The background of the page is a vibrant red color. It is decorated with several abstract geometric shapes in blue, green, and white. In the top right, there is a blue shape with a white circle inside, and a dark blue shape below it. In the top left, there is a green shape with a white circle inside. In the bottom left, there is a blue shape with a white circle inside, and a dark blue shape below it. In the bottom right, there is a large green shape with a white circle inside, and a red shape below it. The text is centered on the left side of the page.

**Appendix J.6**  
Preliminary Design Report –  
Non TII Retaining Walls



# Non TII Retaining Walls Preliminary Design Report

Lucan to City Centre Core Bus Corridor  
BCIDA-ACM-STR\_ZZ-0006\_XX\_00-RP-CB-0012

Client – National Transport Authority  
Stage – Stage 2

Project Reference: BusConnects Package A  
Project Number: 60599126  
BCIDA-ACM-STR\_ZZ-0006\_XX\_00-RP-CB-0012

Date (17<sup>th</sup> January 2022)

# Preliminary Design Report – Consultation

## STA-1b

### Categories 1, 2 & 3

#### Scheme

Name and Location BusConnects – CBC 06 Lucan to City Centre

#### Structures(s)

Name and nature of the Structure(s) CBC06-RW03 Chapelizod Hill Road Retaining Wall No.1; CBC06-RW04 Chapelizod Hill Road Retaining Wall No.2

#### Preliminary Design Report

Reference BCIDA-ACM-STR\_ZZ-0006\_XX\_00-RP-CB-0012

Revision L01

Date 03 / 02 / 2022

#### Submitted by

Signed 

Name Niamh Rodgers

Position Structures Design Lead (Team Leader)

Organisation AECOM

Date 03 / 02 / 2022

#### Structures Section confirmation of consultation:

Signed: - \_\_\_\_\_

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Position: - \_\_\_\_\_

Date: - \_\_\_\_\_

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# 1. Introduction

## 1.1 Brief

The BusConnects Dublin – Core Bus Corridor (CBC) Infrastructure Works (herein after called the CBC Infrastructure Works) involves the development of continuous bus priority infrastructure and improved pedestrian and cycling facilities on twelve radial core bus corridor schemes in the Greater Dublin Area.

The National Transport Authority (NTA) have appointed AECOM in a joint venture with Mott MacDonald to undertake the design of the infrastructure works for Package A of the BusConnects Programme. Package A includes the following three CBC schemes:

Clongriffin to City Centre CBC;

Lucan to City Centre CBC; and

Tallaght/Clondalkin to City Centre CBC.

Each scheme contains several structures with various structural forms. As part of the scope AECOM have agreed to take all structures through the *Technical Acceptance of Road Structures on Motorways and Other National Roads* procedure as outlined in DN-STR-03001.

This Preliminary Design Report (PDR) will focus on a family of retaining wall structures required as part of the Lucan to City Centre Core Bus Corridor scheme located along the Chapelizod Bypass near its intersection with Chapelizod Hill Road. The PDR is a deliverable at Phase 4 of the Technical Acceptance process.

The family of structures refers to the following retaining walls:

CBC006-RW03 Chapelizod Hill Retaining Wall No.1

CBC006-RW04 Chapelizod Hill Retaining Wall No.2

These retaining walls are required due to proposed changes to the existing road alignment creating additional cross-sectional width along the Chapelizod bypass to meet the project objectives of CBC Infrastructure Works.

## 1.2 Background information

Within BusConnects, there are 16 radial CBCs and plans for a number of orbital bus routes that will service the wider Dublin area to be developed. The Lucan to City Centre CBC commences at Junction 3 on the N4. The CBC progresses east following the N4 to Junction 7 on the M50 where it continues via the R148 along the Palmerstown Bypass, Chapelizod Bypass, Con Colbart Road and St. John's Road West until tying in with the bus infrastructure along the Quays at the Frank Sherwin bridge beside Heuston Station.

As part of the Lucan to City Centre CBC, the existing Chapelizod Bypass needs to be widened to accommodate new bus lanes and footpaths. As part of these works new retaining walls will be required adjacent to the Chapelizod Hill Road Underbridge to retain the existing fill embankment.

## 1.3 Previous studies and their recommendations

The following table is a list of documents as part of previous studies for the development of the proposed retaining walls:

Date	Document Reference	Report Title	Author
Jan 2022	BCIDA-ACM-STR_ZZ-0006_XX_00-RP-CB-0010	Non TII Retaining Walls Structures Options Report	AECOM
2020	BCIDA-ACM-PMG_PD-0006_XX_00-RP-ZZ-0001 (DRAFT)	CBC06 Preferred Route Options Report	AECOM
2017	RPT-16_080-004	Lucan to City Centre Core Bus Corridor Options Study – Feasibility Report	AECOM

**Table 1-1 Previous Studies**

The Structures Options Report (SOR) assessed three different options for each retaining wall. The report assessed each option based on a Multi Criteria Assessment (MCA) and recommended that CBC006-RW03 should be formed by an embedded/piled retaining structure and that CBC006-RW04 should be formed by a soil nail retaining structure.

## 2. Site & Function

### 2.1 Site location

The retaining walls are located along the Chapelizod Bypass near its intersection with Chapelizod Hill Road. The ITM co-ordinates of the retaining walls CBC006-RW03 and CBC006-RW04 are 709996E, 734248N and 710025E, 734252N respectively.



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Figure 2.1 Location Plan

### 2.2 Function of the structure and obstacles crossed

CBC006-RW03 will be required to retain a new widened earthworks embankment which provides sufficient space for a new bus stop along eastbound carriageway the Chapelizod Bypass.

CBC006-RW04 will be required to retain the existing earthworks embankment which will be cut back to provide sufficient space for a new bus stop on the westbound carriageway along the Chapelizod Bypass.

### 2.3 Choice of location

CBC006-RW03 will be located along the eastbound carriageway of the Chapelizod Bypass. The retaining wall will replace a portion of vegetation/trees on the existing embankment which currently forms the boundary of the Chapelizod Bypass. The retaining wall will form the new boundary line between the existing and proposed infrastructure and will be required to tie in with the proposed widening to Chapelizod Hill Road Underbridge.

CBC006-RW04 will be located along the westbound carriageway of the Chapelizod Bypass. The retaining wall will replace a portion of vegetation/trees on the existing embankment which currently forms the boundary of the Chapelizod Bypass. The retaining wall will form the new boundary line between the Chapelizod Bypass and Chapelizod Hill Road.

## 2.4 Site description and topography

The surrounding area primarily consists of residential housing and commercial properties. The retaining walls are located in a well-developed area with a number of busy roads, commercial units, educational facilities and other infrastructure. Multiple services and utilities are located near the walls and will be taken into consideration during all project phases.

The retaining walls are adjacent to Chapelizod Hill Road Underbridge which carries Chapelizod Hill Road in a westerly direction under the Chapelizod Bypass.

Residential housing estates are located at all corners of the site with the exception of the north-west corner at CDET Ballyfermot Training Centre. The housing estates, named Chapelizod Court, Knockmaree, and Convent Lawns, are hidden from view behind relatively large mature trees and vegetation.

There are numerous commercial and educational facilities in the surrounding area of the walls. Some of these facilities include CDET Ballyfermot Training Centre, St Dominics School, Go Electric and Chestnut Daycare.

The existing retail building and carpark are separated from the Chapelizod Bypass alignment by a grass verge and vegetation. Access to the retail park will not be affected by construction works.

## 2.5 Vertical and horizontal alignment

At both retaining walls, the existing Chapelizod Bypass is on a maximum longitudinal fall of 5% from north to south at the wall location. The alignment is on a standard cross fall of 2.5% either side of the centre line.

## 2.6 Cross sectional dimensions on the alignments

The Chapelizod Bypass proposed cross section at the CBC006-RW03 is as follows:

Section	Width (m)
Footpath	2.40
Westbound Bus Stop	3.30
Verge	1.50
Westbound Bus Lane	3.30
Westbound Carriageway	3.30
Westbound Carriageway	3.30
Central Reserve	3.35
Eastbound Carriageway	3.35
Eastbound Carriageway	3.35
Eastbound Bus Lane	3.50
Verge	2.95
<b>Total</b>	<b>33.60</b>

Table 2-1 Chapelizod Bypass proposed Cross-Section at CBC006-RW03

The Chapelizod Bypass proposed cross section at the CBC006-RW04 is as follows:

Section	Width (m)
Footpath	2.00
Eastbound Bus Stop	3.30
Verge	2.45
Eastbound Bus Lane	3.40
Eastbound Carriageway	3.40
Eastbound Carriageway	3.40
Central Reserve	3.35
Westbound Carriageway	3.35
Westbound Carriageway	3.35
Westbound Bus Lane	3.60
Verge	1.35
<b>Total</b>	<b>32.95</b>

Table 2-2 Chapelizod Bypass proposed Cross-Section at CBC006-RW04

## 2.7 Existing underground and overground services

A number of existing services have been recorded in the area surrounding the proposed retaining walls. The following table summarises the service providers and their utilities.

Service Provider	Services	Location
EIR	EIR Duct	West Verge on Chapelizod Hill Road
ESB	MV UG ESB LINE Existing Duct	Northbound Verge on the Chapelizod Bypass
DCC	Foul Water Drain	East Verge on Chapelizod Hill Road
	Storm Water Drain	Central Reserve on the Chapelizod Bypass
	Existing Water Network	East Verge on Chapelizod Hill Road
Virgin Media	Existing Virgin Media Network	West Verge on Chapelizod Hill Road
Gas Networks Ireland	Existing Gas Network	West Verge on Chapelizod Hill Road

Table 2-3 Existing Services

## 2.8 Geotechnical summary

A Preliminary Sources Study Report (PSSR) for the BusConnects Lucan to City Centre CBC was prepared in accordance with Managing Geotechnical Risk DN-ERW-03083 (October 2019), Section 6.1, specifically Appendix C. It addressed the geological, geotechnical, geomorphological, hydrogeological and geo-environmental aspects of the BusConnects CBC.

The preliminary investigation comprised of two boreholes R6-CP10 and R6-CP11 located on the north westerly side of existing the bridge along the Chapelizod bypass carried out in October 2020. A trial pit was also carried out to identify the foundations of the existing underpass.

R6-CP10 encountered made ground from surface terminating in concrete at depth of 4.10 m (21.35 m OD). The borehole comprised of the following:

Depth Below Ground Level (m)	Material Description
0.0-0.3m	BITMAC
0.3-1.0	Black slightly sandy angular fine to coarse gravel of limestone
1.0-3.0	Firm becoming stiff brown slightly sandy slightly gravelly clay
3.0-4.0	Very stiff brown sandy gravelly clay
4.0-4.1	Concrete

**Table 2-4 R6-CP10 Ground Investigation Result**

R6-CP11 encountered made ground from surface terminating in possibly made ground at a depth of 4.12 m (20.93 m OD). The borehole comprised of the following:

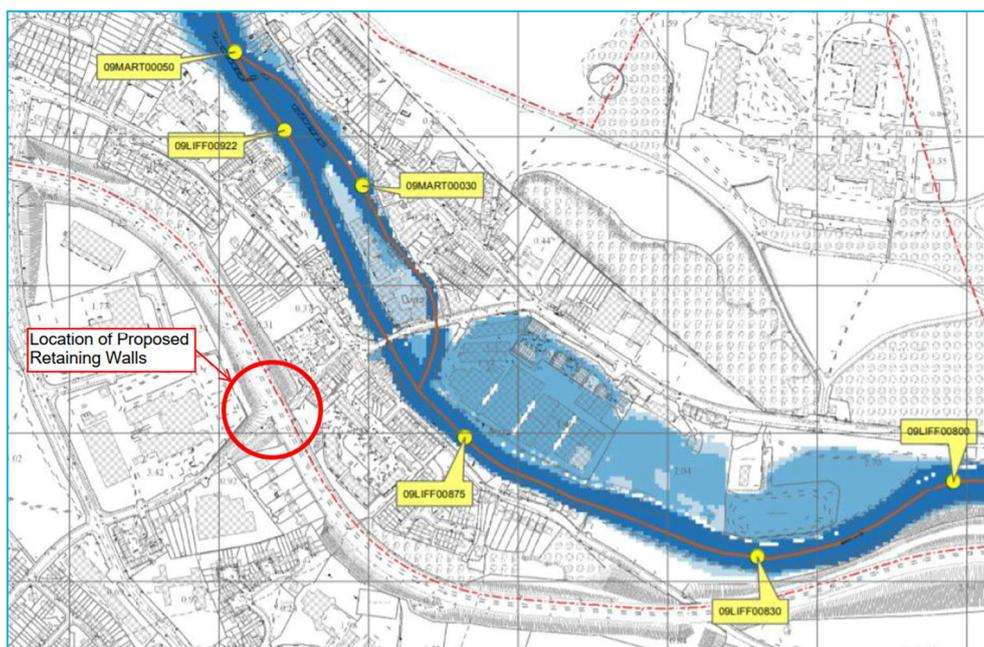
Depth Below Ground Level (m)	Material Description
0.0-0.3m	BITMAC
0.3-1.1	Black sandy angular fine to coarse gravel of limestone
1.1-3.0	Firm becoming stiff brown slightly sandy slightly gravelly clay
3.0-4.2	Very stiff brown sandy gravelly clay

**Table 2-5 R6-CP11 Ground Investigation Results**

## 2.9 Hydrology and hydraulic summary

The River Liffey is located approximately 160m to the northeast of the Chapelizod Bypass and proposed retaining walls. There are no other major rivers, waterways or distributary streams in the immediate surrounding area of the walls, and it is expected that the River Liffey is situated a sufficient distance from the walls to avoid works within the flood plain. The potential flooding impacts caused due to the construction of a new structure should not be ignored and the flooding history of the surrounding location will be investigated.

A review of the OPW flood mapping ([www.floodinfo.ie](http://www.floodinfo.ie)) shows that there are no historical events pertaining to flooding in the areas surrounding the retaining walls. Review of the flood mapping in the area should be revisited at detailed design stage to identify any updates to the flood record. The River Liffey fluvial flood extents are show below.



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Figure 2.2 Fluvial Flood Extents

## 2.10 Archaeological summary

No sites of major archaeological importance were identified at the proposed retaining wall locations during the EIA stage of the project.

## 2.11 Environmental summary

The EIAR prepared as part of the preliminary design did not identify any particular major environmental impacts associated with the construction of the retaining walls. The main findings of the EIAR relating to the retaining walls are as follows:

CBC006-RW03 and CBC006-RW04 - Removal of trees, which make a positive contribution to the separating of the Chapelizod Bypass from the surrounding residential area. The works do not directly impact the residential area but do affect views to and from the properties. Appropriate planting and screening of the retaining wall should be provided for as part of the overall scheme. There is the potential for construction activities, to result in adverse noise impacts at properties in Chapelizod, this will need to be mitigated as part of the design.

## 3. Structure & Aesthetics

### 3.1 General description of recommended structure or family of structures and design working life

CBC006-RW03 will be formed by an embedded/piled retaining wall and CBC006-RW04 will be formed by a soil nail retaining wall. The geometry of wall will be dependent on a number of factors such as predicted loading and available working area.

Parapets will be required for CBC006-RW03 on the edge of Chapelizod Bypass. This parapet will consist of a 1.25m concrete parapet with a 0.55m mesh infill fence on top.

CBC006-RW04 does not require any parapet or boundary wall. For aesthetic purposes, the retaining structure may extend beyond the retained height in locations and act as a boundary wall. In these locations, the wall will have the same pattern profile finish to tie in with the retained structure.

The proposed retaining wall dimensions are as follows:

Parameter	Dimension
Retained Length	38.19m
Max Retained Height	4.50m
Min Retained Height	0.20m
Concrete Parapet Height	1.25m
Fence with Mesh Infill Height	0.55m

Table 3-1 CBC006-RW03 Geometry

Parameter	Dimension
Retained Length	67.58m
Max Retained Height	1.95m
Min Retained Height	0.20m

Table 3-2 CBC006-RW04 Geometry

The embedded/piled retaining wall will be designed to ensure that stability is provided by the forces taken by the piles. Unlike walls founded on soil, which transfer compression-only forces to the foundation, piles usually have a tension capacity. Therefore, the applied overturning moment can be resisted by a couple of forces on the piles, one in tension and one in compression. The resultant sliding force will be resisted by the lateral capacity of the vertical piles. As the retained height increases additional lateral forces may exceed the capacity that can be provided by the piles. In this case inclined ground anchors will be included within the design to take the lateral force. These anchors will help to reduce the lateral loads and the overturning moments within the pile. A reinforced concrete capping beam shall also be provided to the top of the wall connecting each successive pile together ensuring continuity and improving stability of the entire retaining wall.

For the soil nail retaining wall, the horizontal and backfill pressures on the retained side will create the overturning moment, sliding and bearing capacity of the wall. The capacity of the wall is determined by the size/placing of the various soil nails and the installation of a front face support. The design of the retaining wall assumes that the entire cross section of the structure i.e. precast panels, nails and soils act as one element with the overall capacity of the wall derived from the tension capacity of the reinforcing nails and the friction coefficient between the compacted soil. The soil nails will be sized to resist these failures. In the case of sliding a friction coefficient will be applied between the soil nails and the surrounding soil to determine the sliding resistance.

The design working life of the retaining walls will be a minimum of 120 years as defined in the TII publication, DN-STR-03012 - Design for Durability. Maintainable elements and components listed below are subject to greater wear

and will require replacement within the design life. Careful design and detailing combined with thorough routine inspections, quality control and supervision on site will help achieve the minimum expected design life listed in the below table:

Component	Years
Expansion Joints	50
Drainage Systems	50
Parapets	50

**Table 3-3 Minimum Design Life for Structural Elements**

## 3.2 Aesthetic considerations

The retaining wall designs have been developed to take account of the basic principles of aesthetics which respects the surrounding landscape, minimises the environmental intrusion and protects existing vegetation where possible.

The proposed finishes for each of the walls will be critical to ensuring the environmental intrusion of the walls is limited. The quality of concrete finish will have a large effect on the aesthetics of a plain concrete finish. The finish can be specified in formed or unformed and range in quality from 1 to 5 with 5 being the highest quality finish achievable. Where the wall is visible by users an F4 or F5 finish shall be specified to ensure the aesthetics of the wall are not compromised.

A patterned profile concrete finish is recommended for all large areas of exposed concrete. The form liners produce concrete surfaces which avoid streaking. Surfaces with closely spaced vertical ribs or grooves have worked well in the past as the grooves encourage channelling of rainwater or seepage. Consistency of form is an important aesthetic consideration and will depend on materials, proportion, colour and details specified.

In all cases the proposed finishes will be required to match the finish of existing retaining/boundary walls on site. The table below indicates the required finish for each wall.

Retaining Wall	Finish Required
CBC06-RW03	Precast Concrete Cladding Panels with Pattern Profile Finish
CBC06-RW04	Pattern Profile Concrete Finish

**Table 3-4 Required Finishes**

## 3.3 Proposals for the recommended structure or family of structures

### 3.3.1 Proposed Category

Both retaining walls shall be Category 1 (retaining structures <1.5m and >5m) requiring a check by another Engineer within the same design team as the lead Designer in accordance with TII publication DN-STR-03001 Technical Acceptance of Road Structures on Motorways and Other National Roads.

### 3.3.2 Span Arrangements

The retaining walls will be required to retain the existing embankments for a length of 38.19m (CBC006-RW03) and 67.58m (CBC006-RW04) respectively.

### 3.3.3 Minimum headroom provided

Not applicable – unrestricted headroom will be provided at both retaining walls.

### 3.3.4 Approaches including run-on arrangements

Both retaining walls will be required to tie in with existing boundary treatments on approach to the structures. CBC006-RW03 will require a precast concrete cladding panel with a pattern profile finish to tie in with the

surrounding area, including the proposed ramp and stairs linking Chapelizod Hill Road and Chapelizod Bypass. For CBC006-RW04, the shotcrete wall will be finished with a pattern profile finish to tie-in with the walls around it.

### 3.3.5 Foundation type

CBC006-RW03 is an embedded retaining wall, therefore, no additional foundations will be required.

CBC006-RW04 is a soil nail retaining wall. This type of wall will require soil nails to be drilled into the soil as anchors and will not require additional foundations.

### 3.3.6 Substructure

Not applicable

### 3.3.7 Superstructure

The superstructure of CBC006-RW03 will consist of an embedded retaining wall solution which will be formed of a series of adjacent piles constructed to form an earth retaining cantilever structure. These types of walls can be used for more flexible geometry where curvature is required. A reinforced concrete capping beam shall also be provided to the top of the wall connecting each successive pile together ensuring continuity and improving stability of the entire retaining wall.

The superstructure for CBC006-RW04 will utilise soil nailing to create a vertical retaining structure. These soil nails are installed into predrilled holes at an inclination of 10 to 20 degrees to the vertical and then grouted with shotcrete. The soil nails typically have a diameter of 100-200mm with a centre to centre spacing of 1-1.5m.

### 3.3.8 Articulation arrangements, joints, and bearings

Expansion joints shall be located along the length of both walls at maximum spacings of 10m centre to centre. The joints shall be formed with compressible filler board sealed with two-part polysulphide sealant.

### 3.3.9 Vehicle Restraint System

Parapets will be required for CBC006-RW03 on the edge of Chapelizod Bypass. This parapet will consist of a 1.25m concrete parapet with a 0.55m mesh infill fence on top. The fence detail has been added to limit anti-social behaviour in the area such as people sitting on the parapet while waiting for an oncoming bus.

CBC006-RW04 does not require any parapet or boundary wall as it is located outside of the clear zone from the Chapelizod Bypass carriageways.

### 3.3.10 Drainage

A drainage channel shall be provided between the piles and cladding panels on CBC006-RW03. The drainage channel will collect all water which permeates the retained soil. Access for rodding and maintenance of the drainage will need to be considered as part of the design.

No drainage shall be provided within CBC006-RW04 with the wall designed to resist the build-up of pore water pressure to the rear of the wall.

### 3.3.11 Durability

The retaining walls will be designed in accordance with the TII publication DN-STR-03012 - Design for Durability with a minimum design life of 120 years. The design life for replaceable parts such as expansion joints and drainage systems will be 50 years in accordance with DN-STR-03012. The design working life of the retaining walls will be working life category 5 while replaceable parts will be working life category 2 in accordance with GE-POL-01008.

Where required, all buried concrete surfaces will be treated with two coats of epoxy resin waterproofing in accordance with DN-STR-03012 – Design for Durability and CC-SPW-02000 Specification for Road Works Series 2000 – Waterproofing for Concrete Structures.

All exposed concrete surfaces will receive a hydrophobic pore lining impregnation in accordance with DN-STR-03012 – Design for Durability and CC-SPW-02000 Specification for Road Works Series 2000 – Waterproofing for Concrete Structures.

### 3.3.12 Sustainability

The use of cement replacement products, such as Ground Granulated Blast Slag (GGBS) will be maximised in the retaining wall design, reducing the environmental impacts of concrete production. The replacement levels will be in accordance with the levels specified within IS EN 206:2013.

At the end of the service life a large proportion of the concrete can be recycled and reused as hard core for road construction or as an aggregate material for other concrete structures.

### 3.3.13 Inspection and maintenance

Maintenance and inspection of the retaining walls will be required throughout their service life. The inspections will be carried out in line with the TII EIRSPAN Bridge Management System. The EIRSPAN system was introduced in 2001 to provide an integrated management system for the bridges and structures in Ireland. The system coordinates activities such as inspection, repairs and maintenance work to ensure optimal management of structures. As a minimum the following inspection regime should be implemented:

- Routine Inspection – every year;
- Principal Inspection – every six years.

Inspection of the exposed faces of both walls will be carried out from Chapelizod Hill Road and Chapelizod Bypass as required. It is expected that no lane closures or traffic management will be required to facilitate inspection of CBC006-RW04. However, inspection and maintenance of CBC006-RW03 will be carried out from Chapelizod Hill Road using a mobile elevated work platform (MEWP) due to the height of the wall. Traffic Management and lane closures may be required during this inspection.

## 4. Safety

### 4.1 Traffic management during construction including land for temporary diversions

The retaining walls will be constructed parallel to the Chapelizod Bypass carriageway, a highly trafficked road. The construction sequence will need to avoid construction within the carriageway where possible and reduce the need for traffic management measures on the bypass. During any required lane closures suitable traffic management in accordance with Chapter 8 of the Traffic Signs Manual will need to be installed. This traffic management should consider the traffic flows and where possible minimise any negative effects.

### 4.2 Safety during construction

As part of the design development, a Designer's Risk Assessment (DRA) has been prepared in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013 and the amendments of 2019 and 2020. The DRA shall be viewed as a working document to be developed further as the design develops. The DRA includes all risks identified and the resulting mitigation measures or alterations incorporated within the design, where no mitigation is possible the DRA will be used to communicate the risks to the Contractor and site personnel.

Where possible, the hierarchy of risk control will be implemented within the design and construction, with the Designer and Contractor aiming to control all risks through elimination. Where this is not possible, reduction, isolation or mitigation controls will be incorporated to ensure safety during construction.

The following list of particular risks has been identified for the retaining walls:

- The maximum retained height of the retaining walls varies from 1.95m to 4.5m. These retained heights may lead to a risk of burial under earth falls during temporary works. All temporary slopes should be constructed to suitable gradients and benched to minimise the risk of earth falls or slide. If required temporary shoring should be considered to further limit the risk of slope failure.
- Construction works will need to be cognisant of works near live carriageways of the Chapelizod Bypass. The carriageways will need to remain operational during construction; however, it is anticipated that closure of bus lanes during construction will be required to provide a safe working zone.
- Working in a congested urban environment should be considered. The number of traffic movements to and from site should be minimised to avoid increase in the traffic congestion in the area;
- The risk of working near live services such as electrical supplies and drainage networks should be assessed. A health and safety plan should be prepared to determine the correct procedure in the event of contact with live services;
- Consideration should be given to the potential risks to pedestrians and cyclists travelling in the area during construction. Safe work areas should be established, and re-routing of pedestrians and cyclists should be arranged to avoid/minimise conflicts between pedestrians, cyclists and construction vehicles;

### 4.3 Safety in use

Safety of the end user will be considered as part of the Designer's Risk Assessment. A Routine Inspection will be carried out at least once a year or after any significant event in line with the recommendations contained within the EIRSPAN Bridge Management System, as defined by TII. The Routine Inspection will take account of any defects and establish whether the retaining walls require a Principal Inspection to be carried out or if routine maintenance consisting of simple remedial works is sufficient to maintain the safety. A Principal Inspection can only be carried out by an approved Principal Inspection Team Leader according to the TII Bridge Management Section. The Principal Inspection shall record all findings on the EIRSPAN database for future reference.

### 4.4 Lighting

No public lighting is proposed as part of the retaining wall design.

## 5. Cost

### 5.1 Budget Estimate in current year

The construction costs provided below have been based on quantities calculated from the preliminary retaining wall design. Elements associated with retaining walls such as earthworks, concrete and reinforcement have been included. Rates have been based on AECOM's internal cost database or based on Spon's Civil Engineering and Highway Works Price Book 2022 as required. It should be noted that costs are indicative only and may vary depending on the detailed design and the Contractor's methodology.

Allowances have been made for preliminaries, consultancy fees and contingency. A budget of 20% of the construction cost has been provided for preliminaries to cover traffic management, PSCS, temporary accommodation etc. The contingency is 10% of the construction cost and will cover minor elements such as drainage, fencing, landscaping works and any unforeseen unknowns. Finally, an allowance of 10% of the construction cost has been provided for professional fees to deliver the retaining walls from detailed design to handover. These fees will include detailed design, CAT I checks, construction supervision and handover.

The rates used to calculate the amounts presented below are all exclusive of VAT. No allowance has been made for land acquisition within the costs provided below. The cost of land acquisition will be covered under the construction costs for the entire BusConnects CBC06 Lucan to City Centre route.

Series	Amount (€)
CC-SPW-00400 – Road Restraint Systems	35,781.64
CC-SPW-00600 – Earthworks	38,099.33
CC-SPW-01600 – Piling and Embedded Retaining Walls	299,918.18
CC-SPW-01700 – Structural Concrete	8,260.16
CC-SPW-02000 – Waterproofing	8,259.30
<b>Construction Cost</b>	<b>390,318.61</b>
Preliminaries (20% of Construction Cost)	78,063.72
Contingency (10% of Construction Cost)	39,031.86
Professional Fees (10% of Construction Cost)	39,031.86
<b>Total Cost</b>	<b>546,446.06</b>

Table 5-1 CBC006-RW03 Budget Estimate in the current year

Series	Amount (€)
CC-SPW-00600 – Earthworks	13,192.00
CC-SPW-01600 – Soil Nail Retaining Wall	74,454.96
C-SPW-01700 – Concrete	114,494.97
CC-SPW-02000 – Waterproofing	10,181.64
<b>Construction Cost</b>	<b>212,323.57</b>
Preliminaries (20% of Construction Cost)	42,464.71
Contingency (10% of Construction Cost)	21,232.36
Professional Fees (10% of Construction Cost)	21,232.36
<b>Total Cost</b>	<b>297,252.99</b>

**Table 5-2 CBC006-RW04 Budget Estimate in the current year**

## 6. Design Assessment Criteria

### 6.1 Actions

#### 6.1.1 Permanent Actions

Permanent actions and material densities will be applied in accordance with IS EN 1991-1-1 and the Irish National Annex. Material/partial factors will be as detailed in IS EN 1990 and the Irish National Annex. The accepted densities for principal construction materials are as follows:

Material	Density
Reinforced Concrete	25 kN/m <sup>3</sup>
6N/6P backfill to structures	21 kN/m <sup>3</sup>

Table 6-1 Material Densities for Design

#### 6.1.2 Snow, Wind and Thermal Actions

Snow loads are not deemed a critical load case and will not be considered in accordance with the National Annex to IS EN 1991-1-3.

Wind loading will be considered in accordance with IS EN 1991-1-4 and the Irish National Annex. Wind loads will be taken to act simultaneously with other loads in accordance with the NA to IS EN 1990. Wind loads will not be considered in combination with thermal loading in accordance with clause A2.2.2 (6) of the NA to IS EN 1990.

Thermal loading will be considered in accordance with IS EN 1991-1-5 and the Irish National Annex. The combination of thermal and wind loading will not be considered in accordance with the National Annex to IS EN 1990.

#### 6.1.3 Actions relating to normal traffic

The retaining walls will be designed for surcharge loading associated with LM1 and LM2 live Loading in accordance with IS EN 1991-2.

#### 6.1.4 Actions relating to abnormal traffic

The retaining walls will be designed to resist the surcharge loading due to the abnormal load effects of Load Model 3, specifically SV80, SV100 and SV196, as detailed in IS EN 1991-2.

#### 6.1.5 Footway live loading

Surcharge actions on the retaining walls due to LM4 footway loading will be considered in accordance with IS EN 1991-2 and the Irish National Annex.

#### 6.1.6 Provision for exceptional abnormal loads

Not applicable

#### 6.1.7 Accidental actions

Accidental actions on the CBC006-RW03 parapet will be considered in accordance with IS EN 1991-1-7 and the Irish National Annex.

No accidental actions will be applicable on CBC006-RW04 as it is located outside of the clear zone of the carriageways.

### **6.1.8 Actions during construction**

Actions arising during construction will be considered in accordance with IS EN 1991-1-6 and the Irish National Annex.

### **6.1.9 Any special loading not covered above**

Not applicable.

## **6.2 Authorities consulted and any special conditions required**

The following authorities have been consulted as part of the development of the scheme:

- Dublin City Council
- National Transport Authority

### **6.3 Proposed departures from standards**

No departures from standards are envisaged for the design and construction of the retaining walls.

### **6.4 Proposed methods of dealing with aspects not covered by Standards**

Not applicable.

## 7. Ground Conditions

### 7.1 Geotechnical Classification

Considering the guidance in IS EN 1997-1, it is considered that Geotechnical Category 2 is currently the most appropriate for the proposed retaining walls.

Geotechnical Category 2 is for conventional types of structure and foundations with no exceptional risk or difficult loading conditions. This includes spread footing, raft foundations, piled foundations, walls or other structures retaining or supporting water, excavations, bridge piers and abutments, embankments and earthworks, ground anchors and other systems and tunnels in hard, non-fractured rock and not subjected to special water tightness or other requirements.

### 7.2 Description of the ground conditions and compatibility with proposed foundation design

#### 7.2.1 CBC006-RW03

Preliminary geotechnical analysis of the foundation options found that provided the retaining elements are adequately sized during the detailed design phase, the piled elements could achieve Serviceability Limit State settlements of less than 25 mm. This is based on an assumption that the piles will be rock socketed a bedrock. As no bedrock was identified as part of the October 2020 Ground Investigation a further Ground Investigation should be carried out in advance of detailed design stage to identify the depths to bedrock. Where bedrock is not encountered the piles may be designed based on the skin friction only.

The embedded retaining wall reduces the need for extensive temporary excavations into the Chapelizod Bypass embankments compared with traditional gravity methods. Ground anchors may be required to reduce the wall deflections relative to a cantilever embedded retaining wall. This should be reviewed at the detailed design stage. If ground anchors cannot be installed due to the presence of services in the existing carriageway then a large diameter pile and stiffer wall may be required to limit deflections to tolerable amounts. Conservative characteristic parameters for made ground or general embankment fill shall be derived at the detailed design stage. The embedded retaining walls should be designed in accordance with the guidance of CIRIA C760 Guidance on Embedded Retaining Wall Design.

#### 7.2.2 CBC006-RW04

The ground conditions are inferred to be glacial till or clay made ground embankment. A review of Table 4.1 of CIRIA C637 indicates that soil nailing could be favourable for the anticipated soil conditions at the site.

The basic mechanism of soil reinforcement relies on tensile strains developing in the reinforcement to resist those developing in the soil. Adequate bond strength needs to be developed at the soil/reinforcement interface or at the soil/grout interface, as appropriate, to prevent slippage. Some relative movement between the soil and the nails is required to develop the tensile resistance of the soil nails. For steep-sided retaining structures, it will generally occur as each temporary excavation “bench” is stabilised. Once tensile loads are developed in the nails, further deformation of that part of the structure is resisted and the load-carrying capacity is increased.

The design should consider guidance from the following documents:

- CIRIA C637: Soil Nailing – Best Practice Guidance
- BS 8006-2:2011+A1:2017: Code of practice for strengthened/reinforced soils. Soil nail design
- FHWA Soil Nailing manual

## 8. Drawings and Documents

### 8.1 List of all documents accompanying the submission

The following table lists the drawings accompanying this submission. The drawings are contained within Appendix B:

Drawing Number	Revision	Drawing Title
BCIDA-ACM-STR_GA-0006_RW_06-DR-CB-0101	L01.1	RW03.06 Chapelizod Hill Road Retaining Wall No.1 General Arrangement

Table 8-1 CBC006-RW03 Drawing List

Drawing Number	Revision	Drawing Title
BCIDA-ACM-STR_GA-0006_RW_04-DR-CB-0111	L01	RW04.06 Chapelizod Hill Road Retaining Wall No.2 General Arrangement

Table 8-2 CBC006-RW04 Drawing List

# Appendix A Photographs and Photomontages

CBC006-RW03



Photo 1 – View of Existing Retaining Walls



**Photo 2 – Existing Embankment**



**Photo 3 – Existing Embankment**

**CBC006-RW04**

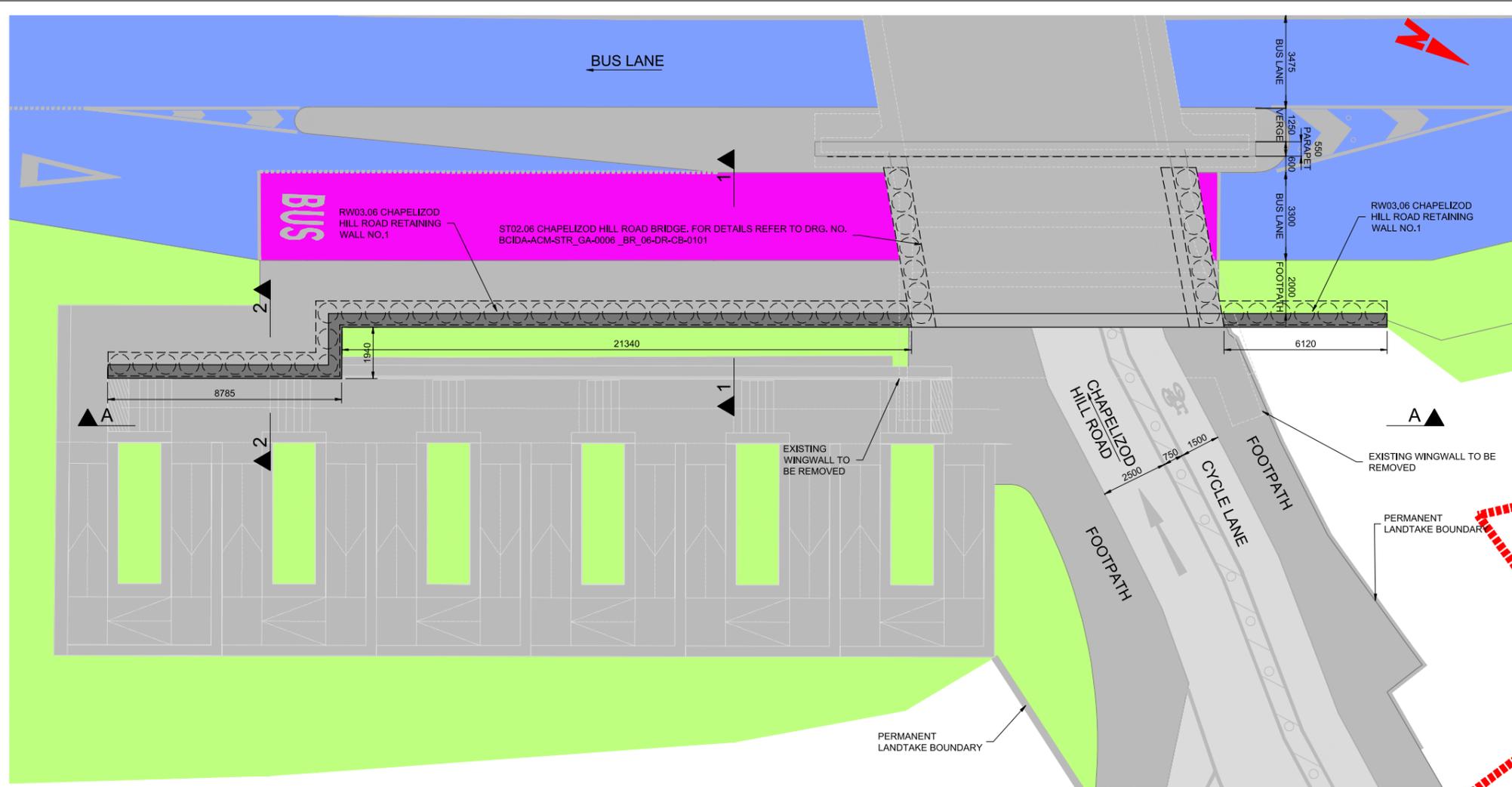


**Photo 4 – View of Existing Retaining Walls**



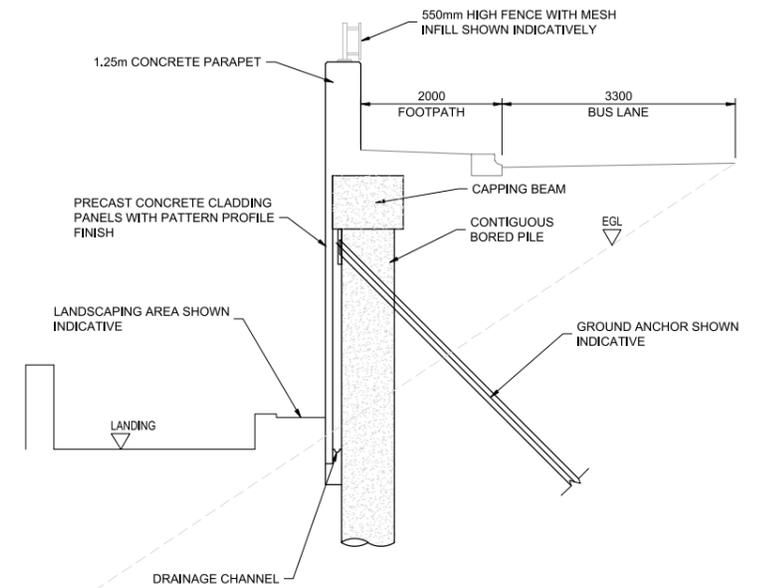
**Photo 5 – Existing Embankment**

# Appendix B Drawings



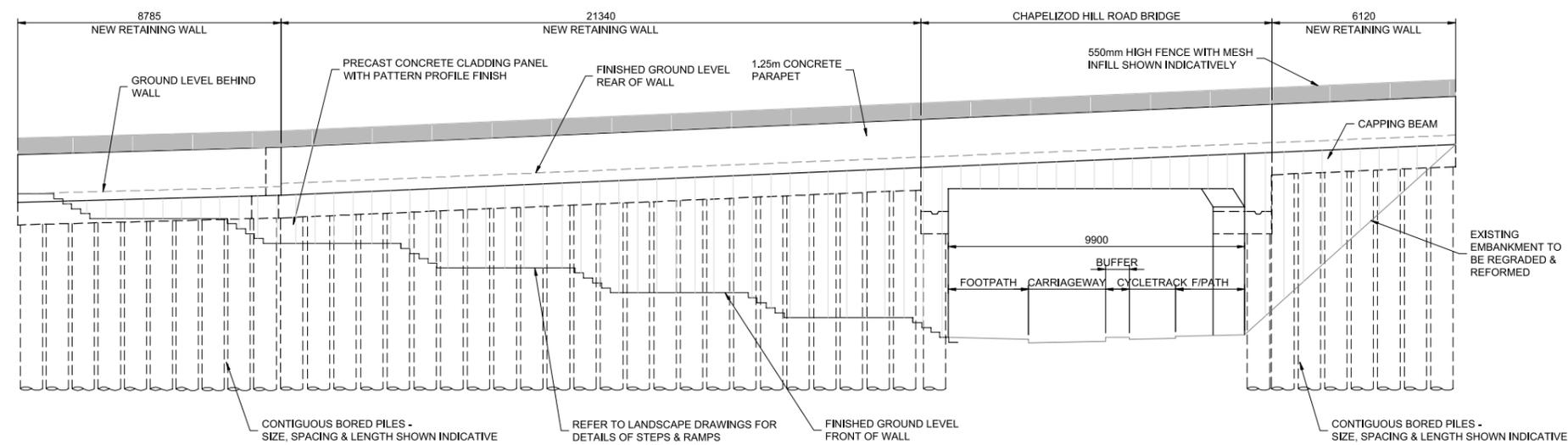
PLAN

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1:200 @ A3



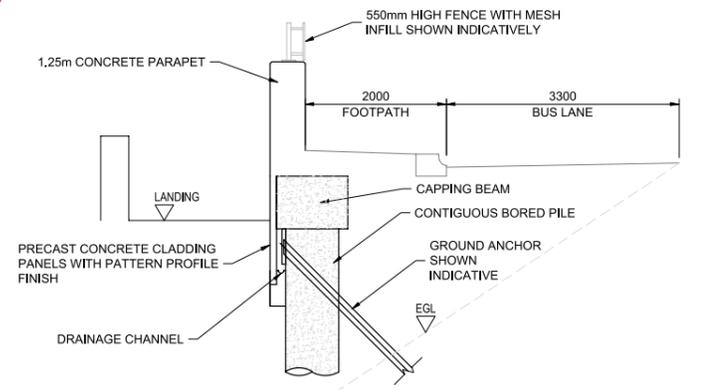
SECTION 1-1

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1:200 @ A3



PROPOSED ELEVATION A-A

1:100 @ A1  
1:200 @ A3



SECTION 2-2

1:50 @ A1  
1:100 @ A3

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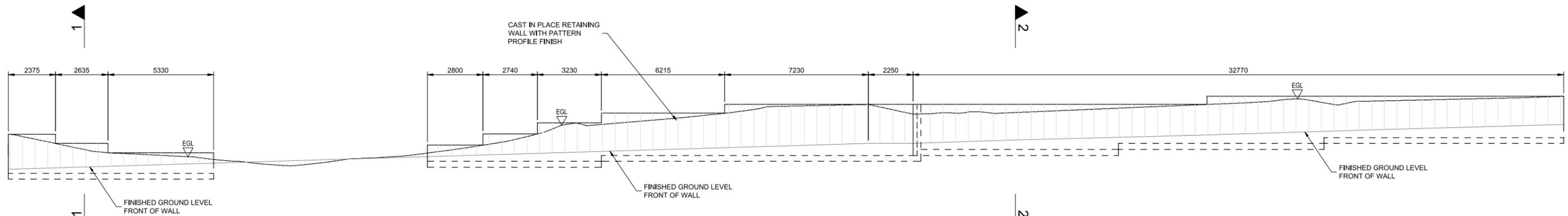
Rev	Date	Drn	Chk'd	App'd	Description
L03	21/01/22	DH	AD	CA	ISSUE FOR PHASE 3: PRELIMINARY DESIGN
L02	25/06/21	SH	CA	JS	ISSUED FOR APPROVAL
L01	22/04/21	DH	NR	JS	ISSUED FOR PEER REVIEW

Client <b>NTA</b> Údarás Náisiúnta Iompair National Transport Authority		Engineering Designer <b>AECOM</b> <b>M</b> <b>MOTT MACDONALD</b>		
Date 21/01/22	Scale AS SHOWN @ A1 AS SHOWN @ A3	Drawn D.HAMILTON	Checked A.T.DALE	Approved C.ACTON
Project Code BCIDA	Originator Code ACM	QMS Code		

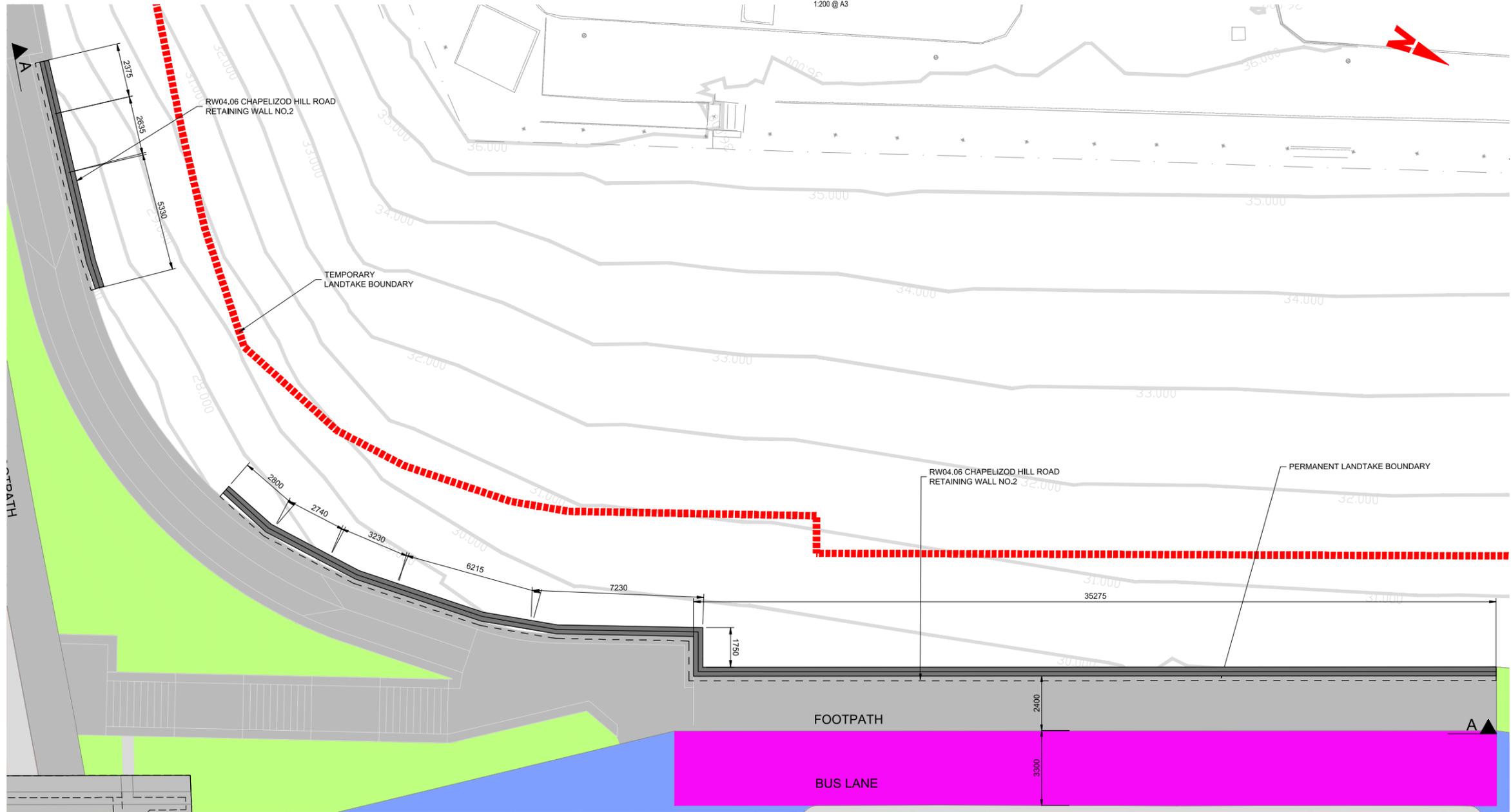
Programme Title <b>BUSCONNECTS DUBLIN</b> <b>CORE BUS CORRIDORS INFRASTRUCTURE WORKS</b>			
Drawing Title LUCAN TO CITY CENTRE CORE BUS CORRIDOR SCHEME RW03.06 CHAPELIZOD HILL ROAD RETAINING WALL NO.1 GENERAL ARRANGEMENT			
Drawing File Name BCIDA-ACM-STR_GA-0006_RW_06-DR-CB-0101	Sheet Number 1 of 1	Status A	Rev L03

W.I.P.

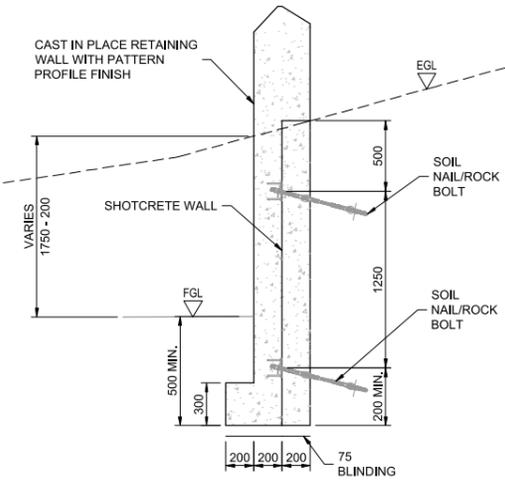
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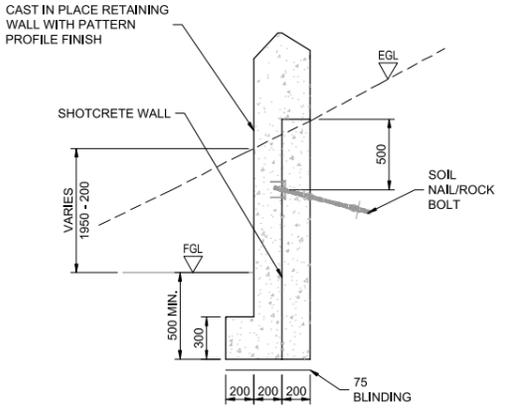
DEVELOPED ELEVATION A-A  
1:100 @ A1  
1:200 @ A3



PLAN  
1:100 @ A1  
1:200 @ A3



SECTION 2-2  
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1:50 @ A3



SECTION 1-1  
1:25 @ A1  
1:50 @ A3

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Building Ireland's Future

Rev	Date	Drn	Chk'd	App'd	Description
L03	21/01/22	DH	AD	CA	ISSUE FOR PHASE 3: PRELIMINARY DESIGN
L02	25/06/21	SH	CA	JS	ISSUED FOR APPROVAL
L01	22/04/21	DH	NR	JS	ISSUED FOR PEER REVIEW

Client: **NTA** Údarás Náisiúnta Iompair National Transport Authority

Engineering Designer: **AECOM** MOTT MACDONALD

Date: 21/01/22  
 Scale: AS SHOWN @ A1, AS SHOWN @ A3  
 Drawn: D.HAMILTON  
 Checked: A.T.DALE  
 Approved: C.ACTON

Project Code: BCIDA  
 Originator Code: ACM

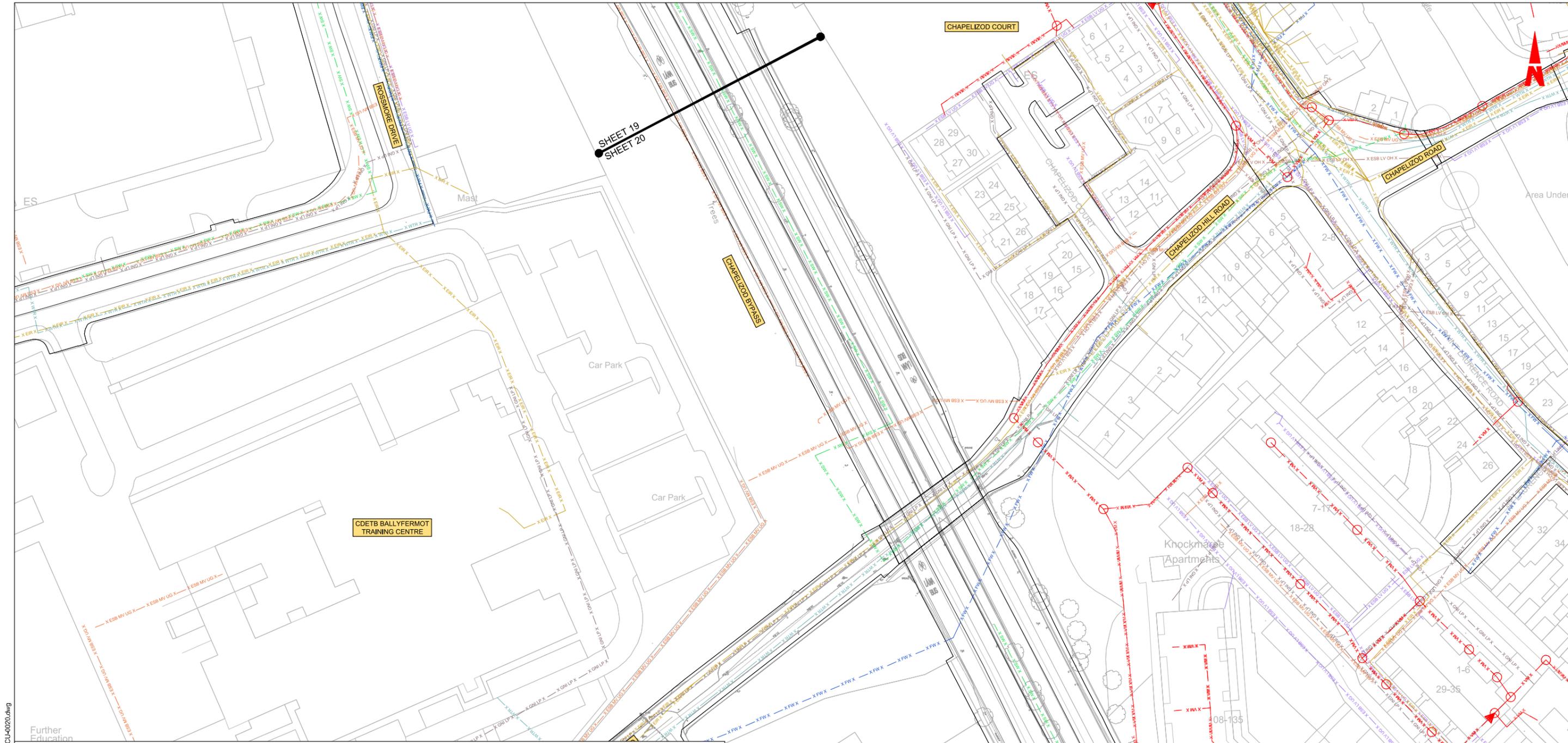
Programme Title: **BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS**

Drawing Title: **LUCAN TO CITY CENTRE CORE BUS CORRIDOR SCHEME RW04.06 CHAPELIZOD HILL ROAD RETAINING WALL NO.2 GENERAL ARRANGEMENT**

Drawing File Name	Sheet Number	Status	Rev
BCIDA-ACM-STR_GA-0006_RW_06-DR-CB-0111	1 of 1	A	L03

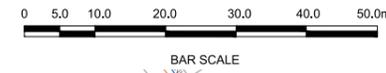
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# Appendix C Utility Drawings



- LEGEND:**
- X ESB LV UG X — EXISTING LV ELECTRICITY (underground)
  - X ESB MV UG X — EXISTING MV ELECTRICITY (underground)
  - X ESB HV UG X — EXISTING HV ELECTRICITY (underground)
  - X ESB HV OH X — EXISTING HV OVERHEAD ELECTRICITY
  - X ESB LV OH X — EXISTING LV OVERHEAD ELECTRICITY
  - X ESB MV OH X — EXISTING MV OVERHEAD ELECTRICITY
  - X GNI LP X — X GNI LP X — EXISTING LP GAS NETWORK
  - X GNI MP X — X GNI MP X — EXISTING MP GAS NETWORK
  - X GNI HP X — X GNI HP X — EXISTING HP GAS NETWORK
  - X SW X — X SW X — EXISTING DRAINAGE

- UTILITY LINE TYPE UNIQUE FOR THIS DRAWING**
- X FW X — X FW X — EXISTING SEWAGE NETWORK
  - X WTR X — X WTR X — EXISTING WATER NETWORK
  - X WTR X — X WTR X — EXISTING ABANDONED WATER NETWORK
  - X VM X — X VM X — EXISTING VIRGIN MEDIA NETWORK
  - X GNI TELCO X — X GNI TELCO X — EXISTING TELCO DUCT
  - X ENET X — X ENET X — EXISTING ENET NETWORK
  - X ER X — X ER X — EXISTING EIR NETWORK
  - X FB X — X FB X — EXISTING FIBRE NETWORK



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Rev	Date	Drn	Chk'd	App'd	Description
L01	18/08/20				ISSUED FOR DESIGN FIX 3

Client: **NTA** Údarás Náisiúnta Iompair National Transport Authority

Date: 18/08/20 Scale: 1:500 @ A1, 1:1000 @ A3

Project Code: BCIDA Originator Code: ACM

Engineering Designer: **AECOM** MOTT MACDONALD

Drawn: [ ] Checked: [ ] Approved: [ ]

QMS Code: [ ]

Programme Title: <b>BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS</b>			
Drawing Title: CBC06 LUCAN TO CITY CENTRE COMBINED EXISTING UTILITIES			
Drawing File Name: BCIDA-ACM-UTL_UC-0006_XX_00-DR-CU-0020	Sheet Number: 20 of 31	Status: S3	Rev: L01

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# Appendix D Designers Risk Assessment

BUSCONNECTS – Lucan to City Centre Route 0006  
 CBC006-RW03 Chapelizod Hill Road Retaining Wall No.1  
 Designers Risk Assessment



<b>Project Number:</b>	60599126	<b>Revision</b>							
<b>Client:</b>	National Transport Authority	<b>Rev</b>	01	02	03	04	05	06	07
<b>Designer:</b>	AECOM	<b>Date</b>	05/03/21						
<b>Contractor:</b>	Not applicable	<b>Client</b>	✓						
<b>Prepared by:</b>	Rionach Murphy	<b>Designer</b>	✓						
<b>Checked by:</b>	Arthur Costello	<b>Main Contractor</b>	-						
<b>Approved by:</b>	Niamh Rodgers	<b>Sub-Contractors</b>	-						
		<b>Other</b>	-						

Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers' interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
1	Access and egress to the site area	Access and egress to the retaining wall location is via Chapelizod Hill Road.	High	Traffic management to be implemented to ensure that safe access and egress is achieved		Low	The contractor is to ensure that suitable traffic management is implemented on site which includes appropriately designed and identified access points for site vehicles.
2	Site security	Unauthorised access by members of the public to the works areas	High	Suitable hoarding/fencing to be erected to prevent unauthorised access to the works areas		Low	Contractor to ensure that fencing is erected and maintained throughout the construction works.
3	Live Carriageways	Site is on Chapelizod Bypass. The road will be live during some of the construction.	High	Traffic lanes to be closed as required during lifting of heavy prefabricated components Traffic management to be implemented to ensure that safe working zones are provided to any works near live carriageways.	Live traffic with traffic management zones	Medium	Traffic Management will be required for any construction works on or near live carriageways. All traffic management plans to be developed in accordance with Chapter 8 of the Traffic Signs Manual. Contractor is to ensure that all staff are aware of the risks of working near a live road.

BUSCONNECTS – Lucan to City Centre Route 0006  
 CBC006-RW03 Chapelizod Hill Road Retaining Wall No.1  
 Designers Risk Assessment



Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers' interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
4	Piling	Piling operations to be undertaken in close proximity to a live road	High	Appropriately designed working areas for piling plant to be provided during construction.		Medium	Contractor to ensure appropriate piling methodology and construction sequences are in place. All proposed piling operations to be agreed with Project Manager and the DSR
5	Plant movements	Insufficient ground bearing pressure for site works.	Medium	Preliminary Ground investigations have been carried out to determine if there are potential risks of low ground bearing pressures.		Low	Further Ground Investigations to be carried out as part of Detailed Design to determine any further areas of low ground bearing pressures. Appropriate hoarding to be provided at construction stage to separate works from areas of adverse ground conditions.
6	Multiple Site Activities	Numerous concurrent construction projects are expected to take place at different locations along the Lucan to City Centre Route	Medium	Phasing of the construction works has been considered to avoid works being carried out in parallel on CBC06		Low	Contractor to discuss sequencing and construction programme with the client and CBC06 Design team. On-site personnel to be aware of ongoing site activities and follow any appropriate safety requirements. Barriers and hoarding to be put in place as appropriate to protect on-site personnel and segregate different site activities.
7	Underground services	Potential for unknown and/or undocumented services in the vicinity of the proposed structure.	Medium	Desk top study of available utility information has been carried out and all known services in the vicinity of the proposed structure have been shown on preliminary design drawings.		Low	Further desk top study to be carried out at Detailed Design stage to identify any additional services which have been constructed in the interim. At construction stage full CAT scan site survey to be carried out prior to commencement. Any services identified should be located by hand excavation, marked and protected or re-routed before commencement of works.

BUSCONNECTS – Lucan to City Centre Route 0006  
 CBC006-RW03 Chapelizod Hill Road Retaining Wall No.1  
 Designers Risk Assessment



Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers' interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
8	Structural Instability	Instability of structural elements during construction	High	The preliminary design has been developed to avoid extensive use of cut slopes limiting the risk of instability during construction.		Medium	Where required the Contractor shall ensure that temporary works are provided on site to ensure structural stability during construction. All temporary works required are to be designed by a temporary works designer.
9	Working at Height	Risk of fall of plant, materials and people.	High	The retaining wall height is over 4m high resulting in a risk of working from height during the temporary construction phase.		Medium	The Contractor shall ensure appropriate guard rails and netting provided to the structure to prevent falling objects. Contractor to ensure suitable fall restraint systems/harnesses to be used when working at height.
10	Anti-Social Behaviour (as built)	Risk to the site from anti-social behaviour and vandalism	Medium	The design has been developed with the aim of minimising antisocial behaviour. A fence has been added to the top of the reinforced concrete parapet to prevent people sitting on the parapet while waiting for an oncoming bus.		Low	The Detailed Designer and Contractor are to ensure that full enclosure is achieved through correct detailing and construction.
11	Substances hazardous to health	Risk of chemical exposure from construction materials such as waterproofing and silane	High	Project Specific Specifications have been prepared to identify a number of likely substances to be used in the construction which are hazardous to health		Medium	Contractor to refer to project specification for further information. All substances to be applied in line with manufacturers recommendations
12	Manual handling	Injury to staff, possible back injury and/or crushing toes, caused by manual handling, lifting tools and equipment, moving materials, and/or hand digging.	High	Consideration of method of construction has been made during detailed design. Elements have been sized such that they can be easily fabricated and transported.	Appropriate location for hoist equipment to be determined.	Low	Contractor to develop method statements and ensure manual handling training is undertaken prior to manual handling activities. Only trained personnel to use tools. Only use the appropriate tool for each activity. Specialised equipment or mechanical hoist equipment to be used where appropriate.

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 CBC006-RW03 Chapelizod Hill Road Retaining Wall No.2  
 Designers Risk Assessment



<b>Project Number:</b>	60599126	<b>Revision</b>							
<b>Client:</b>	National Transport Authority	<b>Rev</b>	01	02	03	04	05	06	07
<b>Designer:</b>	AECOM	<b>Date</b>	05/03/21						
<b>Contractor:</b>	Not applicable	<b>Client</b>	✓						
<b>Prepared by:</b>	Rionach Murphy	<b>Designer</b>	✓						
<b>Checked by:</b>	Arthur Costello	<b>Main Contractor</b>	-						
<b>Approved by:</b>	Niamh Rodgers	<b>Sub-Contractors</b>	-						
		<b>Other</b>	-						

Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers' interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
1	Access and egress to the site area	Access and egress to the retaining wall location is via Chapelizod Hill Road.	High	Traffic management to be implemented to ensure that safe access and egress is achieved		Low	The contractor is to ensure that suitable traffic management is implemented on site which includes appropriately designed and identified access points for site vehicles.
2	Site security	Unauthorised access by members of the public to the works areas	High	Suitable hoarding/fencing to be erected to prevent unauthorised access to the works areas		Low	Contractor to ensure that fencing is erected and maintained throughout the construction works.
3	Live Carriageways	Site is parallel to the Chapelizod Bypass. The road will be live during some of the construction.	High	Traffic lanes to be closed as required during construction. Implemented to ensure that safe working zones are provided to any works near live carriageways.	Live traffic with traffic management zones	Medium	Traffic Management will be required for any construction works on or near live carriageways. All traffic management plans to be developed in accordance with Chapter 8 of the Traffic Signs Manual. Contractor is to ensure that all staff are aware of the risks of working near a live road.

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4	Soil Nailing	Soil nailing procedures to be undertaken in close proximity to a live road	High	Appropriately designed working areas for soil nailing to be provided during construction.		Medium	Contractor to ensure appropriate methodology and construction sequences are in place.
5	Plant movements	Insufficient ground bearing pressure for site works.	Medium	Preliminary Ground investigations have been carried out to determine if there are potential risks of low ground bearing pressures.		Low	Further Ground Investigations to be carried out as part of Detailed Design to determine any further areas of low ground bearing pressures. Appropriate hoarding to be provided at construction stage to separate works from areas of adverse ground conditions.
6	Multiple Site Activities	Numerous concurrent construction projects are expected to take place at different locations along the Lucan to City Centre Route	Medium	Phasing of the construction works has been considered to avoid works being carried out in parallel on CBC06		Low	Contractor to discuss sequencing and construction programme with the client and CBC06 Design team. On-site personnel to be aware of ongoing site activities and follow any appropriate safety requirements. Barriers and hoarding to be put in place as appropriate to protect on-site personnel and segregate different site activities.
7	Underground services	Potential for unknown and/or undocumented services in the vicinity of the proposed structure.	Medium	Desk top study of available utility information has been carried out and all known services in the vicinity of the proposed structure have been shown on preliminary design drawings.		Low	Further desk top study to be carried out at Detailed Design stage to identify any additional services which have been constructed in the interim. At construction stage full CAT scan site survey to be carried out prior to commencement. Any services identified should be located by hand excavation, marked and protected or re-routed before commencement of works.

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8	Excavation adjacent to a live carriageway	Excavations required to construct the retaining wall run the risk of undermining the live carriageways.	High	The retaining wall has been set back from the edge of carriageways to ensure safe working zones can be achieved with minimal traffic management required.		Low	The contractor is to be aware of the risk of undermining existing road. As part of the detailed design the construction methodology should consider if additional works are required to avoid undermining. The contractor is to ensure that vibration levels from excavation are limited and that safe working limits are developed prior to works.
9	Structural Instability	Instability during construction	High	The soil nail design has been developed to avoid large depth temporary cut slopes. Where cut slopes are required, they shall be suitably constructed by the Contractor.		Medium	Where required the Contractor shall ensure that temporary works are provided on site to ensure structural stability during construction. All temporary works required are to be designed by a temporary works designer.
10	Substances hazardous to health	Risk of chemical exposure from construction materials such as waterproofing and silane	High	Project Specific Specifications have been prepared to identify a number of likely substances to be used in the construction which are hazardous to health		Medium	Contractor to refer to project specification for further information. All substances to be applied in line with manufacturers recommendations
11	Manual handling	Injury to staff, possible back injury and/or crushing toes, caused by manual handling, lifting tools and equipment, moving materials, and/or hand digging.	High	Consideration of method of construction has been made during detailed design. Elements have been sized such that they can be easily fabricated and transported.	Appropriate location for hoist equipment to be determined.	Low	Contractor to develop method statements and ensure manual handling training is undertaken prior to manual handling activities. Only trained personnel to use tools. Only use the appropriate tool for each activity. Specialised equipment or mechanical hoist equipment to be used where appropriate.

