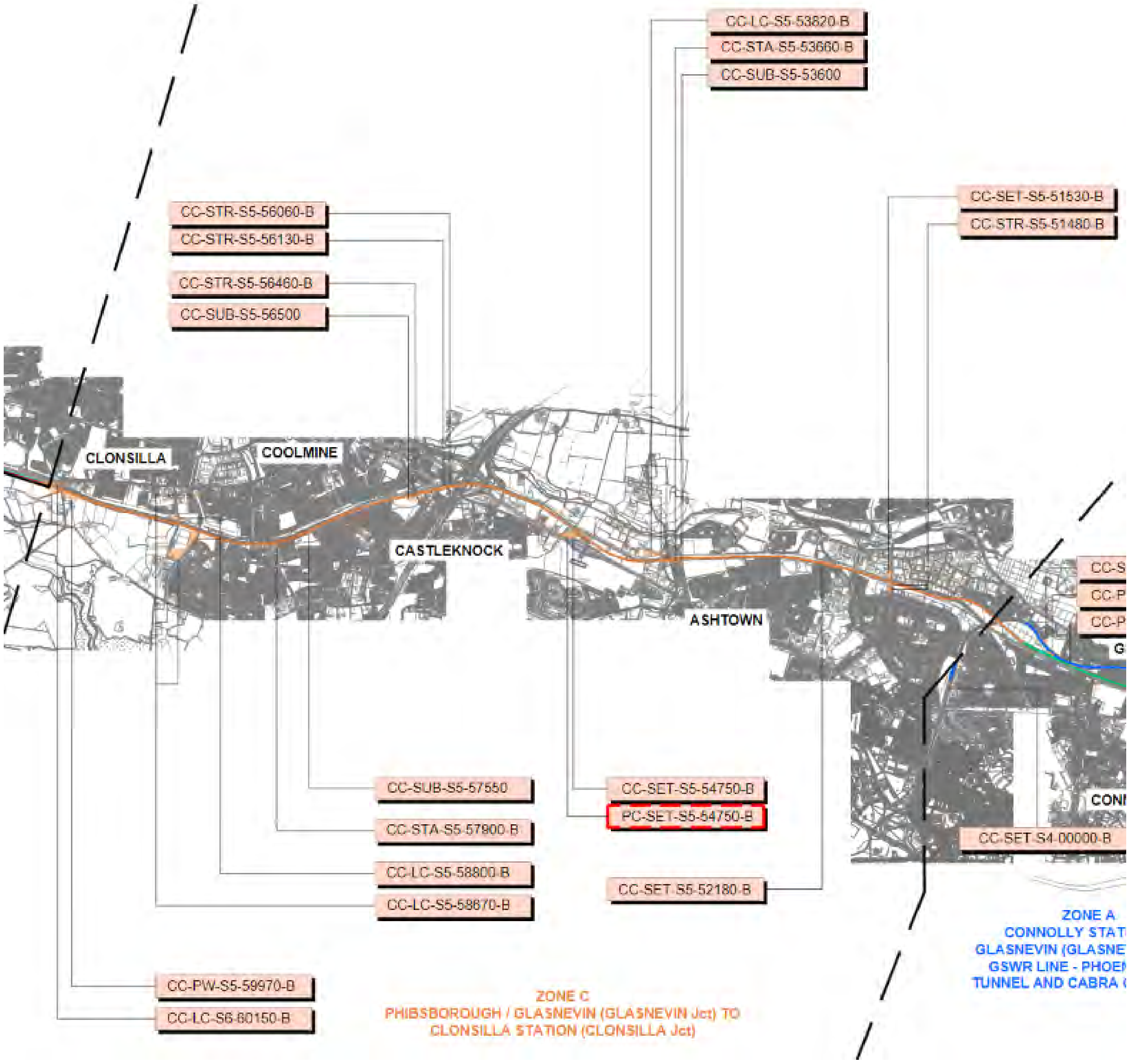


Figure 5-225 Zone C compounds

Two construction compounds located adjacent to Reilly's Bridge (CC-SET-S5-51530-B at Ch 51+530 and CC-SET-S5-52180-B at Ch 52+200) will serve the SET construction works requirements of Zone C. Vehicles delivering to the site are expected to use the access road off R805 connecting to Ballyboggan Rd and Hamilton View, respectively, as shown in Figure 5-226.

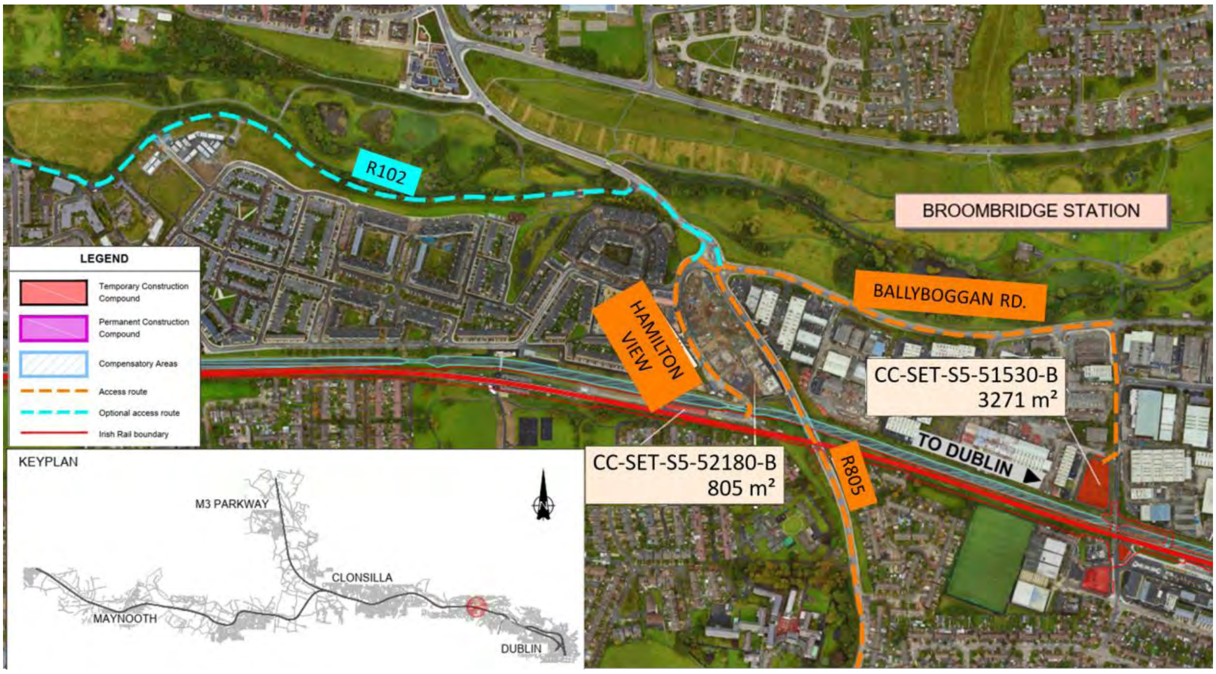


Figure 5-226 Reilly's SET compound haulage route

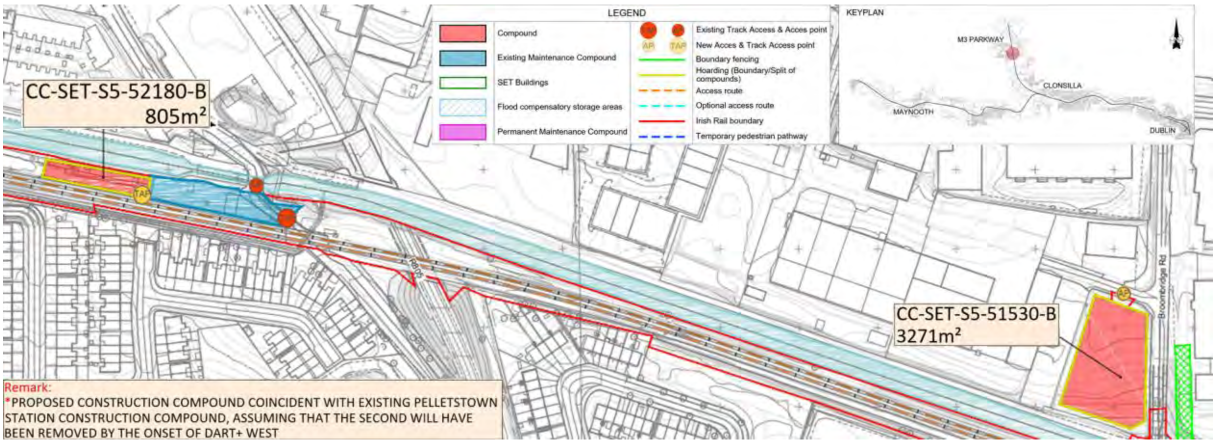


Figure 5-227 Reilly's SET compound

All works proposed in Zone C have been described from east to west, following the structure established in Chapter 4 of this EIAR.

5.6.1 OBG4A Broombridge Station parapet heightening

5.6.1.1 Overview of works required

OBG4A is located in Broombridge station between platforms. The existing parapets on OBG4A are already higher than the required 1.80 m. In order to protect users from the catenary system, works at OBG4A consist of introducing a low-level solid sheet panel 1.20 m high along the front of the existing parapet.

5.6.1.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG4A will follow the construction approach set out in Section 5.3.12.3.

5.6.1.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the OBG5 Compound (CC-STR-S5-51480-B) could be used as a storage area if required.

5.6.2 OBG5 Broome Bridge arch deck reconstruction

This arch limestone railway bridge constructed c.1845 is located adjacent to the Broombridge rail and LUAS Stations and is included in the record of protected structures for Dublin City.

The duration of the works will be as follows:

- OBG5 Broome Bridge Modification (including diversion – traffic & utilities) 40 weeks

Works proposed for the modification of Broome Bridge will include both the demolition of the current deck and reconstruction of a new precast arch deck, as indicated in Section 5.3.8.1.1.

5.6.2.1 Deck reconstruction

The construction phase, working time, and detailed construction methodology have been provided in Section 5.3.8.1.1 of this chapter.

The existing OBG5 Broome Bridge is single lane 8.5 m wide bridge with shuttle traffic.

To achieve a sufficient vertical clearance for the catenary equipment under the bridge, the precast arch deck solution has been proposed. The existing arch shall be demolished. The new arched bridge deck shall be installed 620 mm higher than the original bridge arch position.

With this bridge deck reconstruction and the lifting of the soffit of the arch, no significant impact on the connection of the existing pedestrian bridge to Broombridge Station is expected in the permanent case. During the reconstruction of the arch, the access from the bridge to the existing pedestrian bridge will be temporarily closed for 13 weeks for safety reasons. A temporary pedestrian crossing will be provided in this location to maintain pedestrian access over the railway and canal. The exact location of this will be determined during detailed design.

Temporary material storage area for this bridge has been provided as follows:

- OBG5.

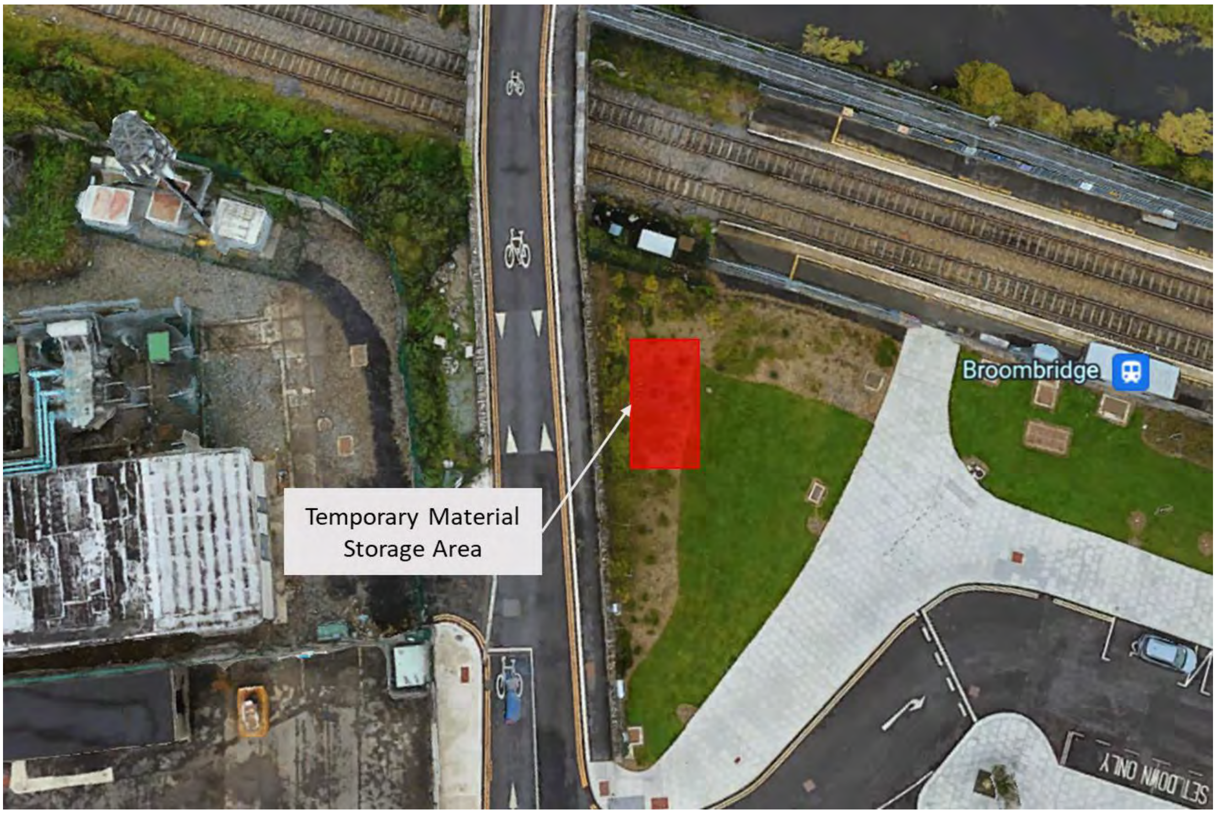


Figure 5-228 Plan of proposed temporary material storage area at OBG5

Figure 5-229 3D view of proposed temporary material storage area at OBG5

Figure 5-230 and Figure 5-231 show the proposed precast arch deck solution for this bridge.

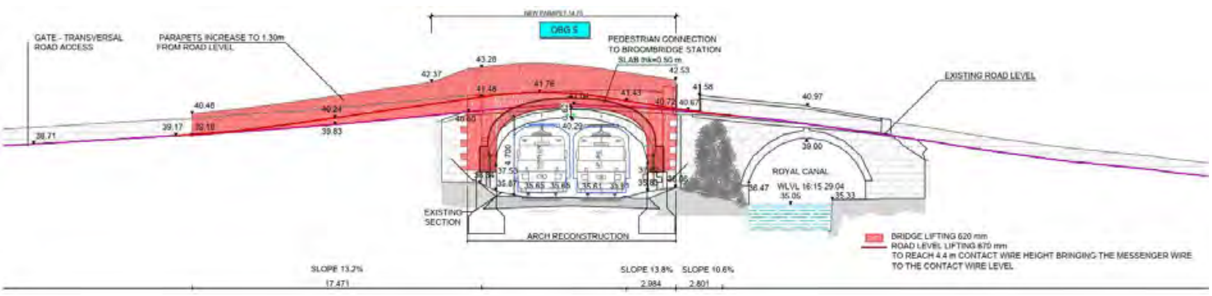


Figure 5-230 Elevation of OBG5 deck reconstruction

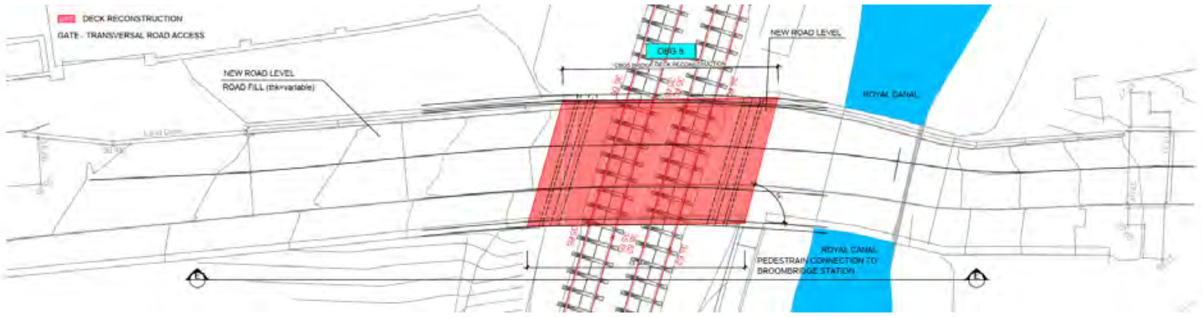


Figure 5-231 Plan of OBG5 deck reconstruction

The construction activities for deck reconstruction have been described in Section 5.3.8.1.1 of this chapter for this bridge.

5.6.2.2 Traffic diversion during construction

During the reconstruction of the bridge deck, the road access to the bridge will be closed. Therefore, until the construction is complete, passing traffic will be diverted. In Figure 5-232 the shortest path between bridge access points is shown. Traffic will have to cross the railway track and the Royal Canal using the bridge on the Ratoath Road (Reilly's Bridge). Broombridge Rd traffic will be diverted from Faussagh Ave to Ratoath Rd and Ballyboggan Rd. Northbound traffic crossing the railway track and the Royal canal on Broombridge Rd will divert south to Faussagh Avenue, west to Ratoath Road, north to Ballyboggan Road, and finally south to the bridge's opposite access point.

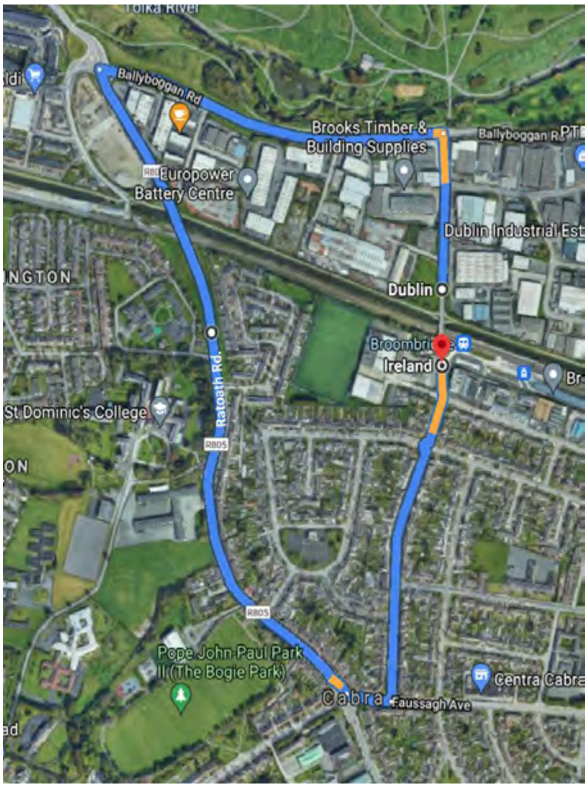


Figure 5-232 OBG5 traffic diversion during construction

Pedestrian movements will be diverted through a temporary ramp across the Canal, which will be constructed at platform level in Broombridge station – see Figure 5-223 below. This new ramp will be operational for the duration of the bridge closure to pedestrians.

Figure 5-233 Pedestrian diversion via temporary ramp at OBG5

5.6.2.3 Construction compounds and haulage routes

OBG5 Broome Bridge main compound (CC-STR-S5-51480-B) is composed of two adjacent compounds on opposite sides of Broombridge Road. They are located in Broombridge at Ch 51+480. Vehicles delivering to the site are expected to access from Broombridge Road using the compound's access route, as shown in the Figure 5-234 below.

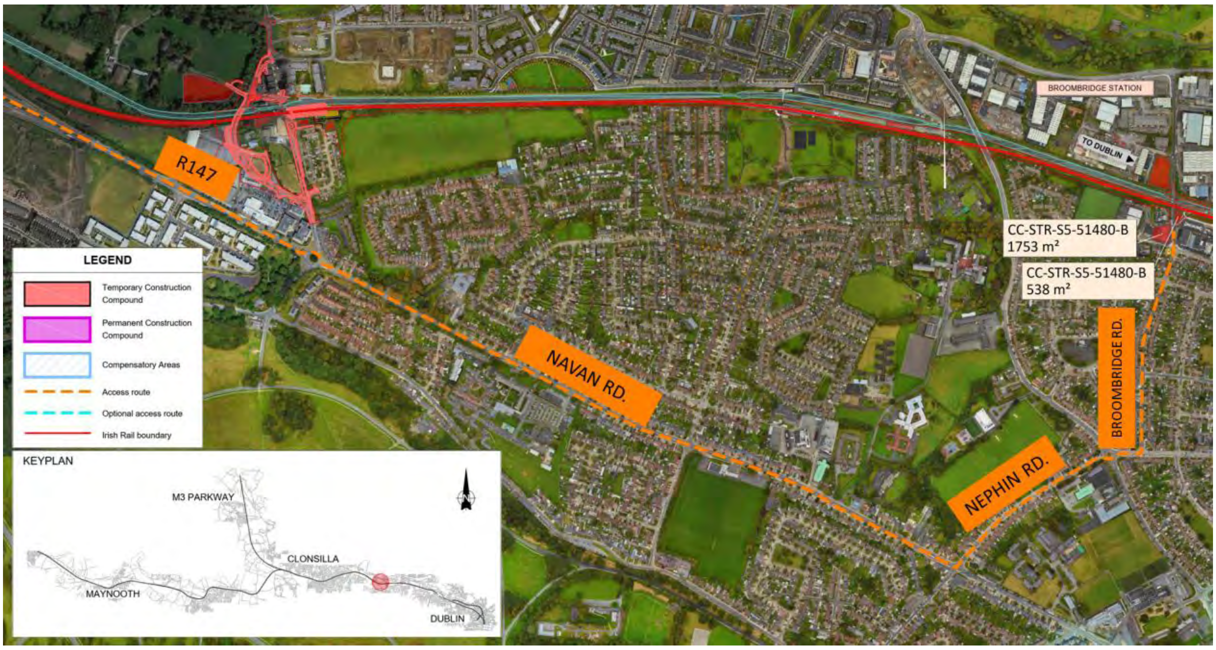


Figure 5-234 OBG5 compound and haulage route

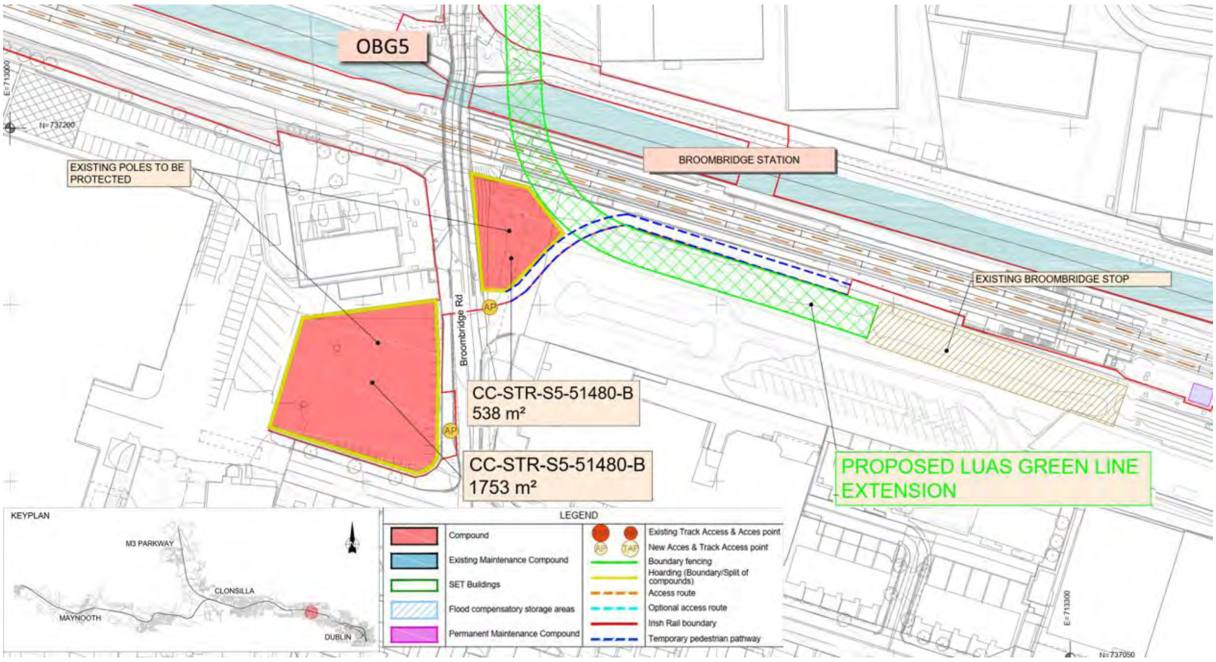


Figure 5-235 OBG5 construction compound

5.6.3 Ashtown substation

5.6.3.1 Overview of works required

Ashtown substation will be located in Ashtown, directly southeast of Ashtown Station – see Figure 5-236 below. The substation structure will be integrated with the pedestrian bridge above as some of the supports for the pedestrian bridge are positioned on top of the substation roof.

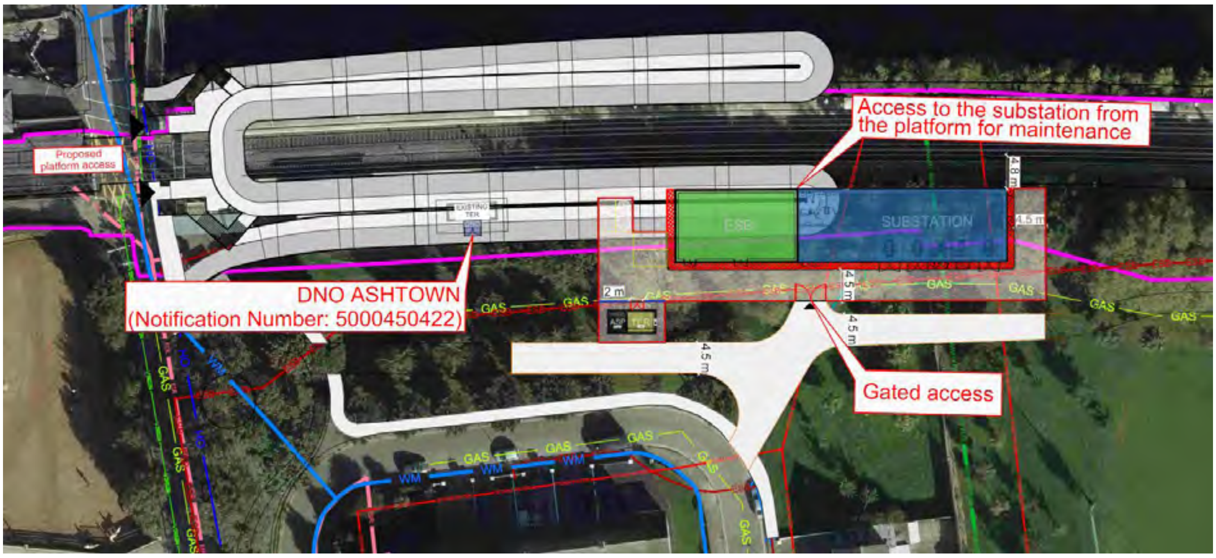


Figure 5-236 Ashtown substation location

5.6.3.2 Construction methodology

Construction of the substation will follow the methodology outlined in Section 5.3.9.

The duration of works will be as follows:

- Civil works at Ashtown substation 18 weeks
- Equipment at Ashtown substation 12 weeks

The construction of the substation will be closely integrated with the construction of the Ashtown Station pedestrian bridge (Section 5.6.4).

5.6.3.3 Construction compounds and haulage routes

Ashtown substation main compound (CC-SUB-S5-53600) is located in Ashtown, south of the substation location. Vehicles delivering to the site are expected to access the compounds using the R147 road before accessing Martin Savage Park and into the site as shown in Figure 5-237. A temporary pedestrian pathway is established south of the site and connects to the compound access road. Ashtown substation construction will need to be coordinated with the building of the new pedestrian and cycle bridge, as described in Section 5.6.4.

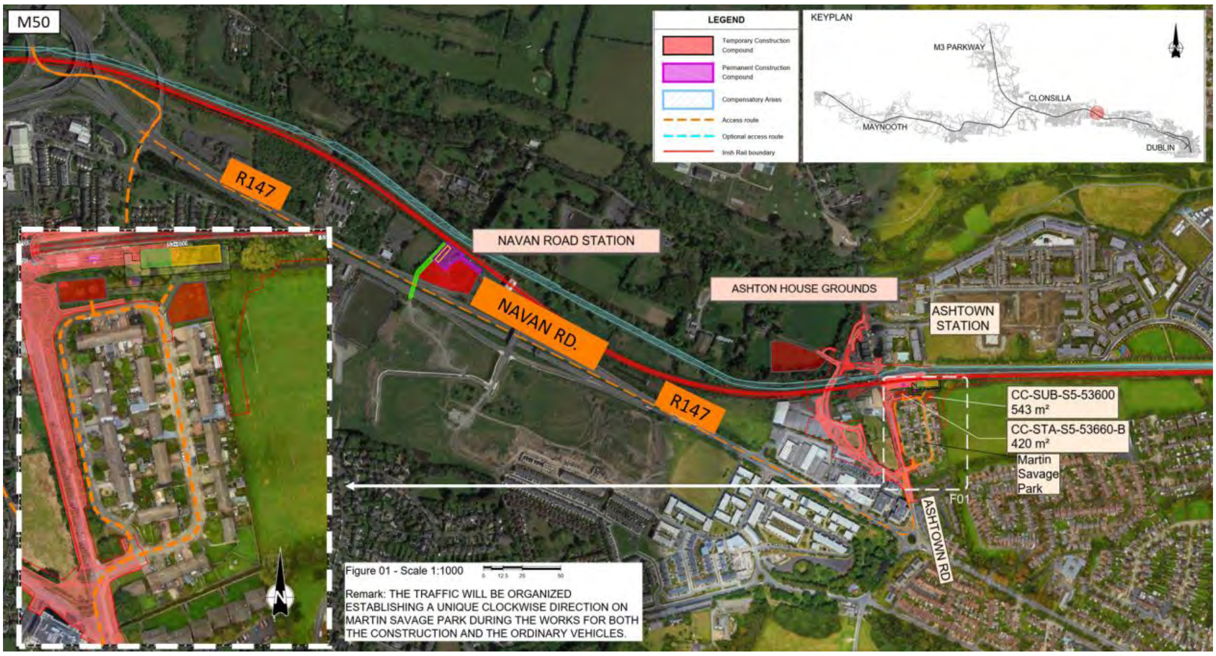


Figure 5-237 Ashtown substation and station construction compounds and haulage routes

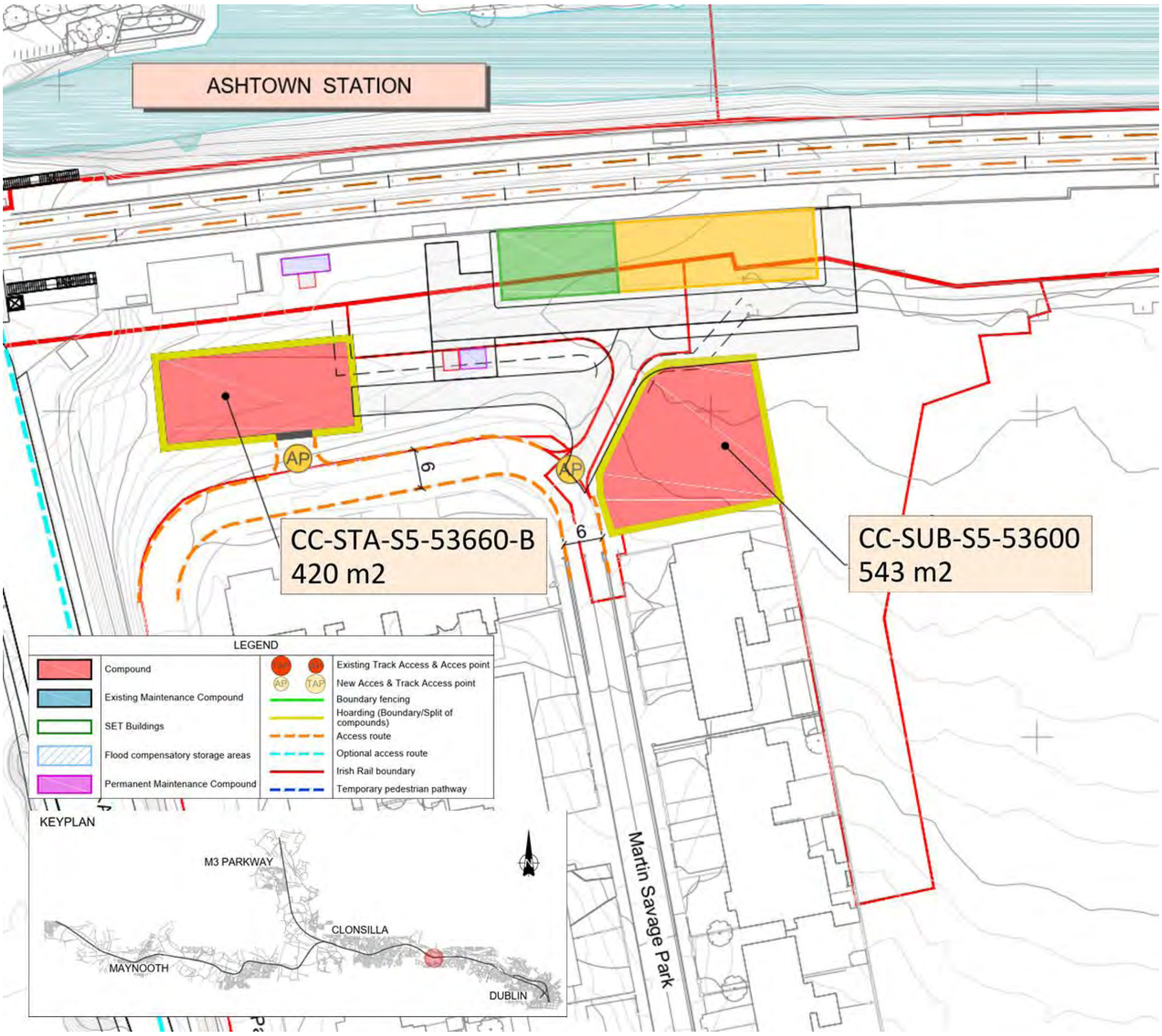


Figure 5-238 Ashtown substation compound

5.6.4 Ashtown Station pedestrian bridge

5.6.4.1 Ashtown pedestrian bridge overview

The current pedestrian bridge at Ashtown Station will be replaced with a new one in order to accommodate the increased pedestrian flow due to the proposed traffic changes. The figure below shows the existing infrastructure that are required to be removed/relocated/altered. This includes demolition of the existing canal pedestrian and cycle bridge, the existing station bridge crossing and the bike shelter. Platform 1 also needs to be extended and the existing station facilities need to be relocated.

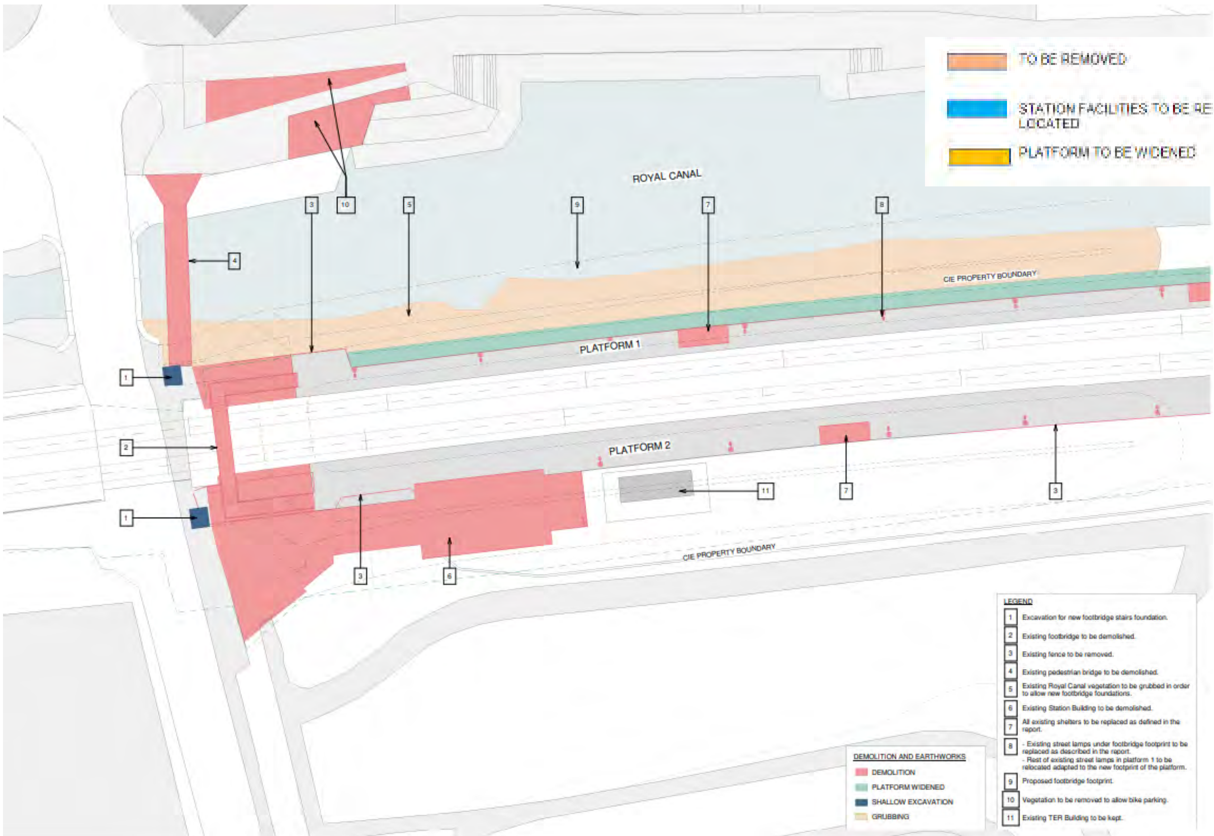


Figure 5-239 Works at Ashtown

The new pedestrian and cycle bridge, as described in Chapter 4 of this EIAR, is shown in Figure 5-240.

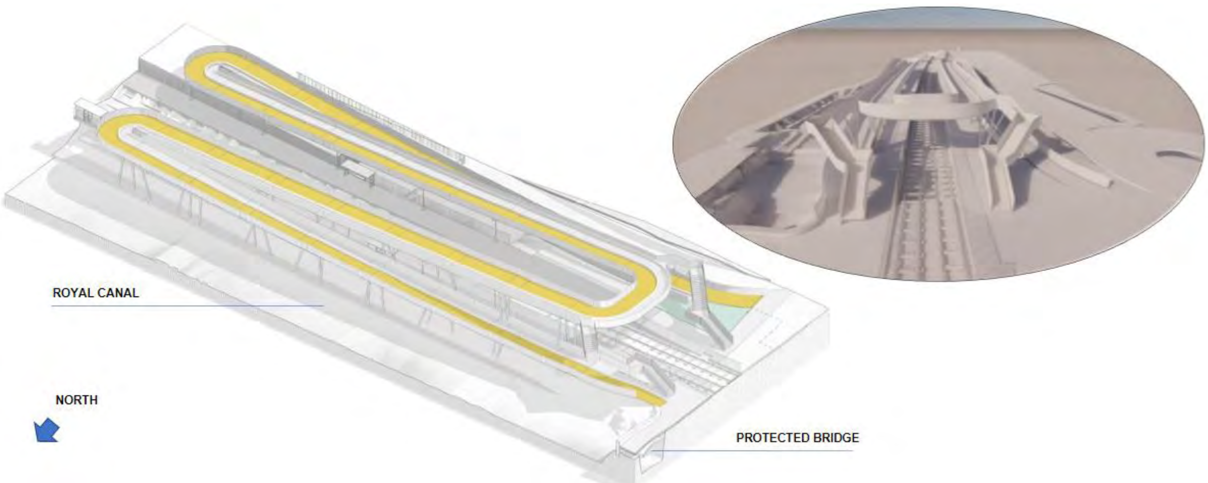


Figure 5-240 Ashtown pedestrian bridge

5.6.4.2 Ashtown pedestrian bridge construction methodology

For the new pedestrian bridge, the construction sequence is described below. It is envisaged at this stage of design that the piles circled in red will need to be constructed from the Canal. The piles in green will be completed from the platform using a mini piling rig situated on the platform.

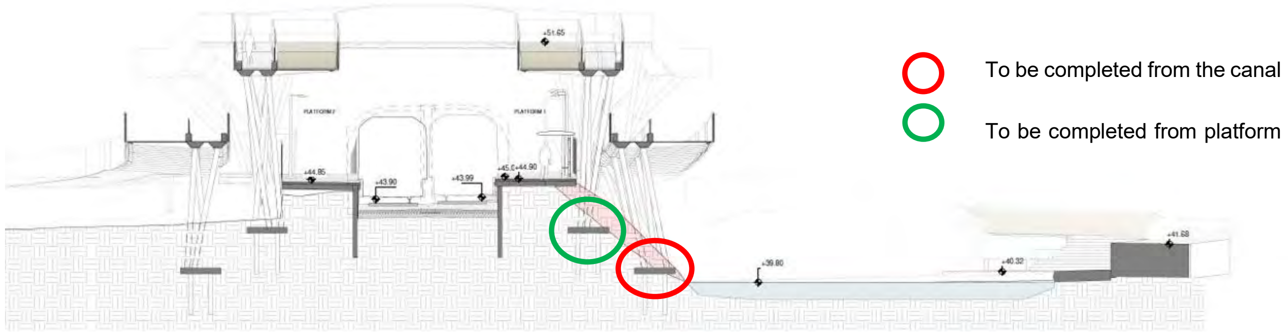


Figure 5-241 Section through Ashtown pedestrian bridge showing foundations

Piling to be completed from the canal:

1. Take possession of canal.
2. Install clay dams.
3. Electro fish.
4. Dewater section of works.
5. Install through flow pipe.
6. Infill canal and install piling mat. (assuming infilling the canal would provide protection to existing canal walls and remove the need to excavate in close proximity to existing railway).
7. Install red piles (approx. 25 in number).
8. Cut piles down to final level.
9. Install pile caps.
10. Remove canal infill, and clay dams.
11. Hand back Canal possession.

For the dewatering works (phase 1 in Table 5-10), approx. 100 m length of canal will be dewatered to facilitate the construction of the piles. The canal is retained by two temporary new clay dams either side of the structure. Dewatering will be required with pumps and settlement tanks running 24 hours a day, discharging water back into the canal. The duration needed will be approximately 10 weeks but will be coordinated with Waterways Ireland planned maintenance periods along the canal. The works will also be coordinated to occur at the same time as the Level Crossing replacement works at Ashtown in order to minimise disruption on the canal.

Once the piles have been installed from the Canal, the next step in the construction sequence will be to widen the existing platform 1 (north side). Once the platform has been widened, the remaining piles can be installed on the north side using a mini piling placed on the platform. These works will be undertaken during night possessions.

The piles to the south of the railway, relocation of the existing station facilities and the construction of the new substation buildings can be completed during daytime project construction working hours, as set out in Section 5.2.1, in a fenced off area.

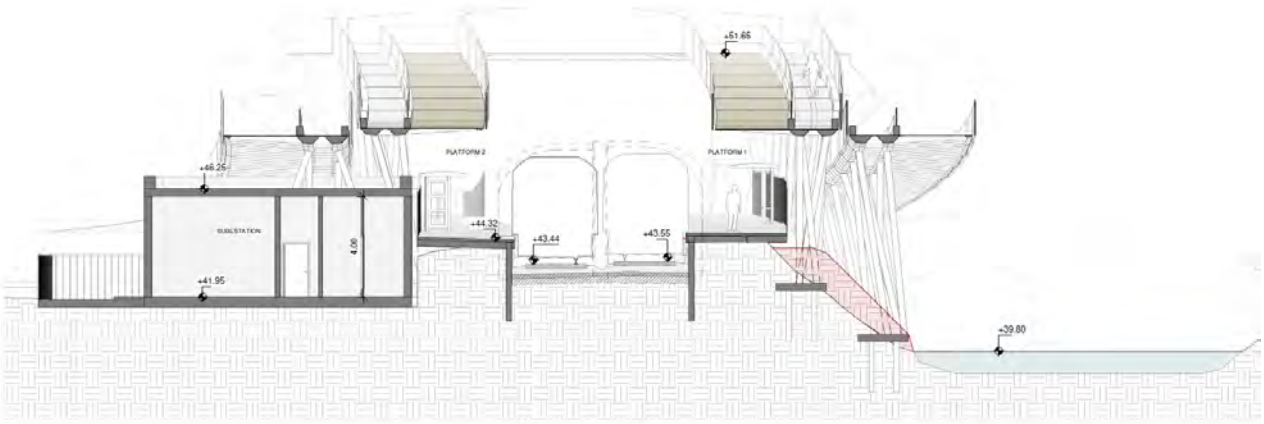


Figure 5-242 Section through Ashtown pedestrian bridge

The next step is to install the superstructure of the bridge. This will be completed during night-time and weekend possessions.

1. Install superstructure up to bridge deck level using a road rail vehicle crane or crane located on the road.
2. Backfill area shown in red in Figure 5-242.
3. Dismantle existing pedestrian bridge.
4. Install the bridge structure during weekend possession.
5. Architectural finishes and MEP fitout.
6. Platforms and access repair.
7. Install and repair boundary walls and fences.
8. Landscaping.

Equipment required will include mobile crane, road rail vehicle cranes, demolition machinery, excavators, piling rig, concrete trucks, dumper trucks, sheet piling rig.

Total duration for the construction of the pedestrian bridge is 5 months.

5.6.4.3 Construction compounds and haulage routes

Ashtown station main compound (CC-STA-S5-53660-B) is located in Ashtown, south of the station. Vehicles delivering to the site are expected to access from the compound access road established just south of the site as shown in Figure 5-243. An additional temporary pedestrian pathway is established south of the site and connects to the compound access road. Vehicles delivering to the site are expected to access from the R147 to access Martin Savage Park where the compound can be accessed.

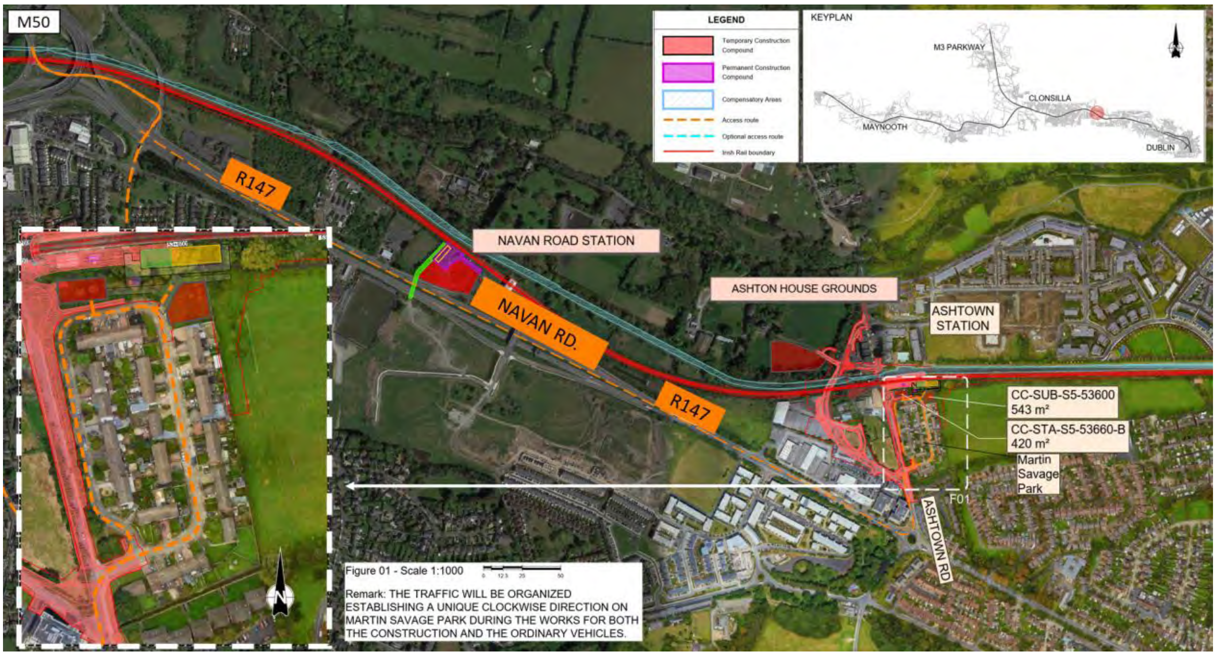


Figure 5-243 Ashtown Station compound and haulage route

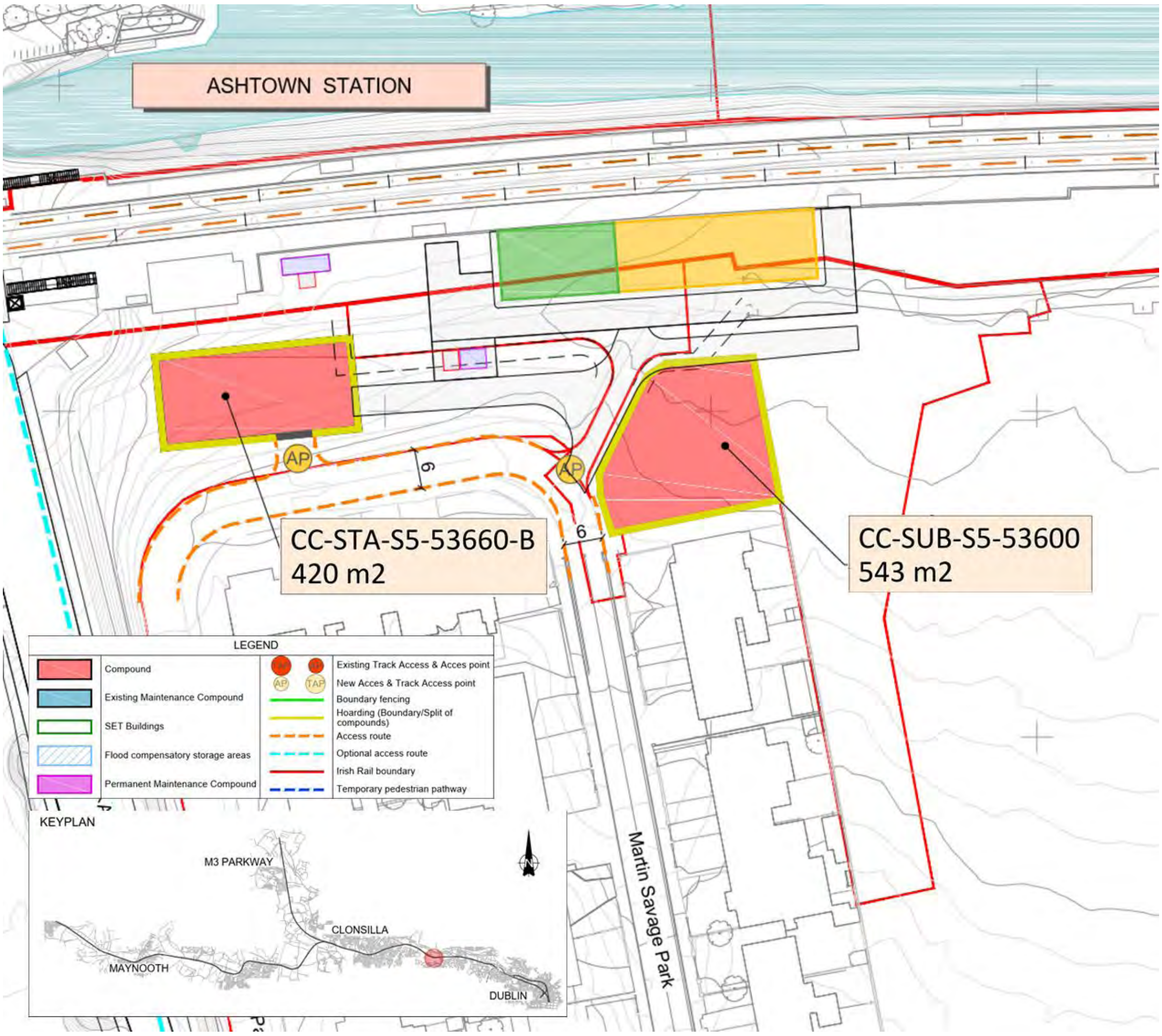


Figure 5-244 Ashtown Station compound

5.6.5 Ashtown level crossing

To maintain vehicular transport links following the closure of the Ashtown level crossing an underpass is proposed on the Dublin to Sligo Railway Line (the Connolly to Maynooth line) between Ashtown Station and Navan Road Parkway Stations.

The construction sequence of the Ashtown Underpass has been split into two sections: the rail underbridge and the canal aqueduct.

The introduction of the structure design for the underpass has been provided in Chapter 4 of this EIAR.

5.6.5.1 Overview of works required

The site clearance will be undertaken first to clear the site of vegetation and topsoil to facilitate the site set up. The construction of the proposed underpass will be the most time-consuming element of the works. The proposed underpass is expected to be constructed at the same time as the approach retaining walls. After the other phases are complete the surfacing, barriers, and finishing to the entire project are expected to be installed.

Much of the construction activity south of the railway will be offline and will not affect road traffic. This involves typical longitudinal earthworks and roadworks construction. The proposed project will reuse as much of the excavated material as fill material as possible, and material that cannot be reused will be disposed of at an authorised disposal site.

North of the railway, through access along Mill Lane is likely to be closed from an early stage in the project while access to properties will be maintained throughout the works . Drainage works are likely to progress early in the project with outfall and attenuation being constructed followed by longitudinal drainage elements extending south towards the level crossing. The drainage will pass under the canal and railway and will ensure a positive gravity drainage system for the whole of the Ashtown element of the scheme.

5.6.5.2 Construction methodology

Construction sequencing for different elements of the scheme is presented below:

Rail Underbridge

1. Partially, or wholly demolish existing building to south of railway.
2. Take first railway possession.
3. Install green zone fencing.
4. Install north side railway underbridge corner piles (2No.).
5. Install south side railway underbridge corner piles (2No.).
6. Install bearing plinths to corner piles.
7. Bring railway underbridge on SPMT to railway boundary.
8. Take second railway possession.
9. Take up track.
10. Excavate to approximately 3 m depth to extents of proposed bridge deck and downstand walls (assuming all existing utilities have been diverted).
11. Install ground mats for SPMT (self-propelled modular transporter).
12. SPMT installation of monolithic reinforced concrete railway bridge deck.
13. Install ballast and reinstate tracks.
14. Hand back second railway possession.
15. Install kingposts to temporary retaining wall beneath railway underbridge, top-down construction.
16. Excavate beneath railway underbridge, and canal aqueduct to approx. 12 m in depth.
17. Install reinforced concrete base slab.
18. Install reinforced concrete retaining walls to railway underbridge.
19. Install stone facing wall.

The rail underbridge construction requires work on or near the railway line to install the rail underbridge corner piles, kingpost wall piles if installed prior to superstructure installation, pilecaps and bearings. Preparatory work for these activities will be undertaken within a fenced zone such that access within approximately 3 m of the nearest running edge is possible without the need for a rail possession. Undertaking piling in successive short overnight or weekend possessions reduces the risks to the railway of the rig toppling onto the tracks or temporarily undermining the track support zone. A bored piling rig and a steel sleeve will be used to install the piles and vibration with impact hammer will be required.

Consideration was given to using a crane to install the bridge deck. This may be within the capacity of a crane but could significantly threaten the programme should the main possession happen during a period of high wind.

Canal aqueduct

1. Take possession of canal.
2. Install clay dams.
3. Electro fish.
4. Dewater section of works.
5. Install through flow pipe.
6. Infill canal and install piling mat (assuming infilling the canal would provide protection to existing canal walls and remove the need to excavate in close proximity to existing railway).
7. Install canal aqueduct piles (assuming making use of railway piling rig with different auger).
8. Cut piles down to final level.
9. Install canal aqueduct capping beam.
10. Remove soil from between the piled walls, down to below deck level.
11. Install canal aqueduct deck and permanent retaining walls. Crane in precast deck units, cast in-situ topping.
12. Infill widened towpath, and maintenance strip.
13. Remove canal infill, and clay dams.
14. Hand back canal possession.

For the dewatering works (phase 1 in Table 5-10), approx. 50 m length of canal will be dewatered to facilitate the construction of the underpass and aqueduct. The canal is retained by two temporary new clay dams either side of the structure.

Dewatering will be required with pumps and settlement tanks running 24 hours a day, discharging water back into the canal. The duration needed will be approximately 1 year (from phase 4 to phase 9 in Table 5-10).

5.6.5.3 Roadway drainage

The proposed Ashtown Road Realignment will require a new drainage system to manage surface water runoff. The drainage system will consist of carrier drains located in the traffic lanes which will be fed by traditional kerb side gullies. It is envisaged that carrier drains will be installed following excavation to the proposed roadway formation level. Carrier drains will be installed in trenches which are mechanically dug. Trenches less than 1.25 m in depth will not require trench support. Trenches that are greater in depth than 1.25 m will require trench support either by poling boards, waling and struts, trench boxes or sheet piles for in the case of excessive depths. Gully connections and gully pots will be laid similarly to the carrier drains.

Some of the machinery involved in the construction of the drainage will be: mini-diggers, wheel loaders, excavators, articulated dump truck, concrete mixer truck, generators and cranes as required to carry out different elements of the works (pipes, precast elements, etc.)

5.6.5.4 Construction duration

As shown in Table 5-10 below, the total construction duration of the underpass is estimated at 2 years.

Table 5-10 Overview of construction phasing and methodology.

Ashtown Underpass Description of the activities required:	Approximate duration of works Works (weeks/months)
Phase 1	
Demolish existing building to south of railway, take possession of canal, install clay dams, and dewater canal, infill canal and install piling mat	6 weeks
Phase 2	
Install green zone fencing, install railway underbridge corners piles during short possession(s), construct railway underbridge superstructure offline	2 weeks
Phase 3	
Construct railway bridge superstructure offline	3 months
Phase 4	
Install canal aqueduct abutment piles, install railway underbridge bearing plinths, bring SPMT to railway boundary	2 weeks
Phase 5	
Take 37-hour railway possession, take up tracks, excavate for SPMT superstructure installation, SPMT installation of railway underbridge superstructure, reinstate tracks, hand back possession	2 days
Phase 6	
Install canal aqueduct abutment capping beams, install canal aqueduct beams, deck, and retaining walls, infill widened towpath and maintenance strip, hand back canal possession	3 months
Phase 7	
Install sacrificial kingpost retaining walls to railway underbridge, excavate material from the proposed underpass	6 months
Phase 8	
Install reinforced concrete base slab, install R.C. retaining walls to railway underbridge, install liner walls to canal aqueduct, install stone facing wall, install underpass services & drainage	3 months
Phase 9	
Install approach retaining walls and complete combined sewer diversion	3 months
Phase 10	
Install kerbs, surfacing, finishes and road markings, decommission existing level crossing	1 month
Total Construction Phase	2 years

In order to avoid traffic problems, during the underpass construction the existing level crossing will be kept open. Both the new underpass and the pedestrian bridge will be finished before closing the Ashtown level crossing.

Work duration has been established considering the assumptions defined in Section 5.2.2.

5.6.5.5 Construction compounds and haulage routes

Ashtown Level Crossing main compound (CC-LC-S5-53820-B) is composed of three separate compounds on opposite sides of the Royal Canal, an existing Iarnród Éireann compound southwest of the existing level crossing, Mill Lane on the north and within the grounds of Ashton House (main compound). It is intended that the southern and Mill Lane compound will be satellite compounds for short term storage and construction logistics. Vehicles delivering to the site are expected to access from 1) Ashtown Road and 2) River Road.

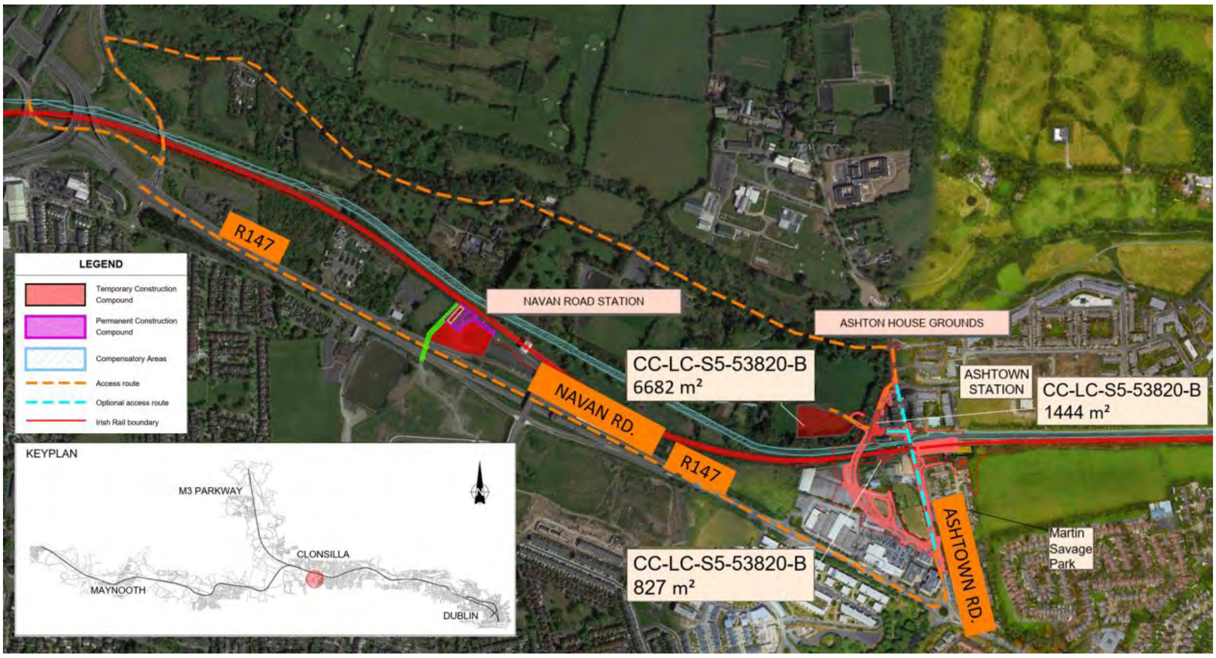


Figure 5-245 Ashtown level crossing compound haulage route

5.6.5.6 Utilities

Utilities affected due to the activities planned for Ashtown Level Crossing have been identified. ESB distribution network crosses Ashtown road, which will have to be diverted. Impacts on the Irish water network have also been detected. Typical works for different utilities diversion or protection has been detailed in Section 5.3.5.

5.6.6 Electrification compound – Navan Road Parkway

5.6.6.1 Overview of works required

A new and permanent Electrification compound will be located in Navan Road, for which a site next to Navan Road Station has been identified. The works will consist of the construction of a Permanent Maintenance Building and the associated infrastructure.

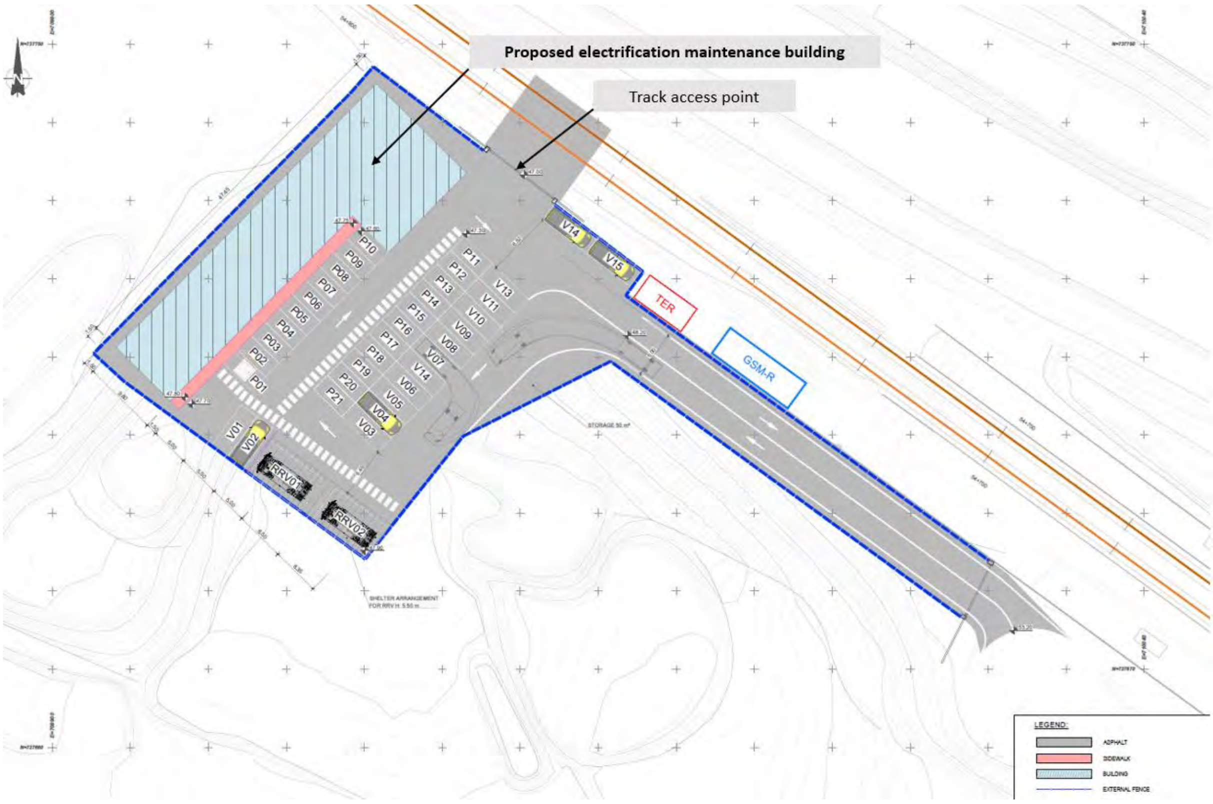


Figure 5-246 Navan Road permanent maintenance compound

5.6.6.2 Construction methodology

The works can be carried out during daytime project construction working hours as set out in Section 5.2.1. The general construction methodology foreseen is as follows:

- Site clearance and enabling works.
- Earthworks.
- Foundations.
- Structure of the building.
- Utilities and CMS connection.
- MEP, architecture, façade and finishes.
- Urban development and landscaping (pedestrian pavements, road network, etc.).
- Fencing and gates.

The works will have an approximate duration of 10 months.

5.6.6.3 Construction compounds and haulage routes

Navan Road SET Compound (CC-SET-S5-54750-B) is located in Ashtown, south of Navan Road station. Vehicles delivering to the site are expected to access from the compound access road off of R147 Navan Road as shown in Figure 5-247.

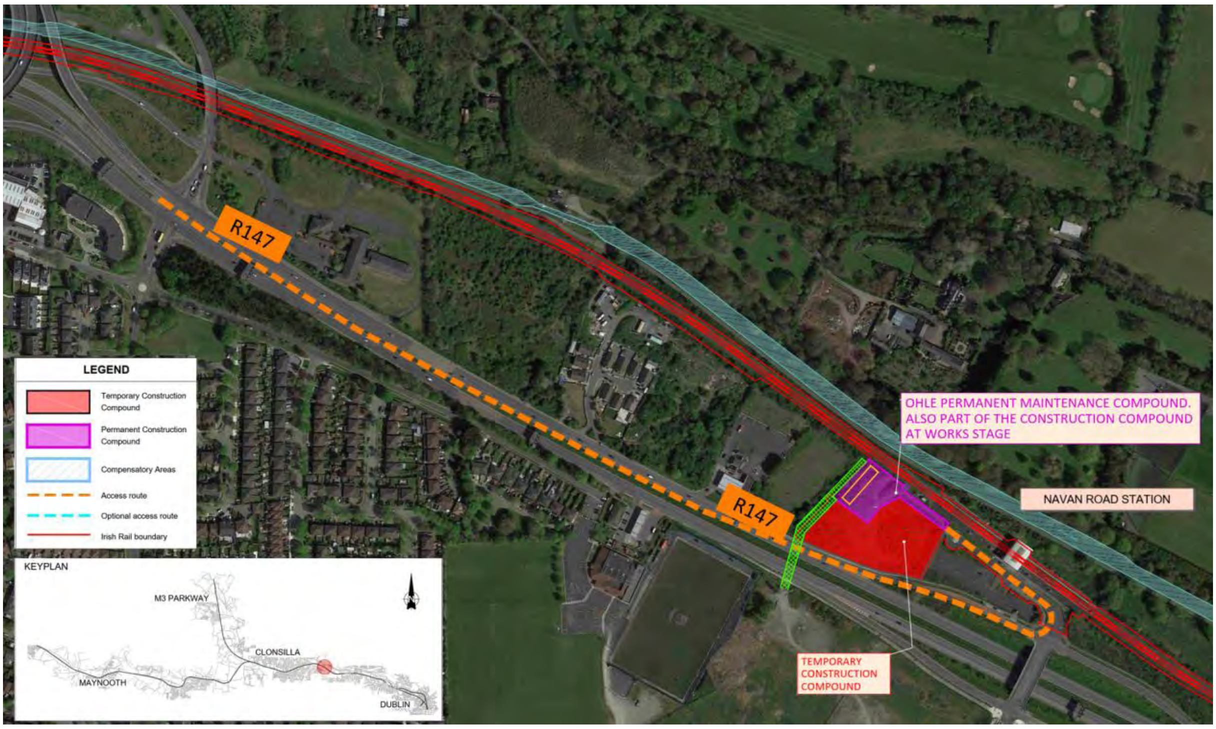


Figure 5-247 Navan Road Station compound and haulage route

5.6.6.4 SET Works

The new Electrification Compound will require access to SET's GigE and MPLS-TP (Electricity) networks. Two access switches will be installed for that purpose. The access switch for GigE will connect to an ODF in Navan Road station TER via fibre. The switch for MPLS-TP (Electricity) will connect to the Electricity optical fibre cable, which runs along the tracks.

5.6.7 OBG6B Dunsink Lane Rail Bridge parapet heightening

5.6.7.1 Overview of works required

OBG6B is located in Blanchardstown just east of Navan Road interchange. Existing parapets on OBG6B are already higher than 1.80 m. In order to protect users and the public from electric shock, works in OBG6B are as detailed in Section 5.3.12.

5.6.7.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG6B will follow the construction scheme in Section 5.3.12.1.

5.6.7.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Castleknock Structures Compound (CC-STR-S5-56460-B) as a parapet heightening compound could be used if required.

5.6.8 OBG6D, OBG6C and OBG7A area track lowering

5.6.8.1 Overview of works required

OBG6D, OBG6C, and OBG7A are all located on the Navan Road interchange in Blanchardstown that connects Navan Road (N3) to the M50 as shown below. Tracks under these bridges are to be lowered to allow for the required OHLE clearance under the OBG7A bridge.

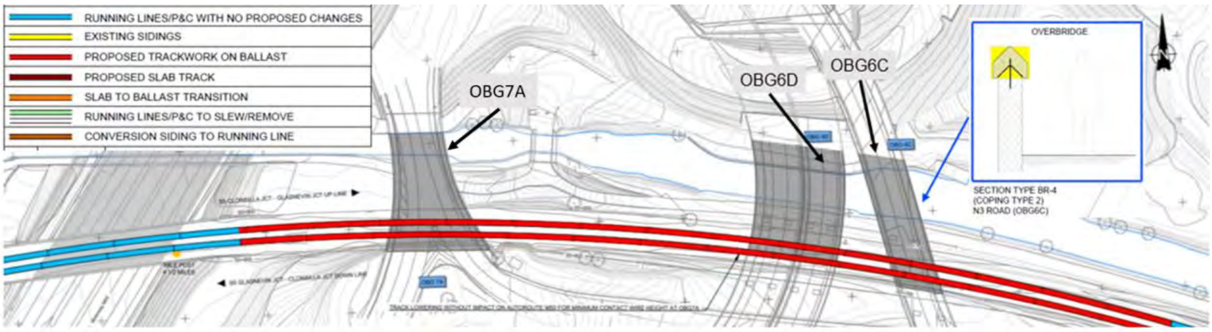


Figure 5-248 Location of OBG7A, OBG6C and OBG6D

A track lowering of up to 338 mm will be carried out below OBG6D, OBG6C and OBG7A along 215 m of track, following the scheme proposed in Section 5.3.6.1.

5.6.8.2 Construction methodology

Performing the track lowering will follow the construction scheme proposed in Section 5.3.6.1. As described in this section, these works will require to be done during night-time/weekend possessions.

The general sequence of works will be as follows:

- Track lowering at M50 Roundabout 3 weeks

5.6.8.3 Construction compounds and haulage routes

The use of construction compound CC-SET-S5-56060-B and CC-SET-S5-56130-B are proposed as they are the closest construction compounds to OBG7A. The construction compounds are located in Blanchardstown, Fingal County on both sides of Old Navan Road bridge, next to the track. Vehicles delivering to the site are expected to access from the compound access road (see Figure 5-254).

5.6.9 OBG6C parapet heightening

5.6.9.1 Overview of works required

OBG6C is located on the N3 road bridge in Blanchardstown. In order to protect users and the public from the OHLE, works in OBG6C are as detailed in Section 5.3.12.

5.6.9.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG6B will follow the construction scheme in Section 5.3.12.1.

5.6.9.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Castleknock Structures Compound (CC-STR-S5-56460-B) as a parapet heightening compound could be used if required.

5.6.10 OBG9 Old Navan Road Bridge modification

5.6.10.1 Deck lifting

The OBG9 is a 13.76 m wide flat deck bridge in Blanchardstown and the modification construction works for this structure will have an impact on access as this road is a cul-de-sac providing access to four houses.

The proposed structural solution for the bridge consists of heavy deck lifting to increase the vertical clearance under the bridge while modifying the access ramps on both sides of the bridge. The required deck lift for this bridge is 320 mm to obtain a sufficient clearance for the OHLE system and not to cause a significant modification of the road alignment.

The construction phase, working time, and detailed construction methodology for deck lifting have been provided in Section 5.3.8.1.2 of this chapter.

Temporary material storage area for this flat deck bridge has been provided as follows:

- OBG9.

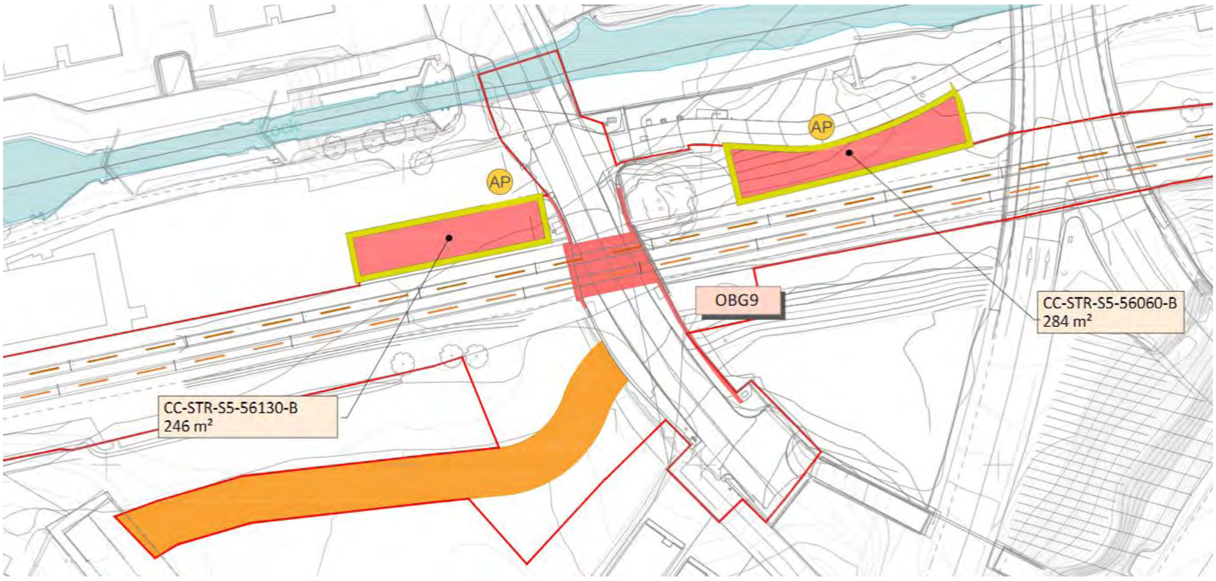


Figure 5-249 Plan of proposed temporary material storage area at OBG9

Figure 5-250 Plan of proposed temporary material storage area at OBG9

Figure 5-251 and Figure 5-252 show the proposed flat deck lifting solution for this bridge.

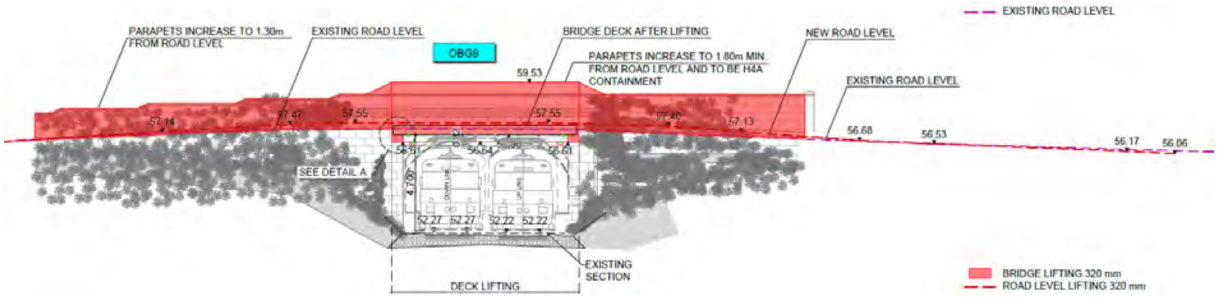


Figure 5-251 Elevation of OBG9 deck lifting

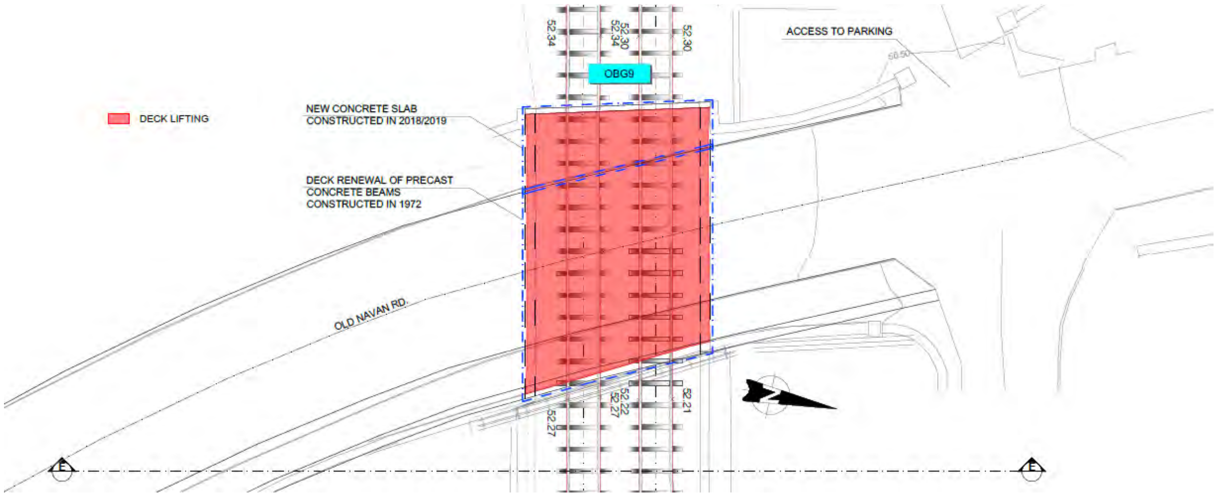


Figure 5-252 Plan of OBG9 deck lifting

The construction sequencing and duration has been proposed in Section 5.3.8.1.2.

5.6.10.2 Traffic diversion during construction

During construction, houses located south of the Old Navan Road bridge require alternative road access. A temporary solution will be required for 9 weeks as outlined in Section 5.3.8.1.2.3. The proposed solution considers a connection road between Ashleigh Green Street and the Old Navan Rd (blue shade) as shown in Figure 5-253.

Pedestrians will also require to be diverted for a period of 7 weeks as outlined in Section 5.3.8.1.2.3. Pedestrian diversion is shown in cyan colour in Figure 5-253 below.

Figure 5-253 Diversion routes during OBG9 construction

5.6.10.3 Construction compounds and haulage routes

OBG9 Structures compounds (CC-STR-S5-56060-B and CC-STR-S5-56130-B) are located on both sides of Old Navan Road bridge, next to the track. Vehicles needing to deliver material or access the compounds will use the N3 road to connect to Old Navan Road to access the compounds.

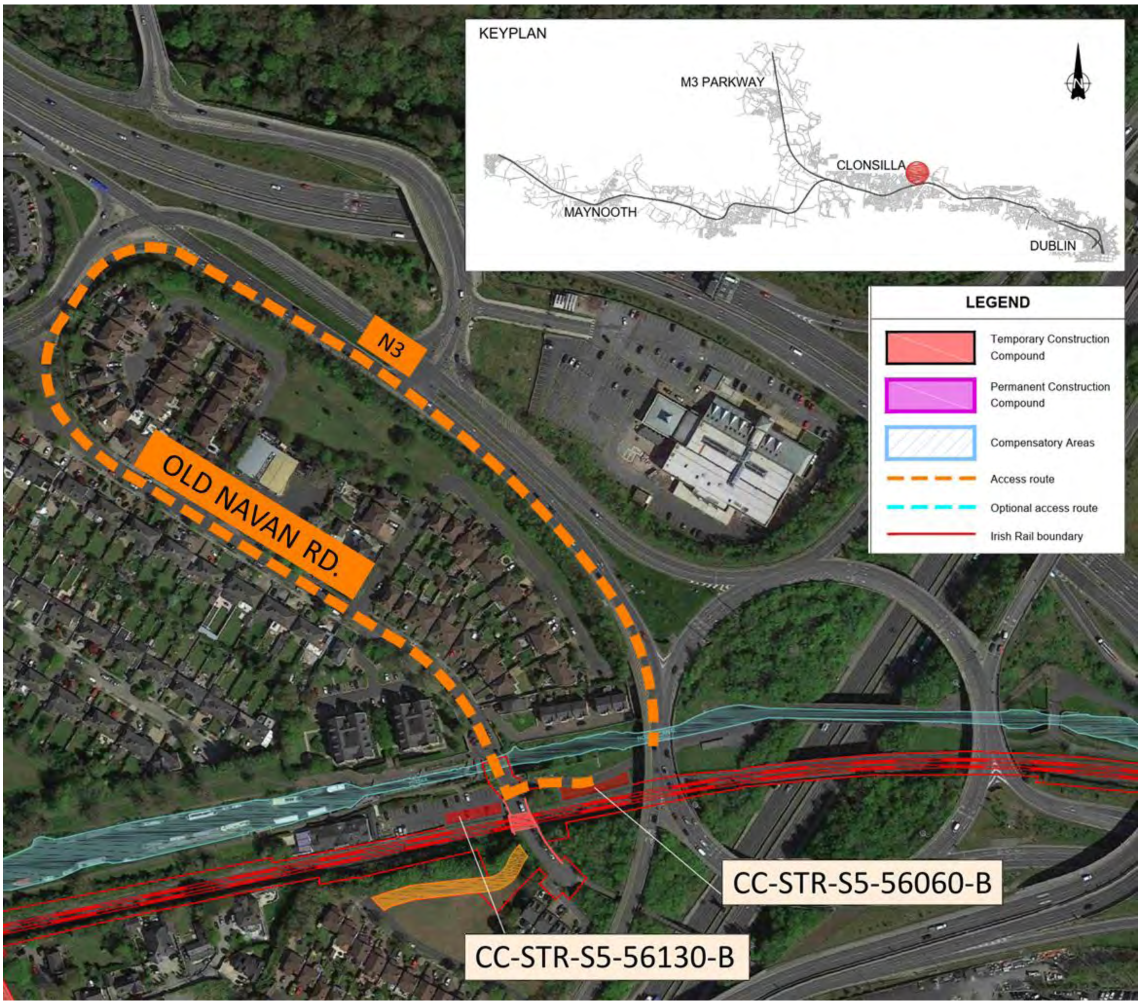


Figure 5-254 OBG9 haulage route

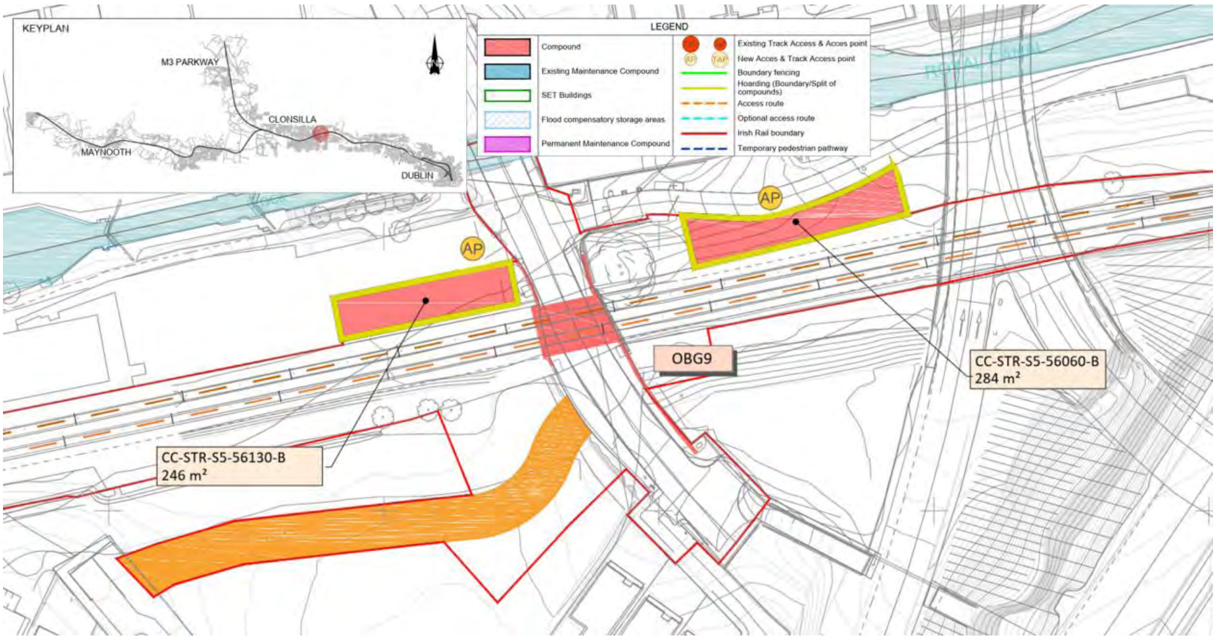


Figure 5-255 OBG9 construction compound

5.6.11 OBG11 Castleknock Bridge modification

5.6.11.1 Deck reconstruction

OBG11 is a 19th-century arch bridge that carries the Castleknock Road over the railway and is located next to the Royal Canal bridge which is listed in the National Inventory of Architectural Heritage (NIAH ref no. 11354002). It is a two-lane bridge with 10.95 m wide span.

To achieve a sufficient vertical clearance for the catenary equipment under the bridge, the precast arch deck solution has been proposed. The existing arch shall be removed. The new arched bridge deck shall be installed 410 mm higher than the original bridge arch position. The existing canal bridge will not be impacted.

The construction phase, working time, and detailed construction methodology have been provided in Section 5.3.8.1.1 of this chapter.

Temporary material storage area for this bridge has been provided as follows:

- OBG11.

Figure 5-256 Plan of proposed temporary material storage area at OBG11

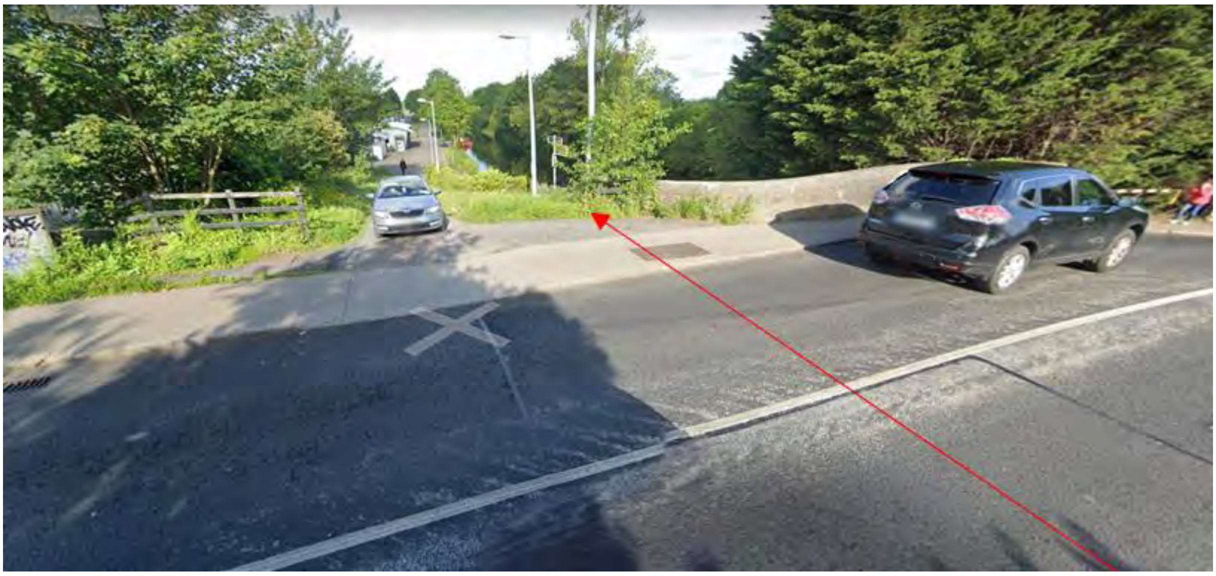


Figure 5-257 3D view of proposed temporary material storage area at OBG11

Figure 5-258 and Figure 5-259 show the proposed precast arch deck solution for this bridge.

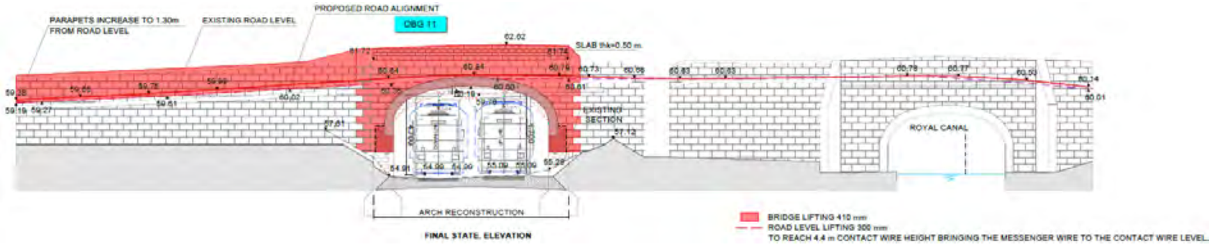


Figure 5-258 Elevation of OBG11 deck reconstruction

Figure 5-259 Plan of OBG11 deck reconstruction

The construction activities and durations for deck reconstruction have been described in Section 5.3.8.1.1 of this chapter for this bridge.

OBG11 Structures compound (CC-SET-S5-56460-B) is located in Castleknock at Ch 56+460. Vehicles delivering to the site are expected to access from the compound access road off Castleknock Road as shown below.

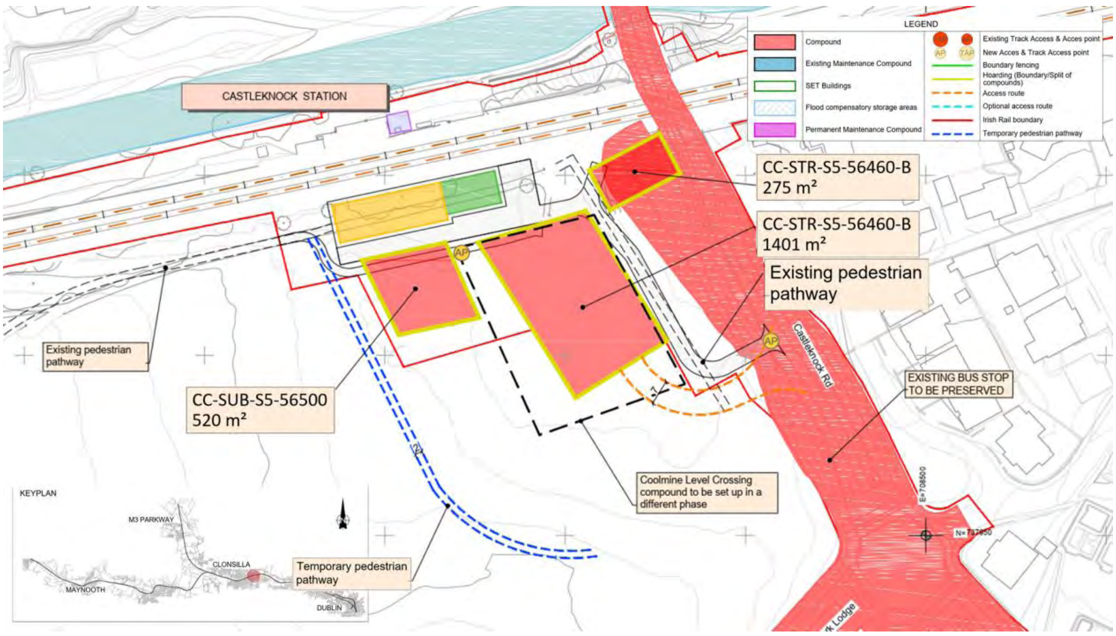


Figure 5-260 OBG11 Castleknock construction compound

5.6.11.2 Traffic diversion during construction

During the bridge reconstruction, road access will be closed, therefore traffic must be diverted. Vehicles needing to cross the bridge can choose between two alternatives, neither of which will require much deviation from the existing route. The first option is crossing the railway and the Royal Canal using Coolmine Road, connecting the north and the south areas though the Coolmine level crossing. Travellers from the southern part of the M50 can cross the railway and the canal by using the M50 junction and the N3 road, which may be faster than using the Coolmine level crossing.

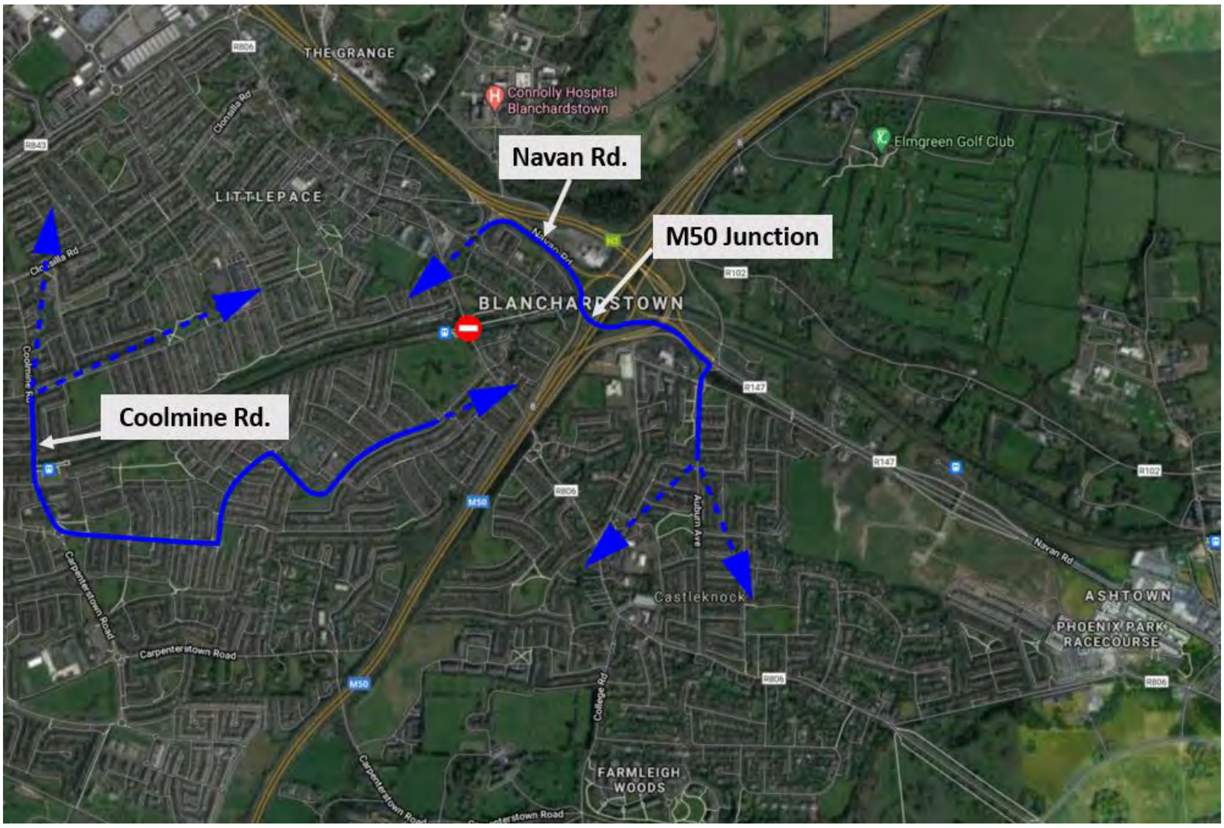


Figure 5-261 Traffic diversion during OBG11 construction

The footbridge in Castleknock station will be used to provide access to pedestrians, as shown in Figure 5-262 below.

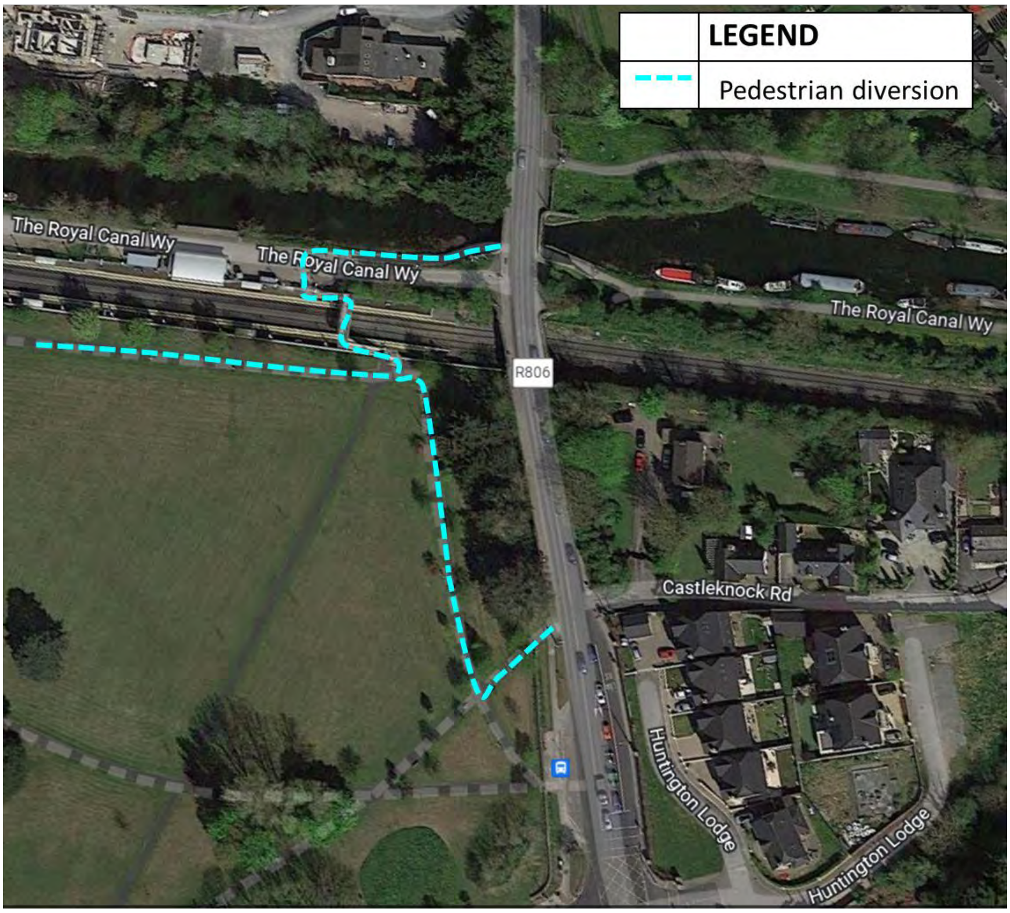


Figure 5-262 Pedestrian diversion during OBG11 construction

5.6.11.3 Construction compounds and haulage routes

Castleknock structures compound (CC-STR-S5-56460-B) is located west of OBG11 and south of the track. Vehicles needing to deliver material or access the compound will use the R806 road into the site, as shown in Figure 5-263.

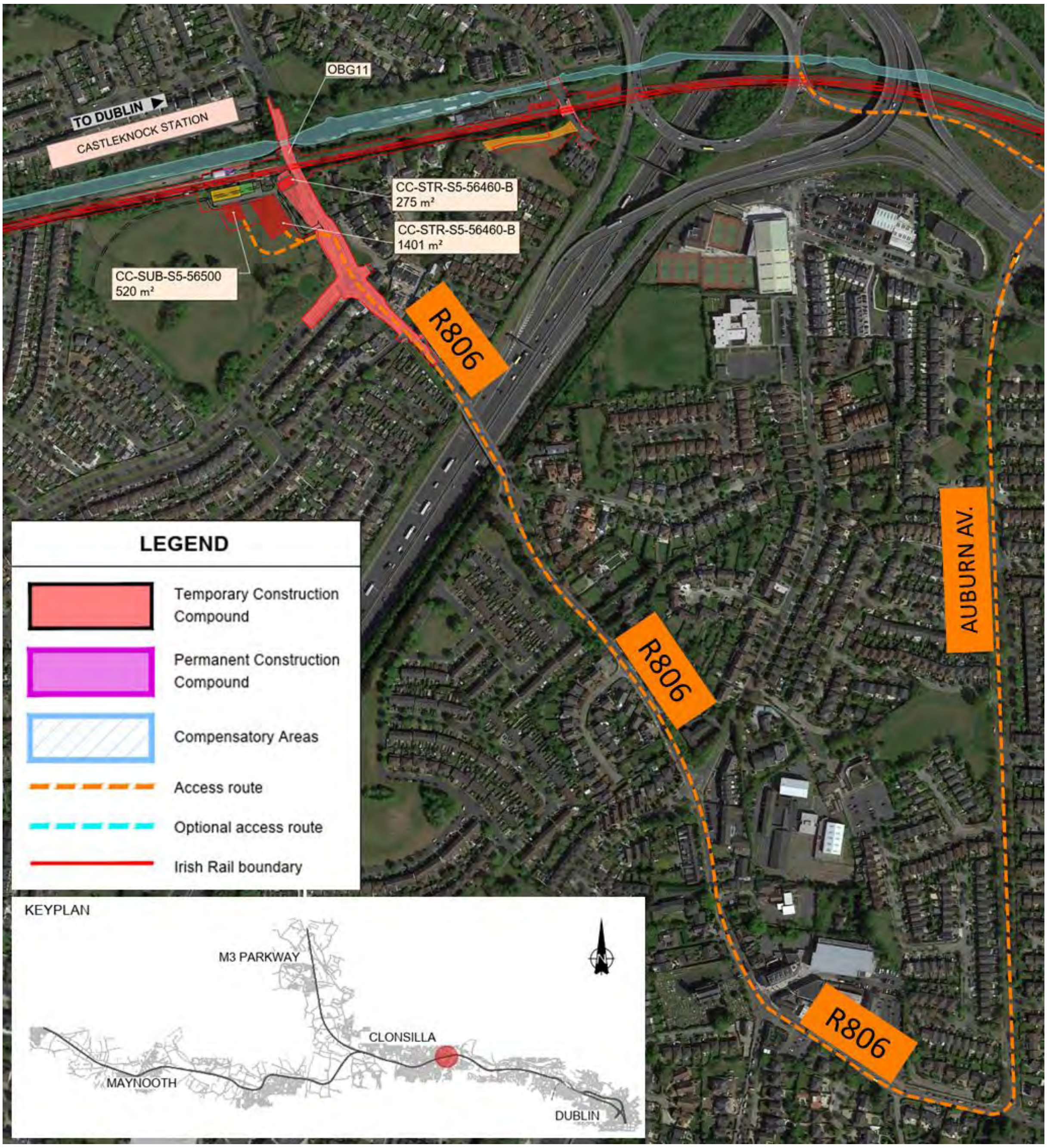


Figure 5-263 Castleknock construction compound and haulage route

5.6.12 OBG11A Castleknock Station parapet heightening

5.6.12.1 Overview of works required

OBG11A is located in Castleknock Station between platforms. Existing parapets on OBG11A are already higher than 1.80 m. In order to protect users from the OHLE equipment, works in OBG11A are detailed in Section 5.3.12.

5.6.12.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG11A will follow the construction scheme in Section 5.3.12.3.

5.6.12.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Castleknock Structures Compound (CC-STR-S5-56460-B) as a parapet heightening compound could be used if required.

5.6.13 Castleknock substation

5.6.13.1 Overview of works required

Castleknock substation will be located at the south of the railway, near the existing R806, on its western side.

5.6.13.2 Construction methodology

The construction method has been detailed in Section 5.3.9.

The duration of works will be as follows:

- Civil works at Castleknock substation 18 weeks
- Equipment at Castleknock substation 12 weeks

5.6.13.3 Construction compounds and haulage routes

Castleknock substation's compound (CC-SET-S5-56500) is located in Castleknock, south of the substation layout. Vehicles delivering to the site are expected to access from the compound access road from the R806 road as shown in Figure 5-264.

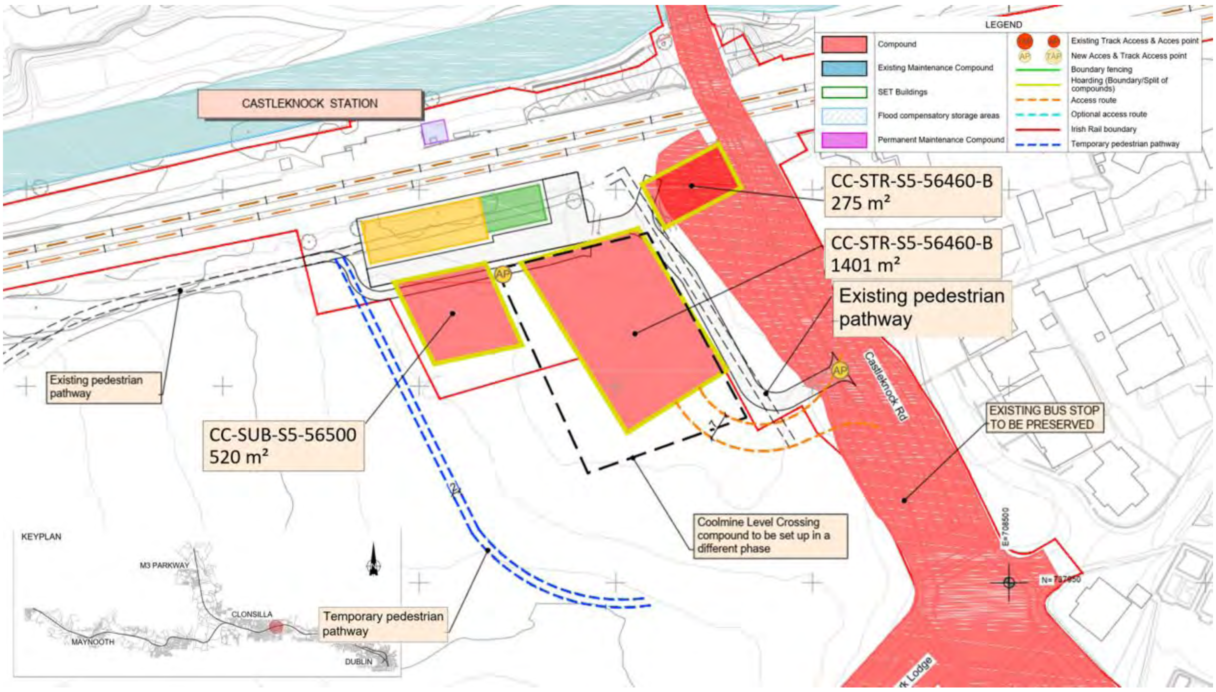


Figure 5-264 Castleknock substation compound

5.6.14 Coolmine substation

5.6.14.1 Overview of works required

The Coolmine substation will be located on a greenfield area next to a residential area, located 400 m east of Coolmine Station.

5.6.14.2 Construction methodology

The construction method has been detailed in Section 5.3.9.

The general sequence of works will be as follows:

- Civil works at Coolmine substation 18 weeks
- Equipment at Coolmine substation 12 weeks

5.6.14.3 Construction compounds and haulage routes

Coolmine substation compound (CC-SUB-S5-57550) is located in Coolmine south of the substation layout. Vehicles delivering to the site are expected to access from the compound and will use the R121 to access Diswellstown Road followed by Riverwood Distributor Road into the sites as shown in Figure 5-265.

Figure 5-265 Coolmine substation construction compound and haulage route

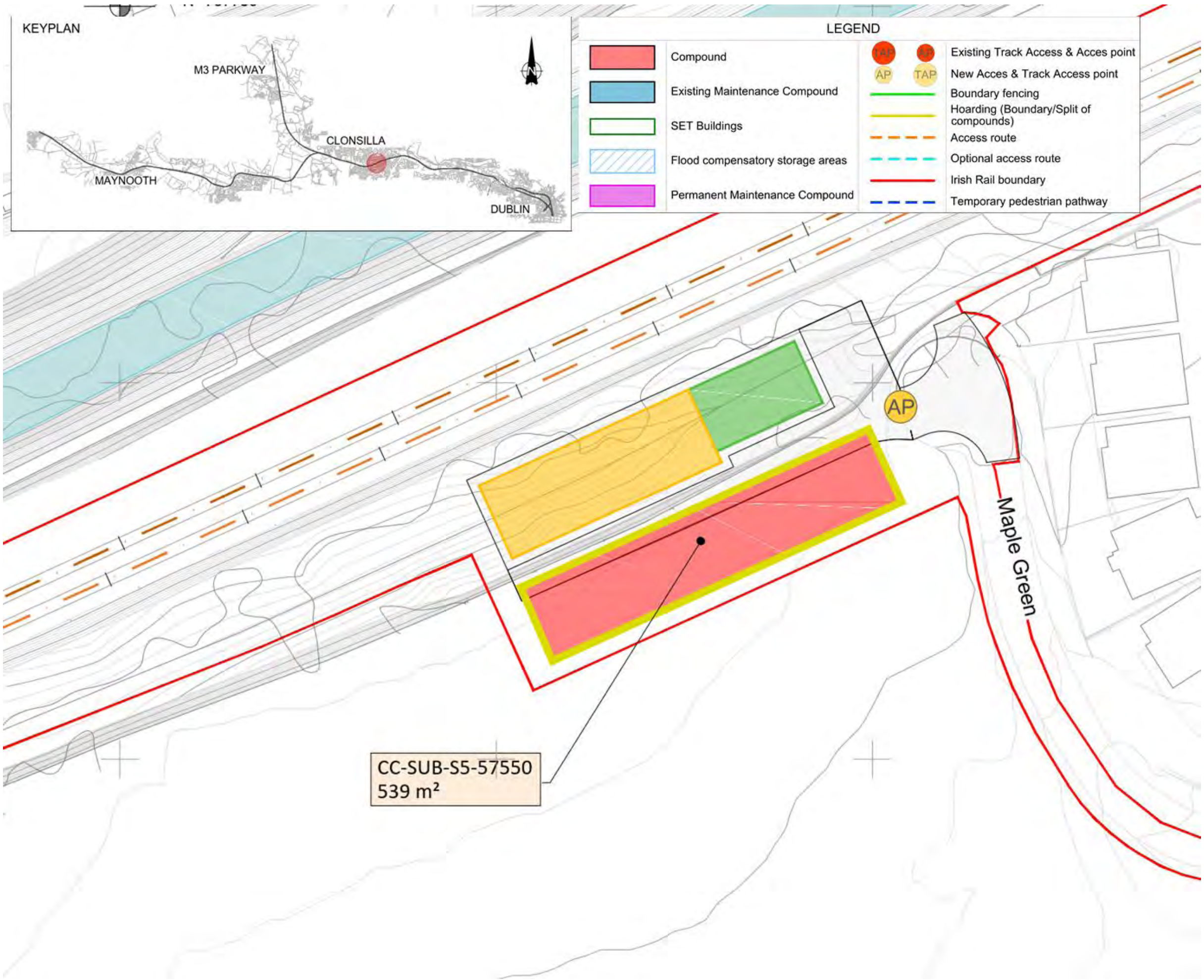


Figure 5-266 Coolmine substation construction compound

5.6.15 Coolmine Station

5.6.15.1 Overview of works required

The current pedestrian bridge at Coolmine Station will be replaced with a new pedestrian and cycle bridge in order to deal with the pedestrian flow increase due to the proposed traffic changes. Figure 5-267 shows the existing infrastructure that requires to be removed/relocated/altered. This includes demolition of the existing canal pedestrian and cycle bridge, the existing station bridge crossing and the bike shelter. The existing station facilities also need to be relocated.

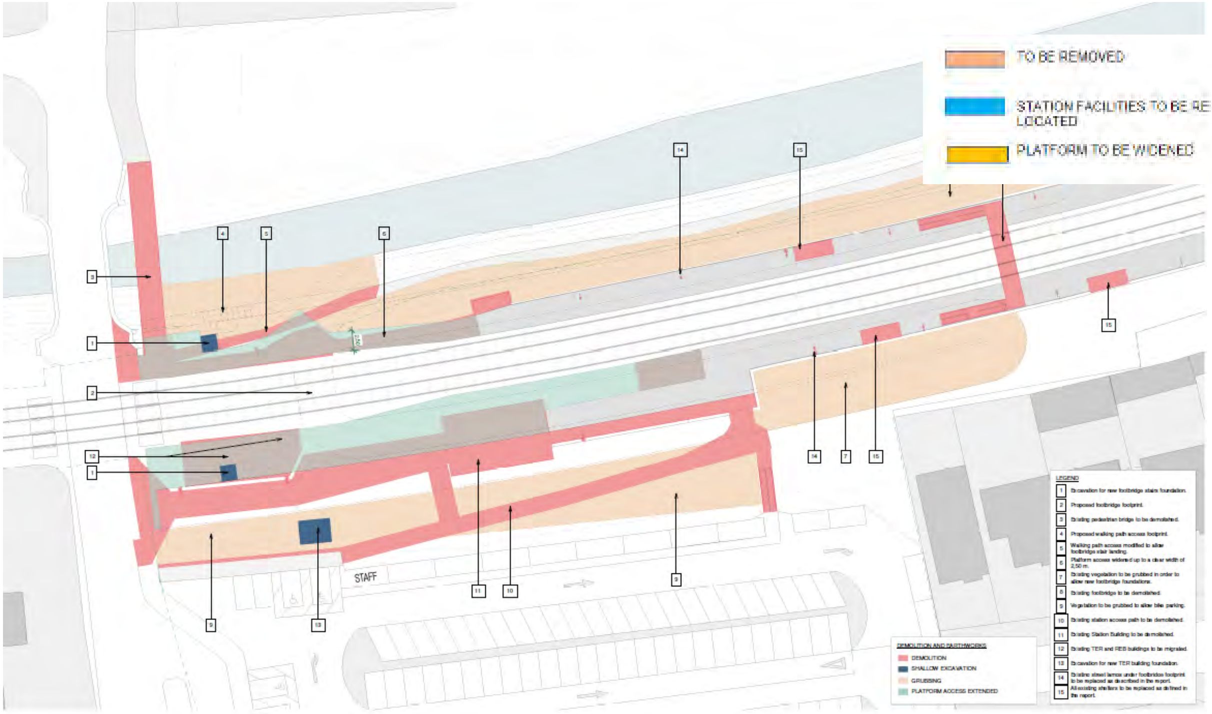


Figure 5-267 Demolition works at Coolmine

The new pedestrian and cycle bridge, as described in Chapter 4, is shown in the figure below.

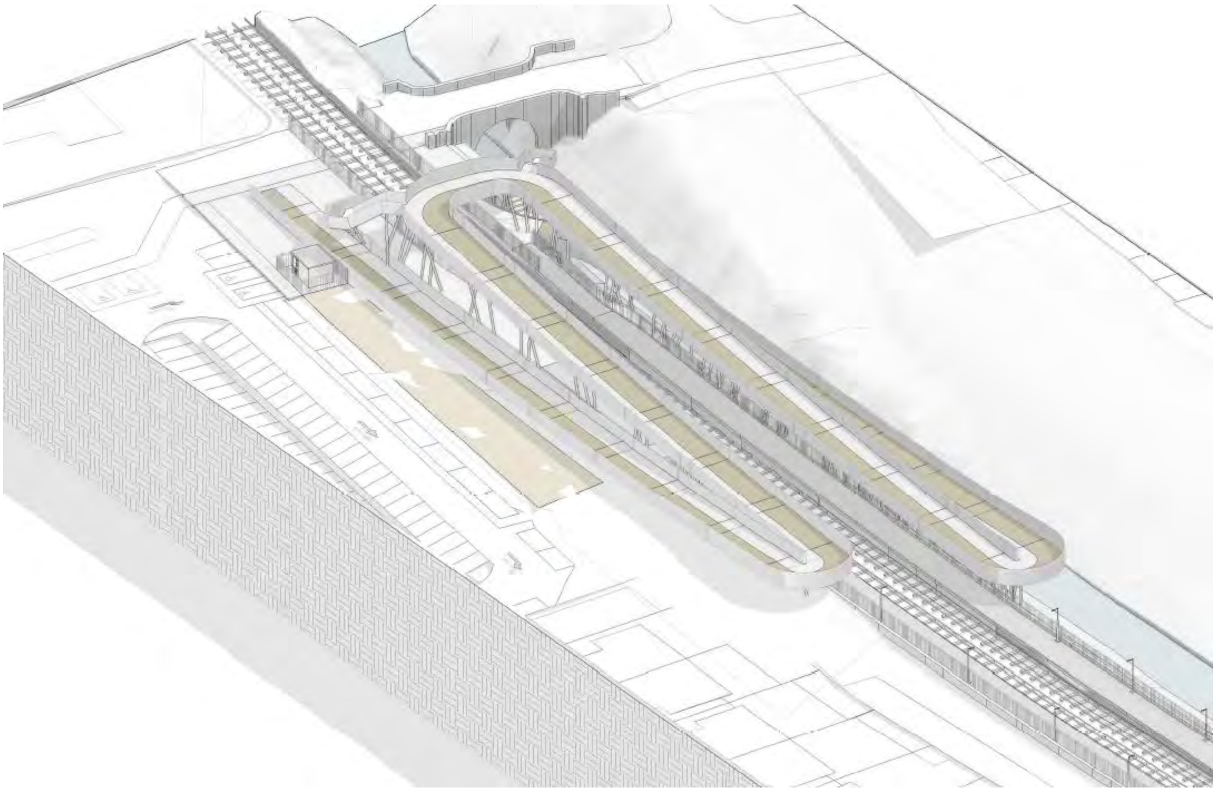


Figure 5-268 Coolmine pedestrian bridge

5.6.15.2 Construction methodology

The construction sequence for the new pedestrian bridge is described below.

Piling for foundations

It is envisaged at this stage of design that the piles to the north of the station platforms can be constructed without having to drain the canal using temporary works such as sheet piling and backfill platforms. However, as a safety precaution it is likely that the canal and the pedestrian footpath will need to be closed during the piling works given the proximity of the piles to these areas for a minimum of 6 weeks.

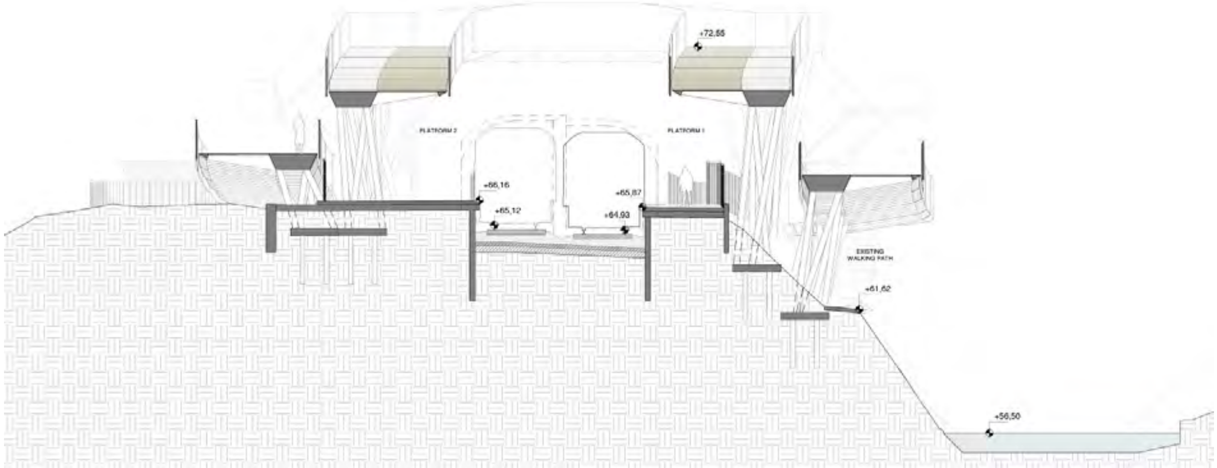


Figure 5-269 Section through Coolmine pedestrian bridge showing foundations

The piles to the south of the railway, relocation of the existing station facilities and the construction of the new substation buildings can be completed during project construction working hours, as set out in Section 5.2.1, in a fenced off area.

The next step is to install the superstructure of the bridge. This will be completed during night-time and weekend possessions.

1. Install superstructure up to bridge deck level using a road rail vehicle crane or crane located on the road.
2. Backfill area around the structural supports.
3. Dismantle existing pedestrian bridge.
4. Install the bridge structure during weekend possession.
5. Architectural finishes and MEP fitout.
6. Platforms and access repair.
7. Install and repair boundary walls and fences.
8. Landscaping.

Equipment required will include mobile crane, road rail vehicle cranes, demolition machinery, excavators, piling rig, concrete trucks, dumper trucks, sheet piling rig.

All works which will affect the railway will be completed during night and weekend possessions. Other works will be during daytime. Total duration for the construction of the pedestrian bridge is approximately 5 months.

5.6.15.3 Construction compounds and haulage routes

Coolmine Station compound (CC-STA-S5-57900) is located in Coolmine, south of the station. Vehicles delivering to the site are expected to access from the compound access road from Carpenterstown Road as shown in Figure 5-270. Vehicles delivering to the site are expected to access from the R121 to access Diswellstown Road followed by Riverwood Distributor Road.

Figure 5-270 Coolmine Station compound and haulage route

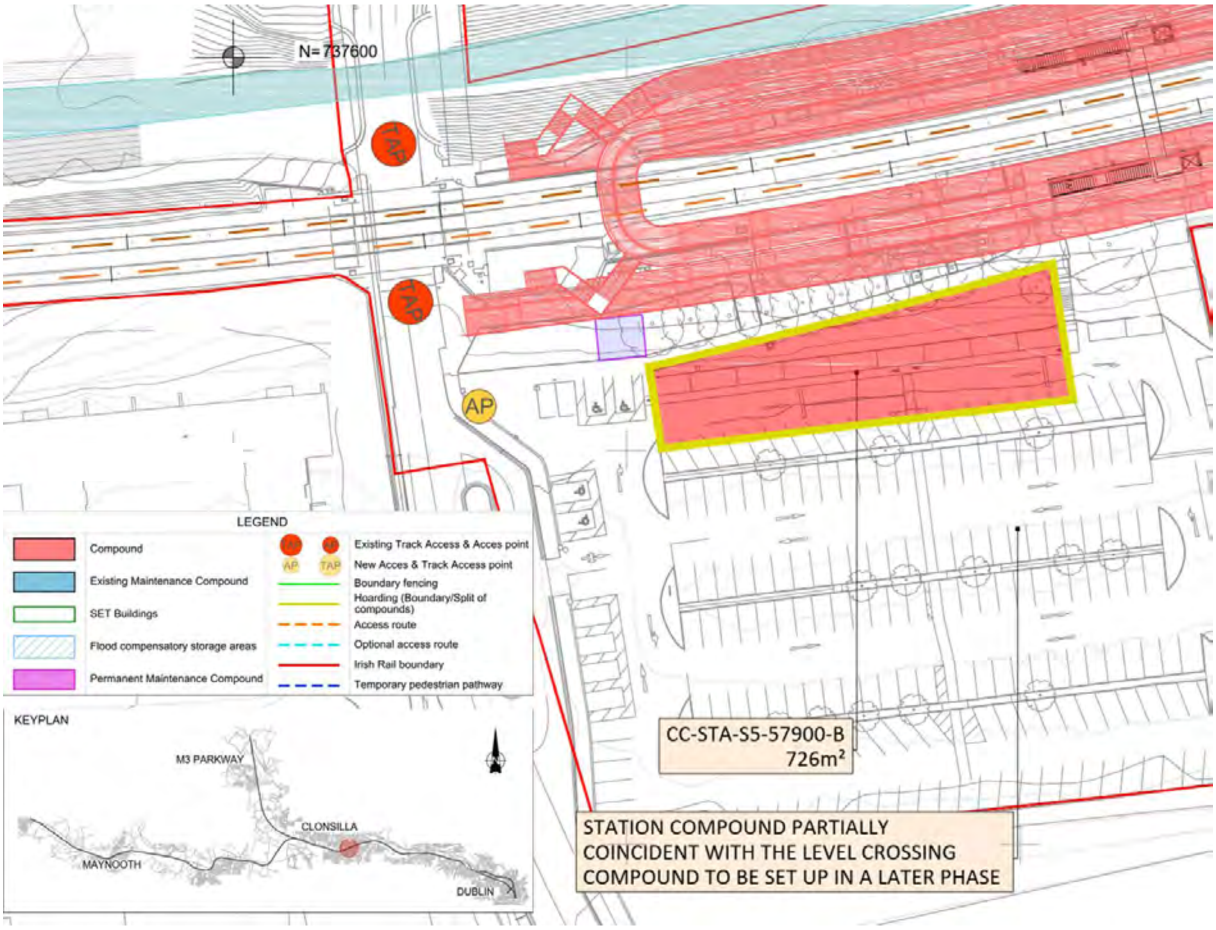


Figure 5-271 Coolmine Station compound

5.6.16 Coolmine level crossing

The introduction of the structural design for Coolmine level crossing has been provided in Chapter 4 of this EIAR.

To maintain transport links following the closure of the Coolmine level crossing a pedestrian and cyclist bridge is to be constructed at the level crossing (reference Section 5.6.15). Four junctions in the vicinity of the level crossing are to be upgraded to cater for displaced vehicular traffic. The junctions include:

- Diswellstown Road/Porterstown Road Junction.
- Porterstown Road Junction.
- Clonsilla Road/Diswellstown Road Junction.
- Castleknock Road/Park Lodge Junction.

5.6.16.1 Overview of works required

Junction works will be undertaken prior to the closure of the level crossing to manage traffic flows during the works. Preparatory works for the construction of the pedestrian and cyclist bridge can be undertaken at the same time as the junction works. To maintain traffic flows and mitigate against possible congestion during the works, the junctions at Clonsilla Road and Diswellstown Road will not be undertaken at the same time. It is envisaged that the Diswellstown Road junction and Castleknock Road junction will be undertaken at the same time. In addition, to reduce disturbance, the Castleknock Road junction works will be undertaken at the same time as the road closure required for the Castleknock Bridge works. Following completion of these junction, the Clonsilla Road and Porterstown Road junction works can be undertaken, followed by the closure of the level crossing and completion of the pedestrian and cyclist bridge works.

Pedestrian and Cyclist Bridge

Details on the pedestrian and cyclist bridge construction methodology have been included in Section 5.6.15 of this document.

Junction Works

At all junctions, except as detailed below, works will be undertaken within the existing carriageway boundaries under temporary traffic management agreed with the Local Road Authority. In all cases, works involved the reconfiguration of the junctions resulting in alteration to kerbs line and associated roadway surfacing and footway paving. Works include:

- Upgrade and reconfiguration of existing signalised junctions.
- Installation of public lighting.
- Pavement construction (roadway and cycle track) and pavement inlay.
- Paving and kerbing.
- Demolition of existing boundary walls.
- Drainage works.
- Utility diversions.
- Protection of existing utilities.
- Soft landscaping.
- Street Furniture including fencing.
- Road marking and traffic signs.
- Traffic management.

Diswellstown Road/Porterstown Road Junction

At Diswellstown Road junction eastern arm, it is envisaged that demolition of the existing boundary walls on the link road will be undertaken first to facilitate set back of the boundary wall and widening of the roadway. Similarly, on the northern arm, the existing roadway is to be widened to the west to facilitate road widening. The earthworks involved in the northern arm widening can be undertaken offline without temporary traffic management. The sequencing of the remainder of the works will be determined by the Contractor. The Contractor will be required to liaise with Scoil Choilm Community School in relation to traffic management.

Castleknock Road/Park Lodge Junction

At the northern arm, the western side of the road is to be widened into Laurel Lodge Park to facilitate additional traffic lanes. The northern arm is bounded by a masonry retaining wall to retain the roadway as it rises over the railway and large mature trees on the park side of the retaining wall. The existing retaining wall will be retained to the underside of the proposed formation level. The existing masonry above formation level will be taken down carefully for reuse as the roadway boundary to retain the existing character of the Castleknock Bridge approach. The widening will be constructed on an earthen embankment, the footprint of which, will extend into Laurel Lodge Park. Earthworks to facilitate the widening can be undertaken offline without disruption to the roadway. Prior to the earthworks operations, an existing ESB substation located within the Laurel Lodge Park will be required to be moved. It is envisaged that this will be undertaken prior to the main works commencing. The sequencing of the remainder of the works will be determined by the Contractor. An existing bus stop is located on the northern arm adjacent to Laurel Lodge Park. It is envisaged that the Contractor will provide a temporary bus stop, in consultation and agreement with Dublin Bus, during the works.

Clonsilla Road/Diswellstown Road Junction

Works on the Clonsilla Road/Diswellstown Road junction are to be undertaken wholly within the existing carriageway extents. The works will be undertaken under temporary traffic management agreed with the local authority and liaison with St. Mochta's National School located on the western arm. Existing bus stops are located on the northern and southern arms. It is envisaged that the Contractor will provide temporary bus stops, in consultation and agreement with Dublin Bus, during the works.

Porterstown Road Junction

At the Porterstown Road junction eastern arm, it is envisaged that the existing stone wall in the Annfield Lawn park area will be carefully taken down for reuse to facilitate widening of the roadway. The remainder of the works are within the existing carriageway boundaries and will be undertaken under temporary traffic management agreed with the Local Authority. The sequencing of the remainder of the works will be determined by the Contractor.

5.6.16.2 Construction methodology

Junction Roadworks

The procedure for the construction of the junction modifications is as follows:

1. Set up construction compounds and welfare facilities.
2. Implement temporary traffic management (including temporary traffic lights if required) and site fencing.
3. Site clearance including any electrical disconnections required.
4. Setting Out.
5. Earthworks including breaking out roadways and footways if required.
6. Utility diversion as required including drainage works.
7. Install subbase.
8. Install kerb lines.
9. Install foundations for public lighting and traffic signals.
10. Reconstruct boundary walls/provide boundary fencing.
11. Footway works.
12. Install public lighting columns and traffic signals and commissioning.
13. Road surfacing works.
14. Install road markings.
15. Substantial completion and opening of new works.
16. Snagging works.
17. Demobilise.

5.6.16.3 Roadway drainage

The proposed works at the 4 junctions at Coolmine will require addition and alteration to the existing drainage network to manage surface water runoff. At some locations, new gullies will be connected to the existing drainage network. At other locations, additional carrier drains will be required which will then be connected to the existing drainage network. It is envisaged that carrier drains will be installed following excavation to proposed roadway formation level. Carrier drains will be installed in trenches which are mechanically dug. A trench that exceeds 1.25 m in depth will not require trench support. Trenches that are greater in depth than 1.25 m will require trench support either by poling boards, waling and struts, trench boxes or sheet piles for in the case of excessive depths. Gully connections and gully pots will be laid similarly to the carrier drains.

Some of the machinery involved in the construction of the drainage will be: mini-diggers, wheel loaders, excavators, articulated dump truck, concrete mixer truck, generators and cranes as required to carry out different elements of the works (pipes, precast elements, etc.)

5.6.16.4 Construction duration

Upgrades to junctions associated with the Coolmine level crossing closure can commence at the same time as the Ashtown Level Crossing replacement works. However, Coolmine junction works must be completed prior to the closure of Coolmine level crossing. Work duration for the junction upgrade construction is estimated at 6 months as shown in Table 5-11 below.

Table 5-11 Overview of construction phasing and methodology, junction upgrades

Pedestrian Cycle and Mobility Impaired Bridges	Approximate duration of works
Description of the activities required:	Works (months)
Phase 1: Diswellstown Road and Castleknock Road Junctions	**3 months**
Phase 2: Clonsilla Road and Porterstown Road Junctions	**3 months**
Total Construction Phase	6 months

The level crossing will be closed after finishing the pedestrian bridge, that way, the pedestrian, and cyclist accessibility will not be affected by the different stages of the construction, keeping a crossing option always available.

5.6.16.5 Construction compounds and haulage routes

Coolmine Level Crossing compound (CC-LC-S5-58670-B) is composed of 4 different compounds. A main compound will be located in grassed area north of the western arm of the Diswellstown Road/Porterstown Road junction. This compound will serve as the main compound for all junctions works, and the Diswellstown Road junction works, and include material storage, office and welfare facilities. Another 3 smaller compounds will be located adjacent to the other junction. These compounds will serve for plant/machinery storage and daily/weekly materials requirements. The compounds will be accessed via the N4 and R843, as shown Figure 5-272.

Figure 5-272 Coolmine level crossing compound and access

5.6.17 OBG11C Diswellstown Road parapet heightening

5.6.17.1 Overview of works required

OBG11C is located in Diswellstown road, just east of Porterstown Level Crossing. Existing parapets on OBG11C are 1.60 m high. In order to protect users from the OHLE equipment, works in OBG11C are as detailed in Section 5.3.12.

5.6.17.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG11C will follow the construction scheme in Section 5.3.12.1.

5.6.17.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Porterstown Level Crossing Compound (CC-LC-S5-58800-B) as a parapet heightening compound could be used if required.

5.6.18 Porterstown level crossing

The introduction of the structure design for Porterstown level crossing has been provided in Chapter 4 Description of the Proposed Development.

Closure of the Porterstown level crossing will require the construction of a pedestrian and cyclist bridge, in addition to urban interventions to upgrade the existing carriageway in the vicinity of the level crossing.

5.6.18.1 Overview of works required

The site clearance will be undertaken first to clear the site of vegetation and topsoil to facilitate the site set up for the site and casting area for deck units. Temporary works in and around the canal will be undertaken first to enable the piling and construction of the approach reinforced earth walls. Precast beams shall be installed during a possession/closure of both the railway and canal. Modifications to the existing highway network can be undertaken at the same time as the bridge construction with landscaping and finishing to the entire project undertaken last.

During construction the Contractor will be required to obtain possessions of the railway from the Divisional Engineer strictly in accordance with Iarnród Éireann’s procedures. Possession will be required for work on, over or adjacent to the Railway. Any work over the Railway and immediately adjacent, i.e. lifting prefabricated sections, installation of parapets, etc. will require absolute possession.

5.6.18.2 Construction methodology

The following section describes the anticipated construction sequence for the proposed pedestrian and cycle bridge in the level crossing of Porterstown:

1. Offsite fabrication of bridge beams and deck slab units.
2. Erect temporary fencing and site clearance.
3. Site Clearance.
4. Excavate to foundation level and uplift as required.
5. Construct insitu reinforced concrete pad/spread foundation.
6. Install bored pile and pile cap for intermediate pier support.
7. Construct in situ piers, crossheads, abutments and retaining walls.
8. Construct reinforced earth/embankment support structure on northern and southern approach ramps.
9. Transport prefabricated beams and slab units to agreed laydown area on both sides of the canal and railway.

10. Crane setup for bridge beam/deck installation including hard standing areas.
11. Install precast bridge beams.
12. Install permanent formwork between bridge beams and between piers.
13. Cast diaphragms.
14. Install precast deck slab units.
15. Cast insitu deck slab along ramped approaches.
16. Install precast reinforced concrete parapet on north face of upper section of south approach ramp under possession.
17. Install parapets.
18. Install surfacing and drainage.
19. Removal of temporary fences and construction of permanent fences and
20. Install remaining finishes and lighting.

It is assumed that the bridge will be constructed prior to railway OHLE being installed. If this is not the case, then OHLE isolation within a possession may be required during some stages of construction.

5.6.18.3 Roadway drainage

The proposed works at the Porterstown level crossing will require alteration to the existing drainage network to manage surface water runoff. New gullies will be connected to the existing drainage network. Trenches for gully connections will typically not exceed 1.25 m in depth and consequently will not require trench support.

Some of the machinery involved in the construction of the drainage will be: mini-diggers, wheel loaders, excavators, articulated dump truck, concrete mixer truck, generators and cranes as required to carry out different elements of the works (pipes, precast elements, etc.).

5.6.18.4 Construction duration

Work duration for the level crossing closure and the bridge construction is estimated around 12 to 14 months as shown in Table 5-12 below.

Table 5-12 Overview of construction phasing and methodology. Pedestrian cycle and mobility impaired bridges

Pedestrian Cycle and Mobility Impaired Bridges	Approximate duration of works
Description of the activities required:	Works (months)
Phase 1: Site clearance	
Vegetation removal, topsoil removal, site set up	1 month
Phase 2: Approaches and public realm	
Excavation, backfilling, kerbs, drainage, footpaths etc.	3-4 months
Phase 3: Bridge substructure	
Pad and piled foundation solution, construct abutments and wingwalls, backfilling	1-2 months
Phase 4: Bridge superstructure	
Install precast pier heads and bridge beams, install permanent formwork, cast deck stitches and deck slab, complete backfilling	2 months
Phase 5: Surfacing, barriers, finishing	
install surfacing, install barriers	1 month
Phase 6: Decommissioning existing level crossing	
Remove existing surfacing, divert services as required, remove existing level crossing controls and barriers, install new boundary treatments	1 month
Total Construction Phase	9 to 12 months

The level crossing will be closed after finishing the pedestrian bridge, that way, the pedestrian, and cyclist accessibility will not be affected by the different stages of the construction, keeping a crossing option always available.

5.6.18.5 Construction compounds and haulage routes

Porterstown Level Crossing compound (CC-LC-S5-58800-B) is composed of two different compounds across both sides of the Royal Canal, in Porterstown. The compound located to the south of the railway will act as the main compound and include plant/machinery/material storage and office and welfare facilities. The compound to the north of the railway will store materials for short durations as required for the works. Construction related vehicles will access the compounds via the N4, R843 and R121, as shown in Figure 5-273.

Figure 5-273 Porterstown level crossing compound

5.6.19 Clonsilla level crossing

The introduction of the structure design for Clonsilla level crossing has been provided in Chapter 4 of this EIAR.

The proposed works at Clonsilla involve the construction of a new cycle/foot bridge over Clonsilla level crossing to facilitate access over the railway and canal. In addition, urban interventions to the existing carriageway are required to facilitate the closure of vehicle access across the level crossing.

5.6.19.1 Overview of works required

The site clearance will be undertaken first to clear the site of vegetation and topsoil to facilitate the site set up for the site and casting area for deck units. Damming and dewatering of the canal will be required to install the foundations under the piers at the north approach ramp. Temporary works in and around the canal will be undertaken to enable the piling and construction of the approach reinforced earth walls. Precast beams shall be installed during a possession / closure of both the railway and canal. Modifications to the existing highway network can be undertaken at the same time as the bridge construction with landscaping and finishing to the entire project undertaken last.

During construction the Contractor will be required to obtain possessions of the railway from the Divisional Engineer strictly in accordance with Iarnród Éireann's procedures. Possession will be required for work on, over or adjacent to the Railway. Any work over the Railway and immediately adjacent, i.e. lifting prefabricated sections, installation of parapets etc. will require absolute possession.

5.6.19.2 Construction methodology

The following points describe the construction sequence for the proposed bridge:

1. Offsite casting of precast prestressed bridge beams.
2. Erect temporary fencing and site clearance.
3. Damming and dewatering of the canal. This will be required to install the foundations under 3 no. piers at the north approach ramp.
4. Install piled foundations or install in-situ reinforced concrete spread foundations subject to detailed geotechnical investigation.
5. Construct insitu abutments and pier crossheads.
6. Construct reinforced earth/embankment support structure on northern and southern approach ramps.
7. Cast deck slab on precast prestressed beams in laydown area.
8. Install precast deck units and parapets over railway and canal. Absolute possession required for the placement of the main span over the railway.
9. Install permanent formwork between bridge beams and between piers for ramps.
10. Cast diaphragms.
11. Cast insitu deck slab along ramped approaches.
12. Install steel guardrails.
13. Install surfacing and drainage.
14. Removal of temporary fences and construction of permanent fences.
15. Install remaining finishes and lighting.

The bridge construction will require work on or near the rail to install the bridge foundations and substructure. It is assumed that the bridge will be constructed prior to railway OHLE being installed. If this is not the case, then OHLE isolation within a possession may be required during some stages of construction.

For the dewatering works, discrete sections of canal along a 60 m length of the northern bank will be locally narrowed and dewatered to facilitate the construction of the pad foundations for the access ramp. A sheet pile coffer dam will be installed and dewatered with pumps and settlement tanks running 24 hours a day discharging water back into the canal. The duration needed will be approximately 3 months (phase 3 in the table below).

5.6.19.3 Roadway drainage

The proposed works at the Clonsilla level crossing will require alteration to the existing drainage network to manage surface water runoff. New gullies will be connected to the existing drainage network. Trenches for gully connections will typically not exceed 1.25 m in depth and consequently will not require trench support.

Some of the machinery involved in the construction of the drainage will be: mini-diggers, wheel loaders, excavators, articulated dump truck, concrete mixer truck, generators and cranes as required to carry out different elements of the works (pipes, precast elements, etc.).

5.6.19.4 Construction duration

Works at Clonsilla cannot begin until the new Barberstown overbridge is finished. The estimated total duration is approx. 12 – 14 months.

Table 5-13 Overview of construction phasing and methodology. Pedestrian cycle and mobility impaired bridges

Pedestrian Cycle and Mobility Impaired Bridges	Approximate duration of works
Description of the activities required:	Works (months)
Phase 1: Site clearance	
Vegetation removal, topsoil removal, site set up	1 month
Phase 2: Approaches and public realm	
Excavation, backfilling, kerbs, drainage, footpaths etc.	3-4 months
Phase 3: Canal works	
Installation of temporary works (sheet pile coffer dam and dewatering of part of the canal) to enable bridge foundations to be installed.	3 months
Phase 4: Bridge substructure	
Pad and piled foundation solution, construct abutments and wingwalls, backfilling	1-2 months
Phase 5: Bridge superstructure	
Install precast pier heads and bridge beams, install permanent formwork, cast deck stitches and deck slab, complete backfilling	2 months
Phase 6: Surfacing, barriers, finishing	
install surfacing, install barriers	1 month
Phase 7: Decommissioning existing level crossing	
Remove existing surfacing, divert services as required, remove existing level crossing controls and barriers, install new boundary treatments	1 month
Total Construction Phase	12 to 14 months

The level crossing will be closed after finishing the pedestrian bridge, that way, the pedestrian, and cyclist accessibility will not be affected by the different stages of the construction, keeping a crossing option always available.

5.6.19.5 Construction compounds and haulage routes

Clonsilla Level Crossing compound (CC-LC-S5-60150-B) is composed of two different compounds across both sides of the Royal Canal, in Clonsilla. Construction related vehicles will access the site compounds via the N4, R843 and R121 from the north and N4, R843, Diswellstown Road and Porterstown Road from the south.

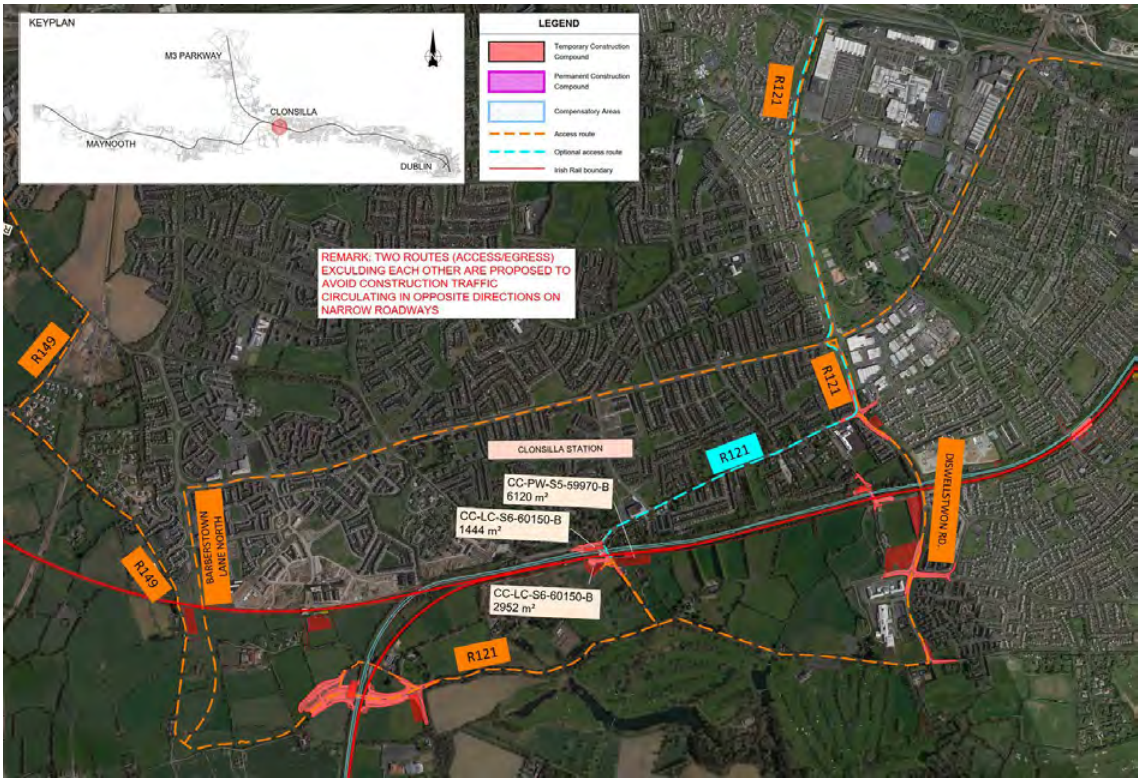


Figure 5-274 Clonsilla level crossing compound haulage route

5.6.20 Clonsilla siding

5.6.20.1 Overview of works required

The existing siding located in Clonsilla, starting from the west, must be extended to be 296 metres in length. The existing track measuring 176 m shall be renewed, and a new track measuring 120 m shall be added as an extension. If the existing track's quality is deemed acceptable, the vertical and horizontal alignment will be modified according to the method explained in Section 5.3.6.2 at detailed design stage.

Additionally, some aspects must be considered:

- P10-10 Siding access turnout and trap point: A later Detail Design phase will establish whether the current turnout and trap point will be used or replaced by new ones.
- Vertical alignment: the longitudinal gradient of the siding, currently 1 in 333, is modified not to exceed the 1 in 500 established in the standard.
- Horizontal alignment: Siding track has to be slewed 500 mm to ensure a least 3400 mm separation with the adjacent running line.
- Superstructure renovation: The replacement of the existing superstructure will be considered depending on their conditions.
- Friction buffer stop: A friction buffer stop will be installed with 6 m track in front of the buffer with a 12 m run-out length plus additional 8 m (obtaining 20 m of Exclusion zone).

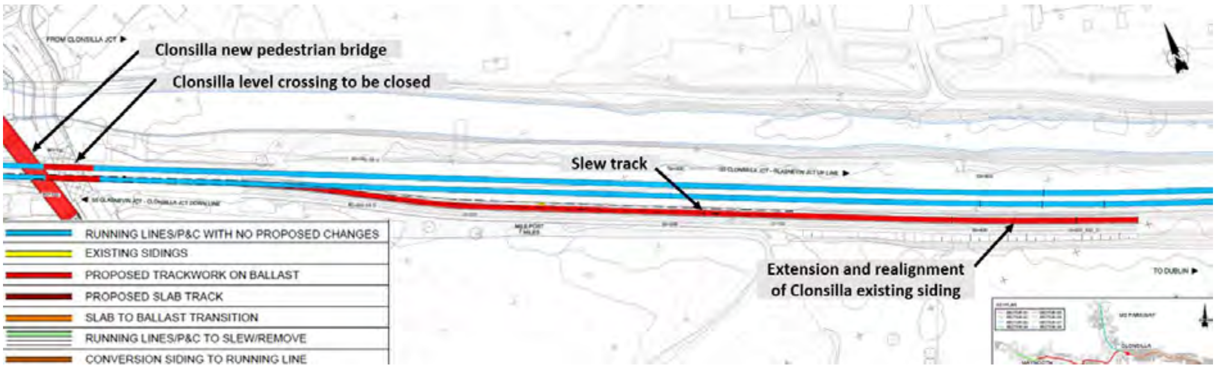


Figure 5-275 Location of Clonsilla siding

The siding can be extended without impacting the existing signalling system.

5.6.20.2 Construction methodology

For the construction of the new track, the following steps must be followed:

1. Enabling works.
2. Removal of existing turnout and replacement with the new one (full weekend possession).
3. Rail cut and track panel removal.
4. Removal of degraded ballast.
5. Excavation of the track formation until desired level.
6. Extension of first ballast layer, levelling and compaction.
7. Lay preassemble track panels and connect them with provisional joints.
8. Extension of second ballast layer, tamping and dynamic stabilisation.
9. Welding of joints and second stabilisation.
10. Rail stressing.

The estimated duration for the construction is approximately 1.5 months, working during the nights and the weekends. Some works can take more time (fencing, drainage, etc.).

5.6.20.3 Construction compounds and haulage routes

Clonsilla Siding compound (CC-PW-S5-59970-B) is composed of a compound on the South riverbank of the Royal Canal, in Clonsilla. Vehicles needing to access the site will do so using the compounds' access route from R121, as shown in Figure 5-277.

An area of approximately 22 m x 34 m is required to be fenced off within the Clonsilla Siding compound in order to protect the barrow site AH04. Refer to Chapter 20 Archaeological & Cultural Heritage for more information.

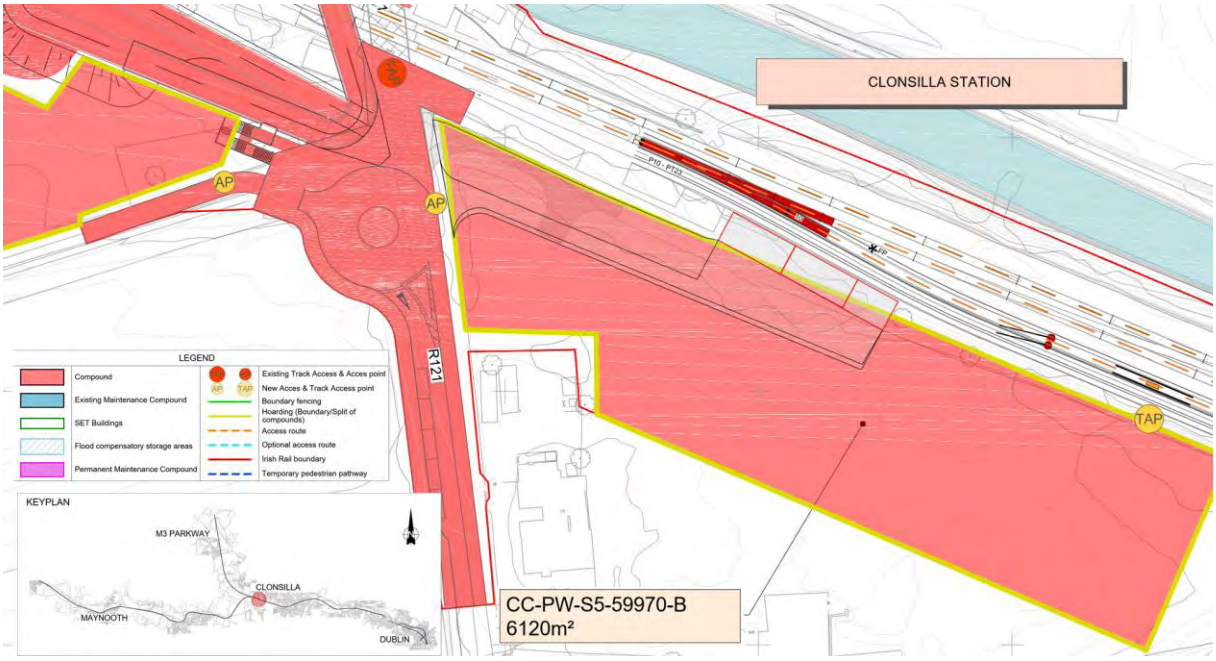


Figure 5-276 Clonsilla permanent way compound

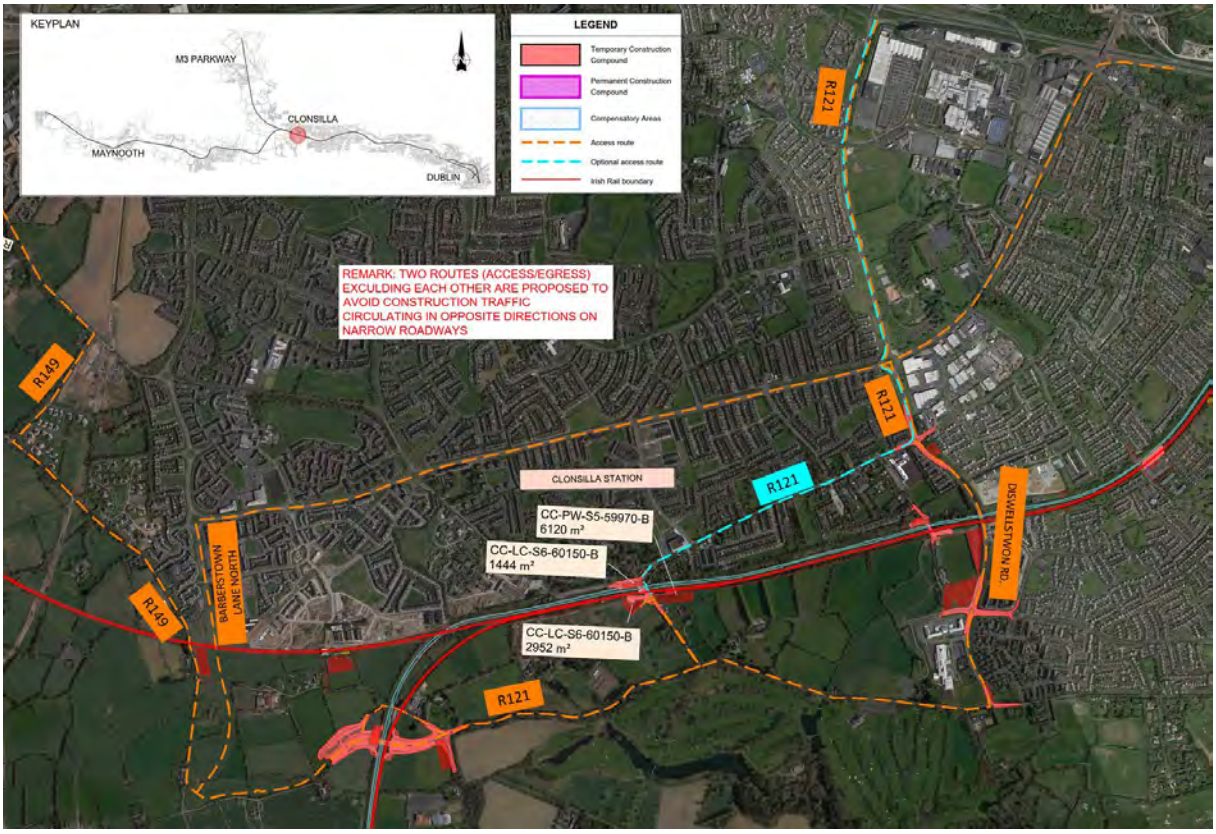


Figure 5-277 Clonsilla permanent way compound haulage route

5.6.21 OBG12 Clonsilla Station parapet heightening

5.6.21.1 Overview of works required

OBG12 is located in Clonsilla Station, between platforms. Existing parapets on OBG12 are 1.20 m high. In order to protect users from the OHLE equipment, works in OBG12 are as detailed in Section 5.3.12.

5.6.21.2 *Construction methodology*

Construction of the aforementioned parapet heightening works on OBG12 will follow the construction scheme in Section 5.3.12.3.

5.6.21.3 *Construction compounds and haulage routes*

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Clonsilla Level Crossing Compound (CC-LC-S5-60150-B) as a parapet heightening compound could be used if required.

5.6.22 OBG12C Clonsilla Station platform parapet heightening

5.6.22.1 *Overview of works required*

OBG12C is located in Clonsilla Station between platforms. Existing parapets on OBG12C are 1.60 m high. In order to protect users from the OHLE equipment, works in OBG12C are as detailed in Section 5.3.12.

5.6.22.2 *Construction methodology*

Construction of the aforementioned parapet heightening works on OBG12C will follow the construction scheme in Section 5.3.12.3.

5.6.22.3 *Construction compounds and haulage routes*

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Clonsilla Level Crossing Compound (CC-LC-S5-60150-B) as a parapet heightening compound could be used if required.

5.6.23 Other SET works

5.6.23.1 *Signalling works*

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling include:

- Modifications to the existing signalling system for the removal of the following level crossings:
  - Ashtown (after the underbridge is finished, described in Section 5.6.5).
  - Coolmine (during Phase 6 described in Table 5-11).
  - Porterstown (during Phase 7 described in Table 5-12).
  - Clonsilla (during Phase 7 described in Table 5-13).
- The new signalling system will be commissioned without these level-crossings.
- For the track works related to the Clonsilla siding explained in Section 5.6.20, these can be done while the existing signalling system is in service without modifying it because the new turnout is almost at the same location of the existing one and the new track section of the siding will be commissioned with the new signalling system.

The specific signalling works for this area can be performed during regular night possessions or when there is a longer possession due to track works, so additional impact on passenger services is not expected due to signalling works. Night services such as freight trains could be affected, especially during test periods.

5.6.23.2 *LV power works*

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling include:

- Clonsilla. Removal of the existing connection from existing DNO/DC to the existing PHCCs. The existing PHCCs will be connected to the new DNO/DC.

- Clonsilla. Turnouts 251A and 251B will be moved from the existing location to a new one. Their heaters and electrical installation will be disassembled and will be reassembled in the new location.

These works are performed during night-time, not impacting railway passenger services.

5.6.23.3 Telecoms works

The following construction activities will occur in Zone C:

- The new trunk cables will be connected to the new DART+ West nodes/buildings in this area, see details in Section 5.3.9.1 (i.e. Broombridge TER, Ashtown TER, Navan Road Parkway TER, Castleknock TER, Coolmine TER, Porterstown TER, Clonsilla SEB, Ashtown substation, Castleknock substation and Coolmine substation).
- The cabling will also be connected to the new DART+ West trackside LOCs and cabinets in this zone (OHLE, Signalling and LV cabinets) and other buildings (PSP).
- OHLE Navan Road Permanent compound will be connected to the optical fibre network.
- Telecoms equipment will be installed in the new TERs, SEB, PSP and substation buildings. There will be reconditioning of re-used TER (Clonsilla).
- Telecoms equipment will be installed in new trackside LOCs and cabinets.
- New telecoms infrastructure (optical fibre, copper, structured cabling, Station LOCs) will be installed in the following stations: Broombridge, Pelletstown, Ashtown, Navan Road Parkway, Castleknock, Coolmine and Clonsilla, including new station end points (e.g. CCTV cameras, CIS displays, PA speakers, etc.).
- Basic testing onsite without live railway interaction.

No impact on passenger services is expected, as these works will be carried out during night possessions (e.g. installation of new trunk cables), or during daytime (e.g. installation of new station elements) as per agreement with SET.

In the next sections, Zone C areas with major construction works are described.

5.6.23.3.1 Ashtown

The existing station TER is co-located with the REB. This building will not be impacted by the construction works of the new Ashtown pedestrian bridge.

A new Station TER will be built to host the new equipment and cabling to provide connectivity to the Telecoms Station subsystems (PA, CCTV, PID, etc.). The decommissioning of the existing Station TER will imply the recovery of all the legacy telecoms systems associated with it (i.e. different types of Telecoms cabling, CCTV cameras, PA speakers, etc.).

Figure 5-278 Existing and proposed TER at Ashtown

In addition, the decommissioning of the existing Level Crossing will imply the recovery of all the legacy telecoms systems associated with it i.e. Lineside telephones and CCTV cameras, see Phase 10 in Table 5-10.

There will be no impact in passenger services for any of the works above, as these will take place during night-time.

5.6.23.3.2 Coolmine Station

The construction of the new pedestrian and cycle bridge will impact the existing station TER and the REB. A new TER will be built in the location shown in the figure below. Before the existing building is demolished, the new TER will have to be commissioned to provide connectivity to all station services (e.g. CCTV, PA, CIS, etc.).

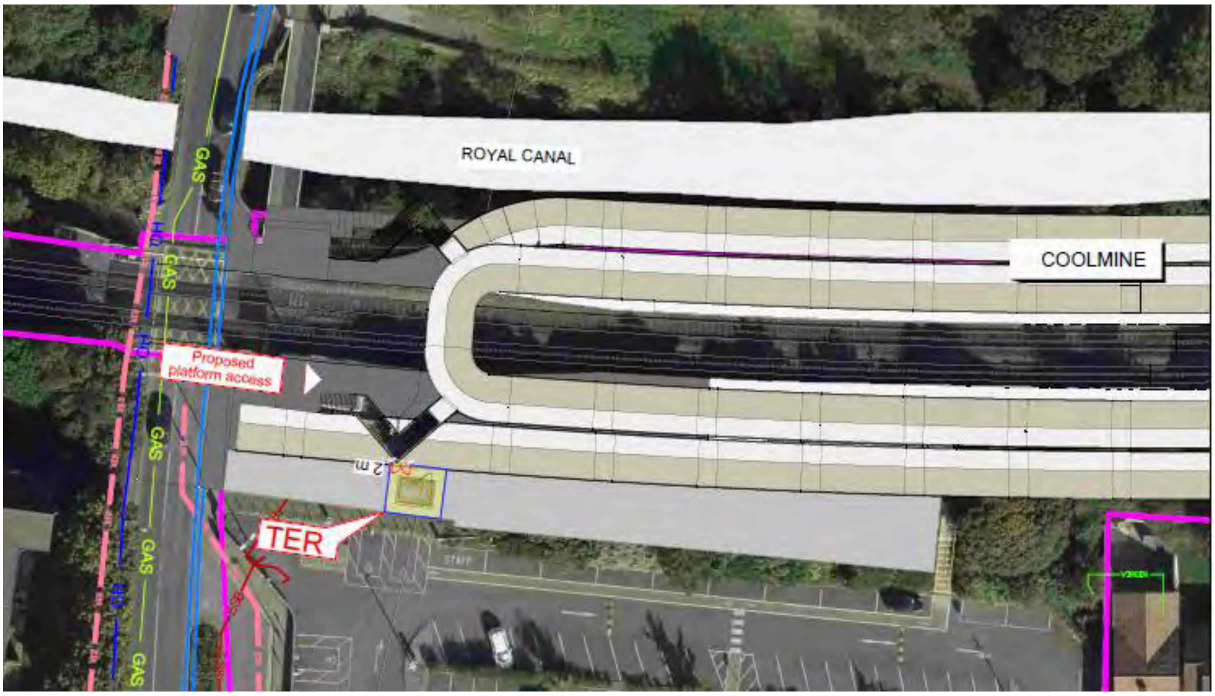


Figure 5-279 Proposed TER location at Coolmine station

Any trunk cables which are currently connected to the REB (e.g. trunk copper cable) will be replaced with new cables, and they will be connected to both the REB and the new TER (in parallel). Once the new TER is commissioned and the LC signalling equipment decommissioned, the existing REB can be demolished.

The decommissioning of the existing Level Crossing will imply the recovery of all the legacy telecoms systems associated with it i.e. Lineside telephones and CCTV cameras, see Phase 6 in Table 5-11.

5.6.23.3.3 Porterstown

A new TER will be built to host all equipment necessary for the HABD (Hot Axle Box Detector) system installed at Porterstown. The installation of the TER will follow the same methodology as a station TER, as they have the same size. The location of this new building can be seen in Figure 5-280.

No impact on passenger services is expected, as the installation of the TER and a potential new HABD detector on the DOWN track, will be carried out during night possessions.

Figure 5-280 New TER for HABD at Porterstown

5.6.23.4 Electrification works (HV/OHLE/SCADA/IESS)

- Installation of elastic bridge arms/OHLE supports to support the OHLE, insulators to support the feeder wires and earth wire clamps at OBG9, OBG7C and OBG7A.
- Installation of earth wire clamps to support the earth wire to the structure at (and insulators to support the feeder wires where applicable) at OBG12C, OBG12, OBG11C, OBG11N, OBG11A, OBG11, OBG6D, OBG6C, OBG6B, OBG5 and OBG4A.
- OHLE feeding connections and MOS installation from Ashtown, Castleknock and Coolmine substations, and mainline OHLE MOS.
- General electrification works for the OHLE installation (as described in 5.3.9.1 SET buildings and cabinets and 5.3.9.6 Overhead Line Equipment (OHLE)) that will generally comprise single track cantilever structures (including twin track cantilevers, portals and wall fixings in some particular locations).

The specific electrification works for this section within Zone C can be performed during regular night possessions or when there is a longer possession (i.e. weekends), so additional impact on passenger services is not expected due to these electrification works.

5.7 Description of Construction Works in Zone D – Clonsilla Station to M3 Parkway Station

Zone D stretches from Clonsilla Junction to M3 Parkway Station and is approximately 7500 metres in length, from Ch 100+000 to Ch 107+500. Works in this section will include:

- Hansfield, Dunboyne and M3 Parkway substations.
- OBCN286 and OBCN290 track lowering.
- OBCN290, OBC290A, OBCN291 and OBCN295A parapet heightening.
- M3 Parkway sidings.
- SET installation (as described in Section 5.7.10).

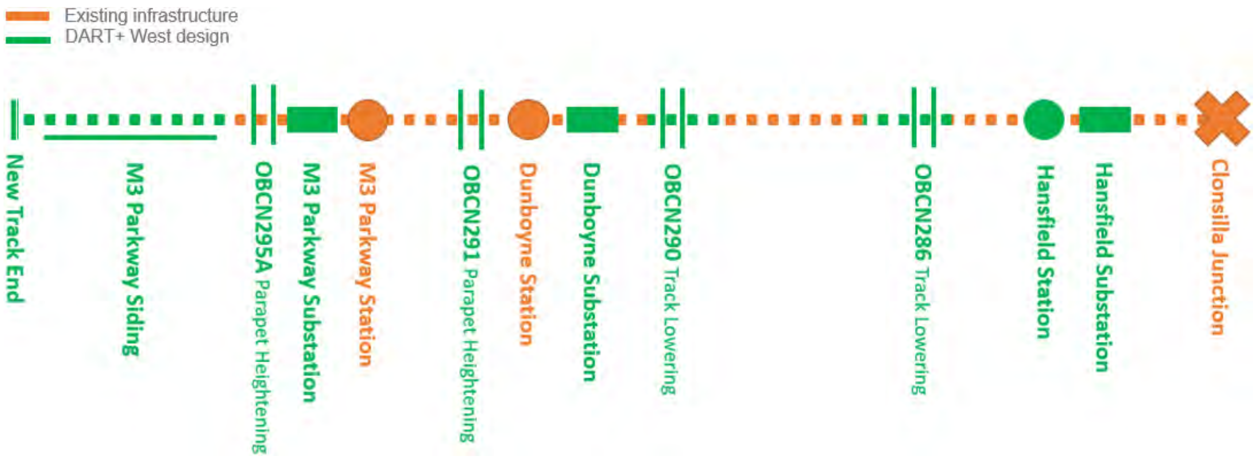


Figure 5-281 Schematic of DART+ West construction activities in Zone D

Early works will include compound installation for track lowerings and other works, as well as utilities diversions. Due to the linear nature of these works, several utility diversion works have been identified in Zone D (described in Chapter 18 of this EIAR) and will require temporary traffic measures. The typical construction methodology used for utility works has been detailed in Section 5.3.5. Typical temporary traffic measures required during the Construction Phase are outlined in Section 5.12.3.

The required construction compounds to carry out the construction works within Zone D are outlined in Table 5-14.

Table 5-14 Construction compounds in Zone D

Compound code	Chainage	Reference	Discipline
CC-SUB-S8-101070	101+070	Hansfield	Substations
CC-PW-S8-101660	101+660	OBCN286	Permanent Way
CC-PW-S8-104970-B	104+970	Dunboyne	Permanent Way
CC-SUB-S8-105060	105+060	Dunboyne	Substations
CC-PW-S8-106950-B	106+950	M3 Parkway PW	Permanent Way
CC-SET-S8-106950-B	106+950	M3 Parkway SET	SET
CC-SUB-S8-106950	106+950	M3 Parkway SUB	Substations

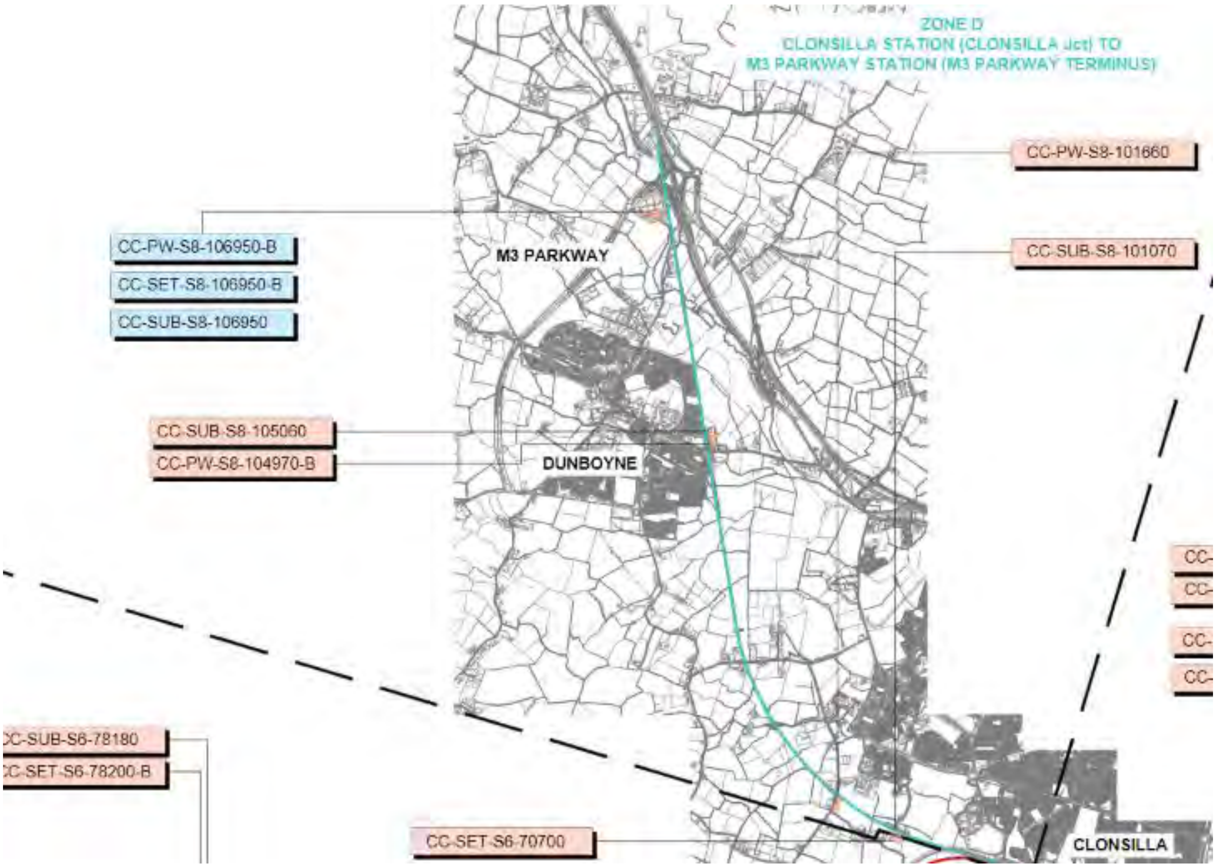


Figure 5-282 Zone D compounds

All works proposed in Zone D have been organised from east to west, following the structure established in Chapter 4 of this EIAR.

A construction compound located in M3 Parkway (CC-SET-S8-106950-B) at Ch106+950 will serve the SET requirements of the zone. Vehicles delivering to the site are expected to use the access road adjacent to the existing maintenance compound located south of the station's building, as shown in Figure 5-283.

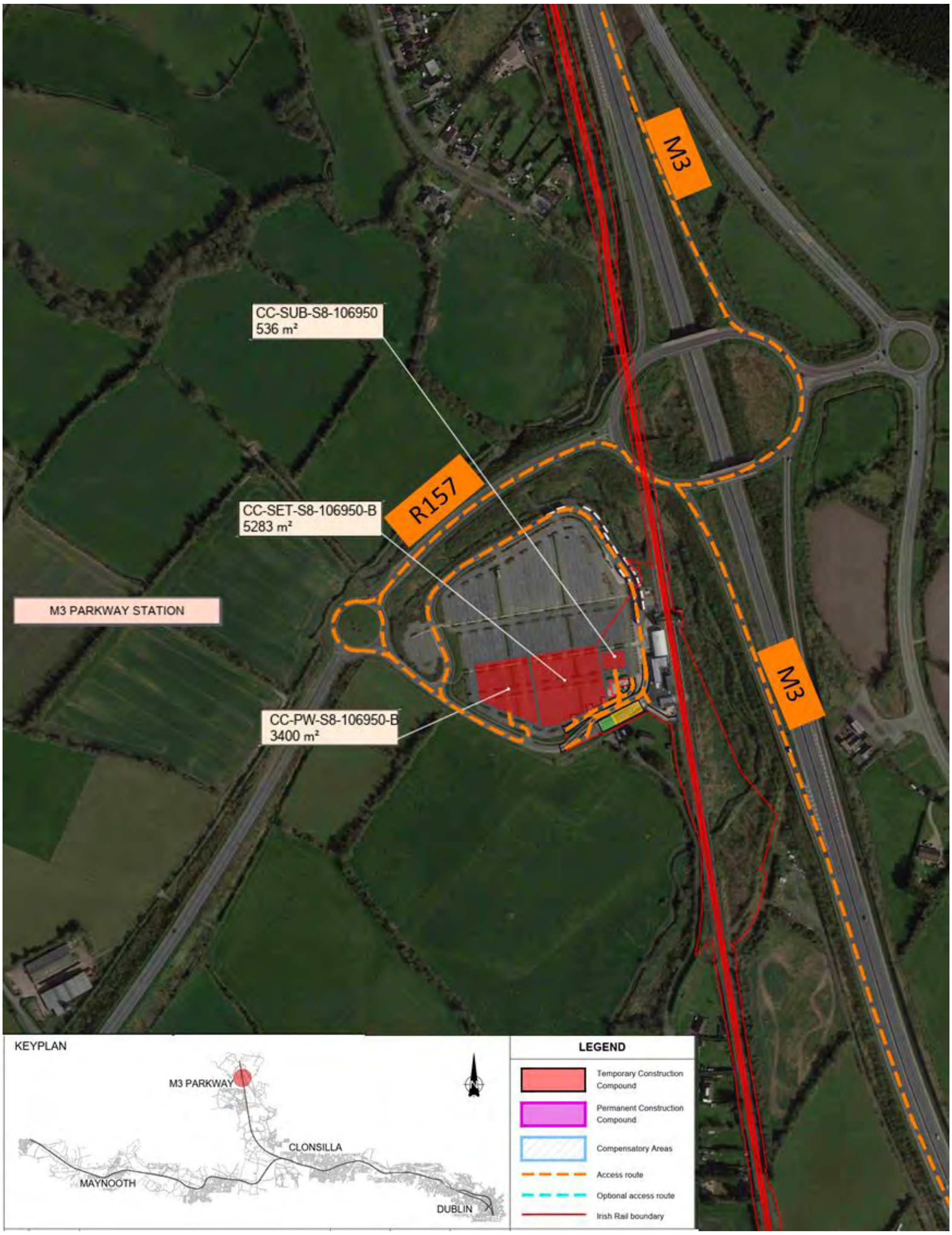


Figure 5-283 M3 Parkway SET compound and haulage route

5.7.1 Hansfield substation

5.7.1.1 Overview of works required

The Hansfield substation will be located at the south of the railway, near Hansfield Station, on its eastern side.

5.7.1.2 Construction methodology

Construction of the substation will follow the methodology outlined in Section 5.3.9.

The duration of the works will be as follows:

- Civil Works at Hansfield substation 18 weeks
- Equipment at Hansfield substation 12 weeks

5.7.1.3 Construction compounds and haulage routes

Hansfield substation's main compound (CC-SUB-S8-101070) is located in Hansfield, south of the substation layout. Vehicles delivering to the site are expected to access from Barberstown Lane North located south of the site using the compound's access route, as shown in Figure 5-284. Note that the access route will be partially located out of IÉ's boundaries.

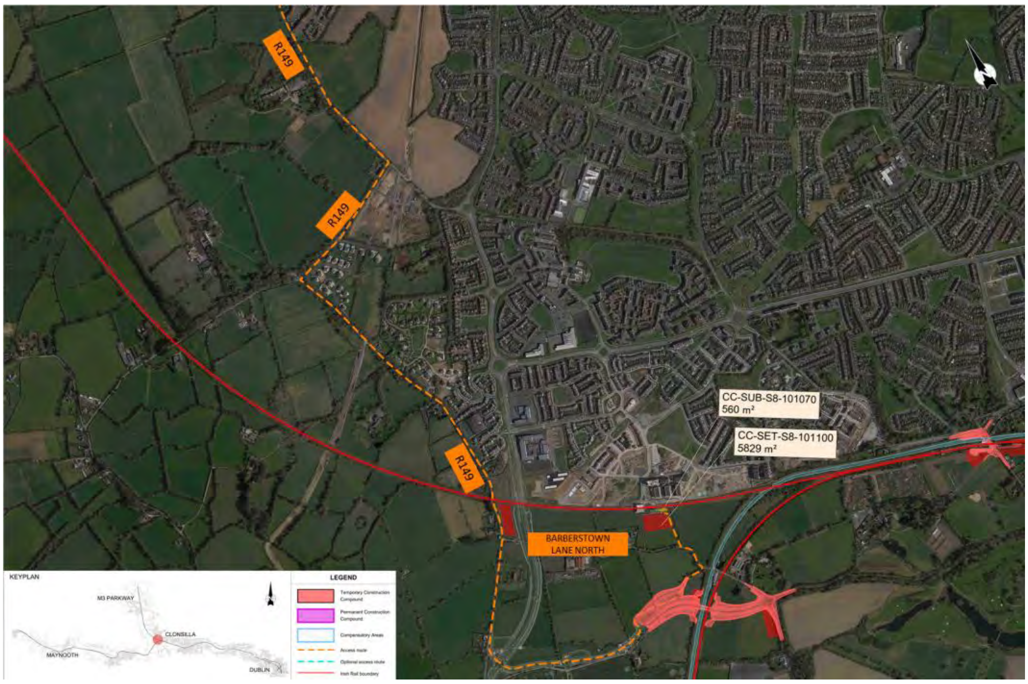


Figure 5-284 Hansfield substation compound and haulage route

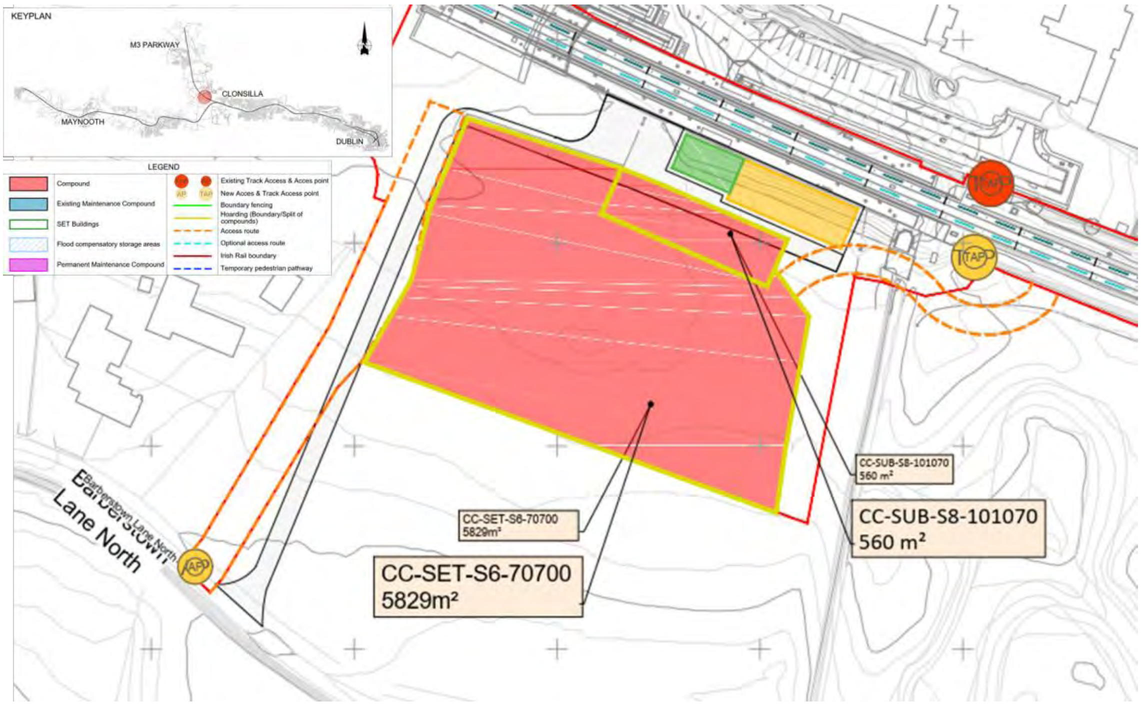


Figure 5-285 Hansfield substation compound

5.7.2 OBCN286 Barnhill Bridge – track lowering

5.7.2.1 Overview of works required

Track lowering of up to 357 mm will be carried out below OBCN286 Barnhill Bridge along 325 m of the track to obtain the required OHLE clearance.

5.7.2.2 Construction methodology

Performing the track lowering will follow the construction sequence proposed in Section 5.3.6.1. As described in this section, track lowering works will need to be completed during night-time and/or weekend possessions.

The general sequence of works will be as follows:

- Track lowering at OBCN286 4 weeks

5.7.2.3 Construction compounds and haulage routes

OBCN286 bridge track lowering main compound (CC-PW-S8-101660) is located west of this bridge. Vehicles delivering to the site are expected to access using the compounds access road off Barberstown Lane North, as shown in Figure 5-286. Vehicles needing to deliver material or access the compounds will use R149 road into the site.

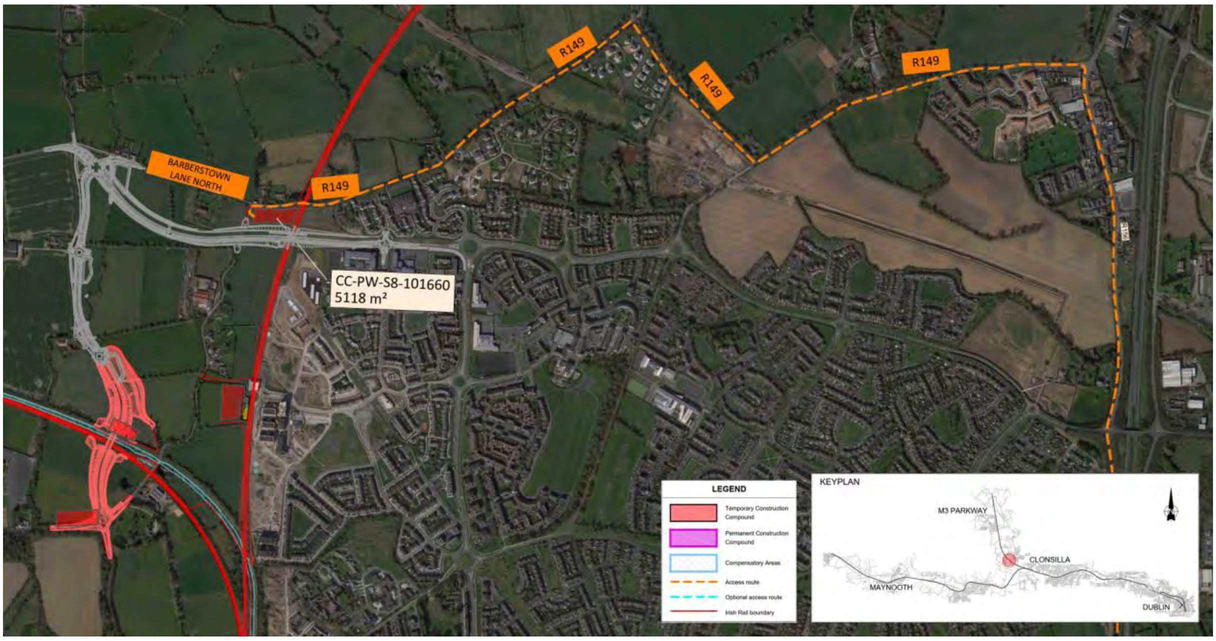


Figure 5-286 OBCN286 Pway compound and haulage routes

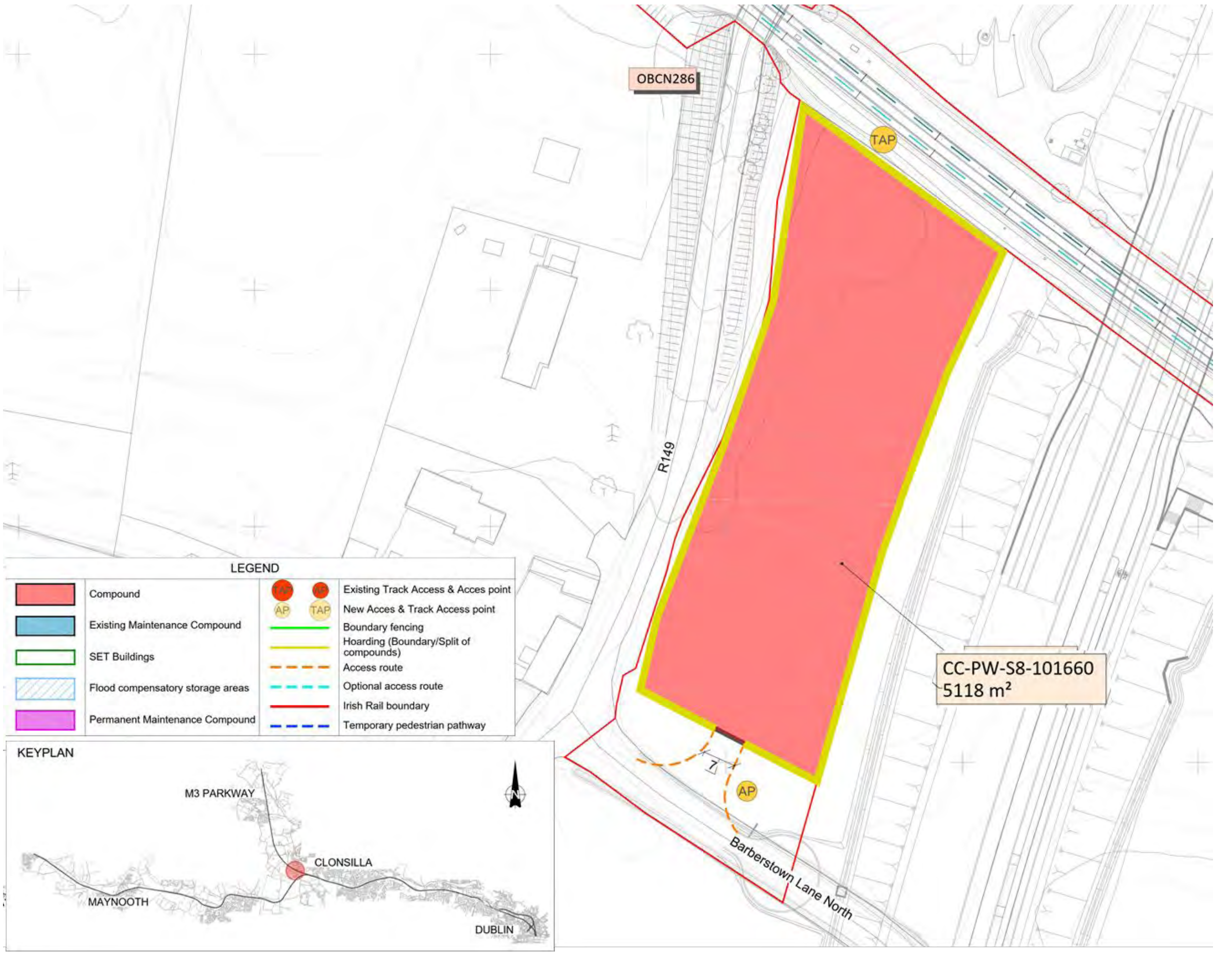


Figure 5-287 OBCN286 Pway compound

5.7.3 OBCN290 Dunboyne Bridge – track lowering and parapet heightening

5.7.3.1 Overview of works required

The OBCN290 is located on the Clonsilla – M3 Parkway line, at the Dunboyne Station exit towards Clonsilla. A track lowering of up to 395 mm will be carried out below OBCN290 along 215 m of the track to obtain the required OHLE clearance.

5.7.3.2 Construction methodology

Performing the track lowering will follow the construction sequence proposed in Section 5.3.6.1.

The general sequence of works will be as follows:

- Track lowering at OBCN290 3 weeks

5.7.3.3 Construction compounds and haulage routes

OBCN290 bridge track lowering main compound (CC-PW-S8-104970-B) is located west of Dunboyne station. Vehicles delivering to the site are expected to access it using the compound's access route off the L2228, as shown in Figure 5-288. Vehicles needing to deliver material or access the compounds will use R147 road to connect to L2228 Lane and into the site.

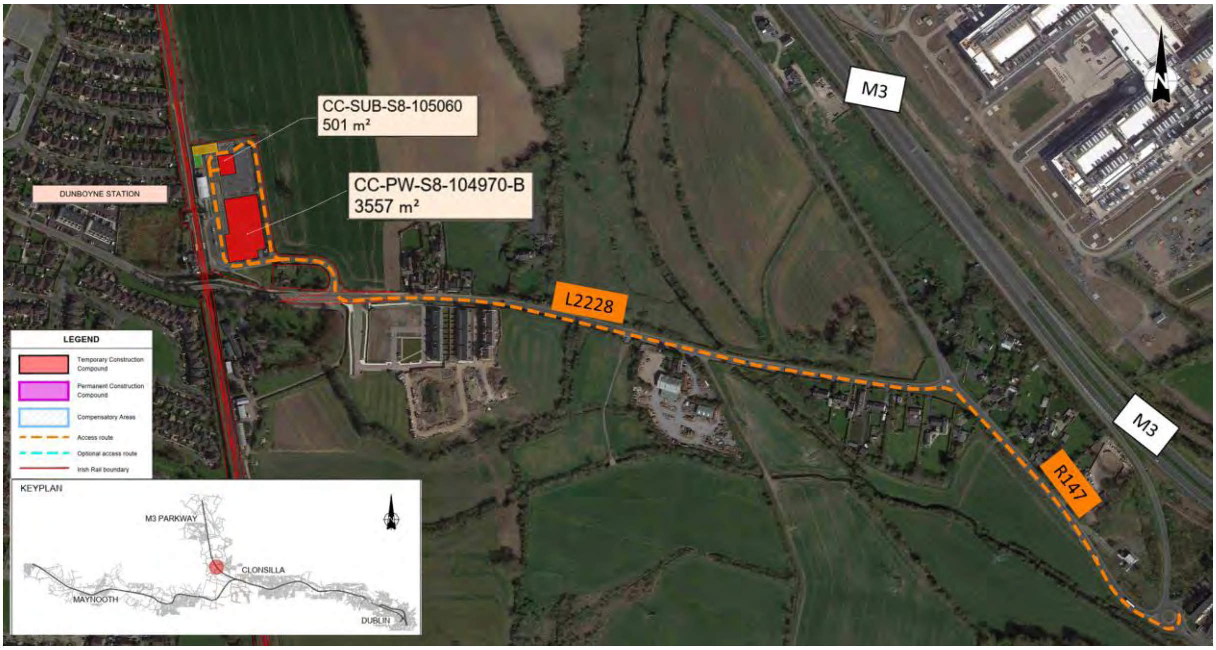


Figure 5-288 Dunboyne permanent way compound and haulage route

Figure 5-289 Dunboyne permanent way compound

5.7.4 OBCN290A Dunboyne Footbridge – parapet heightening

5.7.4.1 Overview of works required

The OBCN290A is located on the Clonsilla – M3 Parkway line, at the Dunboyne Station exit towards Clonsilla. Existing parapets at OBCN290A are already higher than 1.80 m. In order to protect users from the OHLE equipment, works at OBCN290 are as detailed in Section 5.3.12.

5.7.4.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBCN290A will follow the construction scheme in Section 5.3.12.3.

5.7.4.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Dunboyne permanent way Compound (CC-PW-S8-104970-B) as a parapet heightening compound could be used if required.

5.7.5 OBCN291 Dunboyne Station – parapet heightening

5.7.5.1 Overview of works required

The OBCN291 is located in Dunboyne station, between platforms. Existing parapets on OBCN291 are already higher than 1.80 m. In order to protect users from the OHLE equipment, works in OBCN291 are as detailed in Section 5.3.12.

5.7.5.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBCN291 will follow the construction scheme in Section 5.3.12.3.

5.7.5.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Dunboyne permanent way Compound (CC-PW-S8-104970-B) as a parapet heightening compound could be used if required.

5.7.6 Dunboyne substation

5.7.6.1 Overview of works required

The substation will be located east of the railway and just north of Dunboyne Station.

5.7.6.2 Construction methodology

Construction of the substation will follow the scheme outlined in Section 5.3.9.

The duration of the works will be as follows:

- Civil Works at Dunboyne substation 18 weeks
- Equipment at Dunboyne substation 12 weeks

5.7.6.3 Construction compounds and haulage routes

Dunboyne substation's main compound (CC-SUB-S8-105060) is located in Dunboyne, west of Dunboyne station. Vehicles delivering to the site are expected to access it using the compound's access route from L2228. No major modifications are envisaged except for removing the taxi stop.

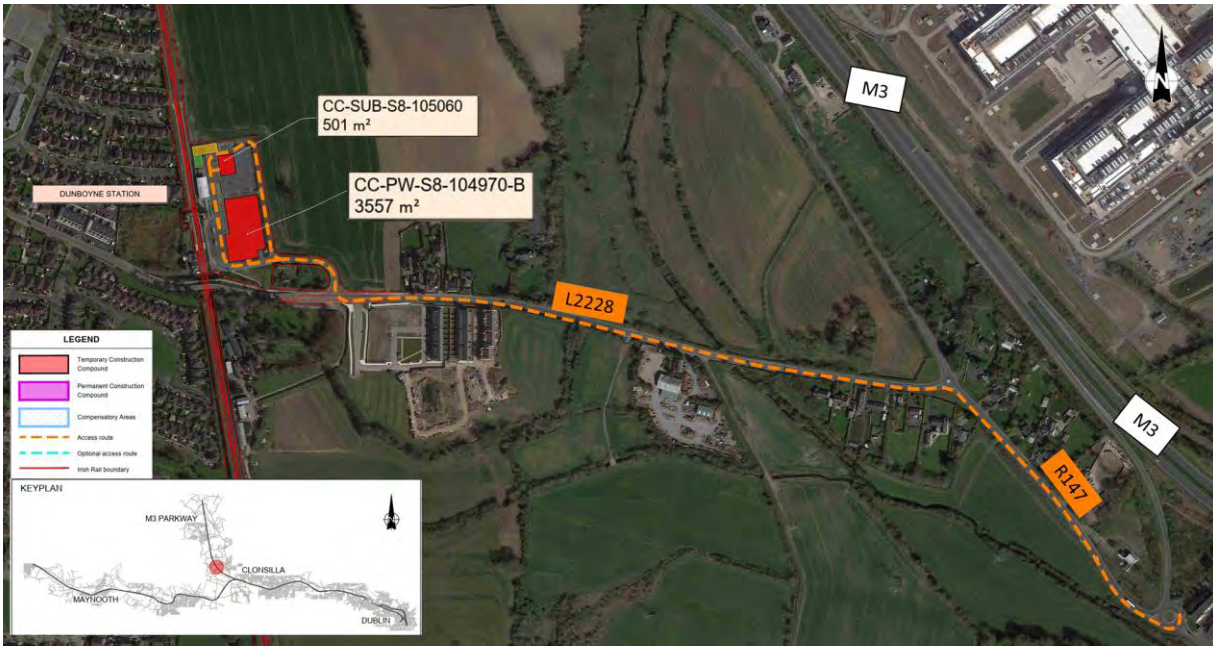


Figure 5-290 Dunboyne substation compound and haulage route

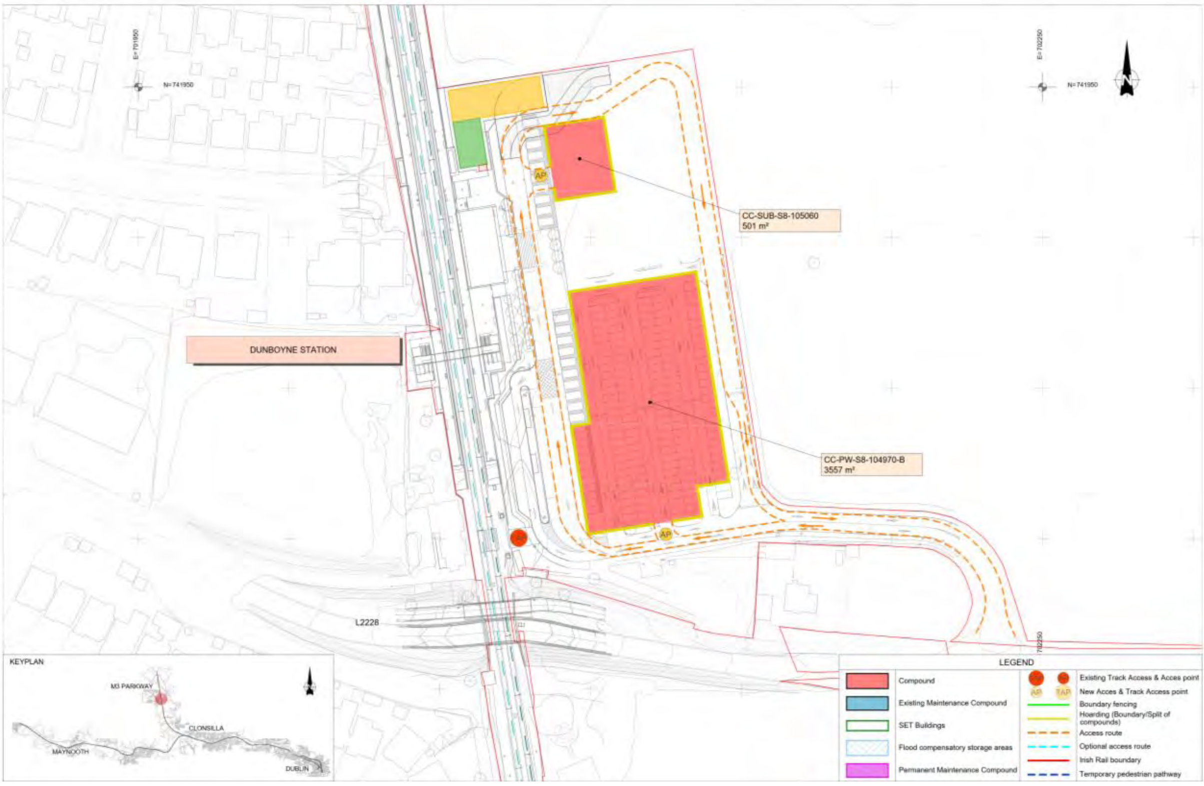


Figure 5-291 Dunboyne substation compound

5.7.7 OBCN295A M3 Parkway Station – parapet heightening

5.7.7.1 Overview of works required

The OBCN295A is located next to M3 Parkway. Existing parapets on OBCN295A are already higher than 1.80 m. In order to protect users from the OHLE equipment, works in OBCN295A are as detailed in Section 5.3.12.

5.7.7.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBCN295A will follow the construction scheme in Section 5.3.12.3.

5.7.7.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the M3 Parkway Compounds (CC-SUB- S8-106950-B or CC-PW-S8-106950-B or CC-SET-S8-106950-B) as a parapet heightening compound could be used if required.

5.7.8 M3 Parkway substation

5.7.8.1 Overview of works required

The substation will be located west of the railway, just north of the M3 Parkway Station.

5.7.8.2 Construction methodology

Construction of the substation will follow the scheme outlined in Section 5.3.9.

The duration of the works will be as follows:

- Civil Works at M3 Parkway substation 18 weeks
- Equipment at M3 Parkway substation 12 weeks

5.7.8.3 Construction compounds and haulage routes

M3 Parkway substation's main compound (CC-SUB-S8-106950) is located in M3 Parkway (within current the parkway). Vehicles delivering to the site are expected to use the access road adjacent to the existing maintenance compound located south of the station's building.

Accommodating the road access from the R157 will not require the undertaking of significant works. The road access will be through the existing access in the station and parking area, but a connection will be needed for providing the substation with parking spaces.

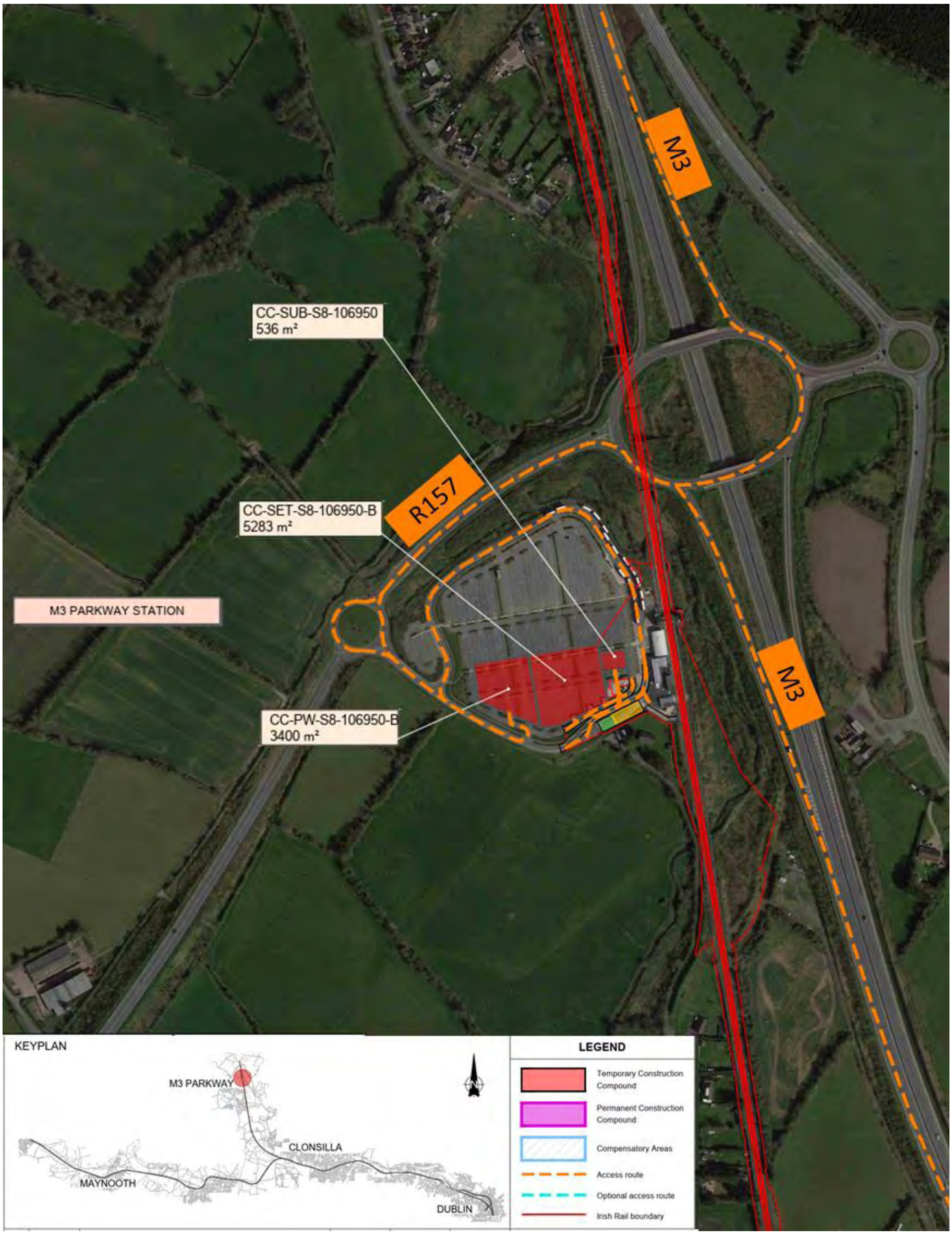


Figure 5-292 M3 Parkway substation compound and haulage route

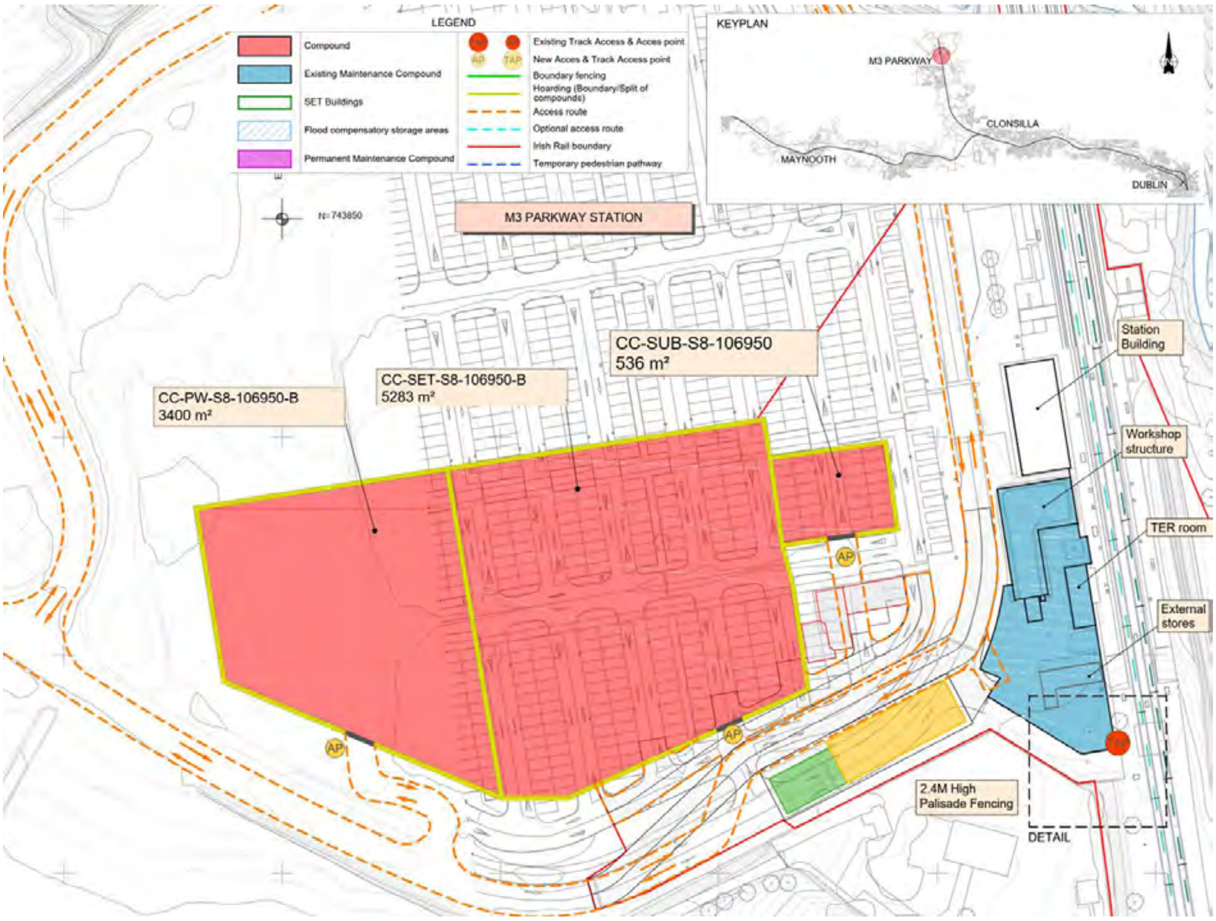


Figure 5-293 M3 Parkway substation compound

5.7.9 M3 Parkway sidings

5.7.9.1 Overview of works required

For the off-peak break in service, two sidings are required to be constructed at M3 Parkway. The double-track extends approximately 200 m after the M3 Parkway Station, converting into a single track for 240 m until the track ends in a buffer stop.

Works for the M3 Parkway sidings include constructing a new siding parallel to the existing siding, followed by renewal of the existing siding, removal of the existing turnout and the construction of a new crossover.

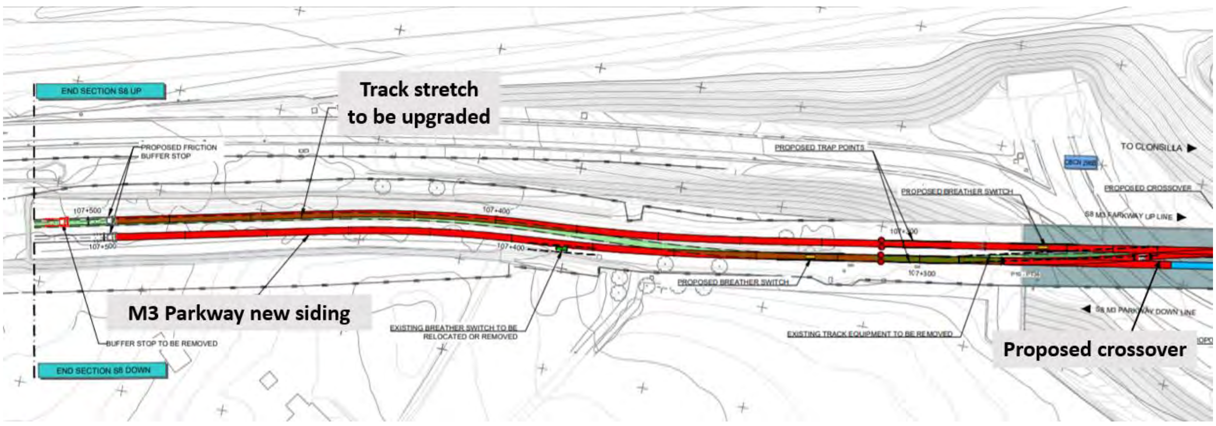


Figure 5-294 Location of M3 Parkway siding

5.7.9.2 Construction methodology

The general duration of the works will be as follows:

- Civil works and tracks 12 weeks

Track works are to be constructed during project construction working hours, as set out in Section 5.2.1, while transportation to and from the compound will take place during night possessions.

5.7.9.3 Construction compounds and haulage routes

For M3 Parkway Permanent Way (CC-PW-S8-106950-B), SET (CC-SET-S8-106950-B) and substation (CC-SUB-S8-106950) compounds: vehicles needing to deliver material or access the compounds will use M3 Motorway to connect to R157 Road and into the site, as shown in Figure 5-295 below.

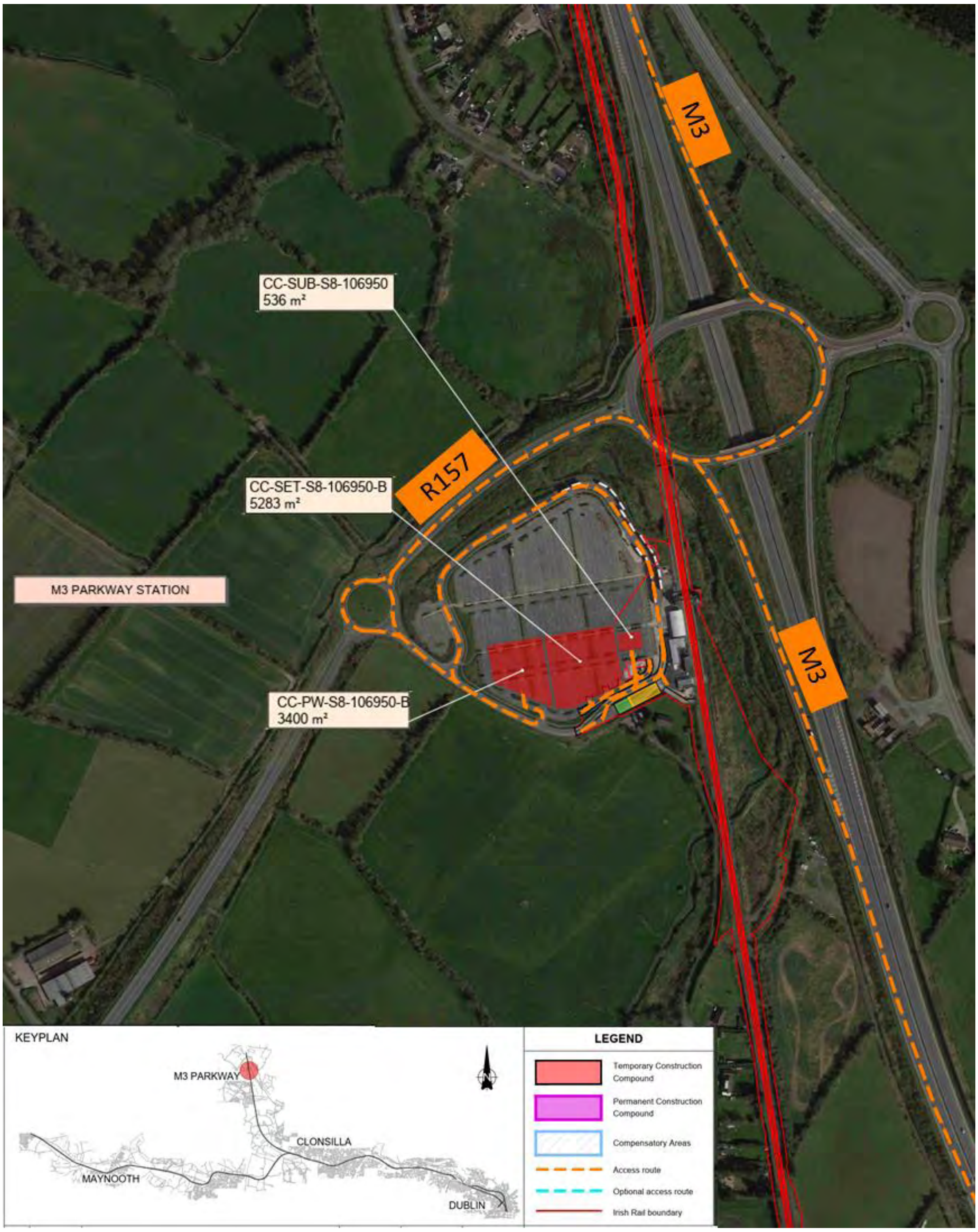


Figure 5-295 M3 Parkway permanent way construction compound and haulage route

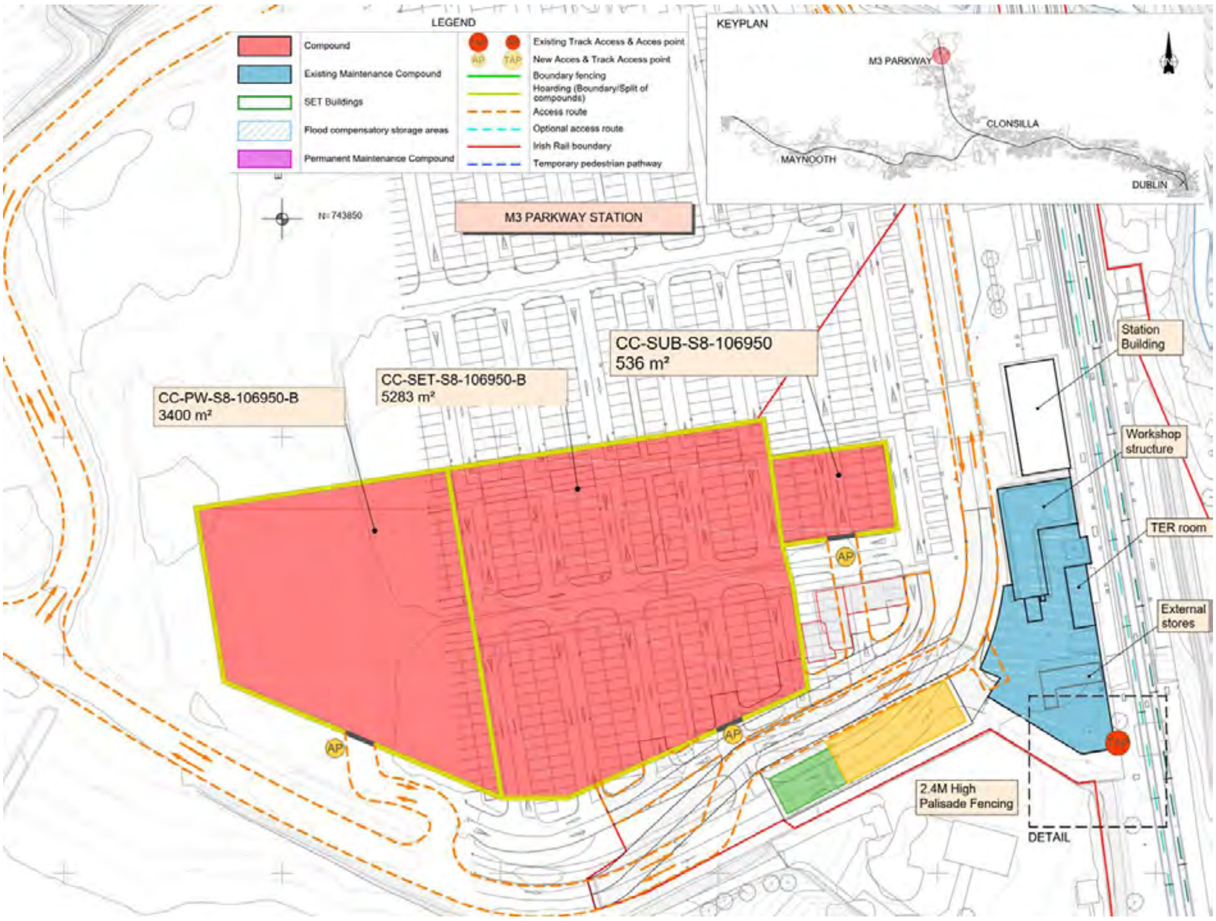


Figure 5-296 M3 Parkway permanent way compound

5.7.10 Other SET works

5.7.10.1 Signalling works

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling are related to the M3 Parkway sidings works explained in Section 5.7.9:

- The new crossover will be installed, but the points leading to the new siding will be blocked. It will work as the existing turnout and there will be no need to modify the existing signalling system.
- The new signalling system will be commissioned with the new crossover and the new siding.

The specific signalling works for this area can be performed during regular night possessions or when there is a longer possession due to track works, so additional impact on passenger services is not expected due to signalling works. Night services such as freight trains could be affected, especially during test periods.

5.7.10.2 LV power works

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling include:

- M3 Parkway. Removal of the existing connection from existing DNO/DC to the existing PHCCs. The existing PHCCs will be connected to the new DNO/DC.
- M3 Parkway. Turnout 304 will be moved from the existing location to a new one. The heater installed in this turnout and the electrical installation will be disassembled and will be reassembled in the new location.

- M3 Parkway. Installation of new PHCC and heater kits to existing P&S (Points & Switches). New electrical connections will be needed for the new PHCC (PC-A) for the following existing points: 301A and 301B.

These works are performed during night-time, not impacting railway passenger services.

5.7.10.3 Telecoms works

The following construction activities will occur in Zone D:

- The new trunk cables will be connected to the new DART+ West nodes/buildings in this area, see details in Section 5.3.9.1 (i.e. M3 Parkway SEB, M3 Parkway substation, Dunboyne substation and Hansfield substation).
- The cabling will also be connected to the new DART+ West trackside LOCs and cabinets in this zone (OHLE, Signalling and LV cabinets) and other buildings (PSP).
- Telecoms equipment will be installed in the new SEB, PSP and substation buildings. There will be reconditioning of re-used TERs (M3 Parkway, Dunboyne, Hansfield).
- Telecoms equipment will be installed in new trackside LOCs and cabinets.
- New telecoms infrastructure (optical fibre, copper, structured cabling, Station LOCs) will be installed in M3 Parkway, Dunboyne and Hansfield stations, including new station end points (e.g. CCTV cameras, CIS displays, PA speakers, etc.).
- Basic testing onsite without live railway interaction.

No impact on passenger services is expected, as these works will be carried out during night possessions (e.g. installation of new trunk cables), or during daytime (e.g. installation of new station elements) as per agreement with SET.

5.7.10.4 Electrification works (HV/OHLE/SCADA/IESS)

- Installation of elastic bridge arms/OHLE supports to support the OHLE, insulators to support the feeder wires and earth wire clamps at OBCN296B, OBCN287 and OBCN286.
- Installation of earth wire clamps to support the earth wire to the structure at (and insulators to support the feeder wires where applicable) at OBCN296A, OBCN295A, OBCN291, OBCN290A, OBCN290, OBCN286E and OBCN285C.
- OHLE feeding connections and MOS installation from Hansfield, Dunboyne and M3 parkway substations, and mainline OHLE MOS.
- General electrification works for the OHLE installation – as described in 5.3.9.1 SET buildings and cabinets and 5.3.9.6 Overhead Line Equipment (OHLE) – will generally comprise single track cantilever structures (including portals at stations).

The specific electrification works for this section within Zone D can be performed during regular night possessions or when there is a longer possession (i.e. weekends), so additional impact on passenger services is not expected due to these electrification works.

5.8 Description of Construction Works in Zone E – Clonsilla to Maynooth Station

Zone E stretches from Clonsilla Junction to just east of Maynooth Station and is approximately 12.6 kilometres in length, from Ch 70+000 to Ch 82+600. Works in this section will include:

- Barberstown and Blakestown level crossings.
- OBG13 and OBG18 track lowering.
- OBG13, OBG15A and OBG18 parapet heightening.
- OBG14 Cope Bridge reconstruction.
- Leixlip Confey and Blakestown substations.

- OBG16 flat deck bridge reconstruction.
- SET installation (as described in Section 5.8.12).

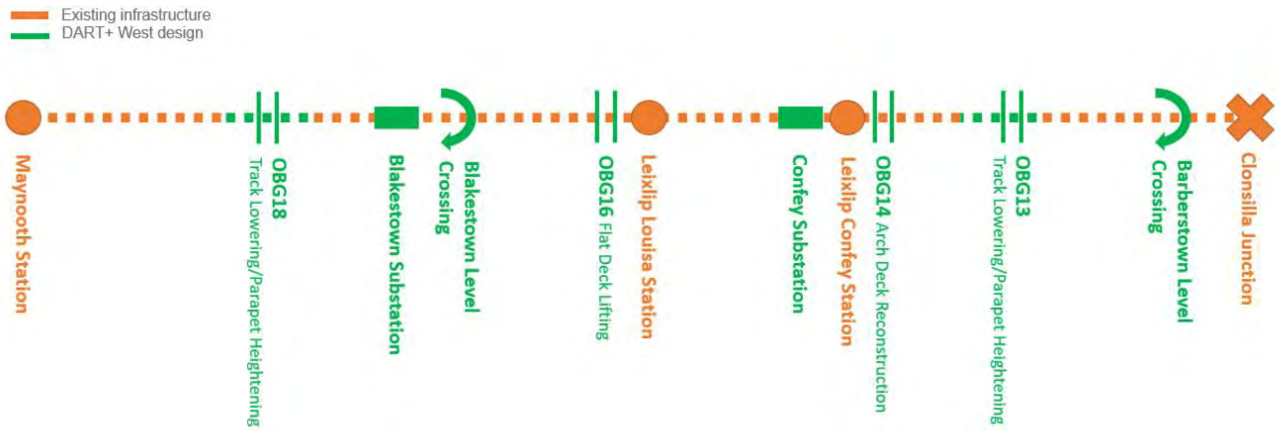


Figure 5-297 Schematic of DART+ West construction activities in Zone E

Early works will include compound installation for track lowerings and other works, as well as utilities diversions. Due to the linear nature of these works, several utility diversion works have been identified in Zone E (described in Chapter 18 of this EIAR) and will require temporary traffic measures. The typical construction methodology used for utility works has been detailed in Section 5.3.5. All temporary traffic measures required during the Construction Phase are outlined in Section 5.12.3. The required construction compounds to carry out the construction works falling within Zone E are outlined in Table 5-15.

Table 5-15 Construction compounds in Zone E

Compound code	Chainage	Reference	Discipline
CC-SET-S6-70700-B	70+700	Barberstown 1 SET	SET
CC-LC-S6-71000-B	71+000	Barberstown Level Crossing	Level Crossing
CC-PW-S6-72830-B	72+830	OBG13	Permanent Way
CC-SUB-S6-74680-B	74+680	Leixlip	Substations
CC-STR-S6-74660	74+660	Leixlip	Structures
CC-STR-S6-76470-B	76+470	Leixlip (Louisa Bridge) Station	Structures
CC-STR-S6-76540-B	76+540	Leixlip (Louisa Bridge) Station	Structures
CC-SUB-S6-78180	78+180	Blakestown	Substations
CC-SET-S6-78200-B	78+200	Blakestown	SET
CC-PW-S6-79950-B	79+950	OBG18	Permanent Way

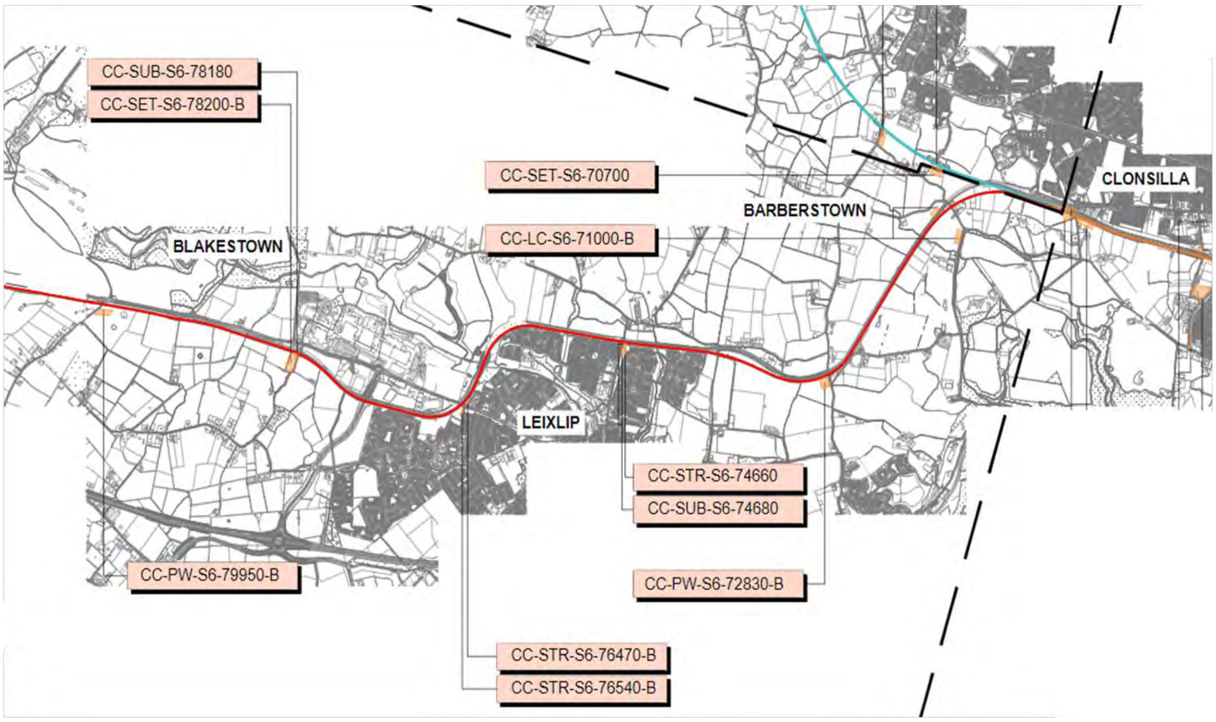


Figure 5-298 Zone E compounds

All works proposed in Zone E have been described from east to west, following the structure established in Chapter 4 of this EIAR.

SET construction works requirements for the zone will be served by a construction compound in Barberstown (CC-SET-S6-70700-B) at Ch 70+700 and a construction compound in Blakestown (CC-SET-S6-78200-B) at Ch 78+200. Vehicles delivering to the Barberstown site are expected to use the access road from R149 as shown in Figure 5-299. Vehicles delivering to the Blakestown site are expected to use the access road off of R148 as shown in Figure 5-300.

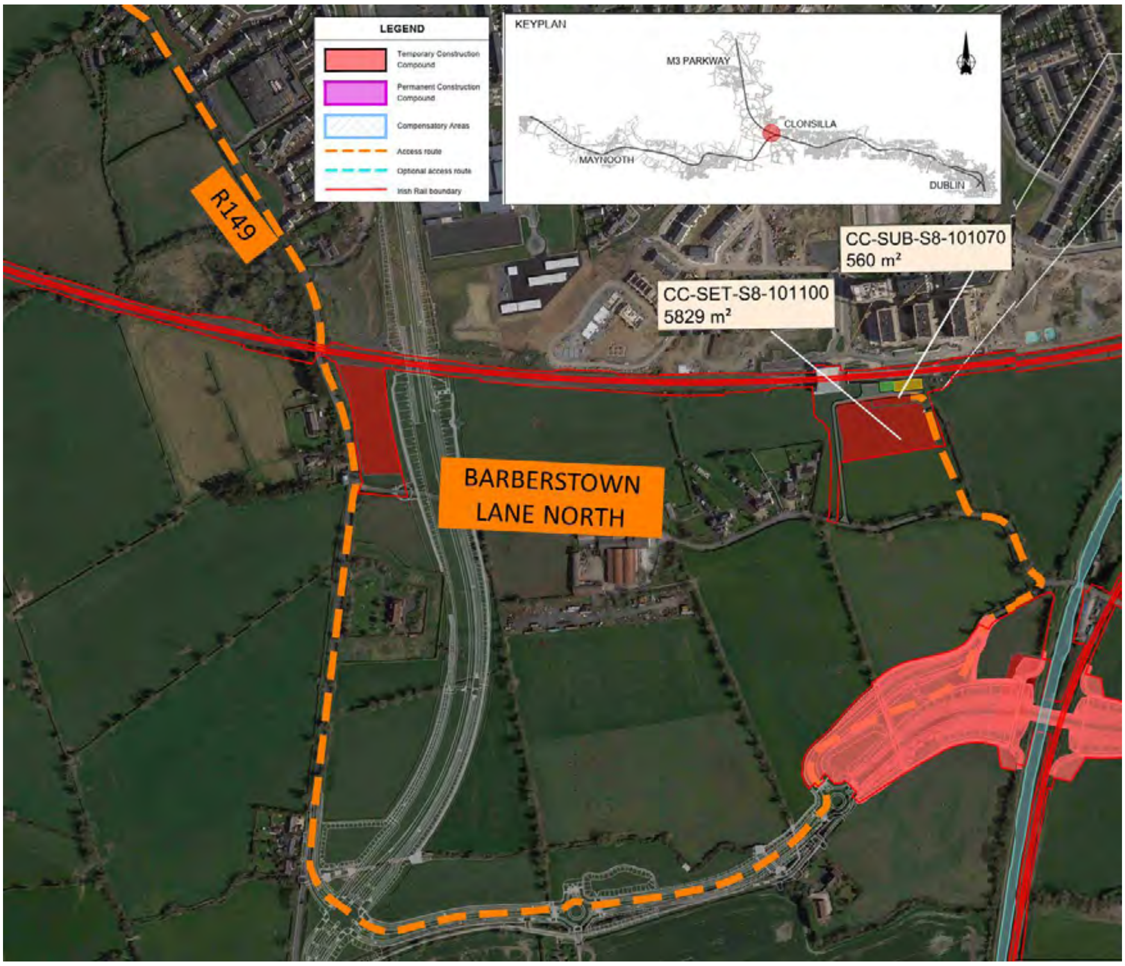


Figure 5-299 Barberstown SET compound

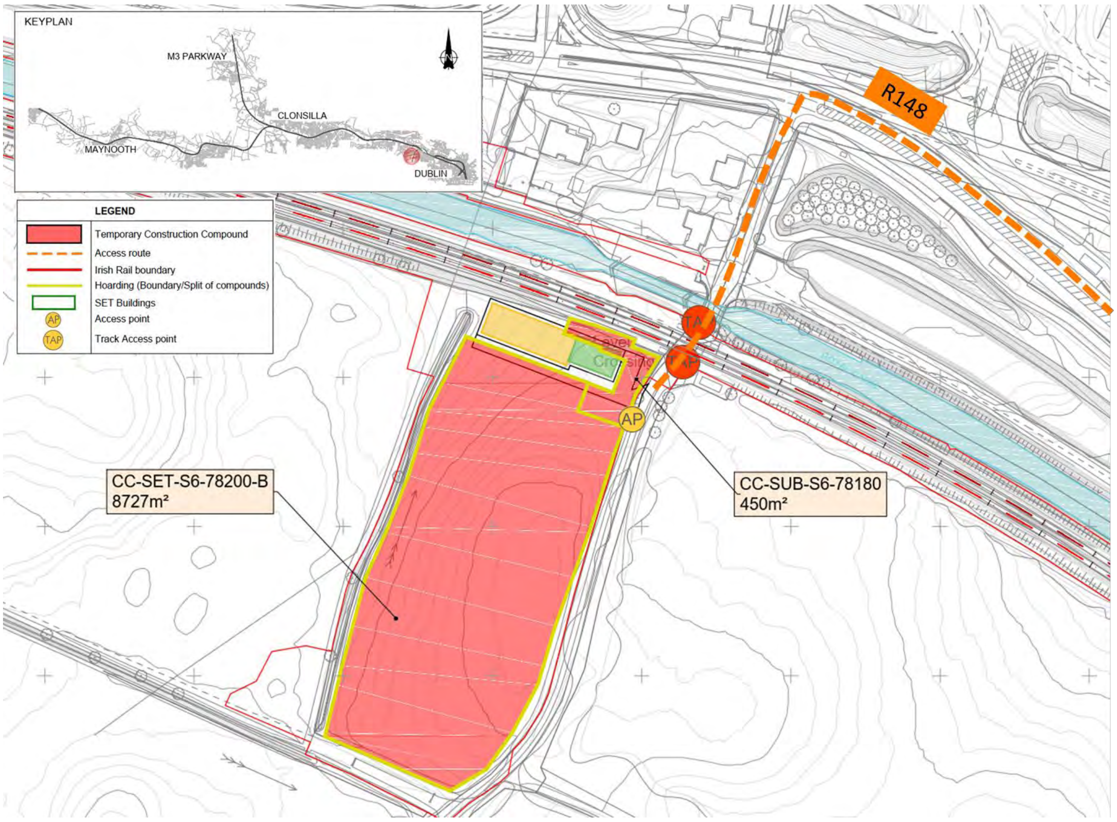


Figure 5-300 Blakestown SET compound and haulage route

5.8.1 Barberstown level crossing

The proposed works at Barberstown Level Crossing include the construction of a new road bridge with pedestrian and cycle facilities crossing the Dublin to Sligo railway and the Royal canal approximately 200 m west of the existing level crossing. The proposals include for the construction of approach roads on raised embankment which will tie into the proposed Barnhill to Ongar Road scheme to the north and to the existing road network south of the railway.

A segregated pedestrian cycle link has also been provided from near the Ongar-Barnhill Link Road in the northbound direction to tie into the link road works that are north of the mainline.

It is anticipated that safety barriers will be required to reduce hazards along the mainline that cannot be eliminated through the forgiving roadsides process. The locations and specifications of the barriers will be designed using DN-REQ-03034.

5.8.1.1 Overview of works required

The site clearance will be undertaken first to clear the site of vegetation and topsoil to facilitate the site set up. The construction of the proposed approach embankments is expected to be the most time-consuming phase of the project due to the relatively large volume of fill material that needs to be brought to site and placed. The junction, link road, detention pond, bridge superstructure and bridge superstructure are expected to be undertaken at the same time as the approach embankments. Tie ins to the existing road networks is anticipated to be completed as one of the last task. These works will be undertaken under temporary traffic management in agreement with the Local Authority. After the other phases are complete the surfacing, barriers and finishing to the entire project are expected to be installed.

5.8.1.2 Construction sequence

The construction sequence of the bridge is envisaged to be conventional: foundations and substructure installed first followed by the superstructure craned into position:

1. Excavate to a suitable founding level, proof roll, and upfill as required.
2. Install piled foundations or install in-situ reinforced concrete spread foundations subject to detailed geotechnical investigation.
3. Construct abutments, and wingwalls.
4. Install precast bridge beams.
5. Install permanent formwork between bridge beams.
6. Cast abutment diaphragms.
7. Cast deck slab.
8. Complete backfilling.
9. Install surfacing.
10. Install barriers.

The bridge construction will require work on or near the rail to install the east abutment's foundations and the substructure. Works will also be required near and over the Royal Canal and will require agreement with Waterways Ireland.

Craning in of the bridge beams will require at least one overnight rail possession.

It is assumed that the bridge will be constructed prior to railway OHLE being installed. If this is not the case, then OHLE isolation within a possession may be required during some stages of construction.

5.8.1.3 Roadway drainage

The proposed Barberstown level crossing will require a new drainage system to manage surface water runoff. The drainage system will consist of carrier drains located in the traffic lanes which will be fed by traditional kerb side gullies and new streams and ditches. The design will also require the diversion of the ditches that run parallel to the canal and railway on the northern and southern side of the rail line. It is envisaged that carrier drains will be installed following excavation to proposed roadway formation level. Carrier drains will be installed in trenches which are mechanically dug. A trench that is less than 1.25 m in depth will not require trench support. Trenches that are greater in depth than 1.25 m will require trench support either by poling boards, waling and struts, trench boxes or sheet piles for in the case of excessive depths. Gully connections and gully pots will be laid similarly to the carrier drains.

Some of the machinery involved in the construction of the drainage will be: mini-diggers, wheel loaders, excavators, articulated dump truck, concrete mixer truck, generators and cranes as required to carry out different elements of the works (pipes, precast elements, etc.).

5.8.1.4 Construction duration

As shown in the following design chart, the total construction duration of the bridge is estimated around **1 to 2 years**.

Table 5-16 Overview of construction phasing and methodology: Barberstown bridge

Barberstown Bridge	Approximate duration of works
Description of the activities required:	Works (months)
Phase 1: Site clearance	
Vegetation removal, topsoil removal, site set up	1 month
Phase 2: Approaches and public realm	
Excavation, backfilling, kerbs, drainage, footpaths etc.	12-14 months (spread over construction programme)
Phase 3: Junction, link road & detention pond	
Excavation, backfilling, kerbs, drainage	6 months
Phase 4: Bridge substructure	
Piling (assumed foundation solution), construct abutments and wingwalls, backfilling	6 months
Phase 5: Bridge superstructure	
Install precast bridge beams, install permanent formwork, cast abutment diaphragms & deck slab, complete backfilling	6 months
Phase 6: Surfacing, barriers, finishing	
Install surfacing, install barriers	2 months
Phase 7: Decommissioning existing level crossing	
Remove existing surfacing, divert services as required, remove existing level crossing controls and barriers, install new boundary treatments	1 month
Total Construction Phase	1 to 2 years

5.8.1.5 Construction compounds and haulage routes

Barberstown Level Crossing compound (CC-LC-S6-71000-B) is located in Barberstown at both sides of the canal. Vehicles delivering to the site will use the access route off of N4/R149 from the north and N4 / R835 / R109 / R121 from the south, as shown in Figure 5-301.

Figure 5-301 Barberstown level crossing compound

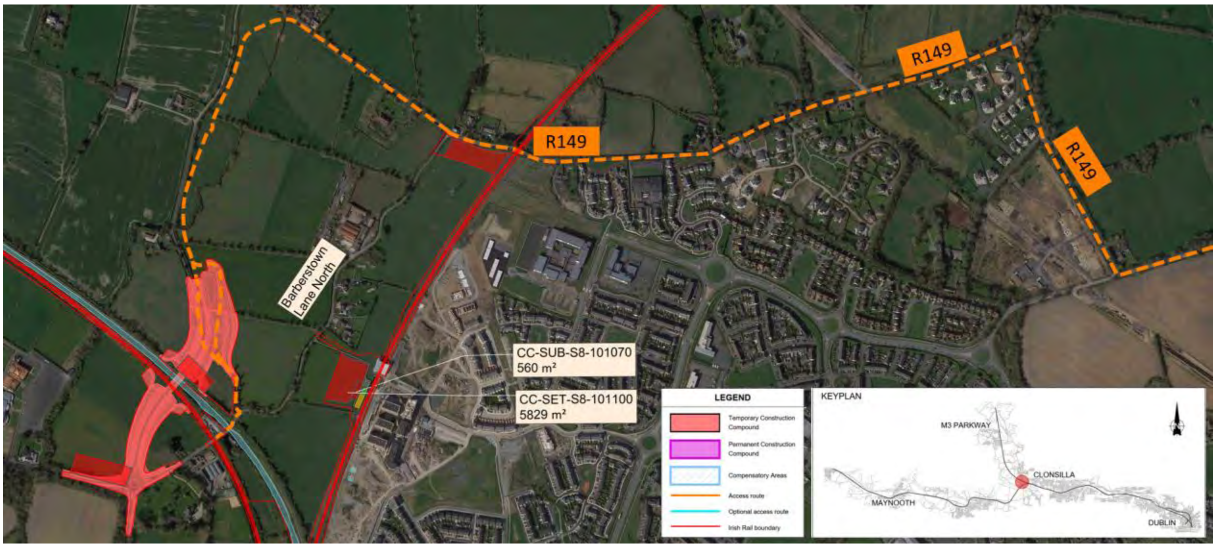


Figure 5-302 Barberstown level crossing compound and haulage route

5.8.2 OBG13 Collins Rail Bridge: track lowering and parapet heightening

5.8.2.1 Overview of works required

OBG13 Collins Rail Bridge is located on the Maynooth line, between Leixlip Confey and Clonsilla stations. Works at OBG13 include track lowering and parapet heightening.

5.8.2.2 Construction methodology

A track lowering of up to 583 mm will be carried out below OBG13 along 365 m of the track to meet the required OHLE clearance. Track lowering construction works will follow the construction scheme in Section 5.3.6.1.

The general sequence of work will be as follows:

- Track lowering (329 m) 9 weeks

The proposed longitudinal gravity drainage runs along the track. To provide drainage at the low point of the vertical alignment (Ch. 72+800), a gravity drain is proposed from the low point to UBG13B following the construction scheme described in Section 5.3.13.

Parapet heightening is as per Section 5.3.12.1.

5.8.2.3 Construction compounds and haulage routes

OBG13 bridge track lowering's main compound (CC-PW-S6-72830-B) is located in Westmanstown, east of Collins rail bridge. Vehicles needing to deliver material or access the compounds will use R136 to connect to R835 then to R109 and finally connect to Laraghcon Lane before accessing the site, as shown in Figure 5-303 and Figure 5-304 below.

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the track lowering main compound (CC-PW-S6-72830-B) as a parapet heightening compound could be used if required.

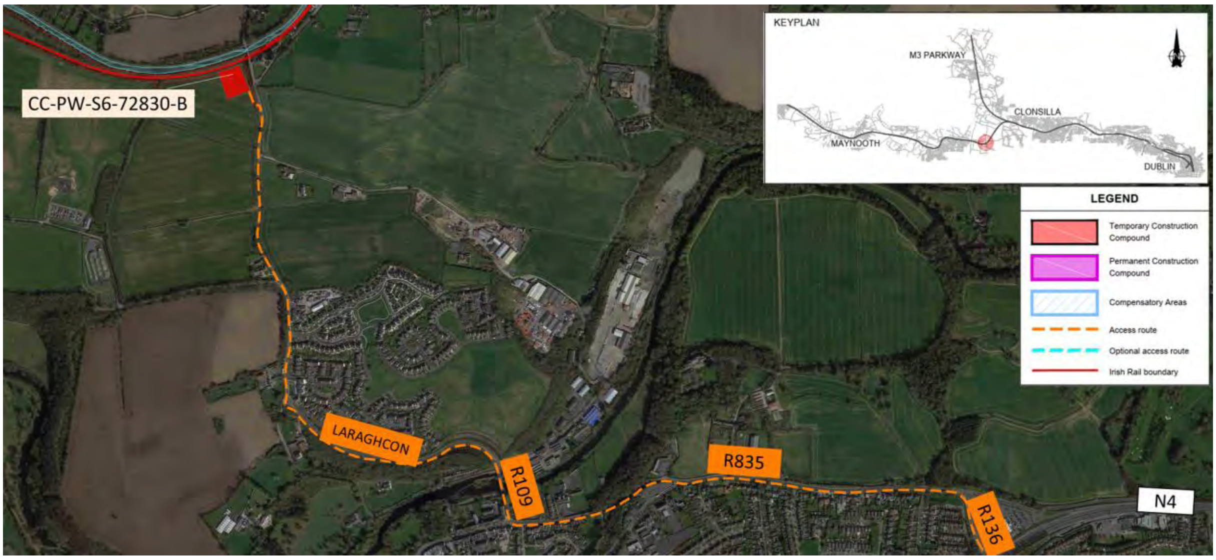


Figure 5-303 OBG13 Permanent way compound haulage route

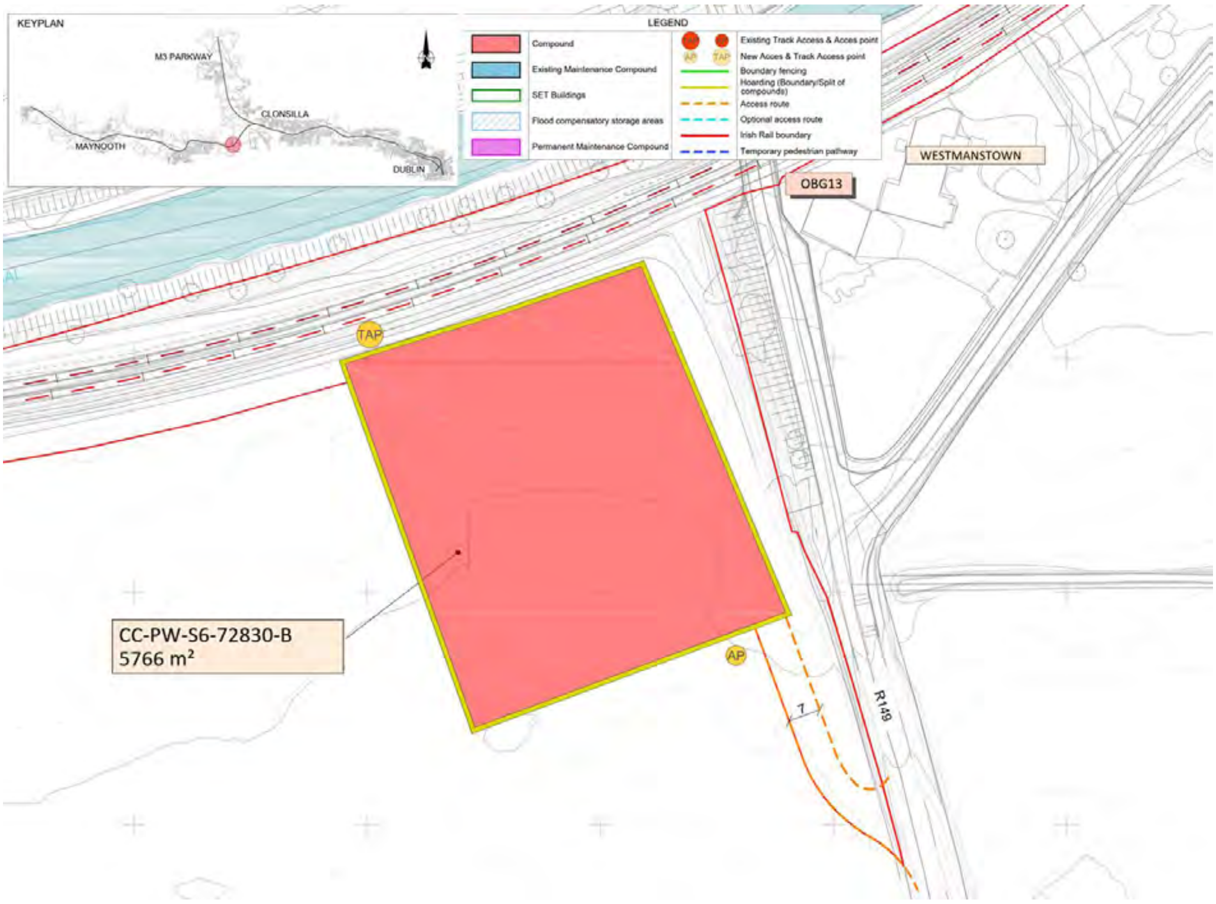


Figure 5-304 OBG13 Permanent way compound

5.8.3 OBG14 Cope Bridge deck reconstruction and widening

5.8.3.1 Overview of works required

OBG14 is located in Newtown. There are no track alterations proposed in this area. To achieve a sufficient vertical clearance for the catenary equipment under the bridge, the precast arch deck reconstruction solution has been proposed. The new arched bridge deck shall be installed 330 mm higher than the original rail bridge arch position. Parapet heightening is required in both OBG14 and OBG14A.

The structure is a proposed protected structure, and the bridge was constructed in the 1700/1800s. Any modifications to the bridge need to consider the impact on the cultural heritage of the bridge. It is a single-lane bridge with 7.6 m wide span.

Figure 5-305 and Figure 5-306 show the proposed precast arch deck solution for this bridge.

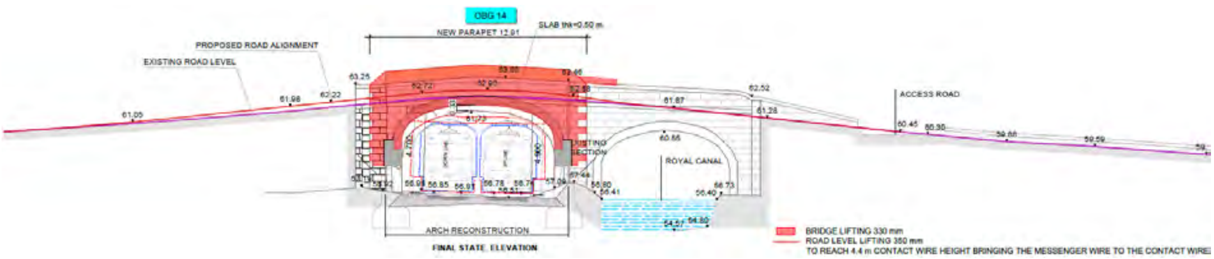


Figure 5-305 Elevation of OBG14 deck reconstruction

Figure 5-306 Plan of OBG14 deck reconstruction

In addition to raising the original rail bridge arch, a bridge upgrade of OBG14 has also been proposed in this project to meet Kildare County Council (KCC) requirements, accommodate future development plans at this location, and provide an opportunity to benefit the wider community.

The proposed widening solution is to build two footbridges adjacent to the existing OBG14, spanning both the railway line and the Royal Canal, to accommodate an improved road and traffic design. The width of each footbridge is 4 m with a total span of around 30 m.

As this proposed solution will significantly impact the heritage value of the canal arch bridge, the structural design work has been carried out in close collaboration with the design architects and conservation architects, and the proposal has been agreed upon from a structural and heritage perspective in a joined-up manner.

The new footbridges will only carry the pedestrian and cyclist traffic, and the existing OBG14 will carry the two-lane road traffic. With this proposed arrangement, the new footbridges can be designed as lighter structures and can therefore mitigate the visual impact on the Royal Canal arch. The new footbridges will be structurally independent of the existing structure.

The new sections have been proposed at the east and west side of the bridge, keeping 2 m from the existing OBG14, as shown in the figure below.

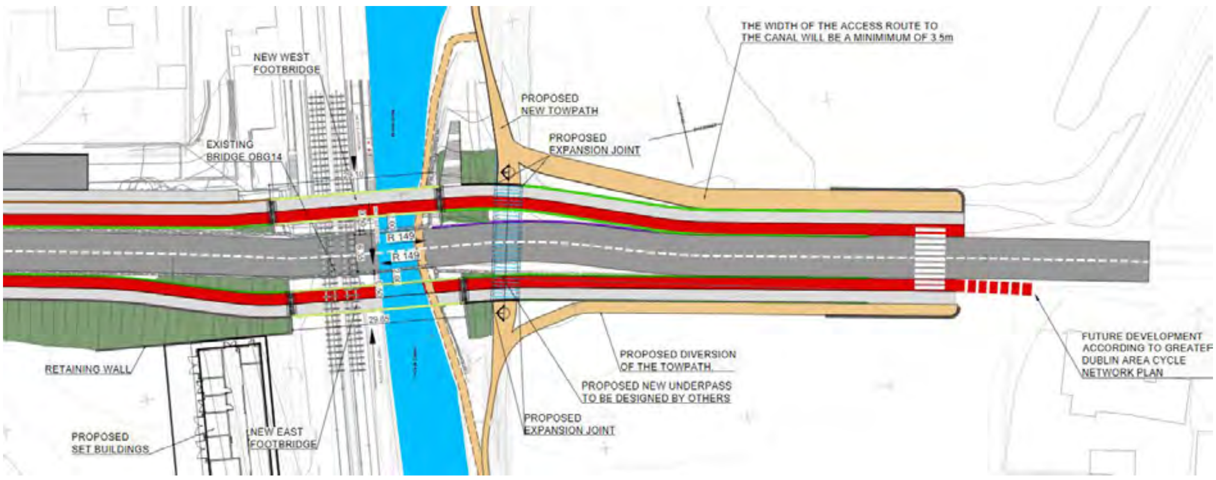


Figure 5-307 Plan of proposed footbridges to east and west of OBG14

The following figure shows the elevation of the new footbridge from the East.

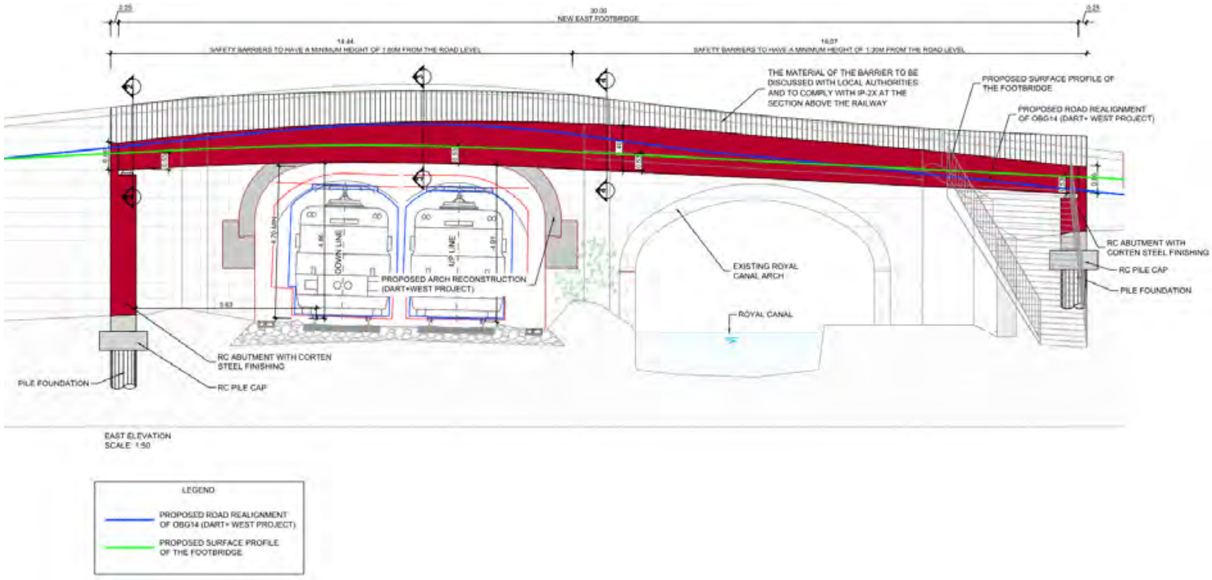


Figure 5-308 East elevation of proposed east footbridge structure

The new footbridge deck consists of transverse weathered steel beams and an RC top slab with a total thickness of 0.40 m and two main lateral beams with a variable thickness from 0.86 m to 1.40 m, see Figure 5-309 below.

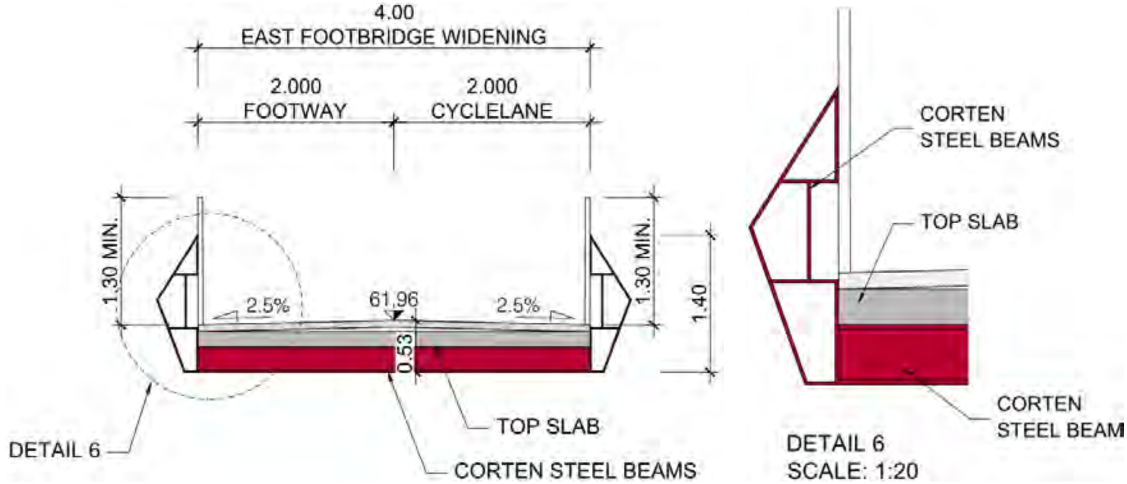


Figure 5-309 Cross section of footbridge deck (indicative cross section outside of railway area)

5.8.3.2 Construction methodology

The new pedestrian and cyclist bridges will be constructed prior to the reconstruction of Cope Bridge and the duration of these works will be as follows:

- New East and West footbridges: 46 weeks per footbridge (both footbridges are proposed to be constructed simultaneously)
- OBG14 Deck reconstruction (including diversions – traffic & utilities): 40 weeks

The construction phase, working time, and detailed construction methodology of the existing road bridge (OBG14) with the proposed arch reconstruction have been provided in Section 5.3.8.1.1 of this chapter.

The construction phase and duration of the new footbridges have been proposed as follows:

1. Site preparation (site clearance, utility diversions on the east and west side of OBG14, etc.).
2. Construction of the piled foundations (pile installation, and excavation and construction of pile caps).

3. Construction of the abutments (construction of concrete walls with weathered steel finishing and embankment).
4. Place deck structure (weathered steel beams, in-situ top slab, and waterproofing elements).
5. Connection to existing road (construction of the road and finishing).
6. Reinstallation of diverted utilities.
7. Place parapets and finishing.

As shown in the following design chart, the total construction duration is estimated at approximately 46 weeks per footbridge.

Most works will be performed during the project construction working hours as set out in Section 5.2.1. Part of the foundation work will be performed during full railway weekend possessions. Placement of the steel deck, in-situ top slab, and placement of parapets will be performed during 4 weeks of night possessions and 2 full weekends possessions on the railway. Further details of working hours for each construction phase have been provided in the table below. As mentioned previously, the construction work of the new East and West footbridges could be carried out before the arch reconstruction of the existing road bridge OBG14.

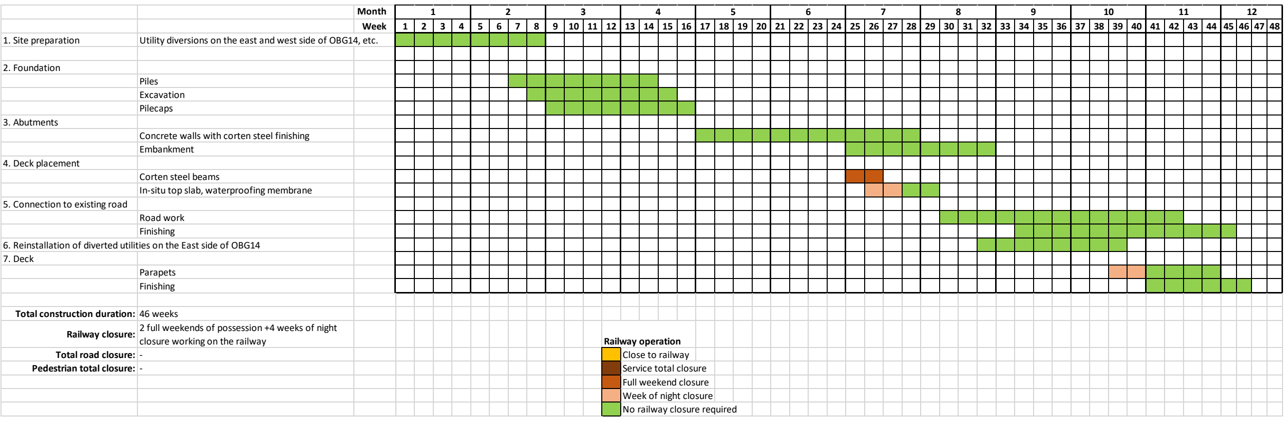


Figure 5-310 Construction duration of east and west footbridges (duration indicated is for one footbridge)

5.8.3.3 Construction compounds and haulage routes

Temporary material storage area for this bridge has been provided as follows:

- OBG14.

Figure 5-311 Plan of proposed temporary material storage area at OBG14

Figure 5-312 3D view of proposed temporary material storage area at OBG14

OBG14 deck reconstruction's main compound (CC-STR-S6-74660) is located in Leixlip Confey at Ch 74+660. Vehicles delivering to the site will use the R148 road to connect to the R149 located south of the compound, as shown in Figure 5-314.

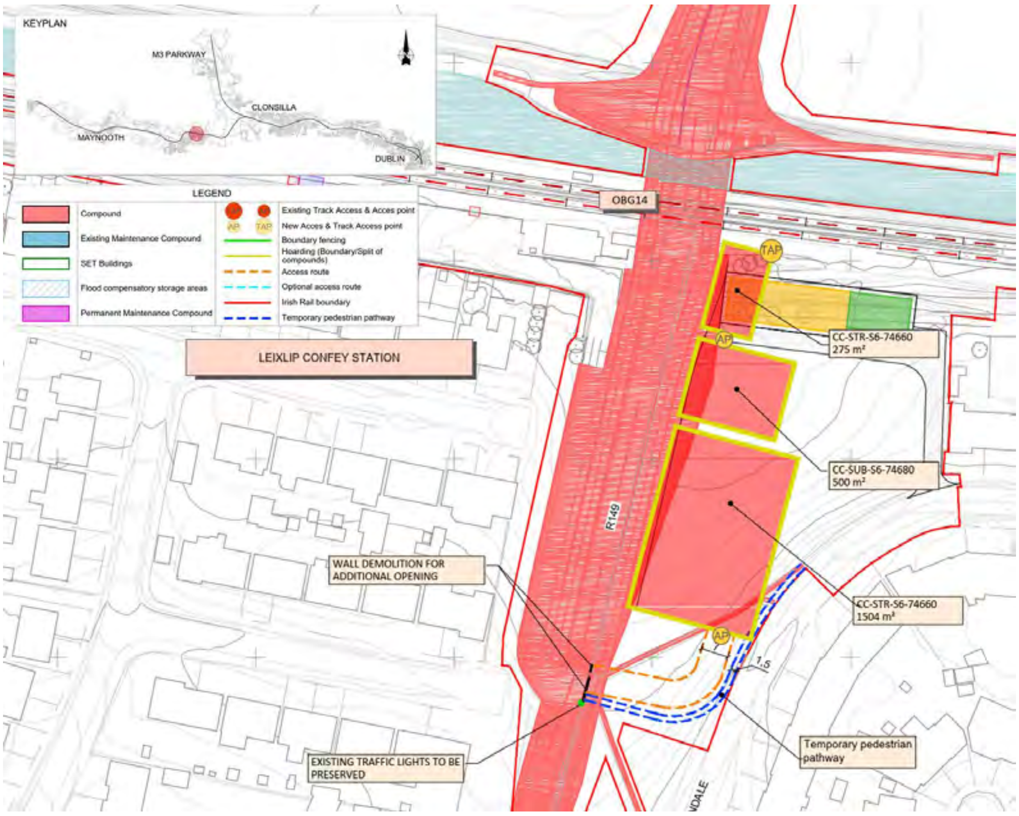


Figure 5-313 OBG14 structures compound

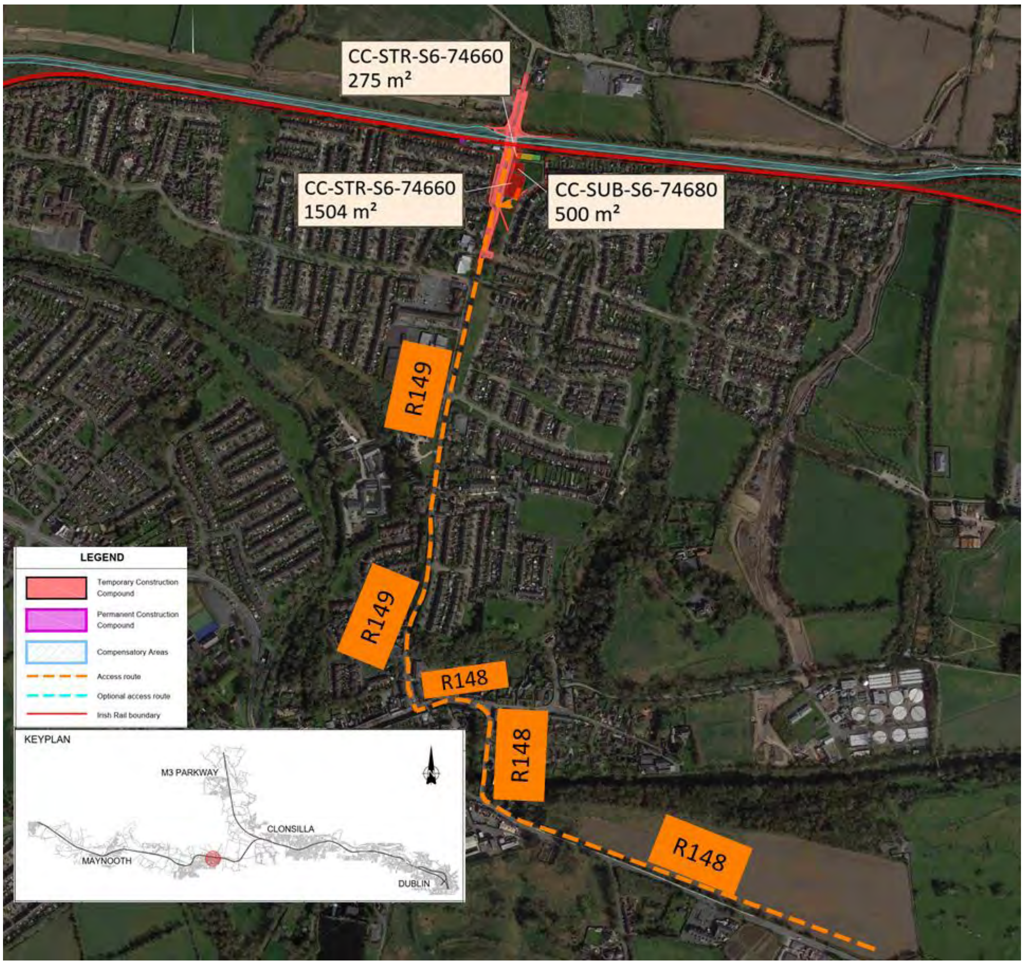


Figure 5-314 OBG14 haulage routes

5.8.3.4 Traffic diversion during construction

During the reconstruction of the bridge deck, the road access to the bridge will be closed. Therefore, until the construction is completed, passing traffic must be diverted. In Figure 5-315 the shortest path between bridge access points is shown. Traffic will have to cross the railway track and the Royal Canal using the Laraghcon Road. In addition, it is planned to use the R148 and R149 roads to connect with Laraghcon Road. Road closure traffic signs will be required in order to inform drivers of the diversion.

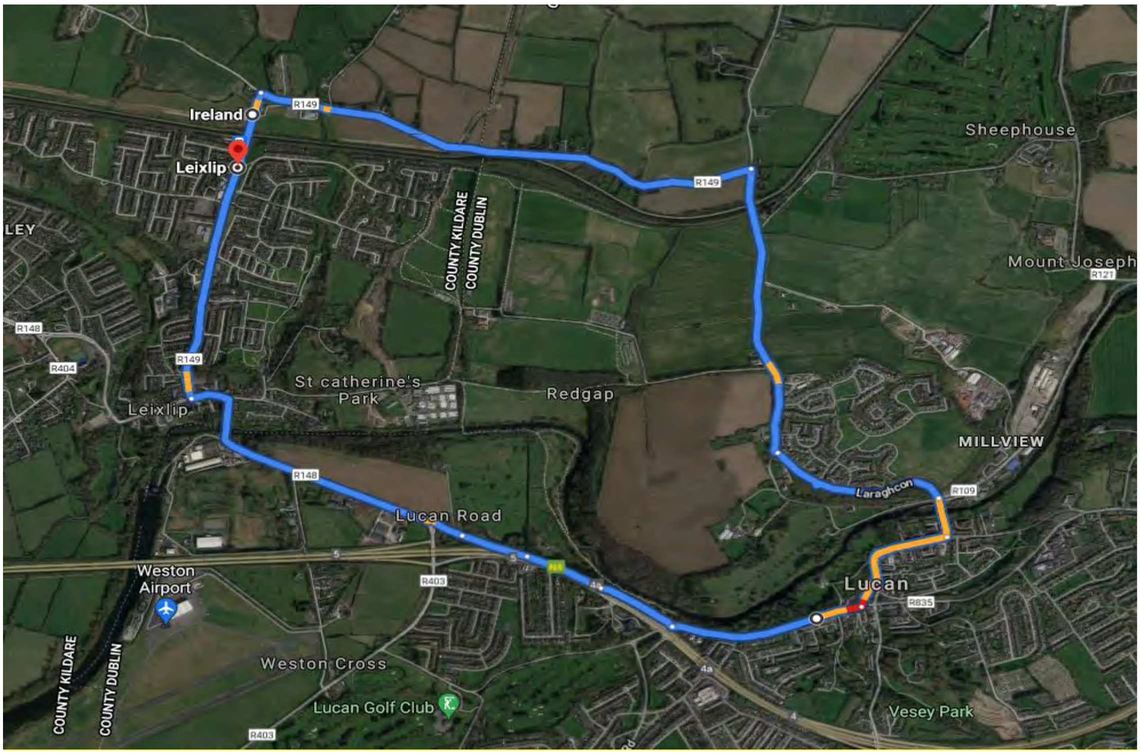


Figure 5-315 Traffic diversion during OBG14 construction

Pedestrians will use the new pedestrian and cycle bridges to cross the canal and railway while the bridge deck reconstruction is carried out, ensuring that no diversions are required.

5.8.4 OBG14 Cope Bridge parapet heightening

5.8.4.1 Overview of works required

For the OBG14 and OBG14A parapet heightening refer to Section 5.3.12.

5.8.4.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG14 and OBG14A will follow the construction scheme in Section 5.3.12.3.

5.8.4.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the OBG14 Structures (CC-STR-S6-74660) compounds may be used as a parapet heightening compound if required.

5.8.5 OBG15A Leixlip Station footbridge parapet heightening

5.8.5.1 Overview of works required

OBG15A is located in Leixlip station between platforms. Existing parapets on OBG15A are already higher than 1.80 m. Parapet heightening works at OBG15A are as detailed in Section 5.3.12.

5.8.5.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG15A will follow the construction scheme in Section 5.3.12.3.

5.8.5.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the OBG14 Structures (CC-STR-S6-74660) compounds as a parapet heightening compound could be used if required.

5.8.6 Leixlip Confey substation

5.8.6.1 Overview of works required

The Leixlip Confey substation will be located to the south of the railway, to the east of the OBG14 Cope bridge access road in the green space, reference Figure 5-317 below.

5.8.6.2 Construction methodology

Construction of the substation will follow the scheme outlined in Section 5.3.9.

The general sequence of work will be as follows:

- Civil Works at Leixlip Confey substation 18 weeks
- Equipment at Leixlip Confey substation 12 weeks

5.8.6.3 Construction compounds and haulage routes

Leixlip Confey substation's main compound (CC-SUB-S6-74680) is located in Leixlip Confey at Ch 74+680. Vehicles delivering to the site will use the access route off of R149 south of the compound. Vehicles needing to deliver material or access the compounds will use R148 road to connect to R149 and into the site.

Figure 5-316 Leixlip Confey substation compound and haulage route

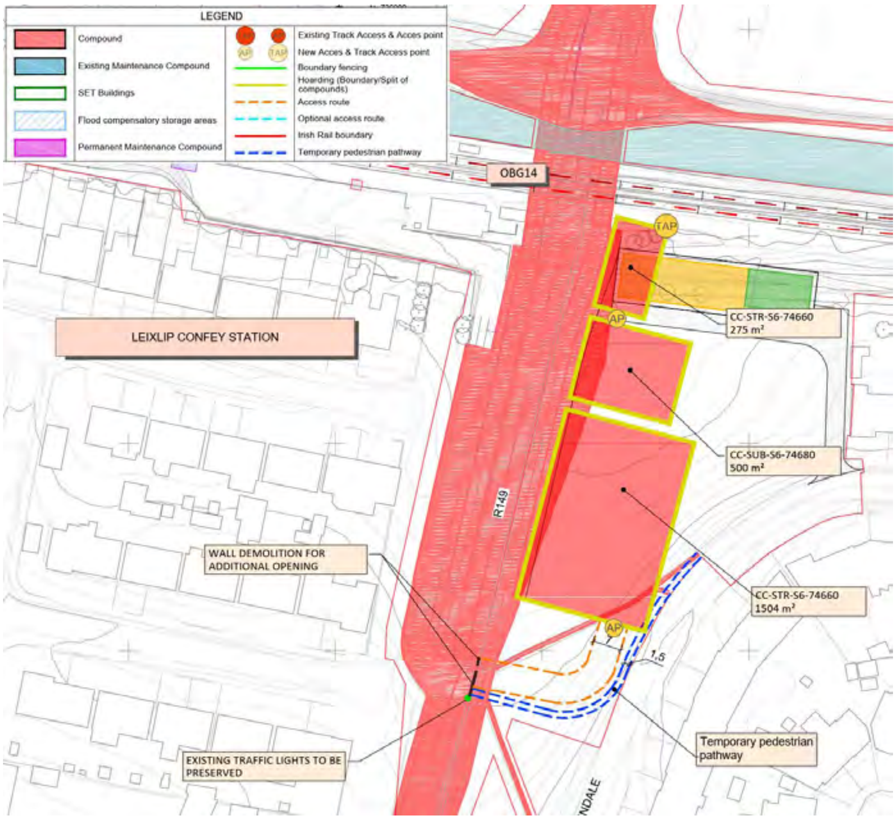


Figure 5-317 Leixlip Confey substation compound

5.8.7 OBG16 Louisa Bridge deck lifting

5.8.7.1 Overview of works required

The OBG16 is a flat deck bridge, located in Leixlip, at Leixlip Louisa Bridge Station exit towards Maynooth (Ch. 76+460).

The required deck lift for this bridge is 290 mm to obtain a sufficient clearance for the OHLE system and prevent a significant modification of the road alignment and the adjacent protected canal bridge.

Figure 5-318 and Figure 5-319 show the proposed flat deck heavy lifting solution for this bridge.

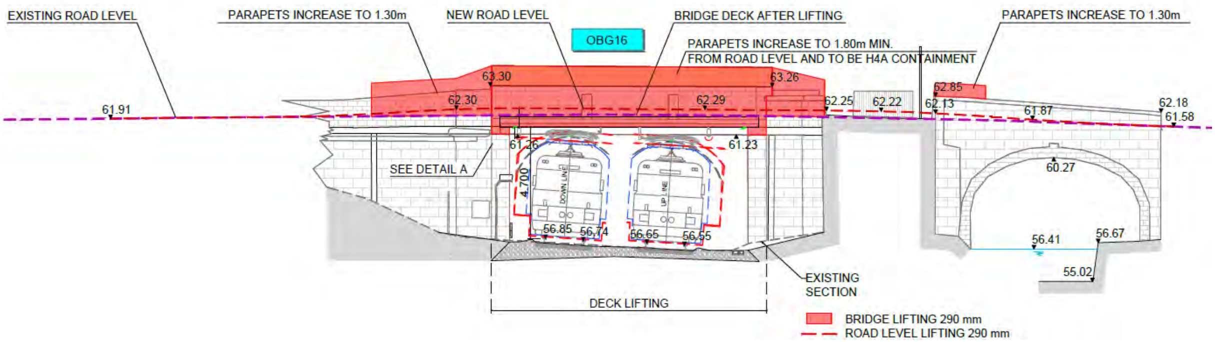


Figure 5-318 Elevation of OBG16 deck lifting

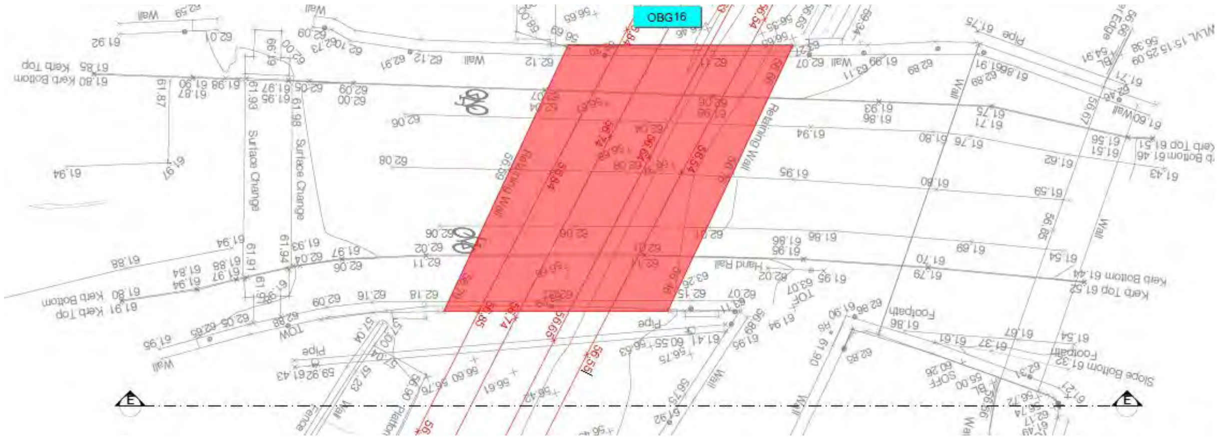


Figure 5-319 Plan of OBG16 deck lifting

This structure is identified at IAMS as a potential flooding area. Drainage has therefore been designed to remove water from the lowest point of this structure to the nearest culvert.

5.8.7.2 Construction methodology

The construction phase, working time, and detailed construction methodology have been provided in Section 5.3.8.1.2 of this chapter.

5.8.7.3 Construction compounds and haulage routes

Temporary material storage area for this flat deck bridge has been provided as follows:

- OBG16.

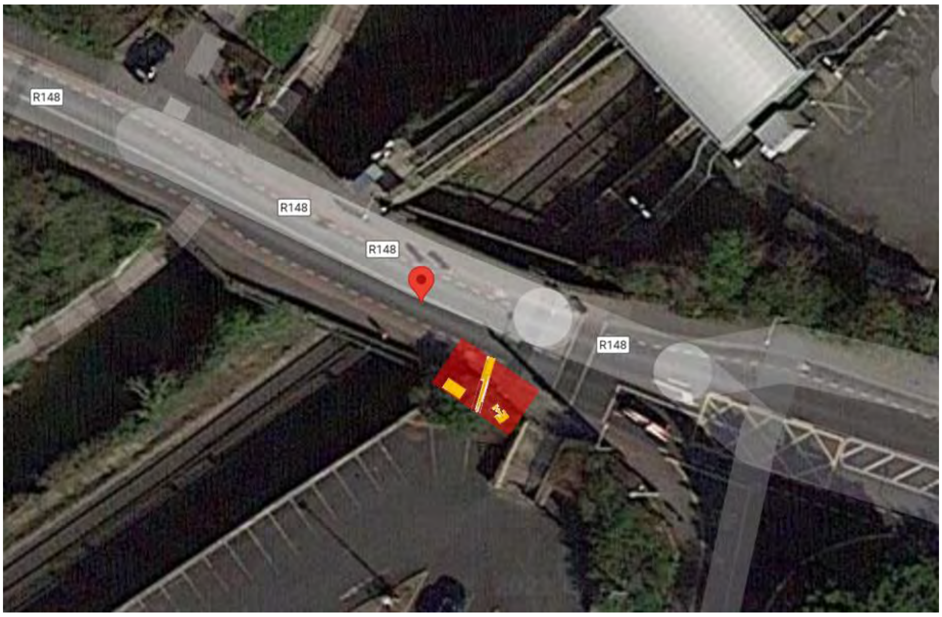


Figure 5-320 Plan of proposed temporary material storage area at OBG16

Figure 5-321 3D view of proposed temporary material storage area at OBG16

OBG16 Louisa Bridge will be served by two compounds (CC-STR-S6-76470-B and CC-STR-S6-76540-B) located in Leixlip, south of the track and at both sides of Louisa bridge. Vehicles delivering to the northern construction compound site (CC-STR-S6-76470-B) will use the access road off of R148, while those delivering to the southern site (CC-STR-S6-76540-B) will use the access route surrounding the adjacent parking provision, and secured by an access gate, as shown in Figure 5-322 below.

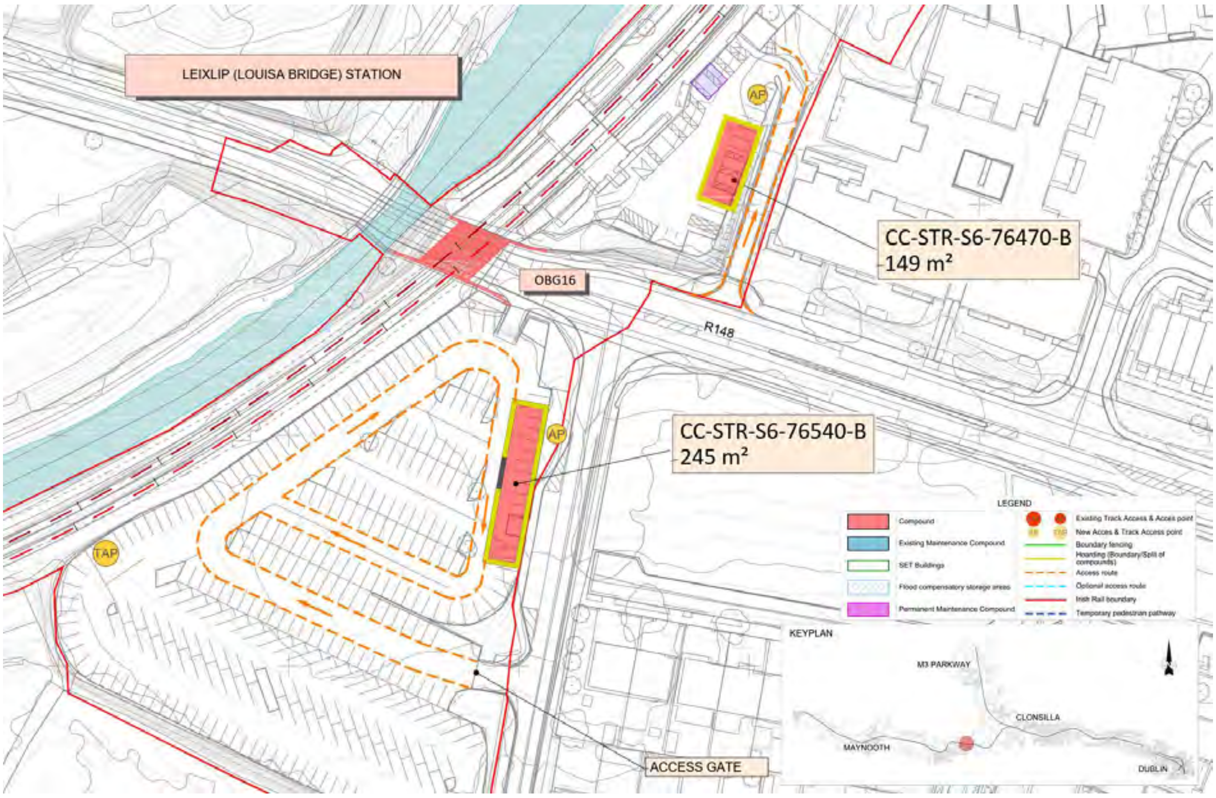


Figure 5-322 OBG16 structures compounds

Figure 5-323 OBG16 haulage routes

5.8.7.4 Traffic diversion during construction

During the lifting of the bridge deck, the road access to the bridge will be closed. Therefore, until the construction is complete, passing traffic must be diverted. In Figure 5-324 the shortest route between bridge access points is shown. Traffic will have to cross the railway track and the Royal Canal using the R449 road. In addition, it is planned to use R148 and Green Lane main to connect with R449.

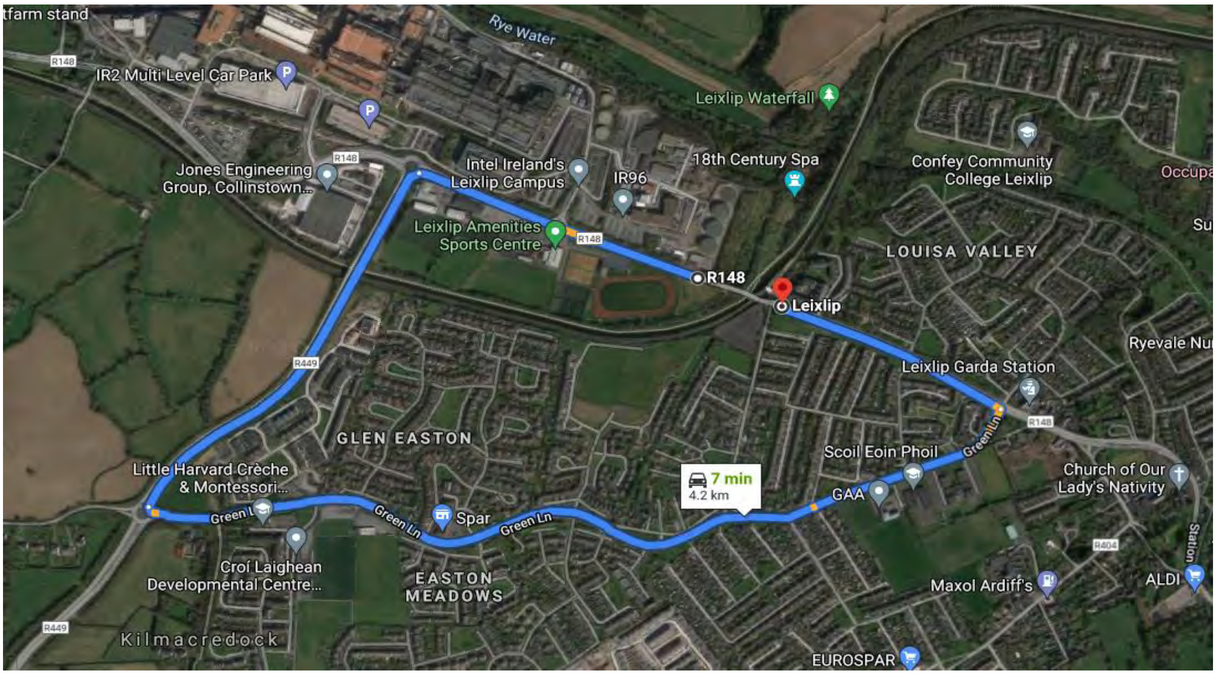


Figure 5-324 Traffic diversion during OBG16 construction

For pedestrians, Leixlip station footbridge will be used, in order to get to the OBG16 stretch above the canal.

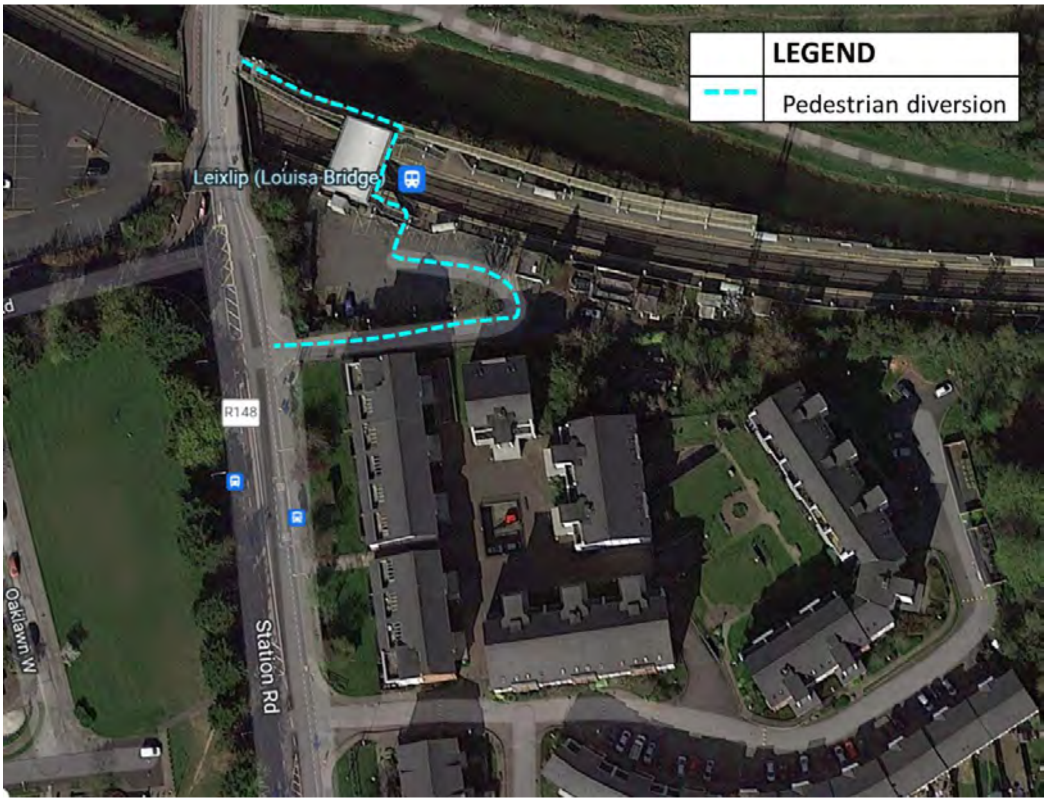


Figure 5-325 Pedestrian diversion during OBG16 construction

5.8.8 OBG16 Louisa Bridge parapet heightening

5.8.8.1 Overview of works required

For the OBG16, parapet heightening will be as detailed in Section 5.3.12.

5.8.8.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG16 will follow the construction scheme in Section 5.3.12.3.

5.8.8.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the OBG16 Louisa Bridge compounds (CC-STR-S6-76470-B and CC-STR-S6-76540-B) as a parapet heightening compound could be used if required.

5.8.9 Blakestown level crossing removal

There are no works proposed at Blakestown in respect of the level crossing closure other than the removal of the level crossing infrastructure and securing the railway boundary with fence and gates for maintenance access.

Fencing construction will follow the same construction methodology as outlined in Section 5.3.10.

5.8.10 Blakestown substation

5.8.10.1 Overview of works required

Blakestown substation will be located at the south of the railway, near the existing railroad crossing of the Deey Bridge and 13th Lock, Royal Canal, on its western side, at 1.8 km from the Leixlip (Louisa Bridge) Station towards the Maynooth Station.

5.8.10.2 Construction methodology

Construction of the substation will follow the construction methodology outlined in Section 5.3.9.

The duration of the works will be as follows:

- Civil Works at Blakestown substation 18 weeks
- Equipment at Blakestown substation 12 weeks

5.8.10.3 Construction compounds and haulage routes

Blakestown substation's main compound (CC-SUB-S6-78180) is located in Blakestown, south of the substation layout. Vehicles needing to deliver material or access the compound will use R449 road to connect to R148 and into the site.

Figure 5-326 Blakestown substation compound and haulage route

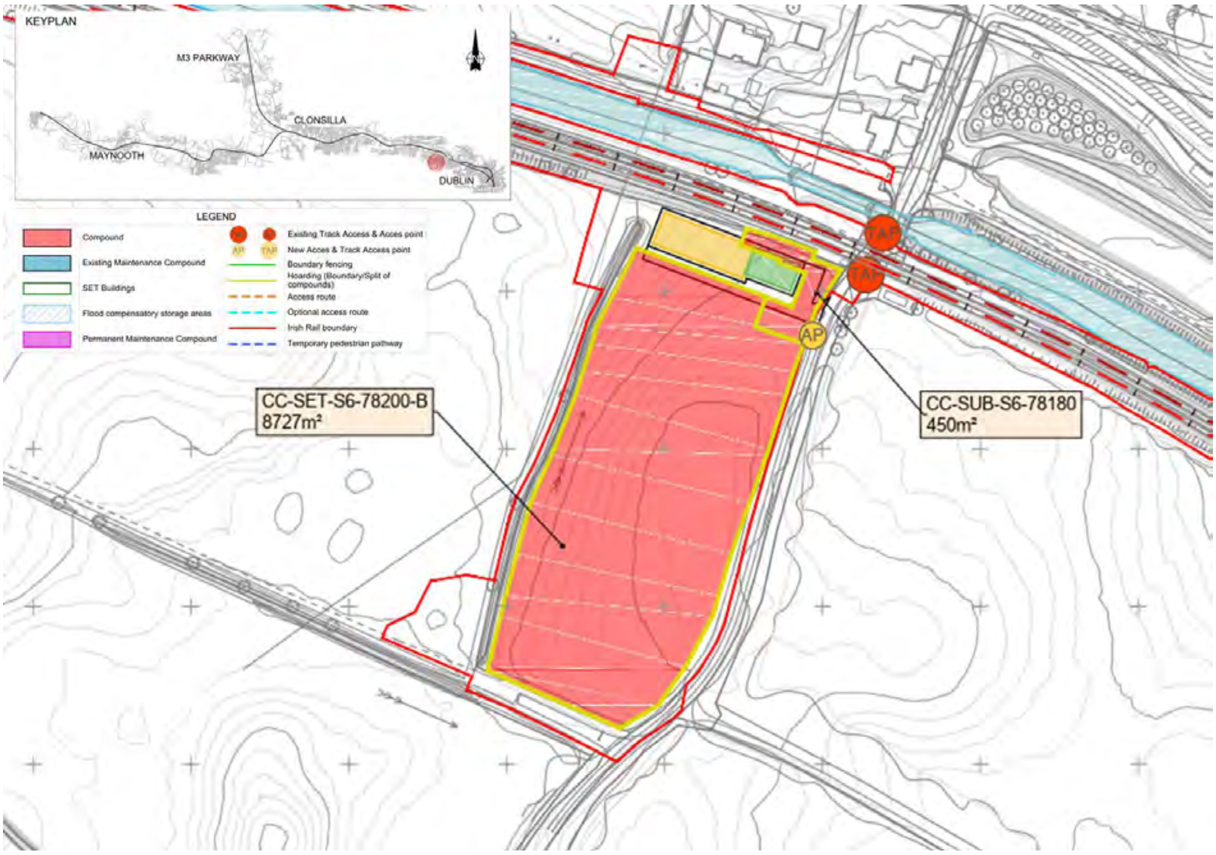


Figure 5-327 Blakestown substation compound

It will be necessary to create access from the existing road. However, this can be part of the closure of the existing level crossing works. Therefore, the access will be through the existing local road network, which connects to the R148.

5.8.11 OBG18 Pike Bridge: track lowering and parapet heightening

5.8.11.1 Overview of works required

The OBG18 Pike Bridge is located 2.2 km from the Maynooth Station towards Dublin.

Works at OBG18 Pike Bridge include:

- Track lowering.
- Parapet heightening.

A track lowering of up to 459 mm will be carried out below OBG18 along 415 m of the track to obtain an enhanced OHLE clearance.

Existing parapets height on OBG18 is between 0.60 and 1 m. Parapet heightening works will be as detailed in Section 5.3.12.

5.8.11.2 Construction methodology

Track lowering construction works will follow Section 5.3.6.1.

The general sequence of work will be as follows:

- On site offices and welfare facilities — 2 weeks
- Track lowering at OBG18 — 9 weeks

Construction of the aforementioned parapet heightening works on OBG18 will follow the construction scheme in Section 5.3.12.3.

5.8.11.3 Construction compounds and haulage routes

OBG18 bridge's main compound (CC-PW-S6-79950-B) is located in Maynooth. Vehicles delivering to the site will use the access route off of the adjacent road to the west of the site. Vehicles needing to deliver material or access the compounds will use R449 to connect to R405 then to Laraghcon Lane followed by R405 and finally connect to Ballygoran Avenue before accessing the site, as shown in Figure 5-328 and Figure 5-329 below.

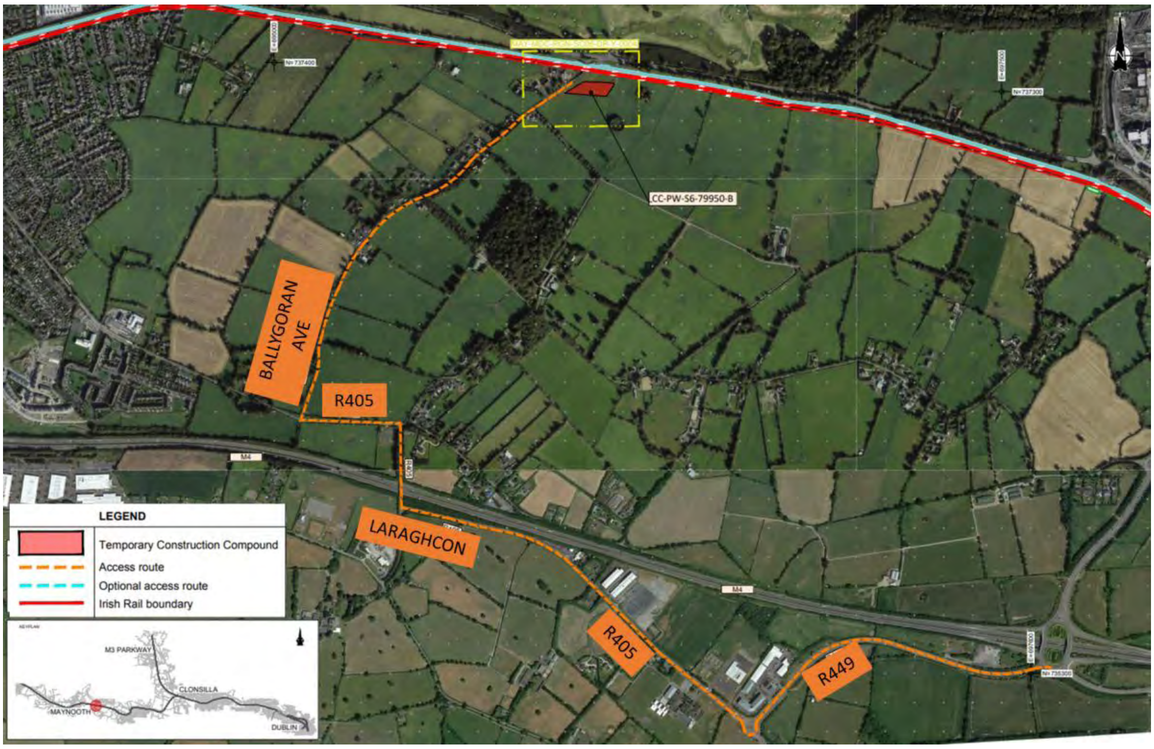


Figure 5-328 OBG18 permanent way compound haulage route

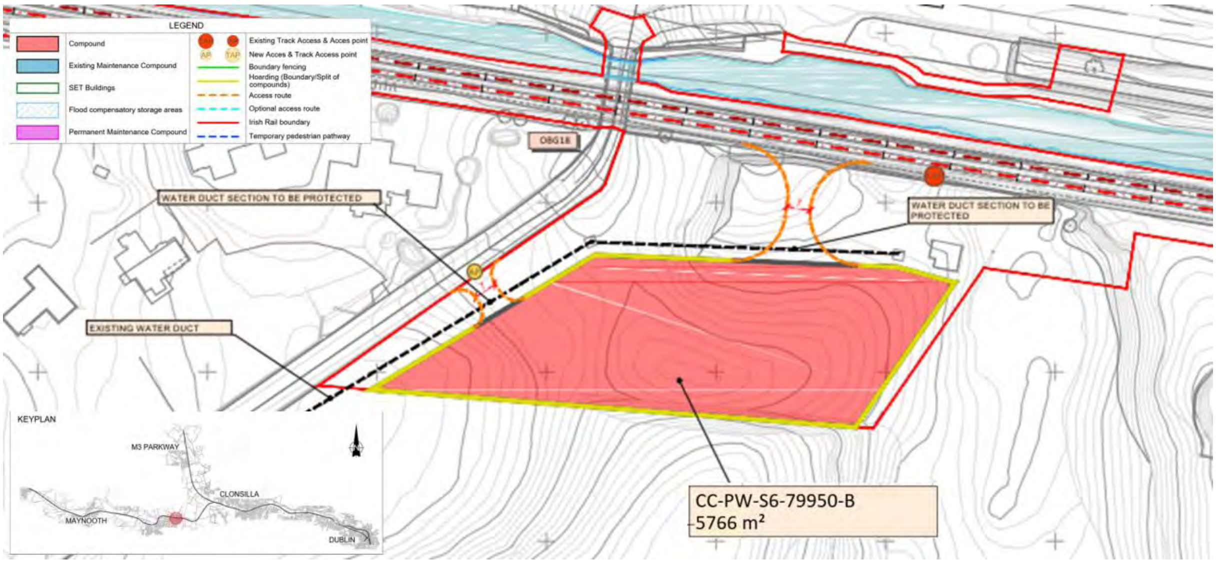


Figure 5-329 OBG18 permanent way compound

5.8.12 Other SET works

5.8.12.1 Signalling works

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling include adapting the existing signalling system to the removal of level crossings. The new signalling system will be commissioned without these level crossings:

- Barberstown level crossing (decommissioned during Phase 7 described in Table 5-16).
- Blakestown level crossing (decommissioned without any dependency on vehicle road works, as described in Section 5.8.9).

The specific signalling works for this area can be performed during regular night possessions or when there is a longer possession due to track works, so additional impact on passenger services is not expected due to signalling works. Night services such as freight trains could be affected, especially during test periods.

5.8.12.2 LV power works

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling include:

- Maynooth. Removal of the existing connection from the DNO/DC to the PHCCs. The existing PHCCs will be connected to the new DNO/DC.
- Maynooth. Turnouts 264A and 264B will be moved from the existing location to a new one. The heaters will be installed in these turnouts and the electrical installation will be disassembled and will be reassembled in the new location.
- Maynooth. Installation of new PHCC and heater kits to existing P&S (Points & Switches). New electrical connections will be needed for the new PHCC (MN-B) for the following existing points: 260A and 260B.

These works are performed during night-time, not impacting railway passenger services.

5.8.12.3 Telecoms works

The following construction activities will occur in Zone E:

- The new trunk cables will be connected to the new DART+ West nodes/buildings in this area, see details in Section 5.3.9.1 (i.e. Leixlip Confey TER, Leixlip Louisa Bridge TER, Leixlip Confey substation and Blakestown substation).
- The cabling will also be connected to the new DART+ West trackside LOCs and cabinets in this zone (OHLE, Signalling and LV cabinets) and other buildings (PSP).
- Telecoms equipment will be installed in the new TERs and substations buildings.
- Telecoms equipment will be installed in new trackside LOCs and cabinets.
- New telecoms infrastructure (optical fibre, copper, structured cabling, Station LOCs) will be installed in Leixlip Confey and Leixlip Louisa Bride stations, including new station end points (e.g. CCTV cameras, CIS displays, PA speakers, etc.).
- Basic testing onsite without live railway interaction.

No impact on passenger services is expected, as these works will be carried out during night possessions (e.g. installation of new trunk cables), or during daytime (e.g. installation of new station elements) as per agreement with SET.

5.8.12.4 Electrification works (HV/OHLE/SCADA/IESS)

- Installation of elastic bridge arms/OHLE supports to support the OHLE, insulators to support the feeder wires and earth wire clamps at OBG16 and OBG14.

- Installation of earth wire clamps to support the earth wire to the structure at (and insulators to support the feeder wires where applicable) at OBG18, OBG16A, OBG15A, OBG14A, New West & East footbridges adjacent to OBG14 and OBG13.
- OHLE feeding connections and MOS installation from Leixlip Confey, Blakestown and Maynooth substations, and mainline OHLE MOS.
- General electrification works for the OHLE installation (as described in 5.3.9.1 SET buildings and cabinets and 5.3.9.6 Overhead Line Equipment (OHLE)) that will generally comprise single track and twin track cantilever structures (including portals at stations).

The specific electrification works for this section within Zone E can be performed during regular night possessions or when there is a longer possession (i.e. weekends), so additional impact on passenger services is not expected due to these electrification works.

5.9 Description of Construction Works in Zone F – Maynooth Station to Depot

Zone F runs east to west from Maynooth Station to the depot. The zone is approximately 10.8 km in length from Ch 82+200 to Ch 93+000. Works in this section include:

- Modifications to the Maynooth Station.
- Construction of the new Maynooth substation.
- Modifications to the existing siding at Maynooth Station.
- Track doubling from Maynooth Station to the new depot.
- Construction of the new UBG22A, UBG22B, and OBG23A structures.
- Construction of the new depot access road.
- Construction of the new depot.
- SET installation (as described in Section 5.9.13).
- Railway Fencing installation (as described in Section 5.3.10).

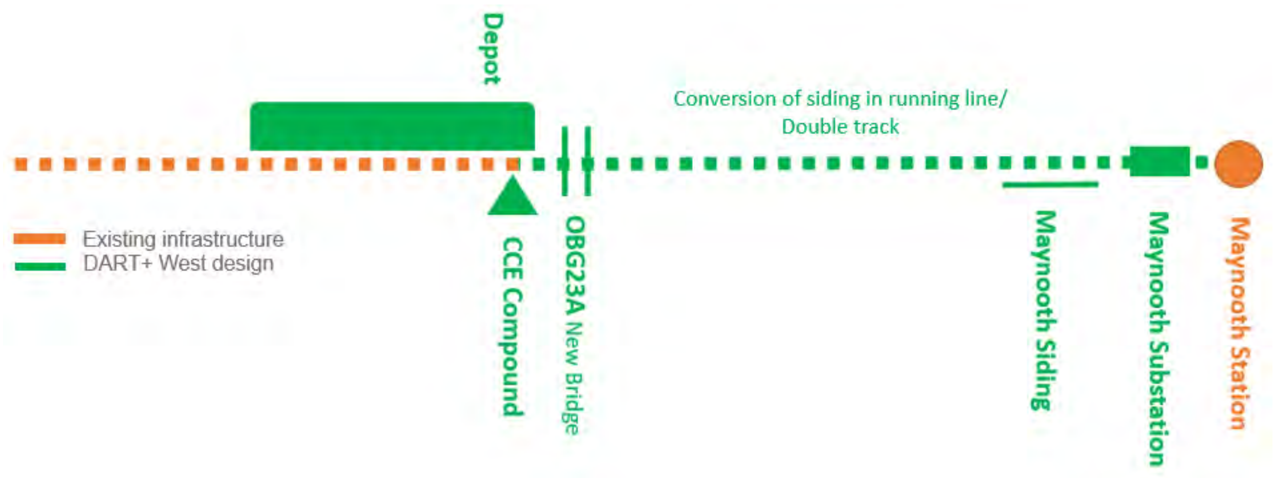


Figure 5-330 Schematic of DART+ West construction activities in Zone F

Early works will include compound installation, as well as utilities diversions. Due to the linear nature of these works, several utility diversion works have been identified in Zone F (described in Chapter 4 and 18 of this EIAR) and will require temporary traffic management measures. The typical construction methodology used for utility works has been detailed in Section 5.3.5.

This zone will require eight compounds and are listed in Table 5-17 below.

Table 5-17 Construction compounds in Zone F

Compound code	Chainage	Reference	Discipline
CC-SUB-S6-82260	82+260	Maynooth	Substations
CC-STR-S7-91880-B	91+880	Millfarm STR	Structures
CC-SET-S7-92100-B	92+100	Millfarm SET	SET
CC-PW-S7-92340-B	92+340	Millfarm PW	Permanent Way
CC-STR-S7-92850-U	92+850	OBG23A	Structures
CC-STR-S7-92900-U	92+900	OBG23A	Structures
CC-DEP-S7-93060-D	93+060	Depot SET	Depot (SET)
CC-DEP-S7-UP-93370-U	93+370	Depot Track	Depot (PW)

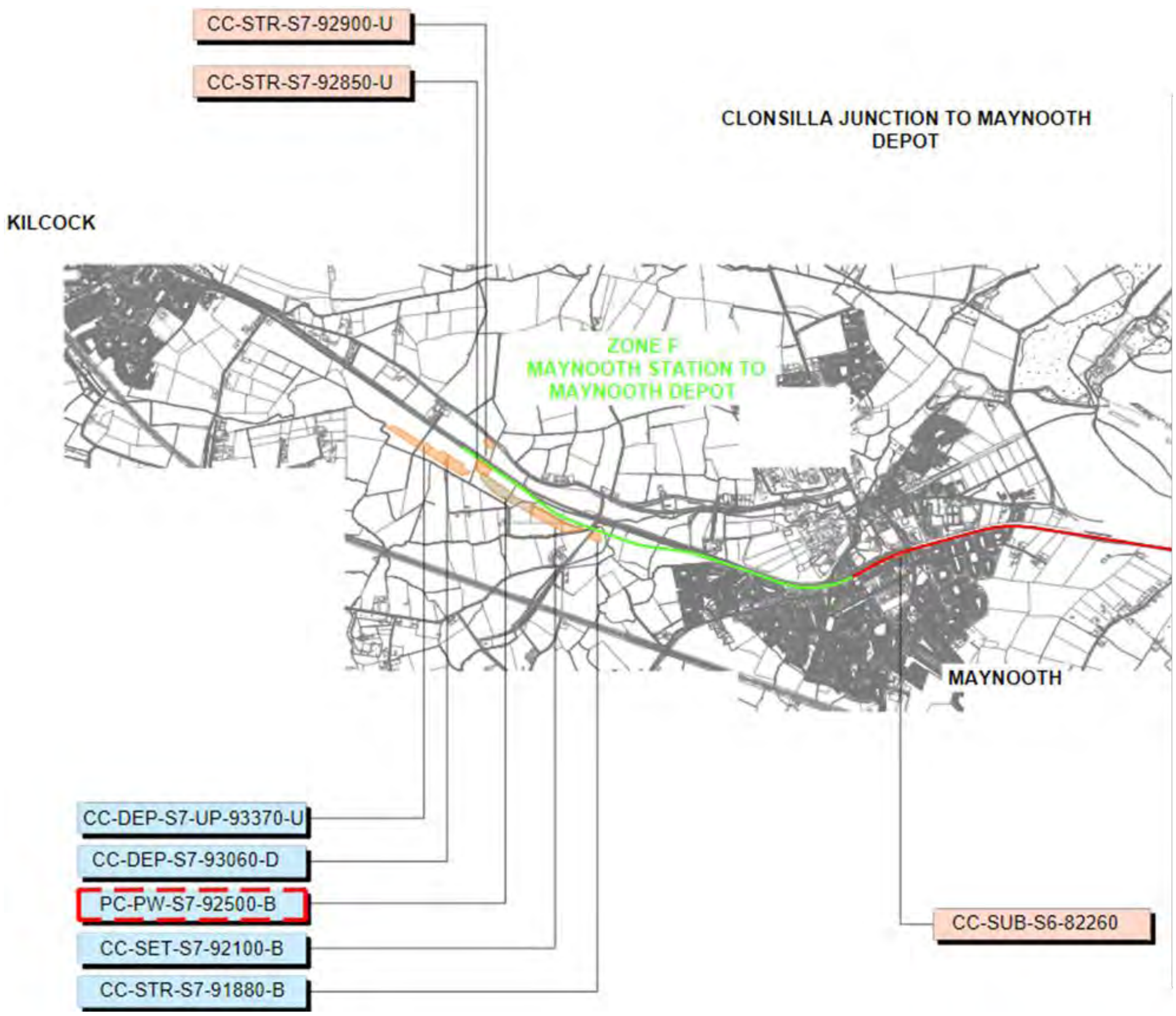


Figure 5-331 Zone F compounds

All works proposed in Zone F have been detailed from east to west, following the structure established in Chapter 4 of this EIAR.

5.9.1 OBG20 Maynooth Station footbridge parapet heightening

5.9.1.1 Overview of works required

OBG20 is located in Maynooth station, between platforms. Existing parapets will be altered as detailed in Section 5.3.12.

5.9.1.2 Construction methodology

Construction of the aforementioned parapet heightening works on OBG20 will follow the construction methodology outlined in Section 5.3.12.3.

5.9.1.3 Construction compounds and haulage routes

As there is no specific compound required for parapet heightening works due to the minimal necessary area needed for the parapet heightening elements, the use of the Maynooth substation compound (CC-SUB-S6-82230-B) as a parapet heightening compound could be used if required.

5.9.2 Maynooth substation

5.9.2.1 Overview of works required

East of Maynooth station, a substation will be constructed to allow for power supply to the OHLE.

5.9.2.2 Construction methodology

Construction of the substation will follow the scheme outlined in Section 5.3.9.

The duration of the works will be as follows:

- Civil works at Maynooth substation 18 weeks
- Equipment at Maynooth substation 12 weeks

5.9.2.3 Construction compounds and haulage routes

Maynooth substation construction compound (CC-SUB-S6-82230) is located on IÉ land in the Maynooth Station parking lot. Access into Maynooth substation compound will be done from R406 Straffan Road through the existing parking area access.

Figure 5-332 Maynooth substation compound and haulage route

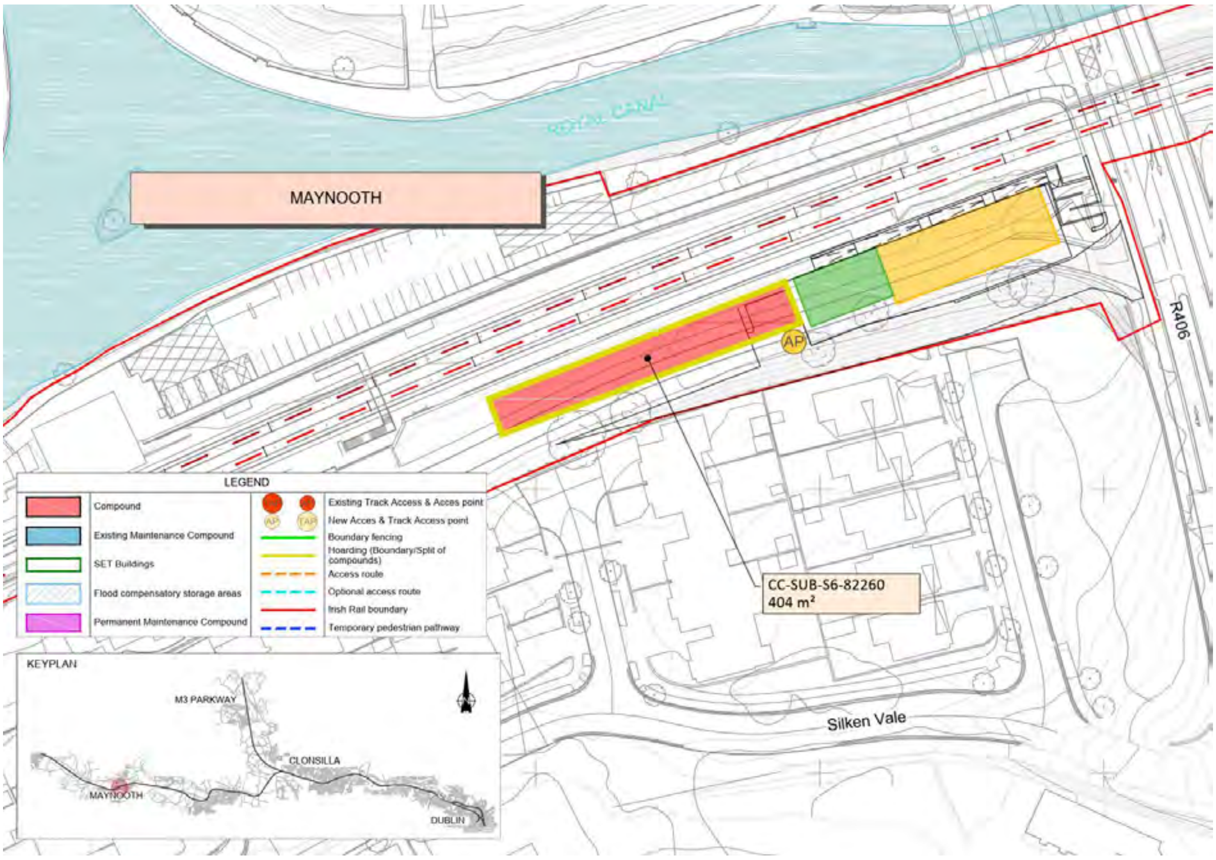


Figure 5-333 Maynooth substation compound

To allow a suitable access for pedestrians and vehicles to the substation the following work activities will require to be carried out:

- Southern retention wall and access widening.
- Northern wall and road realignment (once these works have been completed there is road and pedestrian access provided during the construction).

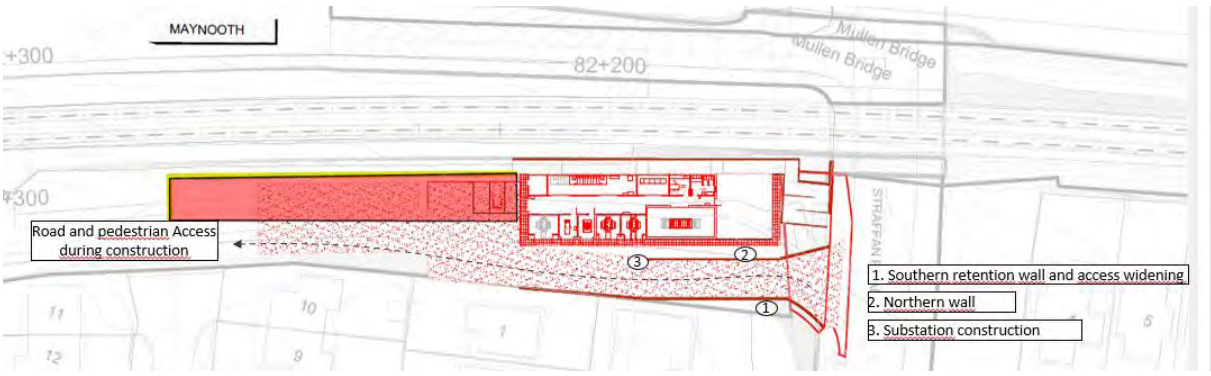


Figure 5-334 Maynooth substation road and pedestrian access

5.9.3 Maynooth Station

5.9.3.1 Overview of works required

In order to allow the track realignment works west of Maynooth Station, the platforms at the station need to be modified. This includes demolishing and realigning the platform ends west of the station.

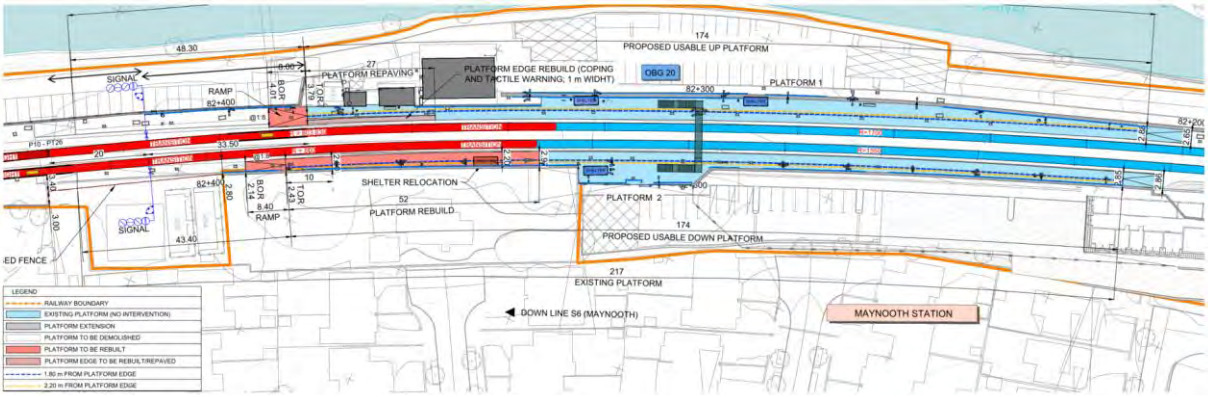


Figure 5-335 Maynooth station track realignment works

The works to be carried out on the platforms are as follows.

West Down Track platform (Platform 2)

- Demolition of 43.40 m of platform length and the ramp: this part is completely demolished and is not rebuilt.
- Demolition of 52 m of platform length and its reconstruction set back at a distance to maintain the clearance to the track new alignment.
- Construction of new ramp (1 in 8 gradient).
- 27 m length of platform realignment. The works consist of platform demolition and its reconstruction set back at a distance to maintain the clearance to the new alignment of the tracks.

Figure 5-336 End of west platform (Platform 2)

The existing services on the platform sections to be demolished are to be dismantled or relocated (see Figure 5-337):

- 1 PA speaker to be dismantled.
- 4 lamp posts to be dismantled.
- 1 CCTV camera to be dismantled.
- 2 twin spot luminaire (emergency) to be dismantled.

- 1 info screen to be displaced.
- 1 shelter to be displaced or removed.
- Removal of platform precast drainage channels.
- Ballast level relocation of the access chamber and service ducts.

Figure 5-337 Services to be removed/relocated on west platform (Platform 2)

East Up Track platform (Platform 1)

- Demolition of 48.30 m of platform length and the ramp: this part is completely demolished and is not rebuilt.
- 27 m length of platform realignment. The works consist of coping realignment. In this situation where the necessary displacement of the platform edge is less than 30 cm, the proposed solution consists of removing the platform edge piece and placing a new cantilevered piece at the required distance without demolishing the platform wall.
- Construction of new ramp (1 in 8 gradient).

Figure 5-338 End of east platform (Platform 1)

The existing services on the platform sections to be demolished are to be dismantled or relocated (see Figure 5-339 below):

- 1 PA speaker to be dismantled.
- 4 lamp posts to be dismantled.
- 3 CCTV cameras to be dismantled.
- 2 twin spot luminaire (emergency) to be dismantled.
- 1 info screen to be displaced.
- Removal of platform precast drainage channels.
- Ballast level relocation of the access chamber and service ducts.

Figure 5-339 Services to be removed/relocated on east platform (Platform 1)

5.9.3.2 Construction methodology

First works consist of the demolition of the platforms where required.

For platform widening of less than 300 mm, the phasing of the works is described as follows:

1. Scour the border of the existing platform.
2. Installation of anchor bars to the existing platform reinforced concrete slab.
3. Installation of the formwork and placement of rebar.
4. Cast the reinforced concrete slab.
5. Install pavement.

For platform widening of more than 300 mm or platform extension the phasing of the works is described as follows:

1. Removal of the ballast in the footprint of the platform.
2. Excavate the soil to the desired foundation depth.
3. Pour lean concrete on the base of the retaining wall.
4. Install reinforced concrete retaining wall.
5. Cast the reinforced concrete slab.
6. Backfill between existing platform and the retaining wall.
7. Install pavement.

Proposed work phasing and duration are both detailed in Section 5.9.5.2. During these works there be a partial closure of the platform for 9 weeks as per the programme included.

5.9.3.3 Construction compounds and haulage routes

As there is no specific compound for platform modification works, the use of the Maynooth substation compound (CC-SUB-S6-82230) as the platform modification compound is proposed, as it is the closest one to the working area.

5.9.4 Maynooth sidings

5.9.4.1 Overview of works required

The existing siding located west of Maynooth Station needs to be upgraded to meet the new operational needs and the electrification requirements. The intervention will consist of the following elements:

- A P10-13 crossover is placed between the station platforms and the siding turnout to allow operation of the siding:
  - o The horizontal alignment of the tracks is modified to allow the implementation of a straight crossover.
  - o The current P15-18.5 crossover is eliminated.
- P10-10 siding access turnout.
- Vertical alignment of the siding modified not to exceed the 1 in 500 gradient established in the standard (4.20.1.3 @ CCE-TMS-300 Track Construction Tolerances).
- Horizontal alignment: the siding axis is modified to comply with the I-PWY-1101 Requirement for Track and Structures Clearances.
- Superstructure renovation.
- Friction buffer stop: A new friction buffer stop with friction elements is designed to comply with the CCE-TMS-386 Requirements for Buffer Stops braking system.
- Modify the existing signalling system.

5.9.4.2 Construction methodology

The vertical and horizontal alignment will be modified according to the methodology explained in Section 5.3.6.2.1. The likely work phasing, duration and timeframe are detailed in Section 5.9.5.2.

5.9.4.3 Construction compounds and haulage routes

The construction compound planned for the Maynooth siding construction is the Maynooth permanent way compound (CC-PW-S7-92340-B), which is located close to the track and west to the UBG22B. Access into the compound will be from R148 road off of the M4 motorway.

Figure 5-340 Millfarm compounds and haulage route

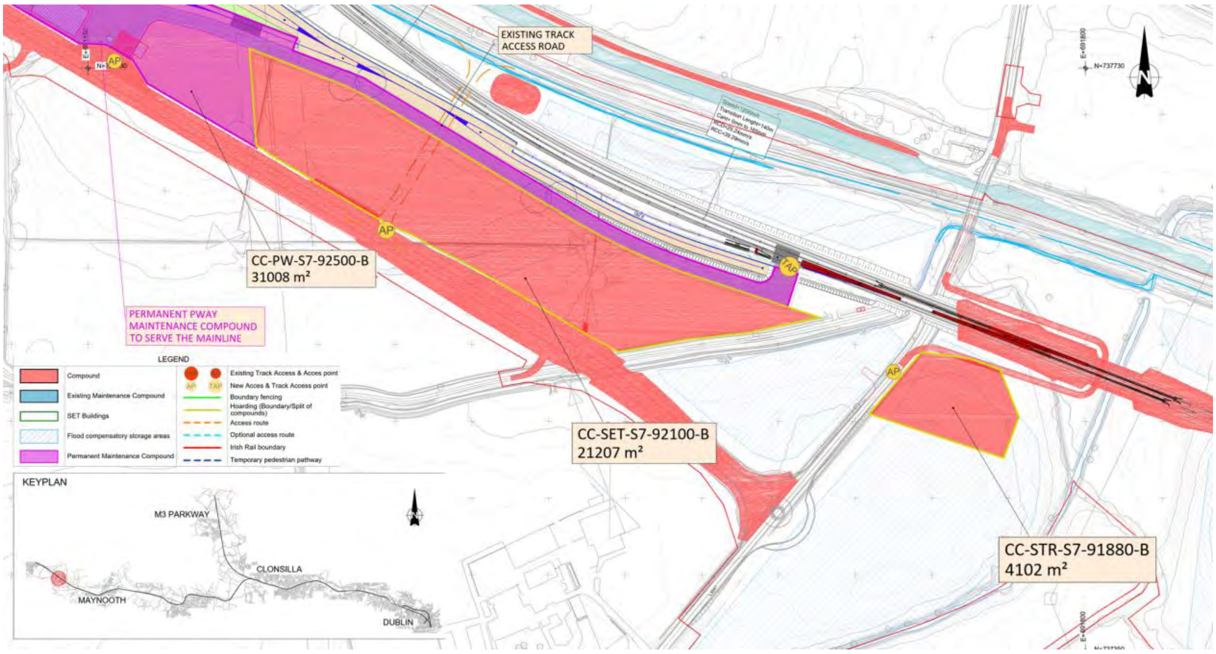


Figure 5-341 Millfarm permanent way compound

5.9.5 Track doubling

5.9.5.1 *Overview of works required*

The railway (referring to the main line) is currently single-track west of Maynooth. It will be necessary to upgrade the railway to a twin-track configuration between Maynooth and the proposed depot. It is proposed that the additional track will be parallel to the existing track.

The works to be performed to allow the new configuration varies depending on the location and the characteristics of the existing track and therefore it has been divided in four distinct sections, as follows.

Section 1. Conversion of existing siding to running line

- 395 m of existing disused siding will be transformed into the Down Track.
- To transform the existing siding into a running track the method explained in Section 5.3.6.2.1 will be followed.
- This section ends at the existing concrete fixed buffer stop at the end of the existing siding which is to be removed.
- Inherent to the twin track proposal is the installation of the OHLE (described in Section 5.3.9.6), services ducting (described in Section 5.3.7), a walkway, drainage (described in Section 5.3.13), installation of new signalling system and boundary treatment (described in Section 5.3.10).
- The likely work phasing and durations are detailed in Section 5.9.5.2.

Sections 2 and 3. West of the Existing Siding for 500 m to Jackson's Bridge Realignment

- This single track section, approximately 680 m in length, extends from the end of the long siding (Ch 90+520) to the new double-track section (Ch 91+200) in a westerly direction parallel to the Royal Canal. After the buffer stop the line passes the residential area of Woodlands. From here for 200 m it is proposed to replace the existing mainline track and add a track north of the existing track. The alignment of the line is modified to use the existing track as the Down Track and to run the Up Track on the additional section of track next to the Royal Canal. This methodology has been described in detail in Section 5.3.6.2.
- The likely work phasing and durations are detailed in Section 5.9.5.2.

Section 4. New double track diversion at Jackson's Bridge

This section consists of a double-track alignment offline of Jackson's Bridge (i.e. to the south), starting just outside the Maynooth urban area and extends for a distance of approximately 1.5 km to the west, and past the turnout for the proposed depot.

The construction phase is described as follows:

1. Earthworks which include but are not limited to the removal of topsoil, removal of vegetation, cut and fill works, grading the area and levelling the ground.
2. Installation of the utilities (as described in Section 5.3.5), surface water drainage system consisting of pipes and chambers, as required, and connect to the designated outfall point (as described in Section 5.3.13).
3. Track works as described in Section 5.3.6.2.

Likely work phasing and durations are detailed in Section 5.9.5.2.

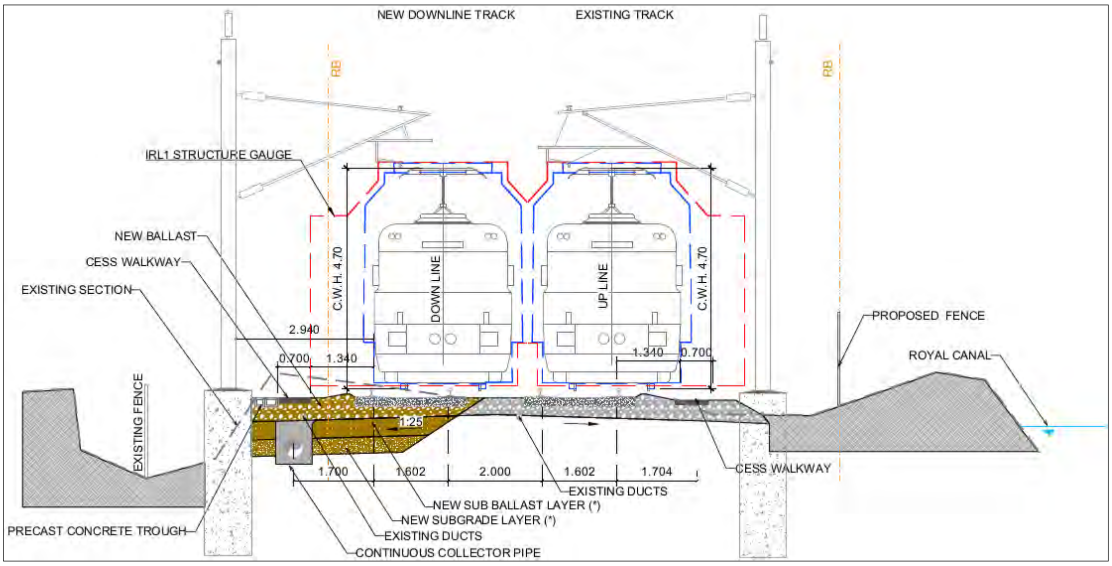


Figure 5-342 Section of new track (Down track) between the existing track and the depot.

5.9.5.2 Construction methodology

The phasing of the works is described as follows:

1. Maynooth siding modification is be executed during daytime project construction working hours, as set out in Section 5.2.1, with a duration of six weeks.

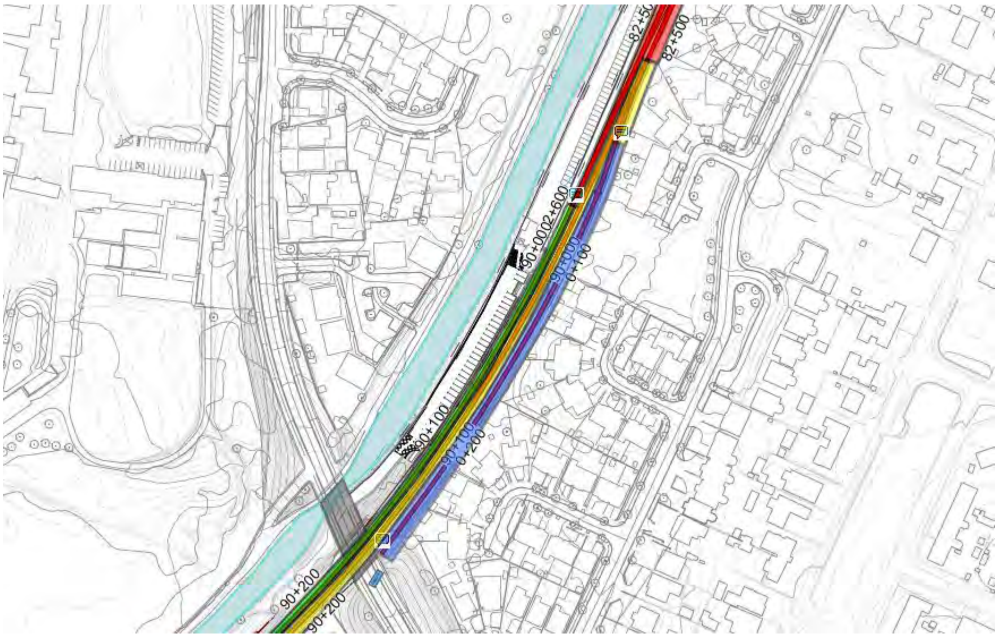


Figure 5-343 Phase 1 Maynooth siding modification (blue)

2. Conversion of the existing siding into running line. This phase can be performed in parallel with phase 1 and covers the conversion of the siding located between Ch 90+000 and Ch 90+500. The bulk of the works will be required to be performed during weekend possessions and night-time possessions. The estimated duration of this phase is 16 weeks.

Figure 5-344 Phase 2 Maynooth siding conversion (yellow)

3. New double track construction. This phase includes the construction of the new track, north of the existing track, between Ch 90+650 and Ch 91+100. This phase can be performed in parallel with phases 1 & 2. The bulk of the works will be required to be performed during weekend possessions and night-time possessions. The estimated duration of this phase is 16 weeks.

Figure 5-345 Phase 3 new double track (purple)

4. New double track construction. This phase includes the construction of the new track, south of the existing track, between Ch 92+500 and Ch 92+900. This phase can be performed in parallel with phases 1, 2 & 3. The bulk of the works will be required to be performed during weekend possessions and night-time possessions. The estimated duration of this phase is 16 weeks.

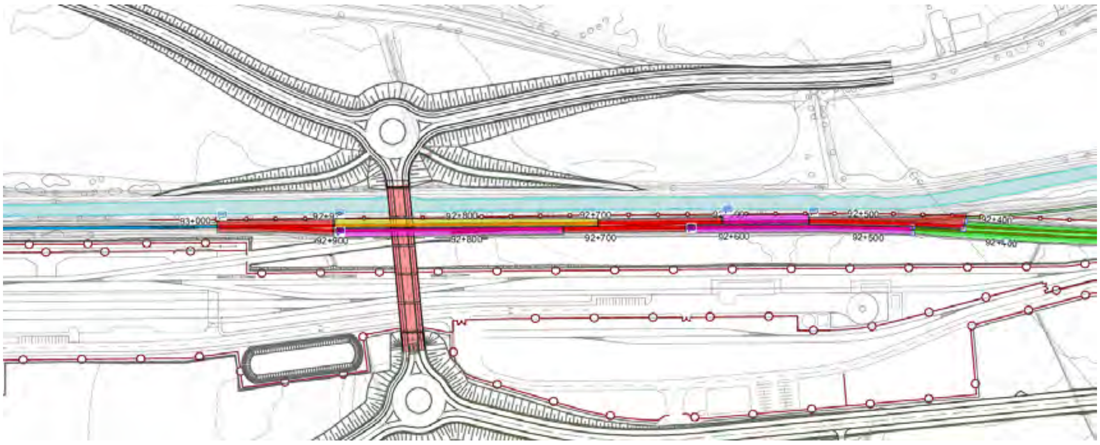


Figure 5-346 Phase 4 new double track (purple)

5. New double track diversion at Jackson's Bridge. This phase covers the construction of the new double track between Ch 91+200 and Ch 92+500, including the UBG22A, and UBG22B structures. Phase 5 is set to begin at the same time as phases 1 to 4 and has an estimated duration of 65 weeks. This phase will be performed during daytime project construction working hours as set out in Section 5.2.1.

Figure 5-347 Phase 5 new double track diversion (green)

6. Track slew. This phase includes the slewing of the existing north track between Ch 90+000 to 90+500 and can begin after phase 2 is completed. This phase will be performed during one weekend possession.

Figure 5-348 Phase 6 track slew (green)

7. Existing track realignment. This phase includes the realignment of the existing track, between Ch 90+700 and Ch 91+100. This phase can be performed after phase 3 is completed. The bulk of the works will be required to be performed during night-time possessions. The estimated duration of this phase is 4 weeks.

Figure 5-349 Phase 7 track realignment (yellow)

8. Existing track realignment. This phase includes the realignment of the existing track, between Ch 92+500 and Ch 92+900. This phase can be performed after phase 4 is completed. The bulk of the works will be required to be performed during night-time possessions. The estimated duration of this phase is 4 weeks.

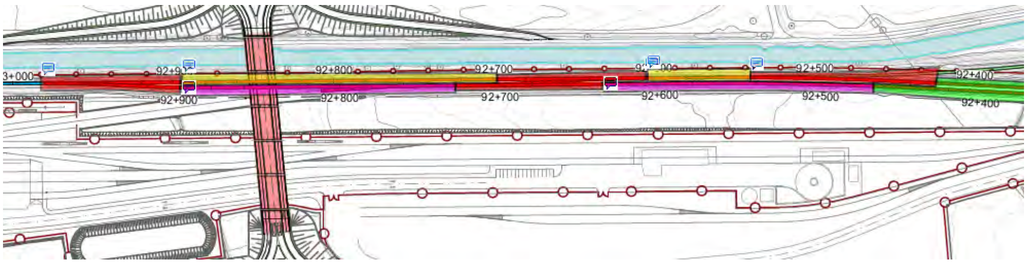


Figure 5-350 Phase 8 track realignment (yellow)

9. Crossover installation at Ch 90+900. This phase will be executed after phase 7 is completed and will be performed during one weekend possession.

Figure 5-351 Phase 9 crossover installation (red)

10. Crossover/turnout installation between Ch 92+700 and Ch 93+000. This phase will be executed after phase 8 is completed and will be performed during two consecutive weekend possessions.

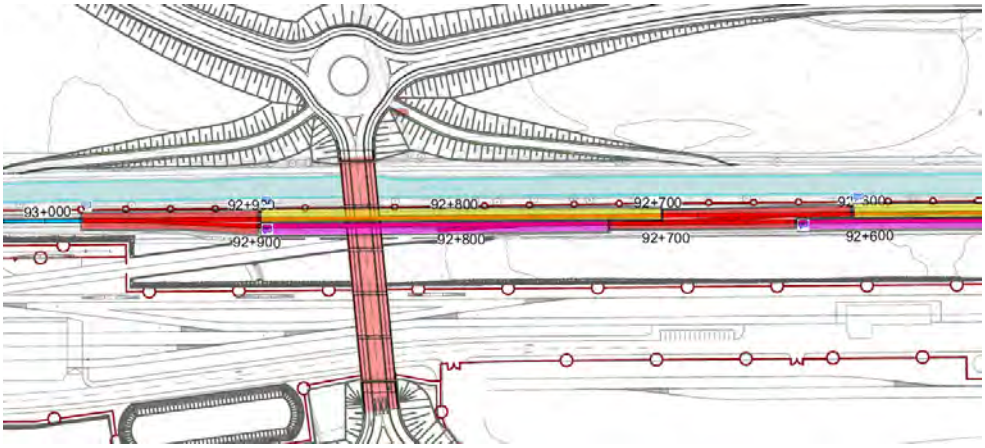


Figure 5-352 Phase 10 crossover & turnout installation (red)

11. Connections at Ch 90+600, Ch 91+200 & Ch 92+500. This phase includes the connection of the existing track to the new double track diversion at Ch 90+600 and Ch 91+200, and the connection between north and south track at Ch 90+600. These connections are required to be performed during one weekend possession after phases 5, 7 & 10 are complete, and the new signalling system is installed and tested.

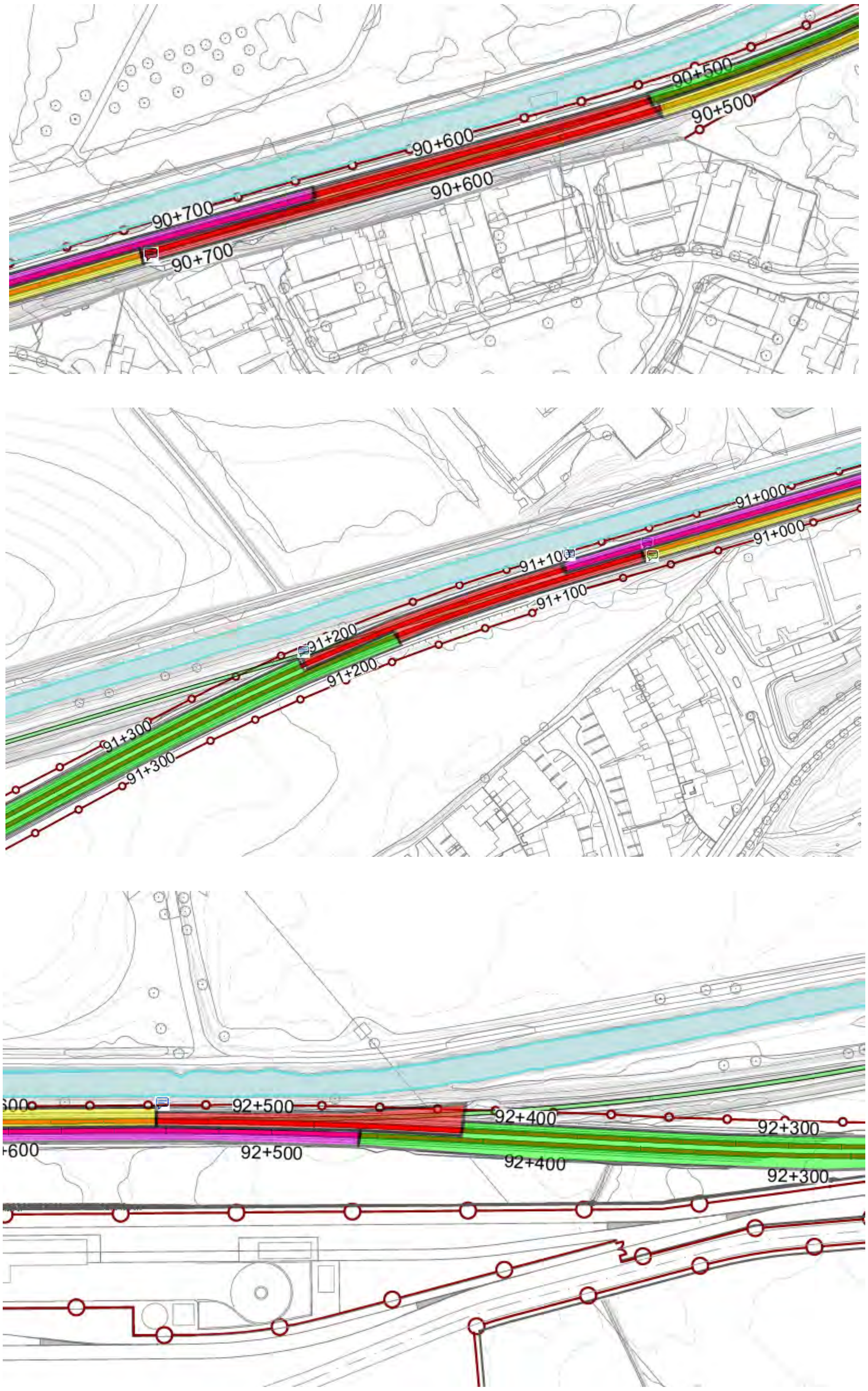


Figure 5-353 Connections at Ch 90+600, Ch 91+200 and Ch 92+500 (red)

12. Maynooth Station South Platform realignment. This phase is set to be completed at the same time as phase 11. The estimated duration is 4 weeks and will be executed during night-time possessions.
13. Maynooth Station track realignment and crossover replacement. This phase is set to begin after phase 13 is completed. This phase will be executed during one weekend possession.

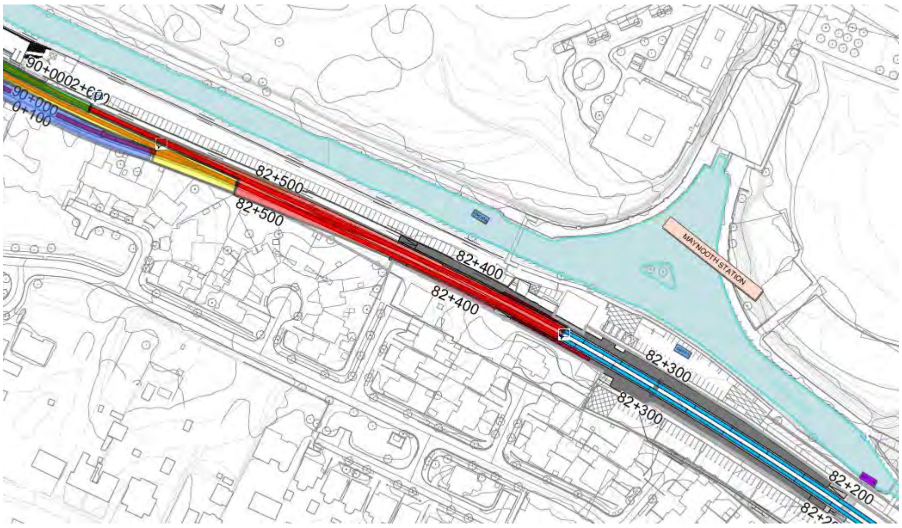


Figure 5-354 Maynooth station track realignment & crossover replacement (red)

14. Maynooth Station South Platform realignment. This phase is set to be completed at the same time as phase 13. The estimated duration is 4 weeks and will be executed during night-time possessions.

The total estimated duration for the permanent way works is 60 weeks, including the required modification to Maynooth station platforms.

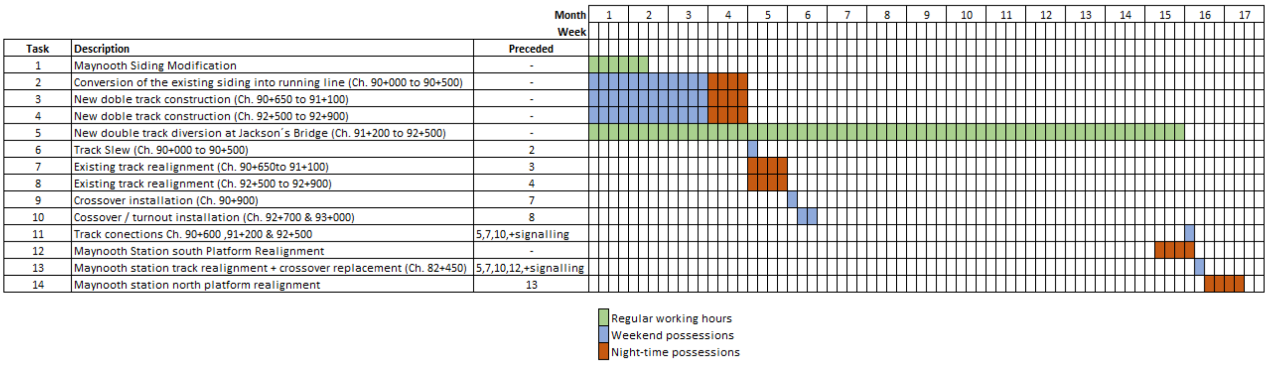


Figure 5-355 Construction duration for Maynooth track activities

5.9.5.3 Construction compounds and haulage routes

The construction compound planned for the track doubling is the Maynooth permanent way compound (CC-PW-S7-92340-B), which is located close to the track and west to the UBG22B. Access into Maynooth permanent way compound will be from R148 road off of the M4 motorway.

Figure 5-356 Millfarm compounds and haulage route

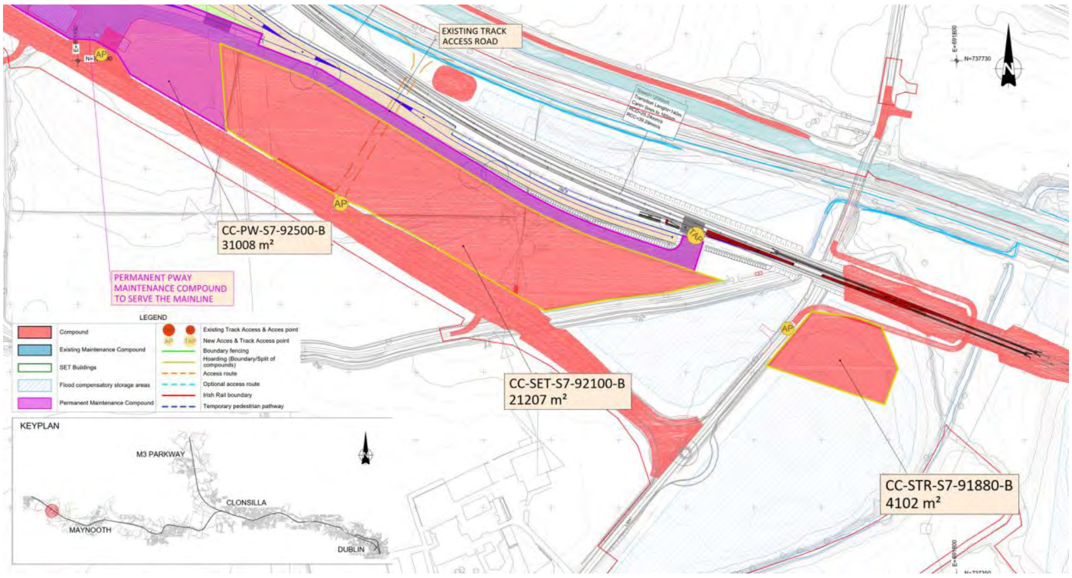


Figure 5-357 Millfarm permanent way compound

5.9.6 New underbridges UBG22A & UBG22B

5.9.6.1 Overview of works required

Before the connection with the depot the alignment crosses the Lyreen River where two structures are required to be construction (UBG22B and UBG22A) as shown below.

- UBG22A: New underbridge crossing over the Lyreen River.
- UBG22B: New underbridge crossing over the Reach 1 Stream.

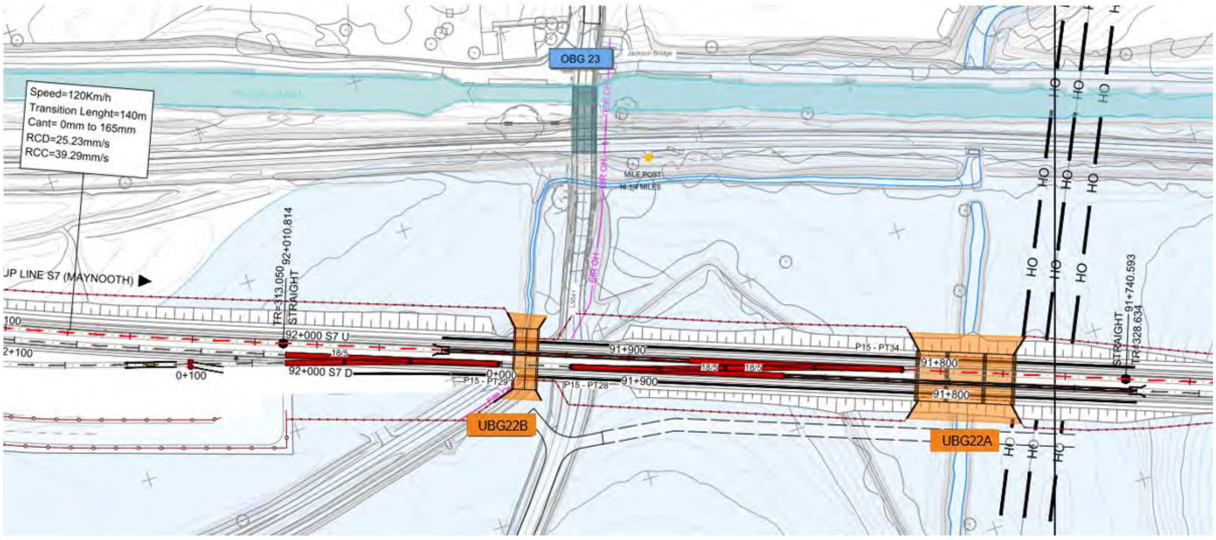


Figure 5-358 New structures UBG22B and UBG22A

For UBG22A, the structural solution for this underbridge is an in-situ reinforced concrete frame section, orthogonal to the railway line and will grant the support of the double-track railway line that runs over it. The internal free dimensions of the underbridge are 12.00 x 4.75 m and with another two spans, one on each side, which brings a total length of 32.00 m. At both ends of the underbridge there are wingwalls to contain the earthwork of the railway line. The chainage position and dimensions of the culvert are detailed in the table below.

Table 5-18 Culvert Specifications

Structure	Chainage	Description	Width (m)	High (m)	Thickness (m)
UBG22A	91+795	Water culvert, railway underbridge	9.50+12+9.50	4.75	Top slab = 1.00 Vertical walls = 1.00 Middle piers = d 1.00

The underbridge consists of a reinforced concrete frame section with a constant thickness for the top slab, bottom slab, middle piers, and solid walls on both ends.

One of the spans designed for the UBG-22A structure will allow pedestrians and cyclists to pass through. The existing ground level has been maintained to ensure sufficient conveyance through the structure.

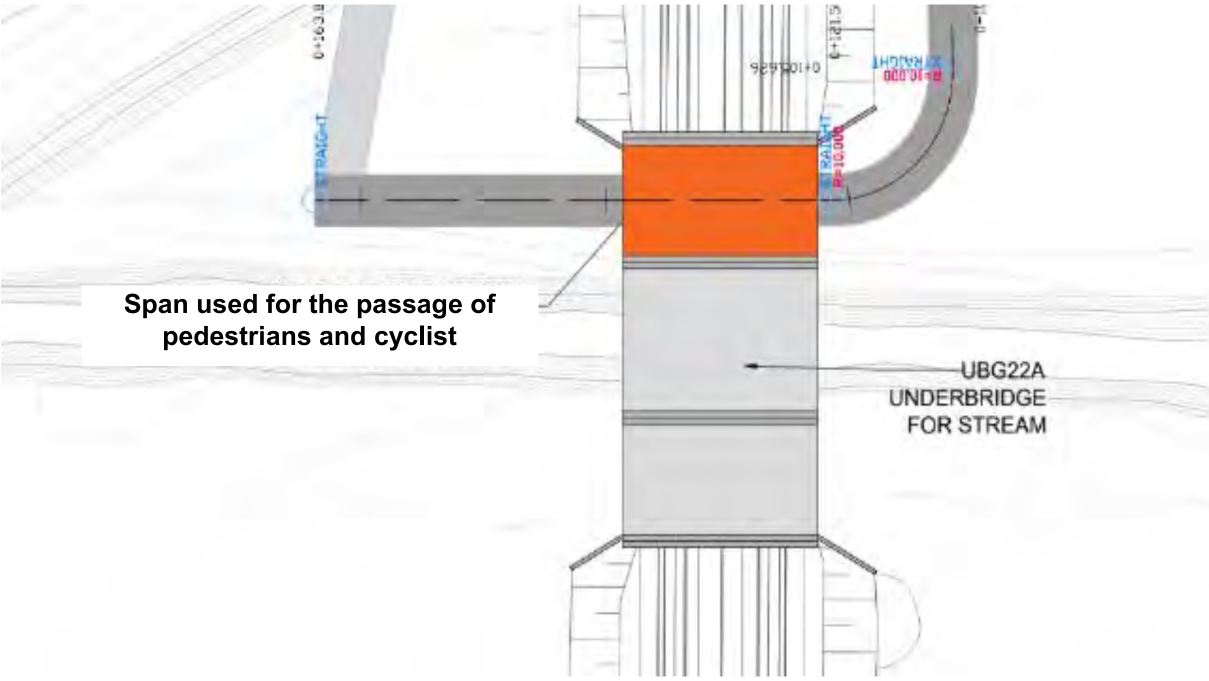


Figure 5-359 Location and plan view of UBG22A

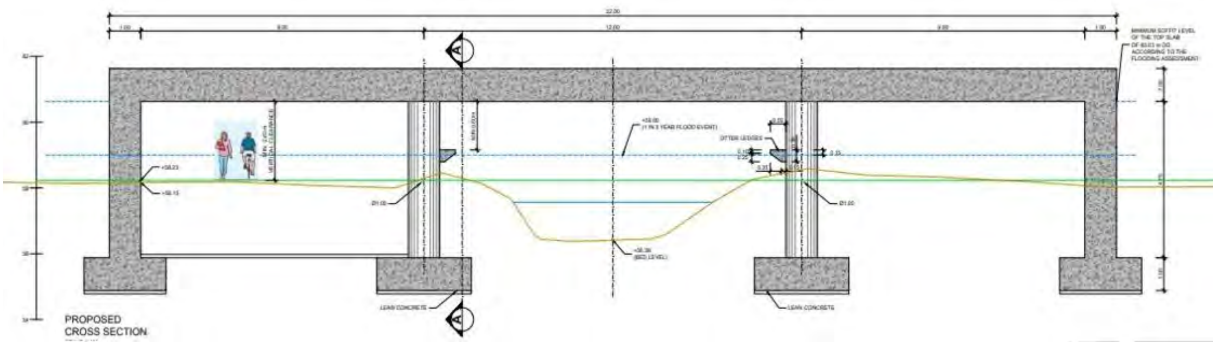


Figure 5-360 Cross section of UBG22A

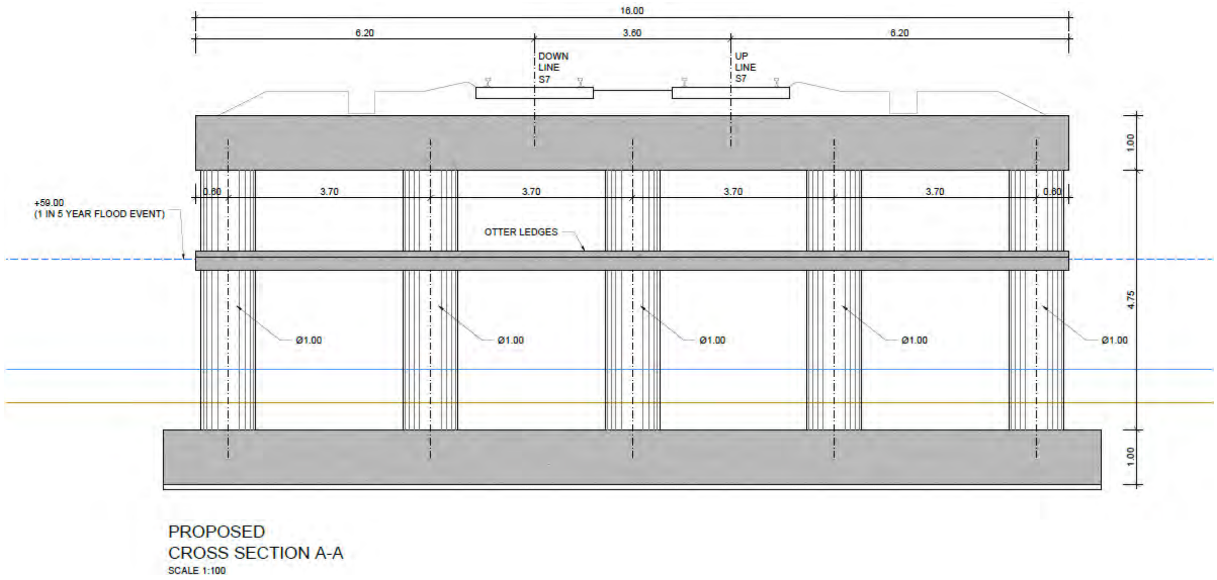


Figure 5-361 Section A-A - proposed pier design

For UBG22B, the structural solution for this underbridge is an in-situ reinforced concrete frame section, orthogonal to the railway line and it will support the double-track railway line that runs over it. The internal free dimensions of the culvert are 7.00 m x 4.40 m and with a length of 19.50 m. At both ends of the culvert there are wingwalls to contain the earthwork of the railway line. The chainage position and dimensions of the culvert are detailed in the table below.

Table 5-19 Culvert Specifications

Structure	Chainage	Description	Width (m)	High (m)	Thickness (m)
UBG22B	91+937	Water culvert, railway underbridge	7.00	4.40	Top slab = 0.60 Vertical wall = 0.50

The culvert is a reinforced concrete frame section with a constant thickness for the top slab, bottom slab and walls.

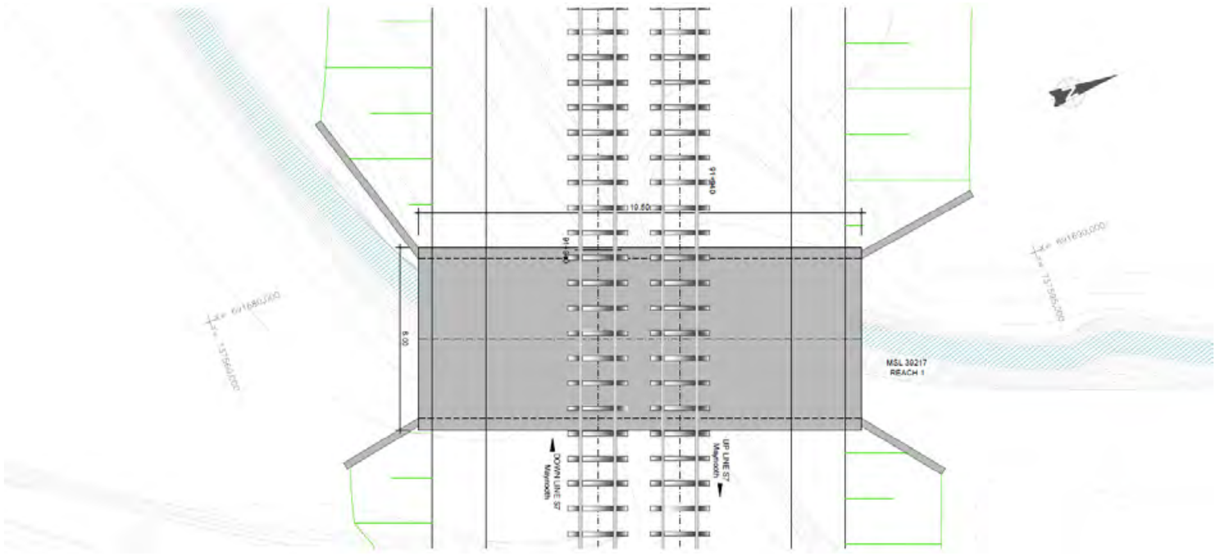


Figure 5-362 Location and plan view of UBG22B

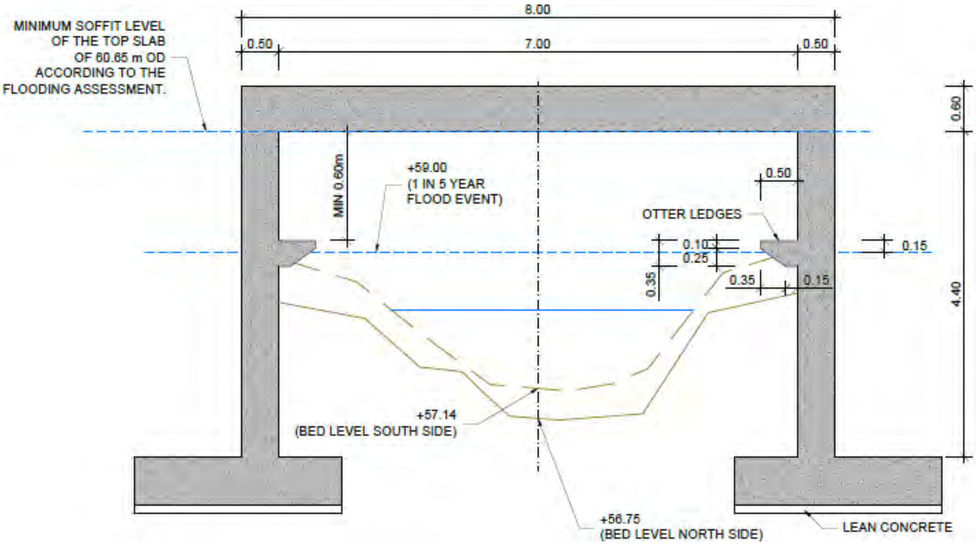


Figure 5-363 Cross section of UBG22B

5.9.6.2 Construction methodology

The construction sequence of the culvert and underbridge structures is proposed as follows:

- Phase 1: Site preparation (utility diversions, place temporary sheet piles to mitigate the impact on the existing stream, etc.).
- Phase 2: Excavation and construction of the foundations, including temporary dewatering during construction where there are potential water ingress issues.
- Phase 3: Construction of the vertical walls.
- Phase 4: Construction of the top slab.
- Phase 5: Excavation and construction of the wingwalls (foundation and vertical wall), including placement of waterproofing elements and drainage system.
- Phase 6: Embankment work (filling and compacting).
- Phase 7: Finishing.

No significant traffic restrictions are anticipated to be required during these works.

As shown in the following design chart, the total construction duration of UBG22A is estimated around 42 weeks. No railway and road closures are required. All the works will be performed during daytime project construction working hours as set out in Section 5.2.1.

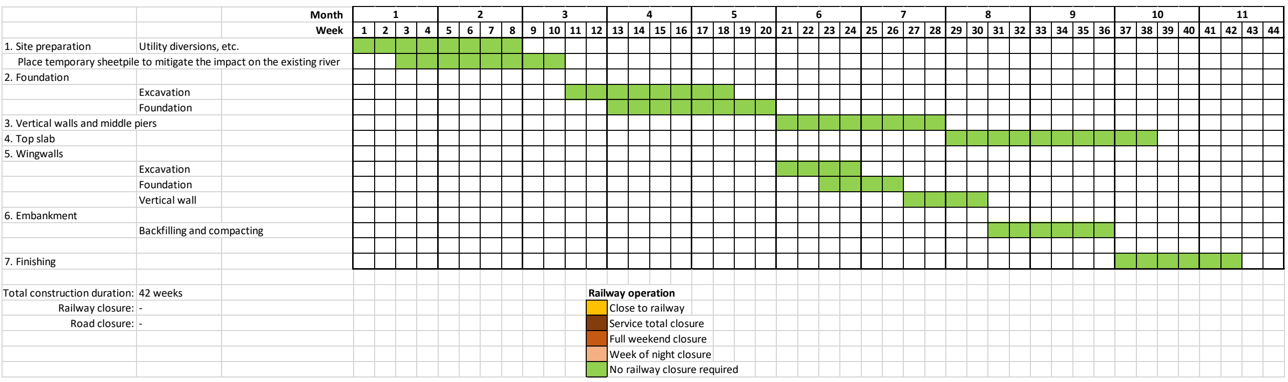


Figure 5-364 Construction duration of UBG22A

The total construction duration of UBG22B is estimated around 36 weeks, see below design chart. No railway and road closures are required. All the works will be performed during daytime project construction working hours as set out in Section 5.2.1.

	Month	1				2				3				4				5				6				7				8				9			
	Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1. Site preparation	Utility diversions, etc.	■	■	■	■	■	■	■	■																												
Place temporary sheetpile to mitigate the impact on the existing stream				■	■	■	■	■	■	■	■																										
2. Foundation																																					
	Excavation											■	■	■	■																						
	Foundation													■	■	■	■																				
3. Vertical walls																		■	■	■	■																
4. Top slab																						■	■	■	■												
5. Wingwalls																																					
	Excavation																	■	■	■	■																
	Foundation																			■	■	■	■														
	Vertical wall																							■	■	■	■										
6. Embankment																																					
	Backfilling and compacting																											■	■	■	■	■	■				
7. Finishing																																		■	■	■	■

Total construction duration: 36 weeks
Railway closure: -
Road closure: -

Railway operation
- Close to railway
- Service total closure
- Full weekend closure
- Week of night closure
- No railway closure required

Figure 5-365 Construction duration of UBG22B

5.9.6.3 Construction compounds and haulage routes

UBG22A and UBG22B main compound will be Millfarm structures compound (CC-STR-S7-91880-B), located in Millfarm at Ch 75+180. Vehicles delivering to the site are expected to access from R148 road from the M4 motorway.

Figure 5-366 Millfarm compounds and haulage routes

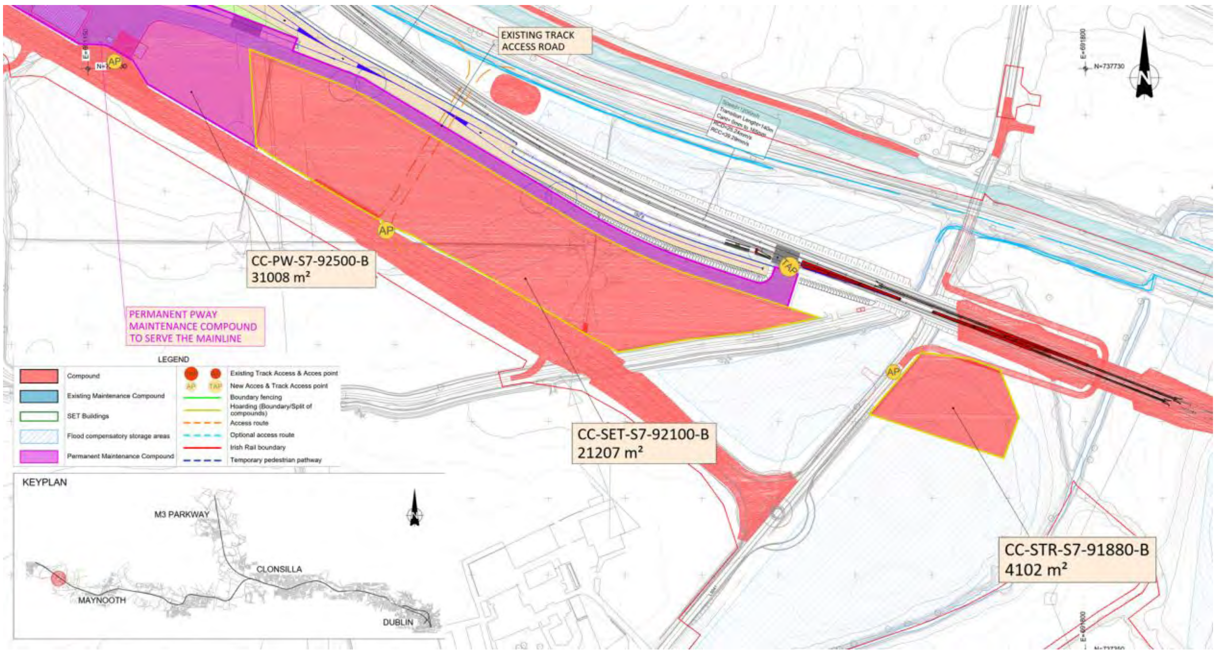


Figure 5-367 Millfarm structures compound

5.9.7 Overbridge OBG23A

5.9.7.1 *Overview of works required*

The construction of a new bridge is required (OBG23A) between the depot and Maynooth, providing access from R148 to the depot.

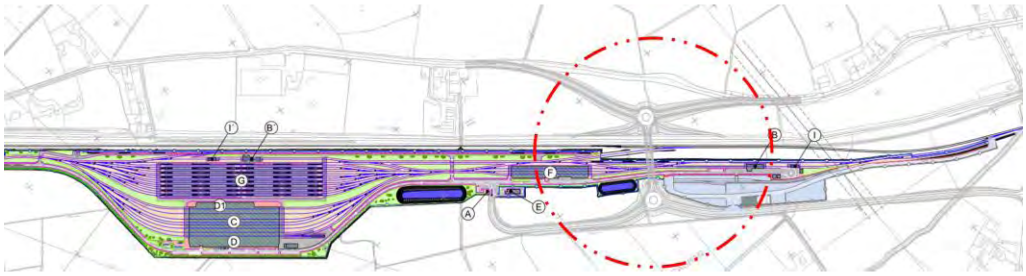


Figure 5-368 Location of OBG23A

It is proposed to construct a precast concrete beam deck of 5 spans.

The total length of the bridge is approximately 107.5 m, consisting of 5 spans of 21.5 m each. The required deck thickness is approximately 1.0 m with a 0.2 m top slab. The width of the bridge is 16.8 m.

A piled foundation solution has been proposed for the Pier-1 to avoid any impact on the adjacent Royal Canal (see Figure 5-369). For the purposes of this EIAR the rest of the piers and abutments are assumed to be founded on piled foundations (worst case). However, it may be possible to change to reinforced concrete pad foundations should the till be stiff or bedrock shallow, subject to detailed geotechnical investigation during detailed design.

5.9.7.2 Construction methodology

The new bridge OBG23A construction methodology is described as follows:

1. Site preparation: utility and existing path diversions (see Section 5.3.5).
2. Excavation and construction of six foundations. A piled foundation solution has been proposed for the Pier-1 to avoid any impact on the adjacent Royal Canal (see Figure 5-369).
3. Construction of the reinforced concrete bridge piers:
    - One pier in the verge located between the Royal Canal and mainline.
    - One pier in the verge located between the mainline and walking track.
    - One pier in the verge located between the walking track and transition platform bypass track.
    - One pier in the verge located between the transition platform bypass track and sidewalk.

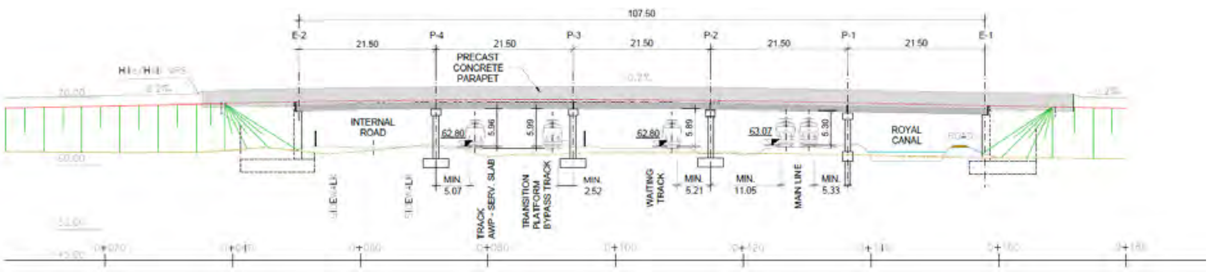


Figure 5-369 Elevation of proposed solution for OBG23A

4. Construction of the reinforced concrete bridge abutments:
    - Two abutments and concrete walls.
    - Backfill of the abutments to form the approach embankments.
5. Construction of the reinforced concrete pier caps and placing bearings.
6. Lifting of beams into position.

7. Casting of the top slab.

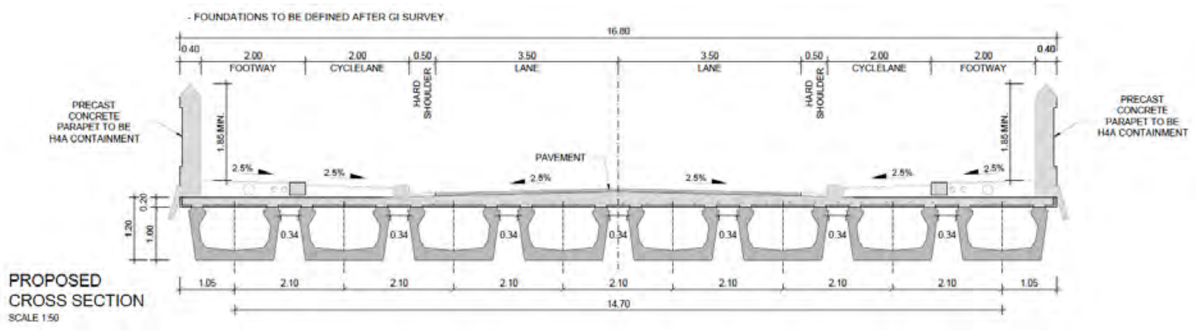


Figure 5-370 Cross section of proposed solution for OBG23A

8. Finishing of carriageway, cycle lanes and footways.
9. Installation of ancillary equipment (parapets, lightning columns, etc.).

As shown in following table, the total construction duration is estimated at approx. 47 weeks, including two full weekends of possession and 2 weeks of night closure working on the mainline railway.

Most works will be performed during daytime project construction working hours as set out in Section 5.2.1.

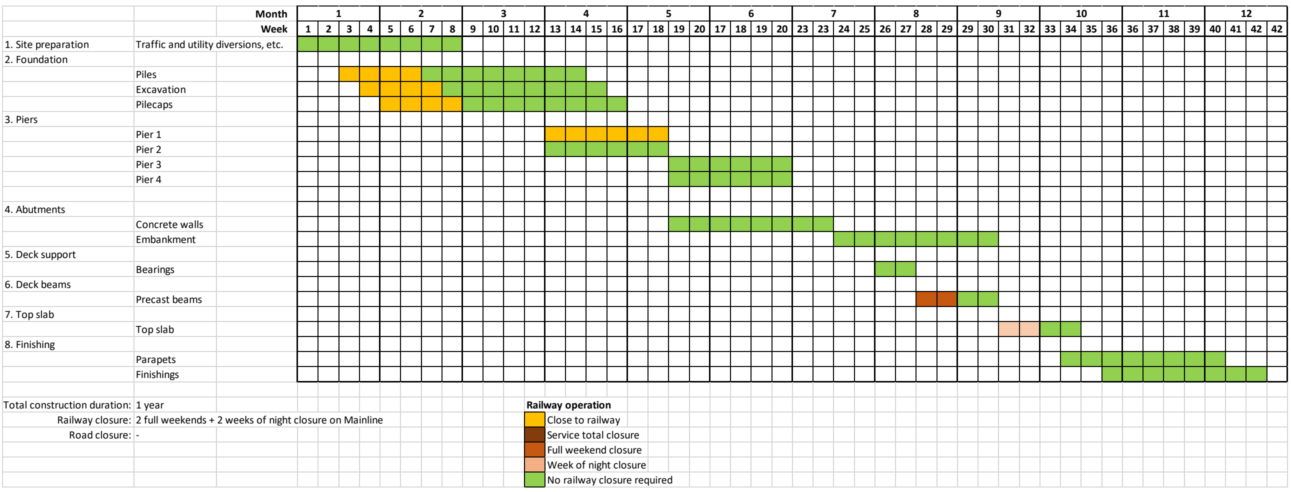


Figure 5-371 Construction duration of OBG23A

5.9.7.3 Construction compounds and haulage routes

OBG23A structure main compounds (CC-STR-S7-92850-U and CC-STR-S7-92900) are located at both sides of the canal, next to OBG23A layout. Vehicles needing to deliver material or access the compounds will use R148 road to connect the compound in the north side and Newtown Road to connect with the compound of the south side.

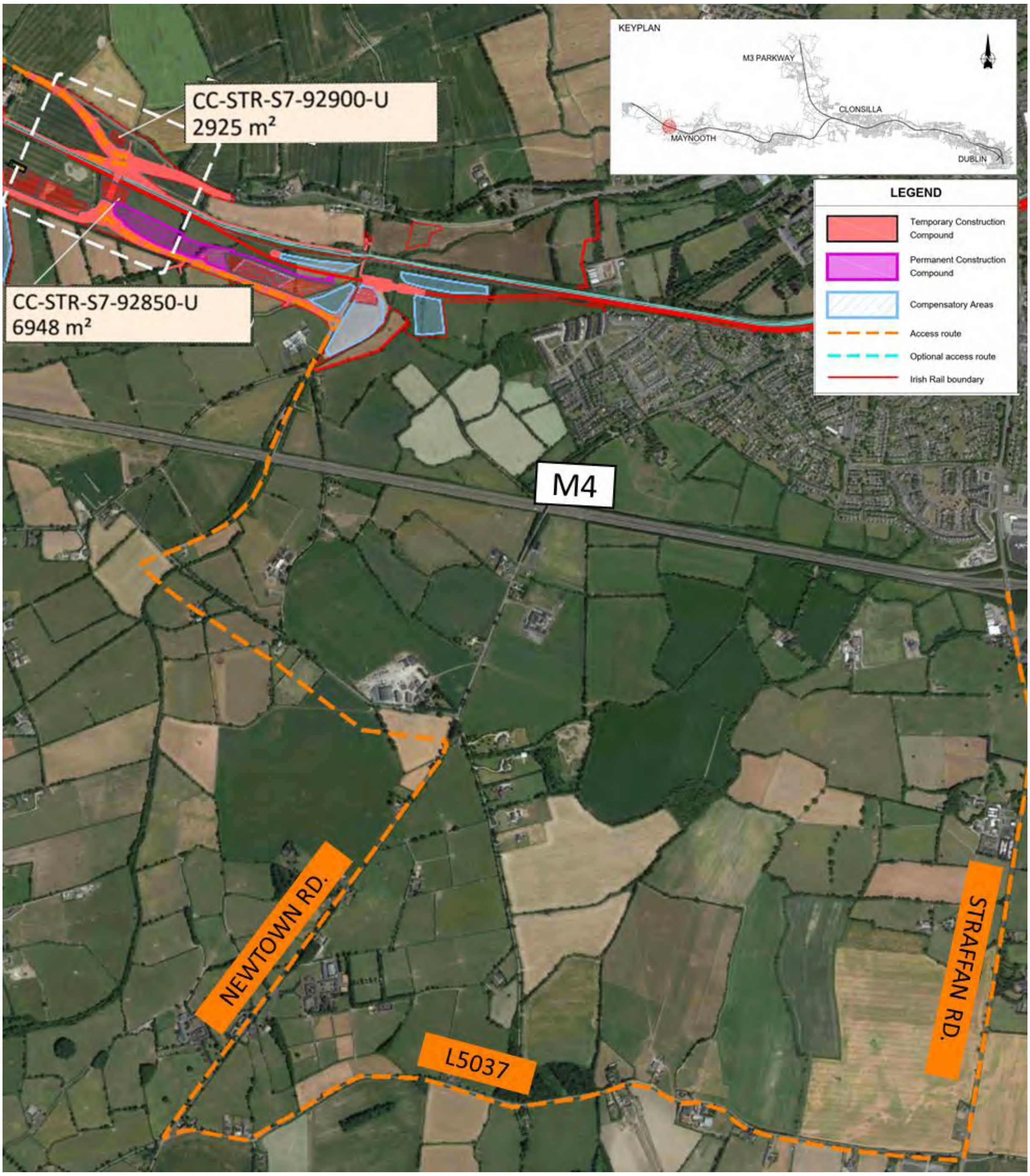


Figure 5-372 OBG23A Construction compounds and haulage routes

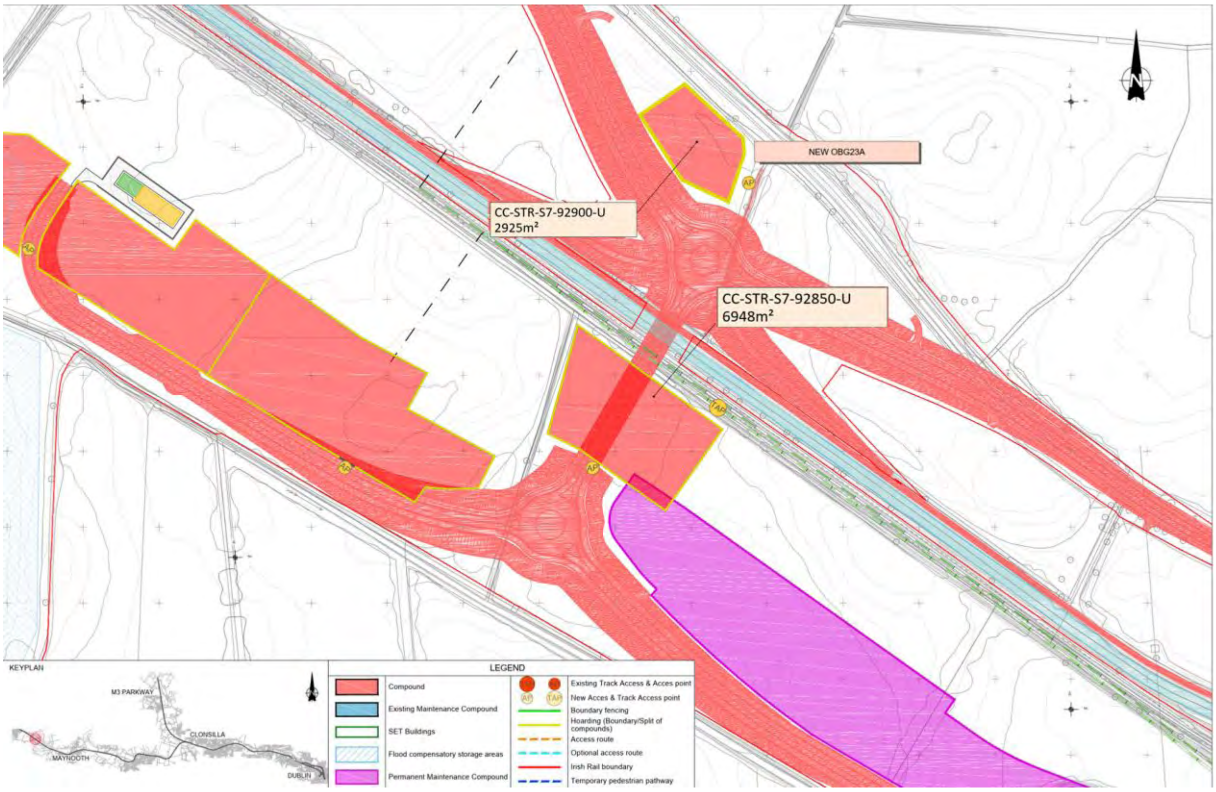


Figure 5-373 OBG23A construction compound

5.9.8 L5041 Road diversion

5.9.8.1 Overview of works required

L5041 will be diverted approximately 850 m to the west and onto the new OBG23A bridge to cross over tracks and the Royal Canal and connect to the R148 road.

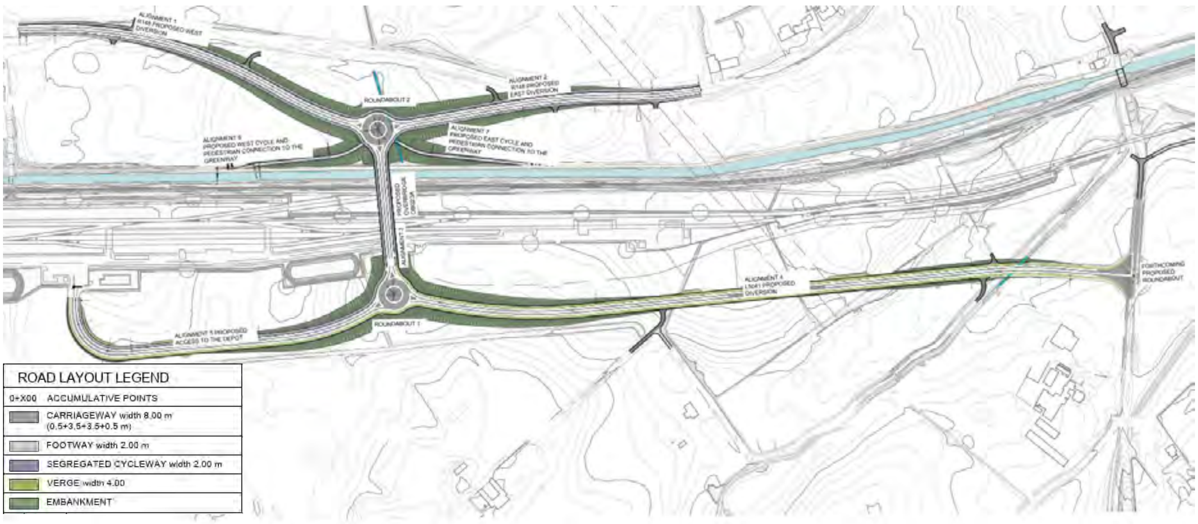


Figure 5-374 Depot access route general layout

5.9.8.2 Construction methodology

The construction methodology for the access road at OBG23A is described as follows:

1. Utilities diversion (see Section 5.3.5).
2. Site clearance and excavation to remove vegetation and topsoil.

3. Soil compaction to the required level.
4. Fine grading.
5. Lay aggregate base for the road.
6. Lay the pavement and finishes.

The estimated duration for the access road construction works for OBG23A is 5 months and will be performed during daytime project construction working hours as set out in Section 5.2.1. During most of the works the existing R148 will remain operational, but there will be an impact during the connection with the new road. This can be done during a night or a weekend.

5.9.8.3 Construction compounds and haulage routes

L5041 road diversion compound will be the same as for the OBG23A construction since both works are part of the L5041 diversion task. Compounds (CC-STR-S7-92850-U and CC-STR-S7-92900) are located at both sides of the canal next to OBG23A. Vehicles needing to deliver material or access the compounds will use R148 road to connect the compound in north margin and Newtown Road to connect with the compound of the south margin.

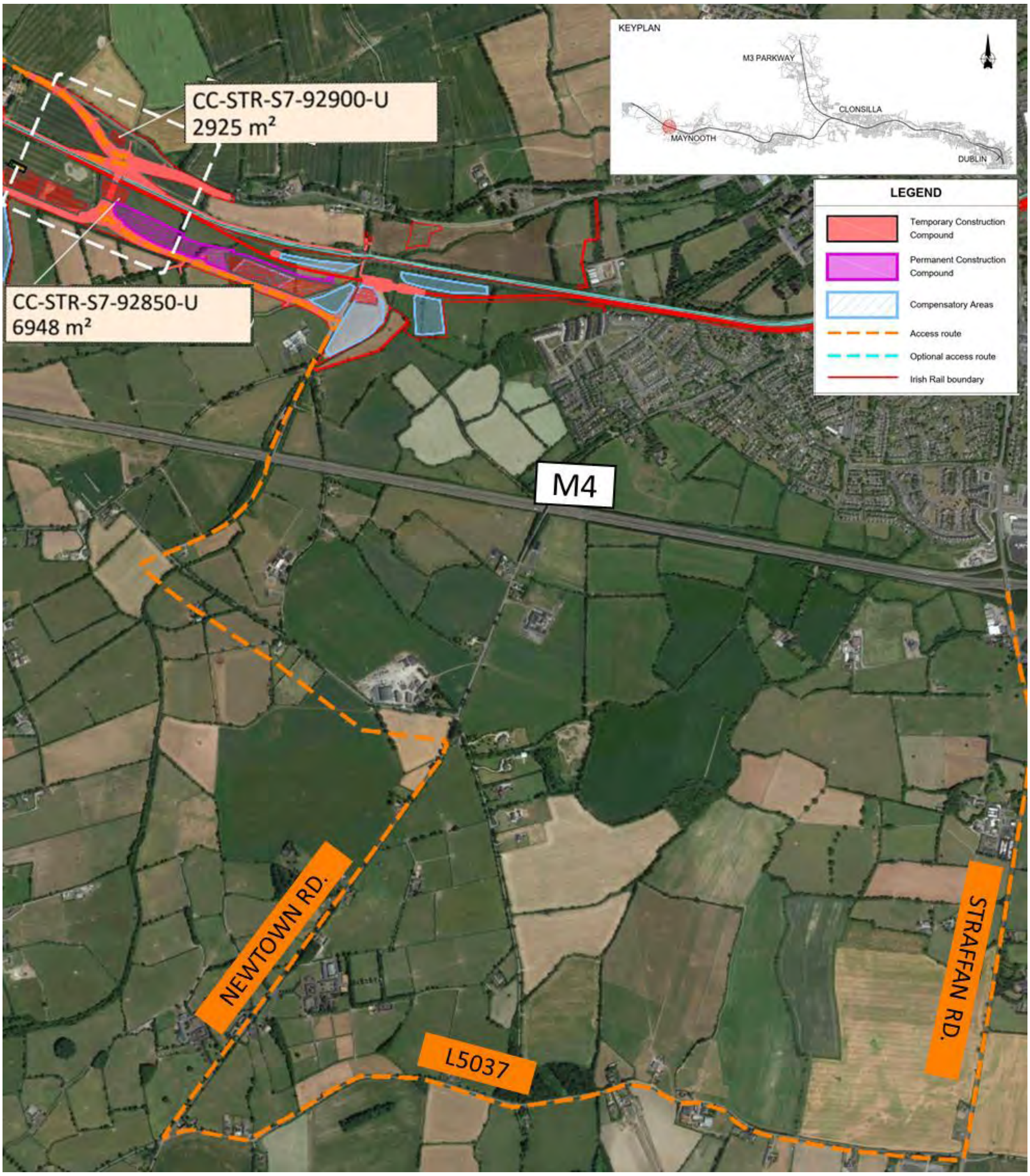


Figure 5-375 OBG23A construction compounds and haulage routes

5.9.9 Compensatory storage areas

5.9.9.1 Overview of works required

The proposed depot is located close to tributary watercourses of the Lyreen river and therefore a perimeter ditch at the southern boundary is needed to divert these elements. The hydraulic assessment has identified areas liable to flood in the vicinity of OBG23 and the depot lands. Development by the DART+ West project within these lands will displace flood waters which could potentially increase the severity of flooding in lands adjacent to the development including the M4 motorway if not mitigated. Compensatory storage in conjunction with flood relief culverts will be required to manage flood risk and maintain the existing flood regime.

Maximum depth of excavation is to be 3.4 m at OBG23 Jackson's Bridge while maximum depth of ~1 m is required at the depot lands. Embankments along the perimeter of the compensatory storage areas will be at a maximum of 1:1 slope. The provision of the compensatory storage will require excavation of ~123,000 m^3 of overburden. W etland habitats will be incorporated into the design of the flood compensatory storage areas. The wetlands will not affect the primary flood storage function of these areas. F urther excavation below the 1 in 2 year flood level and the outlet levels will ensure that water is allowed to pool which will encourage wetland habitats to establish.

Flood conveyance culverts through the new road (L5041) and rail embankments (in the OBG23 area) are built according to the methodology described in 5.9.6.2. Maximum width of these elements is 6 metres, with heights ranging from 0.5 m to 2.7 m. Indicative location of these culverts is shown in Figure 5-376.

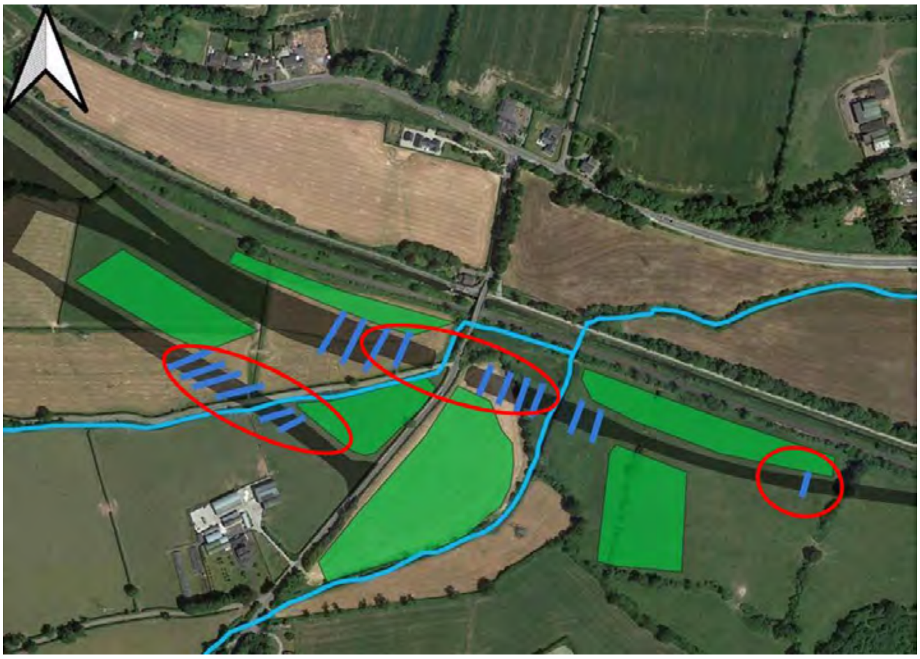


Figure 5-376 Indicative location of flood relief culverts (in red)

5.9.9.2 Construction methodology

The compensatory storage works are to be undertaken concurrently with depot and road/rail embankment earthworks. Works will consist of:

1. Site clearance.
2. Excavation of topsoil and removal to storage.
3. Excavation and removal of overburden to specified depth.
4. Reinstatement of topsoil material.
5. Re-grassing/re-vegetating.

The estimated duration for the compensatory storage area is 5 months and will be performed during daytime project construction working hours as set out in Section 5.2.1. Portions of the compensatory storage area are to be used for biodiversity enhancements and may comprise more intensive vegetative cover.

5.9.9.3 Construction compounds and haulage routes

The compound and the haulage routes are the same as those foreseen for the depot.

5.9.10 Depot

5.9.10.1 Overview of works required

The construction site for the depot will be located to the south of the existing rail mainline, that runs parallel to the Royal Canal and the R148 road, to the east of Kilcock, west of Maynooth and north of the M4 Motorway.

Most of the proposed land take area is currently farmland. The area occupied by the depot is 32.6 Ha, the length of which is 2.58 km and the maximum width is 260 m.

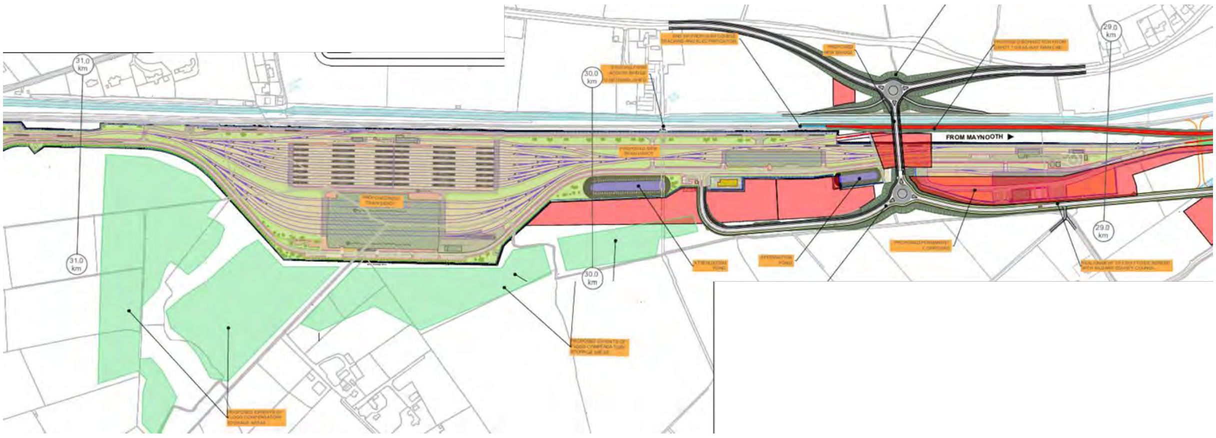


Figure 5-377 Depot general layout

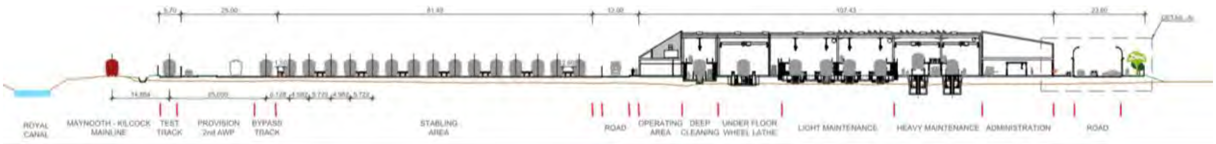


Figure 5-378 Depot cross section

Depot construction will involve civil, SET and building works. The facilities and the main features of the depot have been described in Chapter 4 of this EIAR.

5.9.10.2 Construction methodology

An indicative sequence of major construction activities related to the main depot is as follows:

- Site clearance:
  - OBG24 demolition (see Section 5.9.11).
    - Site clearance during night-time possession (1 week).
    - Joint demolition (isolation of both decks) with a full 1weekend possession.
    - Deck and parapet removal.
    - Internal support demolition.
    - Abutment excavation and demolition.
- Utility diversions:
  - Relocation of ESB Aerial Power Lines.
- Earthworks for the depot embankment:
  Topsoil removal.
  - Removal of unsuitable material.
  - Backfill and compaction with an approved filling material.
- Track works in the yard:
  - In the yard there will be general construction which includes ballast and track installation, all shall be compatible and coordinated with the construction of the different utilities on site (drainage, electricity, etc.).
  - The construction will start with earthworks, by contouring the subbase followed by the first ballast layer.
  - The sleepers are laid, and the rails are fixed in their preliminary position.
  - The second ballast layer is poured, and the topographic alignment of the track is adjusted and fixed.
- Buildings construction:

- Excavation of foundations.
  - Foundations are foreseen to be shallow except at the interface with pit and underpass construction.
  - In the maintenance shed, pits and an underpass are to be constructed; temporary support measures will likely be required.
  - These first foundation activities will be compatible with some utility works for the different systems: electricity, water supply, drainage, sewage and lighting.
- Construction of foundations/construction of new buildings:
  - The construction of the foundations with the columns, frames, and intermediate slabs.
- The roof and façade, as well as the finishes, will be installed.
- Installation of services, MEP, ancillary equipment, finishes, etc.:
  - During these works all the MEP, electricity, water supply, drainage and telecoms works inside the buildings will be coordinated.
- Track works:
  - The construction of the tracks within the building must be compatible with the different elements of the building (structure, the pits, and MEP).
  - The building will have a slab track and tracks in the pit in the maintenance area: firstly, the construction of the pits during the building foundation stage will take place; lastly, the construction of the track will be compatible with the mat slab of the building.
- Equipment:
  - For the major pieces of equipment such as the wheel lathe, overhead platforms, and the underfloor lifting jacks set system, these must be installed and co-ordinated with the building construction.
  - The maintenance equipment required is: AVI system, bridge or monorail cranes, underframe wheel lathe (UWF), pit track equipment, lifting equipment: synchronised lifting jacks, storage equipment, sand filling and CET emptying equipment, automatic washing plant equipment, deep cleaning equipment and shunting vehicles, maintenance vehicles.

- Signalling, electricity, and telecom (SET):
  - The SET assets and infrastructures of the depot are to be coordinated with the rest of the construction elements of the depot project.
  - The cable routing, manholes, signals, OHLE, conduits, masts and poles, and the rest of the elements are dependent on the track works, road and landscaping works as well as the rest of the urban development work.
  - In order to avoid any clash, their construction must be coordinated with the other elements at the different stages of the construction; for example, earthing and bonding must be considered at the first stages, and the mast foundation needs to be compatible with the track works.
  - It is also important to integrate the SET elements properly with the buildings (service slab, washing plant, AVI building, and maintenance shed).
  - To take into consideration the new turnouts to access the depot are installed and blocked until commissioning of the depot.
  - For the Construction Phase 2 of the depot, which encompass the 50% of the stabling tracks, the CMS will be done as part of the civil works of those tracks, as the CMS needed in that area is only needed for the service of those new tracks.
  - For the depot CMS, the phase 2 works include the CMS (as part of civil works) + cabling specific for phase 2, as in phase 1 there is no need to do it in advance, because there is no transit cabling within the phase 2 areas, and the cabling is only needed to give service to the new north stabling area tracks that are part of phase 2.
- Landscaping works.
- Perimeter Security Purpose (SP) Fencing:
  - Excavation of foundations.
  - Concrete the foundations with the posts.
  - Install the SP fencing.

The construction works will commence after OBG23A is built, this way the impact on the local road network is mitigated. The likely construction sequence of the buildings and trackwork at the depot are broken down into a number of key stages of construction as follows with a full description of the construction methodology outlined in the following figures (Figure 5-379 to Figure 5-384).

The first stage includes: the ESB aerial lines diversion, the perimeter ditch diversion, excavation of compensatory areas in the surroundings, OBG24 demolition, earthworks for the embankment in the western area and attenuation pond and outfall to the existing waterways to the south.

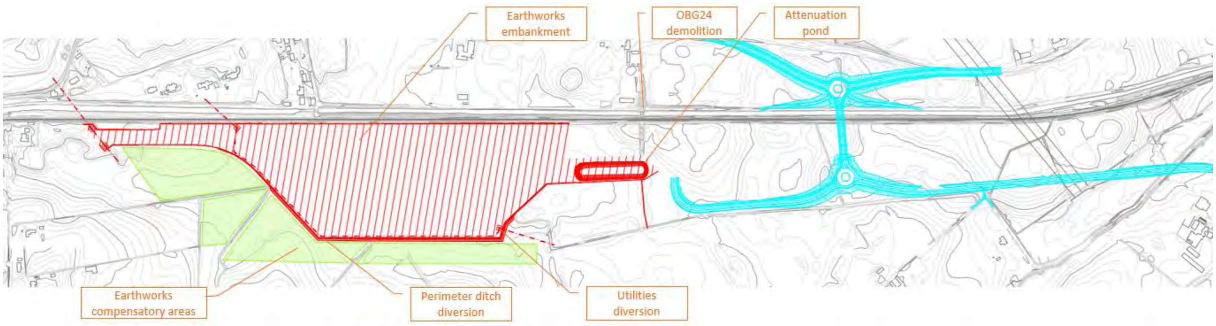


Figure 5-379 Layout of depot (stage 1)

The second stage includes: construction of the main building structure, earthworks in the eastern area and the second attenuation pond where the outfall was built previously under the new bridge OBG23A.

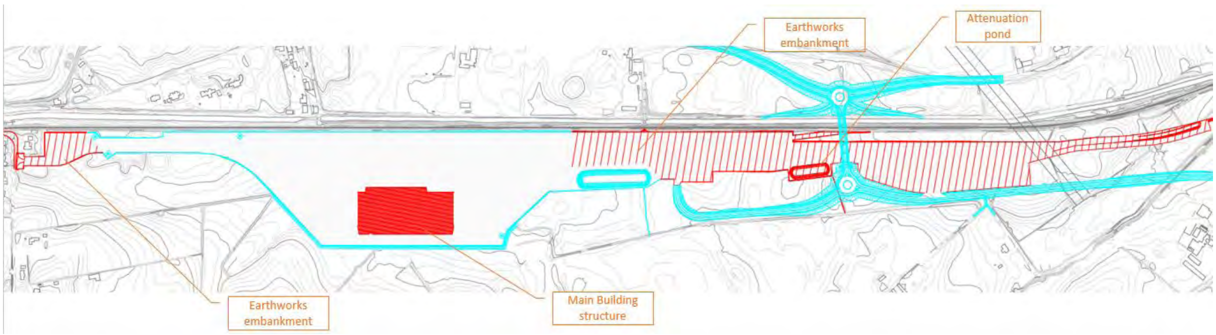


Figure 5-380 Layout of depot (stage 2)

The third stage includes: construction of the remaining buildings structures (service slab, substation, AWP, AVI, security access) and the mechanical, electrical and plumbing installations of the main building.

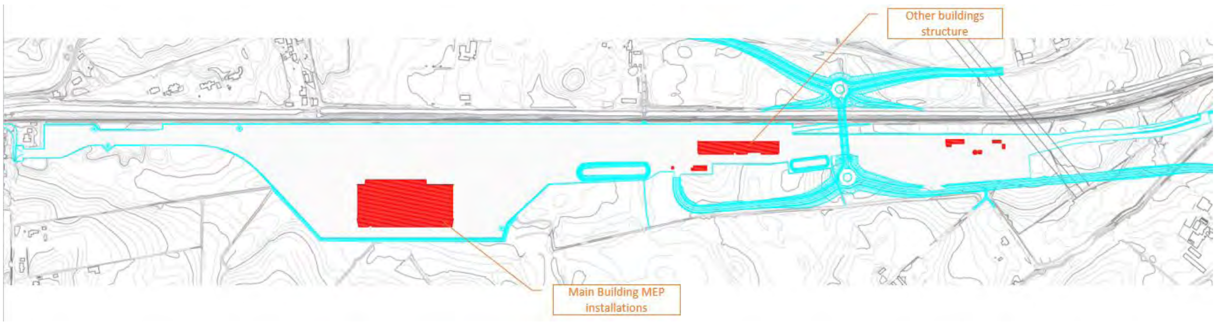


Figure 5-381 Layout of depot (stage 3)

The fourth stage includes: construction of other buildings, mechanical, electrical and plumbing installations, the equipment installation inside the main building and the new services.

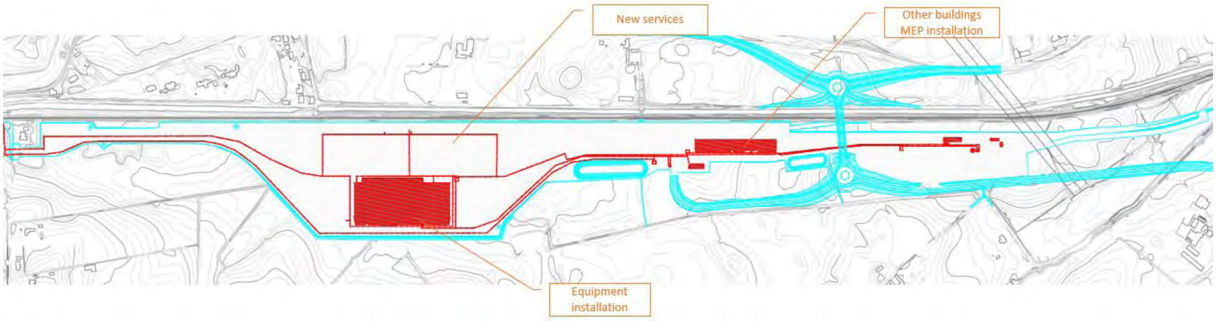


Figure 5-382 Layout of depot (stage 4)

The fifth stage includes: civil, power and systems track works and for other equipment installations within other buildings.

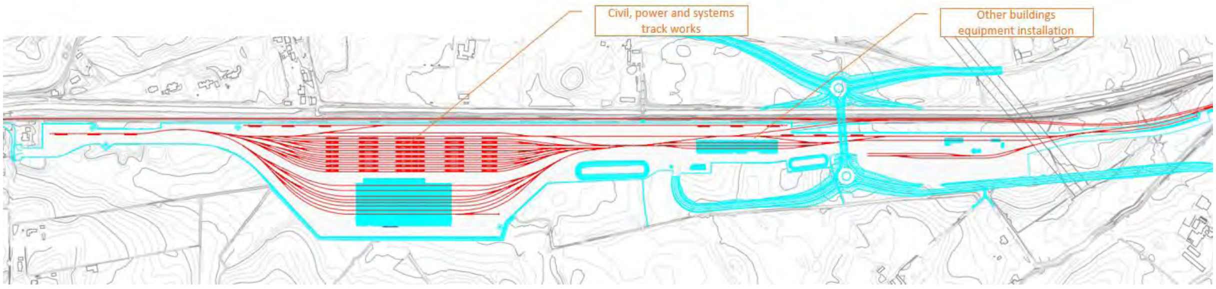


Figure 5-383 Layout of depot (stage 5)

Finally, the sixth stage includes: completion of the urban development and the boundary treatments.

Figure 5-384 Layout of depot (stage 6)

The volume of material required for construction of the depot embankment is 280.000 m^3. For this reason there are some excavation areas along the project where there could be suitable material for reuse and could be transported to this embankment.

The material is proposed to be transported by road from their respective sites to the depot (reference Section 5.5.3.5 for information on movement of material from Spencer Dock area to the depot, which is the bulk of the material that will be transported by road).

5.9.10.2.1 Construction duration

The duration for the principal construction elements at depot is **3 years**.

The key activities for this 120 week period are:

- Depot 30 months
- Depot PW Maintenance Compound 12 months
- Compensatory Storage areas 6 months

The possession strategy is to utilise daytime project construction working hours, as set out in Section 5.2.1, as much as possible because most of the activities are offline from the railway line. There is minimum impact on the railway where the connections to mainline are after the double tracking works are complete. For the OBG24 demolition a full weekend closure is needed.

It is important to note that the depot is phased in two construction stages. Phase 1 is where the depot will be built with the half of the stabling tracks considering an initial stage of 300 EMU. The final design stage considers 15 tracks for 30 FLU. Consequently, this first phase would consider 8 tracks for 16 FLU. In a future when the fleet increases its size, the phase 2 will consist of building the rest of the stabling tracks.

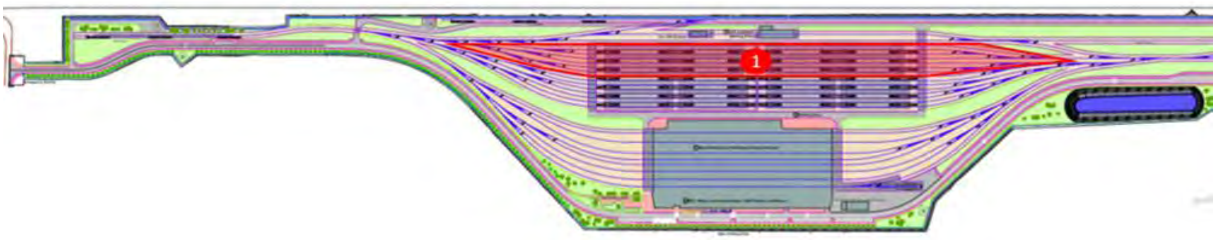


Figure 5-385 Depot stabling area to be constructed in Phase 2

5.9.10.3 Construction compounds and haulage routes

The depot's two main construction compounds are related to the Track compound (CC-DEP-S7-UP-93370-U) and SET compound (CC-DEP-S7-93060-D), which are located immediately adjacent to the depot's location. Vehicles delivering to the site are expected to access from R148 road from the M4 motorway.

The depot construction begins after new access road/OBG23A is completed. The access to local roads is from the new OBG23A and L5041 diversion, so no other alternative access is needed.

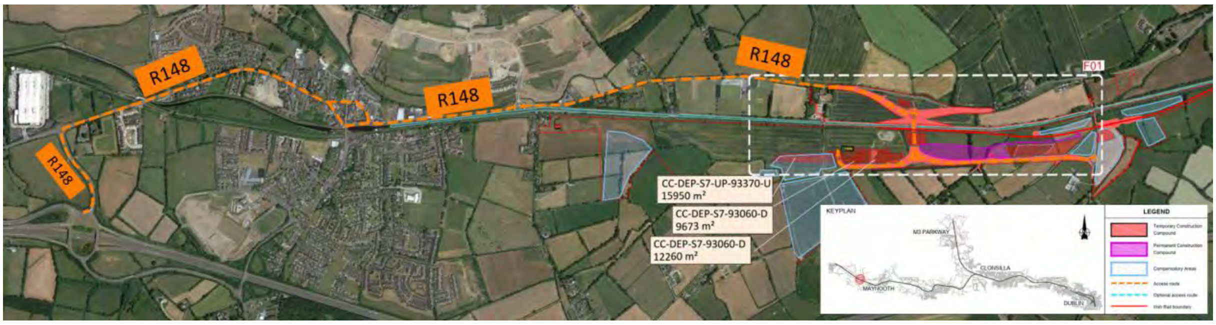


Figure 5-386 Depot siding construction compound and haulage route

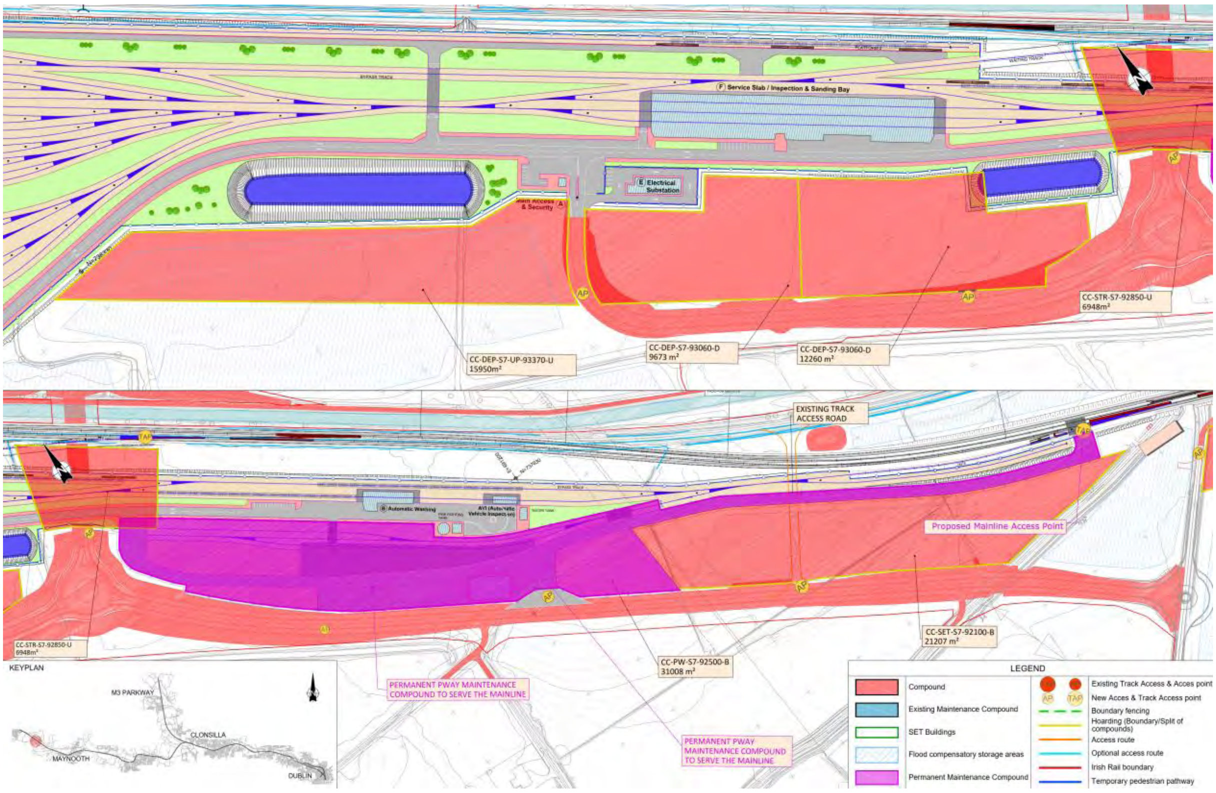
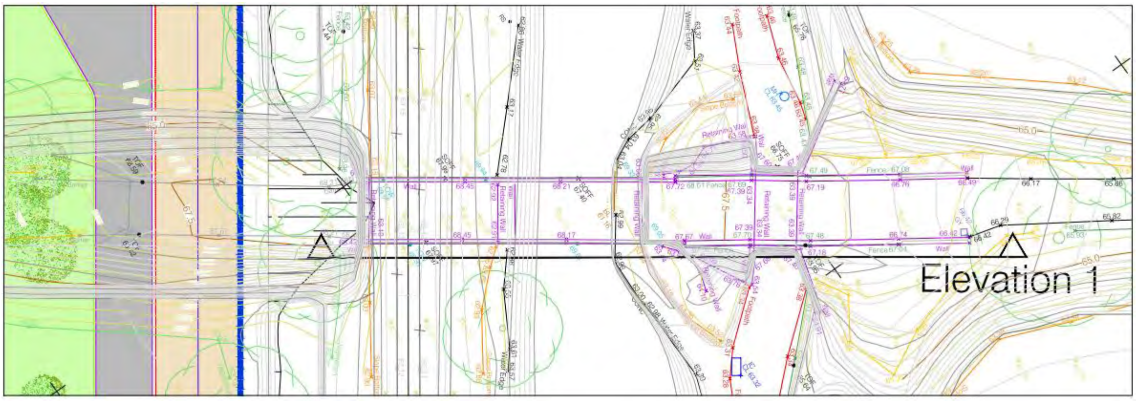


Figure 5-387 Depot construction compounds

5.9.11 OBG24 demolition

5.9.11.1 Overview of the works required

The demolition of the existing OBG24 that crosses the Royal Canal, and the railway line will be necessary for the construction of the new depot. In the figures below the layout and the elevation of the OBG24 are shown.



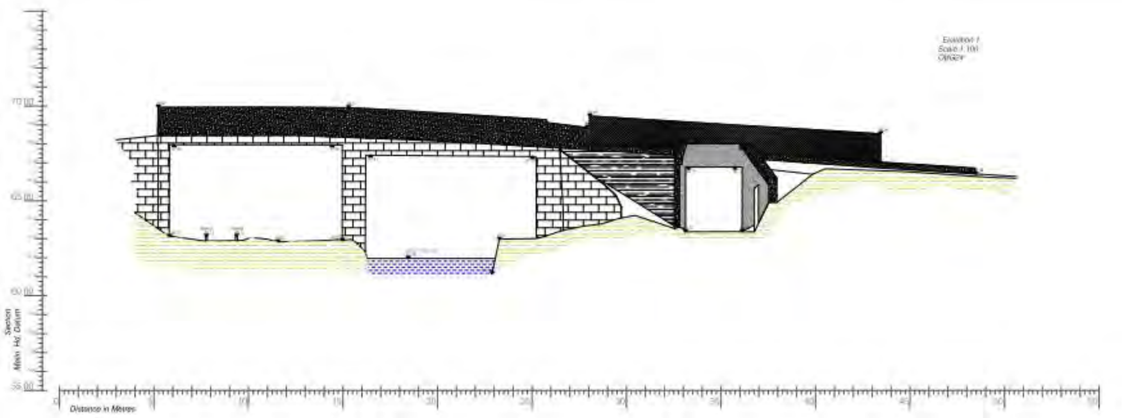


Figure 5-388 Plan (above) and elevation (below) of OBG24 (bridge and underpass for Royal Canal greenway)

The OBG24 is a two-span precast concrete beam bridge. The first span has a length of 9 m and is above the railway line, and the second span has the same length and is above the Royal Canal. There is a concrete underpass in the current Royal Canal Greenway. The figure below shows an image from the Royal Canal.

Figure 5-389 View of OBG24 from the Royal Canal

5.9.11.2 Construction phase

The strategy for the demolition of the bridge is as follows:

1. Site clearance: preparation of the site and construct proper access routes for the auxiliary machinery (cranes).
2. Joint demolition (isolation of both decks and parapets): it is necessary to demolish and cut the joints as shown below to raise the deck with the crane.

Figure 5-390 Joints to be demolished at abutment

3. Deck and parapet removal: once the joints are demolished, the two spans are lifted separately and taken out to one of the banks for being demolished and taken to its final destination as construction waste.

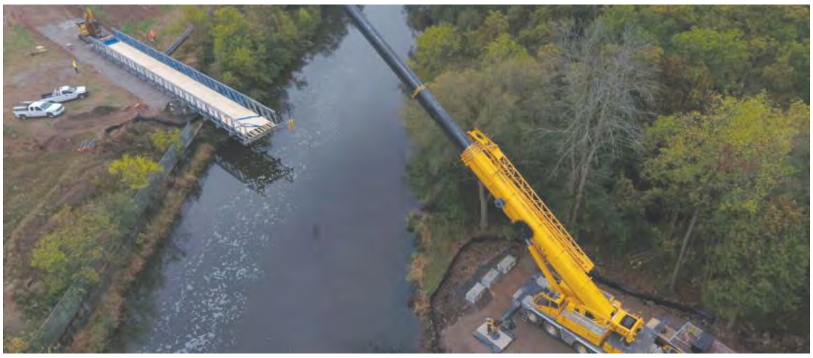


Figure 5-391 Deck lifting example

4. Internal support demolition: the internal support is to be demolished with a backhoe hammer and trucks.
5. Abutment excavation and demolition: finally, the abutments on the depot side, and the underpass in the northern side must be demolished. The abutment on the northern side must be properly fenced maintaining the existing wing wall.

The times expected to carry out the bridge deck removal works after the site clearance and installation are one night possession and one full weekend possession. One week will be required for the demolition of the abutments and the underpass.

5.9.11.3 Construction compounds and haulage routes

The compound and the haulage routes are the same as those foreseen for the depot. Access from the northern property will be necessary for the works.

5.9.12 CCE compound

5.9.12.1 Overview of works required

A new and permanent CCE compound will be located in Maynooth adjacent to the new depot. The works will consist in the construction of CCE building, the storage areas and the associated urban development.

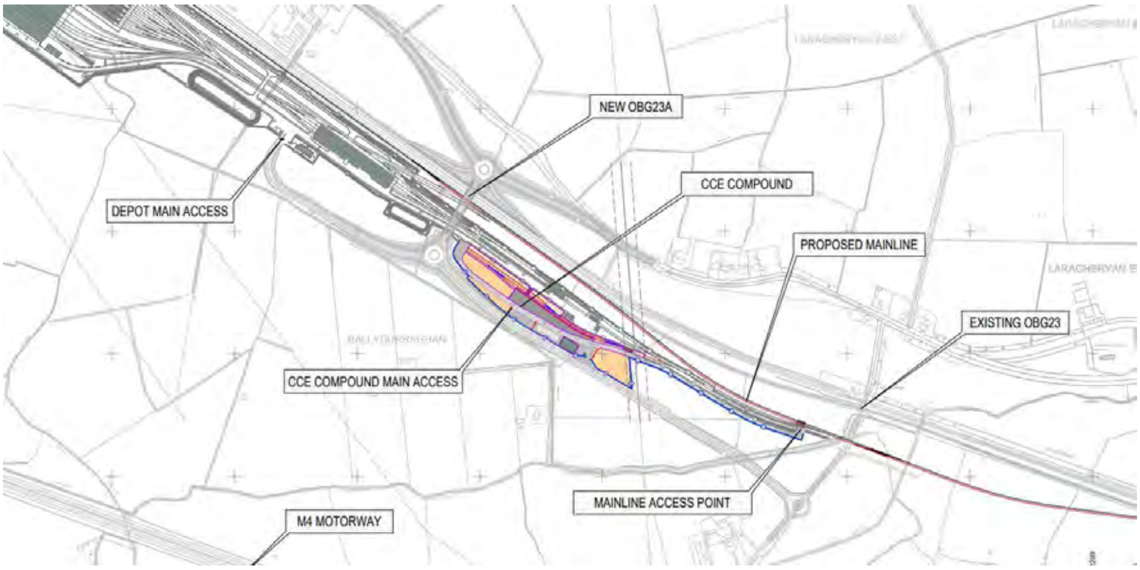


Figure 5-392 CCE compound

5.9.12.2 Construction methodology

The works can be carried out during daytime project construction working hours as set out in Section 5.2.1. The general construction methodology foreseen is as follows:

- Site clearance and enabling works.
- Earthworks.
- Foundations.
- Structure of the building.
- Utilities.
- MEP, architecture, façade and finishes.
- Urban development and landscaping (pedestrian pavements, road network, etc.).
- Fencing and gates.

The compound construction will take approximately 12 months and it will be constructed in parallel to the depot construction at its final stage so both facilities finish at the same time and there are no incompatibilities between them.

5.9.12.3 Construction compounds and haulage routes

The construction compound and the haulage routes are those highlighted for the depot construction in Section 5.9.10.3.

5.9.13 Other SET works

5.9.13.1 Signalling works

Apart from the general signalling works described in Section 5.3.9.4, the specific works in this area for signalling are the following:

- The new crossover and siding west of Maynooth station will be installed modifying the existing signalling system.
- The new up and down tracks will be installed without the connections of the new tracks to the existing tracks, so trains will keep running through the single line. Once the new signalling system is commissioned with the trains still running in the single line, then the required track works for commissioning the double track will be executed along with the modifications of the new signalling system.

- The new crossover to be installed in this section will be blocked until the new system is commissioned and modified to enable the double track running of trains.
- The new turnouts to access the depot will be blocked until the depot is commissioned.

The specific signalling works for this area can be performed during regular night possessions or when there is a longer possession due to track works, so additional impact on passenger services is not expected due to signalling works. Night services such as freight trains could be affected, especially during test periods.

The new interlocking boundary with the Sligo line SSI will be developed and commissioned with the new signalling system.

5.9.13.2 *LV power works*

No other activities are foreseen in this area, further from the generic ones described in Section 5.3.9.

5.9.13.3 *Telecoms works*

The following construction activities will take place in Zone F:

- The new trunk cables will be connected to the new DART+ West nodes/buildings in this area, see details in Section 5.3.9.1 (i.e. Maynooth TER, Maynooth SEB, Millerstown SEB and Maynooth substation).
- The cabling will also be connected to the new DART+ West trackside LOCs and cabinets in this zone (OHLE, Signalling and LV cabinets) and other buildings (PSP).
- Telecom equipment will be installed in the new TER, SEBs, PSPs and substation building.
- Telecom equipment will be installed in new trackside LOCs and cabinets.
- New telecoms infrastructure (optical fibre, copper, structured cabling, Station LOCs) will be installed in Maynooth station, including new station end points (e.g. CCTV cameras, CIS displays, PA speakers, etc.).
- Basic testing onsite without live railway interaction.

No impact on passenger services is expected, as these works will be carried out during night possessions (e.g. installation of new trunk cables), or during daytime (e.g. installation of new station elements).

In the next section, specific construction and installation works in the depot perimeter and the CCE Compound are described.

5.9.13.3.1 Depot works

The following main Telecom and IT works will be deployed, coordinated with the main depot construction works as specified in 5.9.10:

- New SET assets (i.e. a TER, a potential new GSM-R radio site, a substation, three DC Switching houses and new MOS) will be installed inside the depot, which will require connectivity to SET's optical fibre. This will be done by installing two manholes near the mainline tracks at the eastern and western sides of the depot, for diversity purposes. At these manholes SET's mainline optical fibre cables will be joined with SET's depot optical fibre cables.
- In addition to SET's Optical fibre, independent fibre cables for IT/CME network and CCE/CME network will be installed, which will connect the respective distributed equipment along the Depot Yard and the Depot Buildings with the Depot Main Building (where the Depot Server room and Control Centre are located).
- SET Trunk copper cable, lineside telephony, LOCs, tail cable and lineside phones will be installed in the Depot yard connected to the Depot TER (where the lineside PBX will be housed).
- SET Telecom equipment will be installed in Depot SET technical equipment rooms (TER in the Main Building, Depot substation and DC Switching houses) and in SET's LOCs.

- Depot Subsystems and networking equipment (for CME, Group IT and CCE equipment) will be installed in CME Technical equipment rooms in the different Depot buildings and in specific Depot LOCs and Cabinets (e.g. CCE Signalling LOCs, CME IT LOCs, DPPS, etc.).
- Different CME endpoints will be located inside and outside the buildings and in the Depot Yard (e.g. CCTV cameras, PA speakers, etc.).

Most works described above can be carried out without any impact on the live railway. The fibre joints for SET's fibre cable at the manholes will be carried out during night-time, without any impact on passenger services.

5.9.13.3.2 CCE compound

The following Telecoms and IT construction and installation works will take place, coordinated with the CCE compound construction works, as specified in 5.9.12.

- Optical fibre installation inside the CCE Compound to connect with the Depot optical fibre for connectivity to Group IT network.
- CCE Subsystems and networking equipment will be installed in the IT room in the CCE Compound building and in the LOCs deployed along the compound.
- Different CCE endpoints will be installed in the building and outdoors in the compound yard (e.g. CCTV cameras, Access Control, etc.).
- Basic testing onsite will be carried out without live railway interaction.

5.9.13.4 *Electrification works (HV/OHLE/SCADA/IESS)*

- Installation of earth wire clamps to support the earth wire to the structure at (and insulators to support the feeder wires where applicable) at OBG23A, OBG21, OBG20 and OBG19.
- OHLE feeding connections and MOS installation from Depot substation and the three (3) DC Switching houses in the Depot. Leixlip Confey, Blakestown and Maynooth substations.
- Installation of mainline and Depot OHLE MOS.
- General electrification mainline works for the OHLE installation – as described in 5.3.9.1 SET buildings and cabinets and 5.3.9.6 Overhead Line Equipment (OHLE) – that will generally comprise single track and twin track cantilever structures (including portals at stations) for the mainline. At the Depot headspans will be also installed in the stabling area. Different types of OHLE such as Fixed OCR (Rigid Catenary) and Moveable OCR will be installed in the depot Workshop.

The specific electrification works for this section within Zone F can be performed during regular night possessions or when there is a longer possession (i.e. weekends), so additional impact on passenger services is not expected due to these electrification works.

5.10 Testing and Commissioning of the System

5.10.1 Introduction

The Testing and Commissioning (T&C) of the System will consist of a set of tests applied to the subsystems (SET, Permanent way (P-way), Civils, Station, Depots) and integration tests to prove that the subsystems and the system accomplish its requirements, including external interfaces such as the rolling stock (RS). As the project is largely on an existing live railway line, some of the tests will be undertaken at night to minimise the impact on the commercial railway traffic.

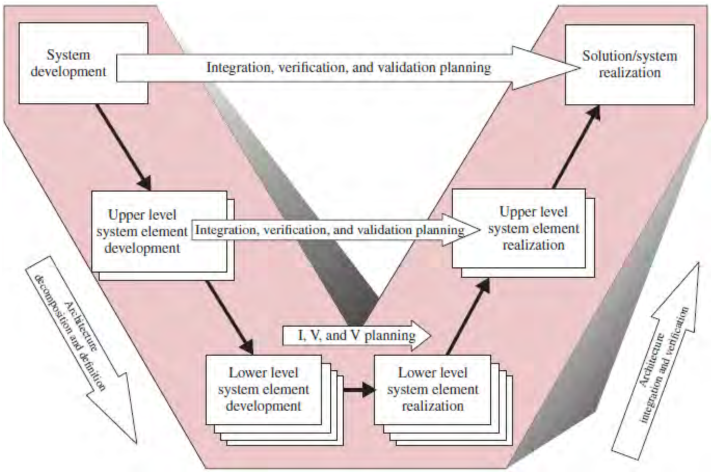


Figure 5-393 The V-model (derived from Forsberg et al. (2005), Figure 7)

In V-shaped life cycle, see Figure 5-393, verification activities will take place at the end of each phase, following the sequential order of the phases, while validation activities are prepared during the downward branch and are carried out mainly during the upward branch.

Objectives for V&V (verification and validation) include:

- Verification: to prove that for each phase of the project the specific inputs, the methods used, the staff involved and the generated deliverables permit, fully meets the requirements for that phase.
- Validation: to demonstrate that the system under consideration, in each step of its development and after its installation, meets the requirements and is suitable for the purpose defined for the system.

Verification and validation shall be done by analysis, exercise (function test), inspection, monitoring and observation as appropriate.

5.10.2 SET tests

SET tests are part of the right branch of the aforementioned V-model (Figure 5-393), and they are phased, as shown in the figure below. To move from one phase to the next, a formal approval process will take place.

Figure 5-394 SET phasing strategy up to new signalling for DMU

In the next table, the SET stages introduced in Section 5.3.9 are mapped to the T&C activities described in this section.

Table 5-20 SET stages

SET stage	T&C activity	Comments
2	FAT, Installation	
3	Subsystem testing: LV+Telecom networks subsystem testing + commissioning	
4	Subsystem testing: Signalling (section by section + all the sections together, including depot)	
4	System testing (integration tests): telecom+LV+signalling testing for all the line, including depot	

SET stage	T&C activity	Comments
4	Trial run (DMU)	
5	Migration + interim operation (DMU)	
5	Completion (DMU)	
6	Recoveries (except electrification. Including level-crossings)	
6	Track modifications for electrification	
6	Track electrification	
6	Subsystem testing: HV/OHLE (section by section + all the sections together, including depot)	
6	System testing (integration tests): all the line, including depot	
6	Trial run (EMU)	
7	Commissioning (line electrification)	
7	Interim operation (EMU)	
8	Completion (EMU)	Spencer Dock + GSWR works described in section 5.5.7.2, are performed at the end
8	Last recoveries (including Docklands station)	
8	Project's closeout	

In the next sections, the dependencies described for the T&C phases are captured based on the explained strategy.

5.10.2.1 Phasing

5.10.2.1.1 Factory acceptance tests

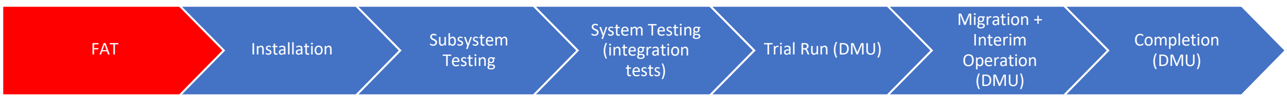


Figure 5-395 FAT stage

FAT (factory acceptance tests) will be required for all the SET subsystems, unless FAT had already been done in the past or it is agreed it is not required because the vendor provides guarantees/certificates enough. The location, duration and no impact on railway operation is listed in Table 5-21.

Table 5-21 FAT

T&C activity	Location	Duration	Impact in railway operation	Dependencies
FAT	**SET Manufacturer premises (lab or factory)**	1-2 d for a single/component (router, signal, diesel generator, UPS etc.) For linear elements (OHLE cables in drums), 2 km/d For OHLE masts, 4 km/d 2 w for each IXL (The IXL has been previously verified by the manufacturer. The manufacturer could need 1-2 m to complete the cycled processes of verification and amend the IXL as necessary)	none	Component / subsystem approved FAT can be done in parallel

T&C activity	Location	Duration	Impact in railway operation	Dependencies
		1 w for other subsystems or complex component (e.g. low-voltage distribution panel)		

5.10.2.1.2 Installation

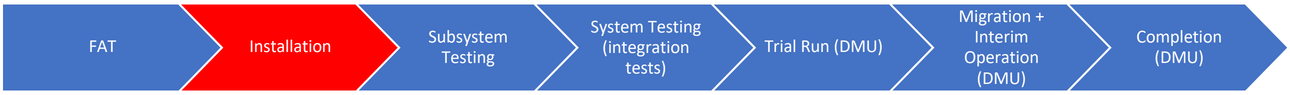


Figure 5-396 Installation stage

After the installation is performed, tests will be carried out for verifying that the installation is completed satisfactorily, according to the specifications. Please note that this section does not cover the "installation" itself – this has been described in previous sections of this chapter. This section refers to the tests to be performed per each component after the installation is finished for testing that the installation is acceptable.

- PICO (post installation check-out) tests will be performed for all the SET equipment. These tests assess the installation, cabling, labelling, earth, etc.
  - The PICO tests will be performed for outdoor and indoor cabling, outdoor and indoor SET equipment. These tests don't require power supply to be available.
- Power-up tests: for the Systems which successfully passed the PICO tests, a Power-up Test will be performed to check the voltage levels and electrical protection.
  - The power-up tests will be performed to all the SET components feed from the power supply, including test of power supply redundancy.

Table 5-22 Installation tests (PICO)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
PICO	**On the field**	Outdoor Fibre 96 optic (reflectometry): 2 optical cable/team, including fibre joint locations at manholes, and LOCs/building within this length. Outdoor copper cable: as a medium of 1 km/2d Indoor cabling (TER, SEB, PSP, ASP, Traction Substation, etc.): 1 building/3d Indoor cabling (Depot): 1 m LOCs, indoor racks: 2 element/day OHLE: 1 km/d	None, except for elements near the tracks (balises, axle counters, LOC, etc.) that require track possession during the night to avoid any impact in railway operation.	Installation finished (Civils, Building (including MEP), CMS Device to be tested installed To be performed in parallel, per section, as per the programme of the sections

Table 5-23 Installation tests (power-up)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Power-up	**On the field**	LOCs, indoor racks: 4 element / day	None, except for elements near the tracks (balises, axle counters, LOC, etc.) that require track possession during the night to avoid any impact in railway operation.	PICO ok New LV power ready ESB connection available or using diesel generators To be performed in parallel, per section, as per the programme of the sections

5.10.2.1.3 Subsystem testing

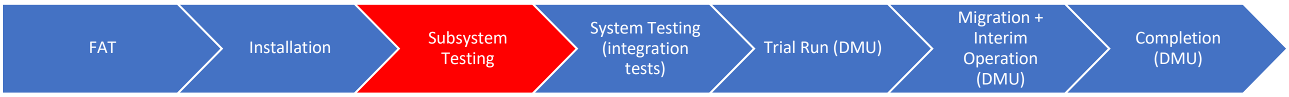


Figure 5-397 Subsystem testing stage

After the previous described tests are performed, each SET subsystem can be tested. These tests will test the specification compliance, at functional level, including internal interfaces among different components of the subsystem. The tests are to be done by section, according to the installation progress by section.

5.10.2.1.3.1 <u>Telecoms</u>

The backbone MPLS-TP&GigE communication network is tested to the devices it will provide connectivity, using laptops and/or analysers at the end-points of different locations to test the communication per service/port.

Table -24 Subsystem tests (telecom) – comms networks

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – Telecoms (comms networks)	**On the field**	1w/Km	During night possessions, as the existing communication networks (MPLS-TP, GigE) are in operation	PICO tests ok LV Power-up tests ok To be performed in parallel, per section, as per the programme of the sections

The CCTV, access control, CIS (customer information service), PA (public address), DOO, telephony, etc. will have central devices located in the CTC/NTCC and/or Depot Control Centre. Therefore, the backbone communication network supporting the connections between the central elements (CTC/NTCC) and the line devices to be tested along the line, need to be tested to perform the complete tests. The new telecommunication devices that will be installed in parallel to the existing, will be covered and disabled except during its test duration to avoid confusion for the operation (telephony, access control, DOO, etc.) and for the passengers (CIS, PA).

Table 5-25 Subsystem tests (telecom) – comms services

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – Telecoms (comms services)	**On the field**	2w/ communication service / section (i.e. telephony: 1 w per section; CIS: 1 w per section, etc.).	During night possessions, as the existing telecoms services are in operation	PICO tests ok LV Power-up tests ok Comms network ok (in the section to test) Comms section to test with CTC/NTCC up for mainline Comms section to test up with Depot Control Centre for the Depot To be performed in parallel, per section, as per the programme of the sections

5.10.2.1.3.2 <u>LV power</u>

The test of the LV power includes both the test of the power and the test of the control. The tests will include the power and its redundancy, whereas the control tests, test that the assets are correctly monitored from the CTC/NTCC and/or Depot Control Centre.

Table 5-26 Subsystem tests (LV power) – power tests

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – LV power (power tests)	**On the field**	3 d/LV location (PSP, ASP, TER) 1 d per PHCC	During night possessions for point heaters for line in operation and feeding for signalling and telecom of existing assets During the day for point heaters for line not in operation (depot, Spencer Dock), and for new buildings (PSP, ASP, PHCC)	PICO tests ok Power-up tests ok (including all ESB connections ready) To be performed in parallel, per section, as per the programme of the sections

Table 5- Subsystem tests (LV power) – control tests

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – LV power (control tests)	**On the field**	3 d/Km	During night, because for the control tests, alarms to the CTC/NTC will be sent	PICO tests ok Power-up tests ok Comms network ok (in the section and section-CTC/NTCC) for mainline Comms network OK with the depot control centre (for depot assets). To be performed in parallel, per section, as per the programme of the sections

5.10.2.1.3.3 HV/OHLE/SCADA/IESS

The power tests include power (HV/OHLE) and control tests (SCADA/IESS). The power tests will test the power and its redundancy, whereas the control tests will test that the assets are correctly monitored and operated from the control centres (CTC/NTCC) and/or Depot Control Centre.

The HV tests test that the traction substation provides power up to the feeders (not yet connected to the OHLE at this stage). The voltage and the protections are tested.

Table 5-27 Subsystem tests (HV power)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – HV power	**On the field**	2 m / Traction Substation	As the Traction Substations are new, no impact, during daytime.	PICO tests ok Power-up tests ok ESB connection up To be performed in parallel, per section, as per the programme of the sections

Further HV/OHLE tests are performed after line electrification. See Section 5.10.2.1.9.

5.10.2.1.3.4 Signalling

The signalling tests are performed in a sequence of test for the devices of the signalling system, the connection of the on field devices to the IXL, the interface between neighbour IXLs, and the interface with the on board devices of the train. Finally, the test will test that the assets are correctly monitored/managed from the CTC/NTCC or Depot Control Centre. The new signals will be clearly covered outside of the testing hours to avoid any confusion to the train drivers. These tests don't involve rolling stock.

Table 5-28 Subsystem tests (Signalling) – On field devices

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – signalling (train detection system)	**On the field**	3 d/Km	During night possessions for line in operation During the day for line sections not in operation such as the depot	PICO tests ok Power-up tests ok LV power OK Telecoms OK in the section and with the CTC/NTCC for the main line Depot Telecoms OK for the depot To be performed in parallel, per section, as per the programme of the sections Previous test of the device before testing the IXL. Later the train detection system will be tested with the IXL.
Subsystem testing – signalling (signals)	**On the field**	4 signals/d	During night possessions for line in operation During the day for line sections not in operation such as the depot	PICO tests ok Power-up tests ok LV power OK Telecoms OK in the section and with the CTC/NTCC for the main line Depot Telecoms OK for the depot To be performed in parallel, per section, as per the programme of the sections Previous test of the device before testing the IXL Later the signal will be tested with the IXL.
Subsystem testing – signalling (points)	**On the field**	4 point/d	During night possessions for line in operation During the day for line sections not in operation such as the depot	PICO tests ok Power-up tests ok LV power OK Telecoms OK in the section and with the CTC/NTCC for the main line Depot Telecoms OK for the depot To be performed in parallel, per section, as per the programme of the sections Previous test of the device before testing the IXL. Later the points will be tested with the IXL.
Subsystem testing – signalling (train protection system)	**On the field**	1 LEU+ its set of balises/d	During night possessions for line in operation During the day for line sections not in operation such as the depot (limited to test track)	PICO tests ok Power-up tests ok LV power OK Telecoms OK in the section and with the CTC/NTCC for the main line Depot Telecoms OK for the depot To be performed in parallel, per section, as per the programme of the sections Previous test of the device before testing the IXL. Later the LEU/balises will be tested with the IXL.

For testing the IXLs, the existing assets that will be part of the final signalling system will be connected to the new IXL (through object controllers) during the testing time and reconnected back to the IXL (through the current object controller) after the tests in a daily basis to allow the commercial service supported by the existing signalling system. The existing system will be tested in a daily basis before restoring any railway traffic. IXL (interlocking) are located at the control centre (CTC/NTCC for the line, depot control centre for the depot). The test will include the test of the IXL functions of commanding the train movements (involving signals, points, train detection system).

Table -5-29 Subsystem tests (Signalling) – interlocking and train protection system

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – signalling (interlocking connection to on field devices: train vacancy detection, signals, points…)	**On the field**	1 w/IXL	During night possessions for line in operation During the day for line sections not in operation such as the depot	PICO tests ok Power-up tests ok LV power ok Depot Telecoms ok for the depot IXL-TMS interface OK To be performed in parallel, per section, as per the programme of the sections
Subsystem testing – signalling (interlocking interface with neighbour IXLs - Remote management)	**On the field**	1 w/IXL	During night possessions for line in operation During the day for line sections not in operation such as the depot	PICO tests ok Power-up tests ok LV power ok Telecoms ok in the section and with the CTC/NTCC for the main line Depot Telecoms ok for the depot IXLs, including train vacancy detection system tests ok IXL-TMS interface OK To be performed in parallel, per section, as per the programme of the sections
Subsystem testing – signalling (train protection system and interface with the trains)	**On the field**	2 m/section	During night possessions for line in operation During the day for line sections not in operation such as the depot	PICO tests ok Power-up tests ok Telecoms ok in the section and with the CTC/NTCC for the main line Depot Telecoms OK for the depot Train detection system tests OK Interlocking connection to on filed devices tests ok IXL-TMS interface OK To be performed in parallel, per section, as per the programme of the sections

As part of the DART+ West project, there are some signalling activities that are linked to permanent way works that require minor signalling changes in the current signalling system or in the new signalling system. As they are performed in a short period of time, over an operating line, they are part of a fast-track procedure that include installation+testing+acceptance all in a row. For further details of these works and its assigned migration stage, please refer to Section 5.3.9.4.3.

Train protection system (TPS) tests are commanded from the control centre (CTC/NTCC for the line). These tests do not involve rolling stock.

For sections of the line that are under commercial operation, the signalling tests will be carried out at night during track possessions and require to be completed in Stages - these Stages will be developed during the Detailed Design stage. Trains loaded with sandbags could be needed for some tests of trains performance of the signalling system as in operation conditions (trial run stage).

The signalling tests (including all the stages described) will take at least 6 months in duration before allowing the system to start the commercial service.

5.10.2.1.4 System integration tests

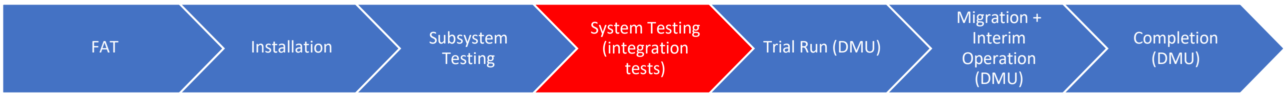


Figure 5-398 System integration tests

For starting this stage, all the subsystems should be completely tested separately in advance. During the system testing (integration tests) all the systems are tested together. The tests include the external interfaces between the SET subsystems and other non-SET subsystems such as RS. RS dynamic tests (running trains) are part of these tests. Part of the System Integration tests are commonly performed during the night-time possessions.

Table -5-30 System Integration tests – per section

T&C activity	Location	Duration	Impact in railway operation	Dependencies
System Integration tests – per section	**On the field**	1,5 m per section, 2,5 m total	During night possessions for line in operation During the day for line sections not in operation such as the depot.	PICO tests ok Power-up tests ok LV power ok Telecoms ok in the section and with the CTC/NTCC for the main line Depot Telecoms ok for the depot Subsystem testing ok for all subsystems (SET and non-SET) except electrification test, that can be performed only after the new signalling is completely in service. To be performed in parallel, per section, as per the programme of the sections

Table 5-31 System Integration tests – all the sections

T&C activity	Location	Duration	Impact in railway operation	Dependencies
System Integration tests – all the sections	**On the field**	6 m	During night possessions	System integration tests within each of the sections ok

During the System Integration tests that involve all the sections, the degraded modes of the operation should be tested. The depot test track will be used to support the signalling integration with the EMU and other features.

5.10.2.1.5 Trial run (DMU)

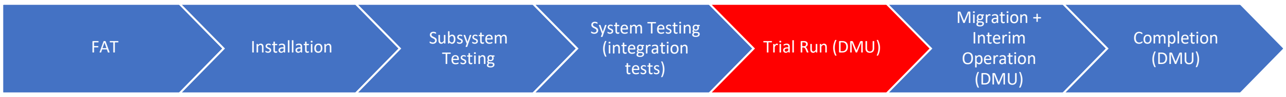


Figure 5-399 Trial run

Once the System Integration tests for all the sections are completed, the trial run can start. The trial run is carried out for the DMU with the updated infrastructure (except the line electrification) without passengers, but trains loaded with sandbags could be needed. The tests are performed during night possessions, including high-frequency train movements to simulate the conditions of normal traffic. During the trial run phase, trial operations are tested to train O&M teams with the new infrastructure in several operating scenarios, such as degraded modes.

Table 5-32 Trial run

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Trial run	**On the field**	1 m	During night possessions	System integration tests are ok for all the sections

5.10.2.1.6 Migration and interim operation (DMU)

After the trial run phase is deemed acceptable, there is a migration and a period of interim operation and monitoring before system completion.

At this stage the new signalling, supported by the new LV and new telecom subsystems, is operating for the DMU (diesel multiple units).

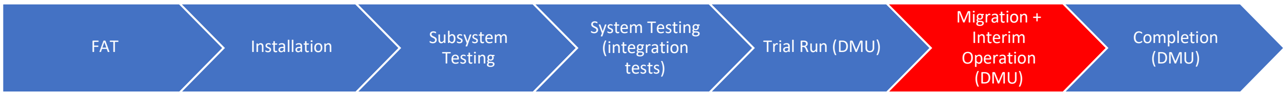


Figure 5-400 Migration and interim operation (DMU)

Table 5-33 Migration and interim operation (DMU)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Migration (DMU)	**On the field**	1 long weekend	1 long weekend closure	Trial runs ok
Interim operation (DMU)	**On the field**	Depending on the monitoring results, but indicative time 2 m	no	Trial runs ok

5.10.2.1.7 Completion (DMU)

After the interim operation is deemed acceptable, this phase includes the system acceptance and handover to O&M (operation and maintenance).

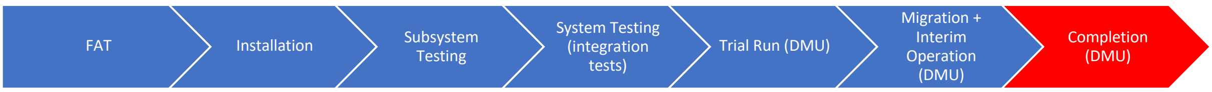


Figure 5-401 Completion (DMU)

Table 5-34 Completion (DMU)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Handover to O&M (administrative tasks related to Safety Cert A)	**N/A (all the line+control centre)**	1d	None	Interim operation ok

5.10.2.1.8 Track modifications for EMU/OHLE

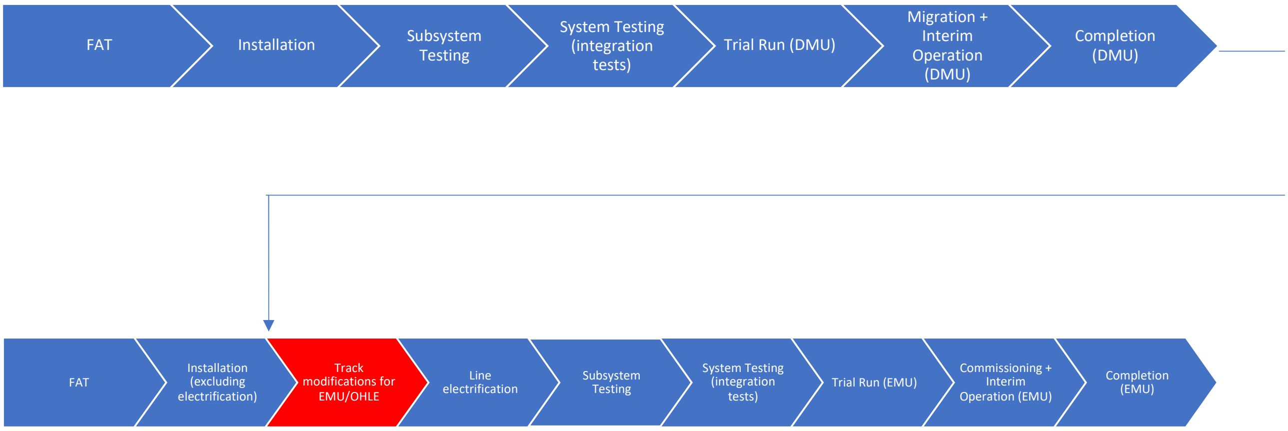


Figure 5-402 Track modifications for EMU/OHLE

After the DMU are working with the new infrastructure, including the new signalling system, the track is ready to prepare it for the electrification, as it is used as an electrical conductor for the return current to the traction substations and needs electrical continuity, without IBJ (insulated block joints), as described in Section 5.10.2.

Table 5-35 Track modifications for EMU/OHLE

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Track modifications for EMU / OHLE	**On the field (existing sections), not applicable to new sections (depot, Spencer Dock)**	1 m	During night possessions	Signalling DMU completion (cert A)

5.10.2.1.9 Line electrification

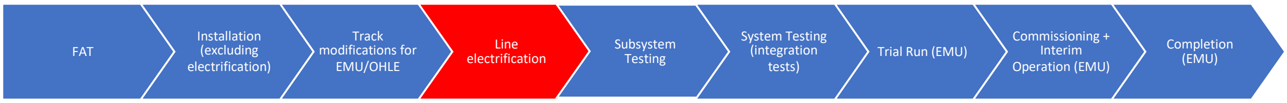


Figure 5-403 Line electrification

After the track has been adapted to support line electrification, the line can be electrified for testing.

Table 5-36 Line electrification

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Line electrification	**All the new electrified sections (excluding Connolly area, already electrified), section by section**	1 m	During night possessions	Track ready for electrification

5.10.2.1.10Subsystem testing

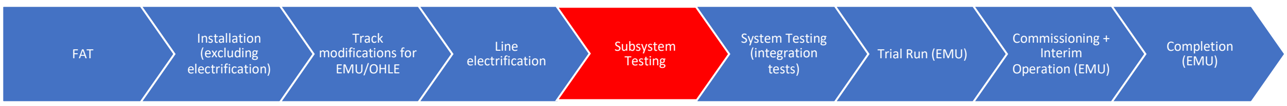


Figure 5-404 Subsystem testing

Previous tests that don't involve line electrification are performed before and described in Section 5.10.2.1.3.3.

After the line is electrified, the HV testing can start for the complete line including the inter-tripping tests.

Table 5-37 Subsystem testing (HV power)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – HV power tests	**On the field**	1-2 w/Traction Substation line section	During night possessions	Line electrified

The OHLE tests are done by connecting the traction substation to the feeders of the OHLE line. The voltage levels, redundancy, and the interface with the RS are tested. It is required to test the OHLE outside of the commercial railway traffic hours with a special vehicle (rail trucks) before the power-up to adjust the contact wire height and staggers.

Table 5-38 Subsystem tests (OHLE power)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – OHLE	**On the field**	1 w/Km	During night possessions, for sections of the currently live main line During normal day, for new sections, such as the depot and Spencer Dock (no current signalling in place that may be interfered by the electrification)	PICO tests ok Power-up tests ok HV power tests ok To be performed in parallel, per section, as per the programme of the sections New signalling operative for DMU Track electrical continuity for the traction return current after removing IBJ and execute rail welding.

The following listed tests can be performed in parallel to the previously-listed OHLE tests (see Table 5-38), to test the OHLE sectioning (manual and motorised) and the emergency shutdown function (IESS).

Table 5-39 Subsystem tests (SCADA/IESS power)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Subsystem testing – SCADA/IESS	**On the field**	1 w/Km	During night possessions, for sections of the currently live main line During normal day, for sections without live main line, such as the depot.	PICO tests ok LV Power-up tests ok HV power tests ok (for the section to test) Comms network ok (in the section and section-CTC/NTCC) for mainline SCADA/IESS at CTC/NTCC ready Comms network ok with the depot control centre (for depot assets) To be performed in parallel, per section, as per the programme of the sections

5.10.2.1.11System integration tests (for EMU)

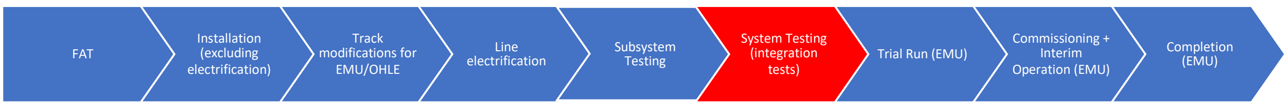


Figure 5-405 System integration tests (for EMU)

For starting this stage, all the subsystems related to electrification should be completely tested separately in advance. During the system testing (integration tests) all the systems are tested together. The tests include the external interfaces between the SET subsystems and other non-SET subsystems such as RS (EMU). RS dynamic tests (running trains) are part of these tests. Part of the System Integration tests are commonly performed during the night-time possessions. It is anticipated that qualified drivers will be needed for participating in the tests carried out outside the commercial service hours.

Table -5-40 System Integration tests – per section

T&C activity	Location	Duration	Impact in railway operation	Dependencies
System Integration tests – per section	**On the field**	2 w per section, total 5 w, in parallel	During night possessions for line in operation During the day for line sections not in operation such as the depot.	Subsystem testing ok for all subsystems (SET and non-SET) for electrification infrastructure, that can be performed only after the new signalling is completely in service. To be performed in parallel, per section, as per the programme of the sections

Table 5-41 System Integration tests – all the sections

T&C activity	Location	Duration	Impact in railway operation	Dependencies
System Integration tests – all the sections	**On the field**	3 w	During night possessions	System integration tests within each of the sections ok

During the System Integration tests that involve all the sections, including the depot. The degraded modes of the operation should be tested.

5.10.2.1.12 Trial run (EMU)

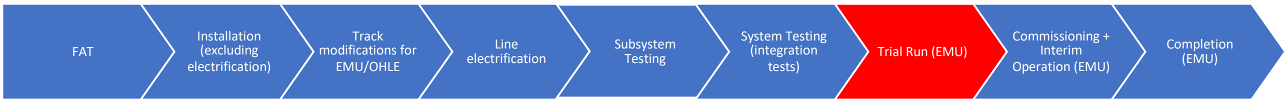


Figure 5-406 Trial run (EMU)

Once the System Integration tests for all the sections are completed, the trial run can start. The trial run is carried out for the EMU with the updated infrastructure (including the line electrification) without passengers, but trains loaded with sandbags could be needed. The tests are performed during night possessions, including high-frequency train movements to simulate the conditions of normal traffic. During the trial run phase, trial operations are tested to train O&M teams with the new infrastructure in several operating scenarios, such as degraded modes.

Table 5-42 Trial run

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Trial run	**On the field**	1 m	During night possessions	System integration tests are ok for all the sections

5.10.2.1.13 Commissioning and interim operation (EMU)

After the trial run phase is deemed acceptable, line electrification is commissioned and a period of interim operation and monitoring before system completion starts with EMUs.

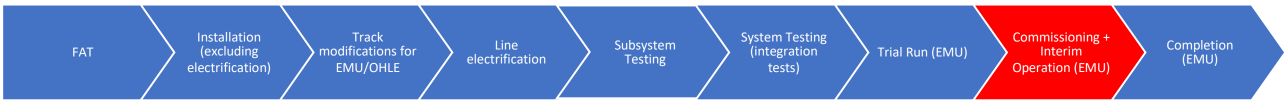


Figure 5-407 Commissioning and interim operation (EMU)

Table 5-43 Migration and interim operation (EMU)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Commissioning (line electrification)	**On the field**	1 long weekend	1 weekend closure	Trial runs ok
Interim operation (EMU)	**On the field**	Depending on the monitoring results, but indicative time 2 m	No	Trial runs ok

5.10.2.1.14 Completion (EMU)

After the interim operation is deemed acceptable, this phase includes the system acceptance and handover to O&M (operation and maintenance).

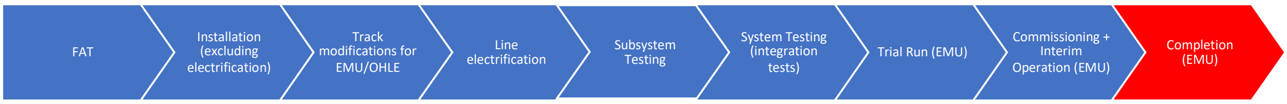


Figure 5-408 Completion (EMU)

Table 5-44 Completion (EMU)

T&C activity	Location	Duration	Impact in railway operation	Dependencies
Handover to O&M (administrative tasks related to Safety Cert A)	**N/A (all the line+control centre)**	1d	None	Interim operation ok

5.11 Recoveries

As this proposed project is brownfield, there are assets that are no longer used after the project execution and may need to be decommissioned and recovered. The recoveries are limited for the mainline because the depot is a greenfield project.

5.11.1 SET recoveries

As the proposed project starts with resignalling and later electrification, there are two different recovering stages, at stage 6 (completion after resignalling) and stage 8 (completion after electrification).

5.11.1.1 Recoveries after resignalling (stage 6)

5.11.1.1.1 Signalling

Table 5-45 Signalling recoveries

Asset to recover	Location	Duration	Impact in railway operation	Dependencies
Signals, train detection system assets (track circuits, axle counters)	**On the field, as per the SSP (signalling scheme plan)**	2 m per section, including cabling	During night possessions	After new signalling completion for DMU. To be performed in parallel, per section, as per the programme of the sections
CAWS / ATP assets	**On the field, all the elements**	1 m per section, including cabling	During night possessions	After new signalling completion for DMU.

Asset to recover	Location	Duration	Impact in railway operation	Dependencies
LOC (location cases), SEB and REB, including IXL, level-crossings	**On the field, as per the LAP (location area plan) plan)**	1 m per section, included cabling	During night possessions	To be performed in parallel, per section, as per the programme of the sections

5.11.1.1.2 LV power

Table 5-46 LV power recoveries

Asset to recover	Location	Duration	Impact in railway operation	Dependencies
Points heating (only recovered supply cabling from existing DNO to existing PHCC)	**On the field**	1 d/location	During night possessions	After new signalling completion for DMU. To be performed in parallel, per section, as per the programme of the sections
Current LV assets in LOC / REB / SEB / PSP / TER and other buildings to be decommissioned	**On the field**	1 m per section, included cabling	During night possessions except infrastructure away from the trackside	After new signalling completion for DMU. To be performed in parallel, per section, as per the programme of the sections
Current ESB connections to be decommissioned	**On the field**	2 d per ESB connection, included cabling	No, DNO are accessible, not near the track	After new signalling completion for DMU. To be performed in parallel, per section, as per the programme of the sections

5.11.1.1.3 Telecoms

Table 5-47 Telecoms recoveries

Asset to recover	Location	Duration	Impact in railway operation	Dependencies
Communication networks	**On the field**	1 m per section, included copper cabling, as trunk fibre cable won't be recovered	During night possessions	After new signalling completion for DMU. To be performed in parallel, per section, as per the programme of the sections
Lineside Telephony	**On the field**	3 w per section, included cabling	During night possessions	After new signalling completion for DMU. To be performed in parallel, per section, as per the programme of the sections
CIS / PA / DOO / CCTV / Access Control / Admin telephony	**Stations**	1 w per station (except Connolly) and level-crossing, included cabling 3 w per Connolly, included cabling	During night possessions	After new signalling completion for DMU. To be performed in parallel, per section, as per the programme of the sections

5.11.1.2 Recoveries after electrification (stage 8)

5.11.1.2.1 Signalling+LV+Telecoms

Table 5-48 Signalling recoveries

Asset to recover	Location	Duration	Impact in railway operation	Dependencies
Last SET assets	**Docklands, changes in Spencer Dock+GSWR**	1 m	During night possessions	After line electrification completion, and EMU operating, including Spencer Dock area

5.11.1.2.2 HV/OHLE

No recoveries are expected in HV.

Table 5-49 OHLE

Asset to recover	Location	Duration	Impact in railway operation	Dependencies
Last SET assets	**Docklands, changes in Spencer Dock+GSWR**	1 m	During night possessions	After line electrification completion, and EMU operating, including Spencer Dock area
OHLE assets *(recovery and replacement of existing OHLE structures at North Wall Junction, East Wall Junction and new crossing near the Tolka River)*	**Interfaces with current electrified line**	Duration included in the new / overall electrification works as these recoveries / replacements are part of them.	During night and long weekend possessions	In the interfaces with current electrified line, some existing assets will be replaced and recovered. These recoveries / replacements must be aligned with the new electrification works in DART+ West.

5.12 Construction Environmental Management Plan

A Construction Environmental Management Plan (hereinafter referred to as CEMP) is available in Appendix A5.1 Construction Environmental Management Plan in Volume 4 of this EIAR. It has been prepared by IDOM in conjunction with CIÉ/IÉ. It presents the approach and application of environmental management and mitigation for the construction of the proposed project. It aims to ensure that adverse effects from the construction phase of the proposed project, on the environment and the local communities, are avoided or minimised. It does not describe the separate mitigation measures relating to the operation and decommissioning of the proposed project; these are provided in the mitigation sections of the individual chapters and in Volume 2 Chapter 27 ‘Summary of Mitigation and Monitoring measures’ of this EIAR.

The CEMP has been prepared in accordance with the IÉ Environmental Management Policy (EMP). The Construction Environmental Management Plan (CEMP) also includes the Environmental Operating Plan (EOP) and Construction and Demolition Waste Management Plan (CDWMP) as Appendices D and E, respectively.

The sections below provide an outline of the contents that are included in the CEMP, CDWMP and EOP and will be used by the Contractor(s) to inform the development of the detailed construction plans.

Prior to any demolition, excavation or construction, a Construction Environmental Management Plan (CEMP) will be produced by the successful contractor. The CEMP will set out the Contractor’s overall management and administration of the construction project. It will be prepared by the Contractor during the pre-construction phase to ensure commitments included in the statutory approvals are adhered to and that it integrates the requirements of the CEMP, Environmental Operating Plan (EOP) and the CDWMP. The Contractor will be required to include details under the following headings:

1. Details of working hours and days.
2. Details of emergency plan - in the event of a fire, chemical spillage, cement spillage, collapse of structures or failure of equipment or road traffic incident within an area of traffic management. The plan must include contact names and telephone numbers for Local Authority (all sections/departments); Ambulance; Gardaí and Fire Services.
3. Details of chemical/fuel storage areas (including location and bunding to contain runoff of spillages and leakages).
4. Details of construction plant storage, temporary offices.
5. Traffic management plan including details of routing of network traffic; temporary road closures; temporary signal strategy; routing of construction traffic; programme of vehicular arrivals; on-site parking for vehicles and workers; road cleaning; other traffic management requirements.
6. Truck wheel wash details (including measures to reduce and treat runoff).
7. Dust management to prevent nuisance (demolition and construction).
8. Site run-off management.
9. Noise and vibration management to prevent nuisance (demolition and construction).
10. Landscape management.
11. Management of demolition of all structures and assessment of risks for same.
12. Stockpiles.
13. Project procedures and method statements for:
    a. Demolition and removal of buildings, services, pipelines, ballast and other infrastructure (including risk assessment and disposal).
    b. Diversion of services.
    c. Excavation and blasting (through peat, soils and bedrock).
    d. Piling.
    e. Construction of pipelines.
    f. Temporary hoarding and lighting.
    g. Borrow pits and location of crushing plant.
    h. Storage and treatment of peat and soft soils.
    i. Disposal of surplus geological material (peat, soils, rock etc.).
    j. Earthworks material improvement.
    k. Protection of watercourses from contamination and silting during construction.
14. Site Compounds including the Main Distribution and Storage Compound (MSDC).

The production of the CEMP will also detail areas of concern with regards to health and safety and any environmental issues that require attention during the construction phase. Adoption of good management practices on-site during the construction and operation phases will also contribute to reducing environmental impacts.

5.12.1 CDWMP

A Construction and Demolition Waste Management Plan (CDWMP) is included as Appendix E to the CEMP (Appendix A5.1 in Volume 4 of this EIAR). It sets out the Contractor's proposals regarding the treatment, storage and disposal of waste including demolition waste. The plan will be a live document that will be amended and updated to reflect current conditions on-site as the project progresses. The obligation to develop, maintain and operate a CDWMP will form part of the contract documents for the project. The CDWMP will include details such as:

1. Details of waste storage to be provided for different waste.
2. Details of where and how materials are to be disposed of - landfill or other appropriately licensed waste management facility.
3. Details of storage areas for waste materials and containers.
4. Details of how unsuitable excess materials will be disposed of where necessary.

5. Details of how and where hazardous wastes such as oils, diesel and other hydrocarbon or other chemical waste are to be stored and disposed of in a suitable manner.

5.12.2 EOP

An Environmental Operating Plan (EOP) is a project management tool and has been prepared as Appendix D to the CEMP (Appendix A5.1 in Volume 4 of this EIAR). It outlines procedures for the delivery of environmental mitigation measures and for addressing general day-to-day environmental issues that can arise during the construction phase of developments. The EOP, will be further developed and updated by the Contractor during the project construction stage.

Before any works commence on site, the Contractor(s) will be required to prepare an EOP in accordance with the TII/National Roads Authority (NRA) Guidelines for the Creation and Maintenance of an Environmental Operating Plan. The EOP will set out the Contractor's approach to managing environmental issues associated with the construction of the scheme and provide a documented account of the implementation of the environmental commitments set out in the EIAR and measures stipulated in the planning conditions. Details within the plan will include:

1. All environmental commitments and mitigation measures included as part of the planning approval process and any requirements of statutory bodies such as the NPWS and IFI as well as a method documenting compliance with the measures.
2. Iarnród Éireann operating procedure documents.
3. A list of all applicable environmental legislation requirements and a method of documenting compliance with these requirements.
4. Outline methods by which construction work will be managed to avoid, reduce or remedy potential adverse impacts on the environment.

To oversee the implementation of the EOP, the Contractor will be required to appoint a suitably competent Site Environmental Manager (SEM) to ensure that the mitigation measures included in the EIAR, the EOP and the statutory approvals are executed in the construction of the works and to monitor that those mitigation measures employed are functioning properly. The CEMP contains the Incident Response Plan (IRP) as Appendix F of Appendix A5.1 in Volume 4 of this EIAR, which describes the procedures, lines of authority and processes that will be followed to ensure that incident response efforts are prompt, efficient, and appropriate to particular circumstances. It will provide the information that each worker may need in order to respond to an emergency and to handle it effectively. The Incident Response Plan (IRP) will also contain a copy of the contractors Major Emergency Plan.

5.12.3 Construction traffic management

The purpose of the Traffic Management Plan (TMP) is to provide the basis for the management of traffic expected during construction and operation of the project on the basis of the designs shown in the planning documents. The contractor will be required to prepare a Construction Traffic Management Plan (CTMP) that maximises the safety of the workforce and the public and minimises traffic delays, disruption and maintain access to properties. The traffic management plan will also address temporary disruption to traffic signals, footpath access and the management of pedestrian crossing points. The contractor shall provide an appropriate information campaign for the duration of the construction works. A CTMP is included in Appendix A6.3 in Volume 4 of this EIAR.

The role of Project Supervisor Design Process (PSDP) will be taken over by the Contractor and as such a Construction Traffic Management Plan for the proposed design must be prepared and agreed in consultation with the respective local authorities, Iarnród Eireann, transport operators, Waterways Ireland. The Contractor will be required to appoint a Temporary Traffic Management Designer who shall prepare detailed temporary traffic management designs for all locations where works are planned on, or impact on, any public road. Prior to commencing the works, the plan must be developed into an Operational Traffic Management Plan by the Project Supervisor Construction Stage (PSCS) and should not be implemented until it has been assessed and developed by the PSCS. The appointed PSCS/Contractor of the project is required to carry out the Safety

Audit on Operational Traffic Management Plans prior to commencing the works. The PSCS shall co-ordinate the implementation of the developed Traffic Management Plan during construction of the works . The developed TMP requirements will be focused on keeping disruption to a minimum and will include the provision of facilities for the safe passage of pedestrian, cyclists, vehicular traffic, local communities, and road users.

The Contractor shall comply with the requirements of:

- "Traffic Signs Manual – Chapter 8 – Temporary Traffic Measures and Signs for Roadworks" Department of Transport, November 2010.
- Guidance for the Control and Management of Traffic at Roadworks – Department of Transport, N.R.A and Local Government Management Services Board, second edition 2010.
- HSA document titled 'Guidelines for Working on Roads; Guide to the Safety, Health and Welfare a Work (Construction)(Amendment) (No. 2) Regulations 2008 (S.I. No. 423 of 2008)'.
- The respective local authority road closure guidelines in Dublin, Fingal, Meath and Kildare.

These Guideline documents shall be read in conjunction with primary Safety Health & Welfare at Work legislation including the 2005 Act, the Safety, Health and Welfare (Construction) Regulations 2013, and any amendment to them (the Construction Regulations).

5.12.4 Construction material management

The proposed project earthworks are distributed along the track alignment. Sites such as the substations, structures, track lowerings, the depot area and the Spencer Dock Area are the sites where most of the large-scale earthworks will be carried out. For example, at the depot area, the flooding levels make it necessary to raise the height of the depot platform up to 1.5 m on average above the existing levels, which will result in a large amount of fill material necessary to prepare the depot embankment.

The project proposes to reuse as much of the excavated material as fill material as possible. However, it should be noted that from the geotechnical point of view not all of the earthworks can be reused. Material that cannot be reused must be sent to an authorised disposal site. The reuse of excavated materials from other parts of the project at the depot site for example has been proposed where possible. Refer to Chapter 9 Land and Soils and Chapter 19 Material Assets: Resources and Waste Management in Volume 2 of this EIAR.

The transportation of the excavation and fill materials along the DART network will use the existing road network. Peak traffic hours will be avoided where possible to minimise the impact on the existing road network.

Collaboration between the different DART+ projects for movement, storage and disposal of materials should be considered, depending on the sequencing of works, the overlap and timelines for each of projects. This would allow the different projects to have shared working areas, compounds, earthworks management, and may allow for cost and time savings for IÉ.