Liffey Valley to City Centre Core Bus Corridor Scheme

May 2022

Preliminary Design Report

BUS CONNECTS

SUSTAINABLE TRANSPORT FOR A BETTER CITY.

Table of Contents

Figures

Tables

List of Acronyms

Acronym	Definition
AVL	Dublin Bus Automatic Vehicle Location
BCPDGB	BusConnects Preliminary Design Guidance Booklet
BJTR	Bus Journey Time Report
CBC	Central Bus Corridor
CBR	California Bearing Ratio
CPO	Compulsory Purchase Order
DCC	Dublin City Council
DEHLG	Department of Environment, Heritage and Local Government
DLAM	Dublin Local Area Model
DM	Do Minimum
DMURS	Design Manual for Urban Roads and Streets
DRA	Designer's Risk Assessment
DS	Do Something
DTTAS	Department of Transport, Tourism and Sport
ED/ED's	Engineering Design/Engineering Designers
EIA	Environmental Impact Assessment
EPR	Emerging Preferred Route
ESB	Electricity Supply Board
GDA	Greater Dublin Area
GDACNP	Greater Dublin Area Cycle Network Plan
GDRCoP	Dublin Greater Dublin Regional Code of Practice
GDSDS	Greater Dublin Strategic Drainage Study
GIS	Geographical Information Systems
HGV	Heavy Goods Vehicle
HP	High Pressure
HRA	Hot Rolled Asphalt
KFPA	Kerbs, Footways and Paved Areas
LAM	Local Area Model
LED	Light Emitting Diode
LP	Low Pressure
MCA	Multi-Criteria Analysis
NCDWC	National Construction and Demolition Waste Council
NDA	National Disability Authority
NPF	National Planning Framework
NSS	National Spatial Strategy
NTA	National Transport Authority
OPW	Office of Public Works
PDR	Preliminary Design Report

Acronym	Definition
PMG	Project Management Guidelines
PMSC	People Movement Signals Calculator
PRO	Preferred Route Option
RSESs	Regional Spatial and Economic Strategies
SDCC	South Dublin City Council
SDRAs	Strategic Development and Regeneration Areas
SSD	Stopping Sight Distances
STMG	Sustainable Transport Measures Grants
SuDS	Sustainable Drainage Systems
TII	Transport Infrastructure Ireland

Executive Summary

This Preliminary Design Report has been prepared for the Liffey Valley to City Centre Core Bus Corridor Scheme and builds on the previous Liffey Valley to Christchurch Core Bus Corridor Options Study and the Preferred Route Options Report for the Liffey Valley to City Centre Core Bus Corridor Scheme.

This report summarises the project background and the need for the scheme in the context of National and Local Planning Policy, summarises the existing physical conditions and documents the surveys undertaken in developing the design.

The report also details the preliminary design, sets out traffic management proposals and outlines the traffic modelling undertaken and the outputs from the junction modelling.

The land use and acquisition requirements are summarised in this report, along with details of affected landowners and property owners, and proposed accommodation works.

The report concludes that the design of the Liffey Valley to City Centre Core Bus Corridor Scheme wholly achieves the scheme objectives. In doing so, it fulfils the aim of providing enhanced walking, cycling and bus infrastructure on a key access corridor in the Dublin region, enabling the delivery of efficient, safe, and integrated sustainable transport movement along the corridor.

1. Introduction and Description

1.1 Introduction

BusConnects is the National Transport Authority's (NTA) programme to improve bus and sustainable transport services. It is a key part of the Government's polices to improve public transport and address climate change. The NTA established a dedicated BusConnects Infrastructure team, the BusConnects Infrastructure team, to advance the planning and construction of the BusConnects Dublin - Core Bus Corridors Infrastructure Works (herein after called the 'CBC Infrastructure Works'). It comprises an inhouse team including technical and communications resources and external service providers procured from time to time, to assist the internal team in the planning and design of the twelve Proposed Schemes.

The CBC Infrastructure Works involves the development of continuous bus priority infrastructure and improved pedestrian and cycling facilities on twelve radial core corridors in the Greater Dublin Area (GDA), across the local authority jurisdictions of Dublin City Council (DCC), South Dublin County Council (SDCC), Dún Laoghaire-Rathdown County Council (DLRCC), Fingal County Council (FCC), and Wicklow County Council (WCC). Overall, the CBC Infrastructure Works encompasses the delivery of approximately 230km of dedicated bus lanes and 200km of cycle tracks along 16 of the busiest corridors in Dublin.

Liffey Valley to City Centre Core Bus Corridor of the CBC Infrastructure Works (hereinafter called the 'Proposed Scheme') measures approximately 9.2km end to end.

The Proposed Scheme begins on the Fonthill Road at the tie in point with the new Liffey Valley Shopping Centre Bus Interchange and Road Improvement Scheme. The CBC will travel along Fonthill Road, Ballyfermot Road, Sarsfield Road, Grattan Crescent, Emmet Road, Old Kilmainham, Mount Brown, James's Street, Thomas Street and High Street. At the junction with Nicholas Street and Winetavern Street the CBC will tie into the existing traffic management regime in the City Centre.

Refer to **Figure 1.1** for the overall layout of the Proposed Scheme.

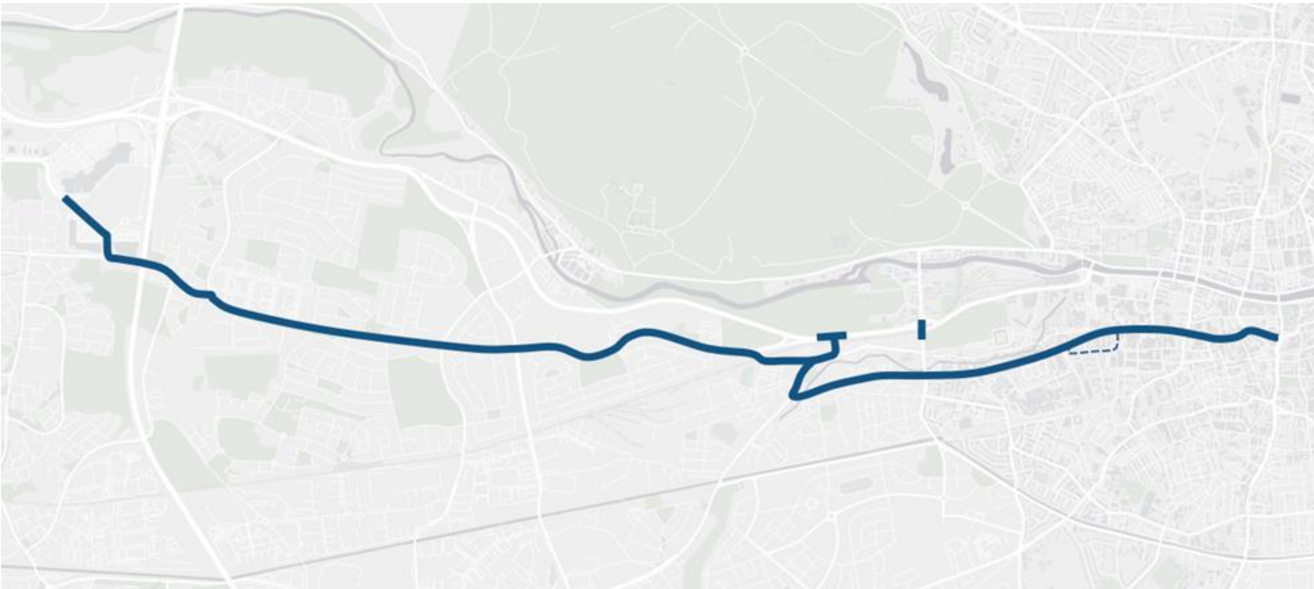

Figure 1.1: Proposed Scheme Route Overview

1.2 Scheme Aims and Objectives

The aim of the Proposed Scheme is to provide enhanced walking, cycling and bus infrastructure along this key access corridor in the northeast Dublin region, which will enable and deliver efficient, safe, and integrated sustainable transport movement along the corridor.

In accordance with the CBC Infrastructure Works the Proposed Scheme objectives are to:

- Enhance the capacity and potential of the public transport system by improving bus speeds, reliability and punctuality through the provision of bus lanes and other measures to provide priority to bus movement over general traffic movements;
- Enhance the potential for cycling by providing safe infrastructure for cycling, segregated from general traffic wherever practicable;
- Support the delivery of an efficient, low-carbon and climate-resilient public transport service, which supports the achievement of Ireland's emission reduction targets;
- Enable compact growth, regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of safe and efficient sustainable transport networks;
- Improve accessibility to jobs, education and other social and economic opportunities through the provision of improved sustainable connectivity and integration with other public transport services; and
- Ensure that the public realm is carefully considered in the design and development of the transport infrastructure and seek to enhance key urban focal points where appropriate and feasible.

1.3 Project Background

The Transport Strategy for the Greater Dublin Area 2016 – 2035 sets out a network of the bus corridors forming the 'Core Bus Network' for the Dublin region. Sixteen indicative radial Core Bus Corridors (CBCs) were initially identified for redevelopment. This is shown in **Figure 1.2** below (extract from Transport Strategy for the Greater Dublin Area 2016-2035).

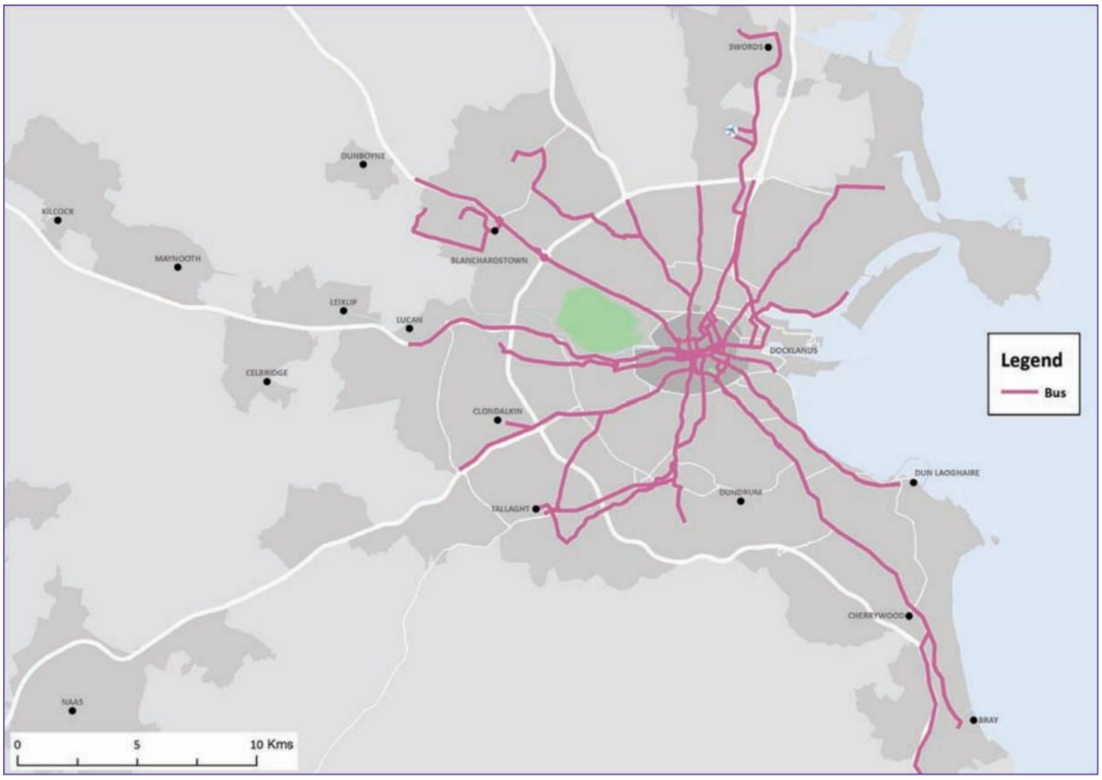

Figure 1.2: 2035 Core Bus Network - Radial Corridors

Collectively, these corridors currently have dedicated bus lanes along less than one third of their combined lengths which means that for most of the journey, buses as well as cyclists are competing for space with general traffic. This means that bus services are directly impacted by the increasing levels of congestion. This results in delayed buses and unreliable journey times for passengers. Following the completion of the Feasibility and Options studies, sixteen radial corridors were taken forward.

In June 2018, the NTA published the Core Bus Corridors Project Report. The report was a discussion document outlining proposals for the delivery of a CBC network across Dublin. The Proposed Scheme is identified in this document as forming part of the Radial Core Bus Network, designated as Liffey Valley to City Centre CBC.

In the context of the proposed planning applications for the CBC Infrastructure Works, the initial sixteen radial CBCs have been grouped as twelve individual Schemes. The twelve Schemes that will be the subject of separate applications to An Bord Pleanála for approval are listed below:

- Clongriffin to City Centre Core Bus Corridor Scheme
- Swords to City Centre Core Bus Corridor Scheme
- Ballymun / Finglas to City Centre Core Bus Corridor Scheme
- Blanchardstown to City Centre Core Bus Corridor Scheme
- Lucan to City Centre Core Bus Corridor Scheme
- **Liffey Valley to City Centre Core Bus Corridor Scheme**
- Tallaght / Clondalkin to City Centre Core Bus Corridor Scheme
- Kimmage to City Centre Core Bus Corridor Scheme
- Templeogue / Rathfarnham to City Centre Core Bus Corridor Scheme
- Bray to City Centre Core Bus Corridor Scheme
- Belfield / Blackrock to City Centre Core Bus Corridor Scheme
- Ringsend to City Centre Core Bus Corridor Scheme

The twelve radial routes that form the CBC Infrastructure works is shown within **Figure 1.3**.

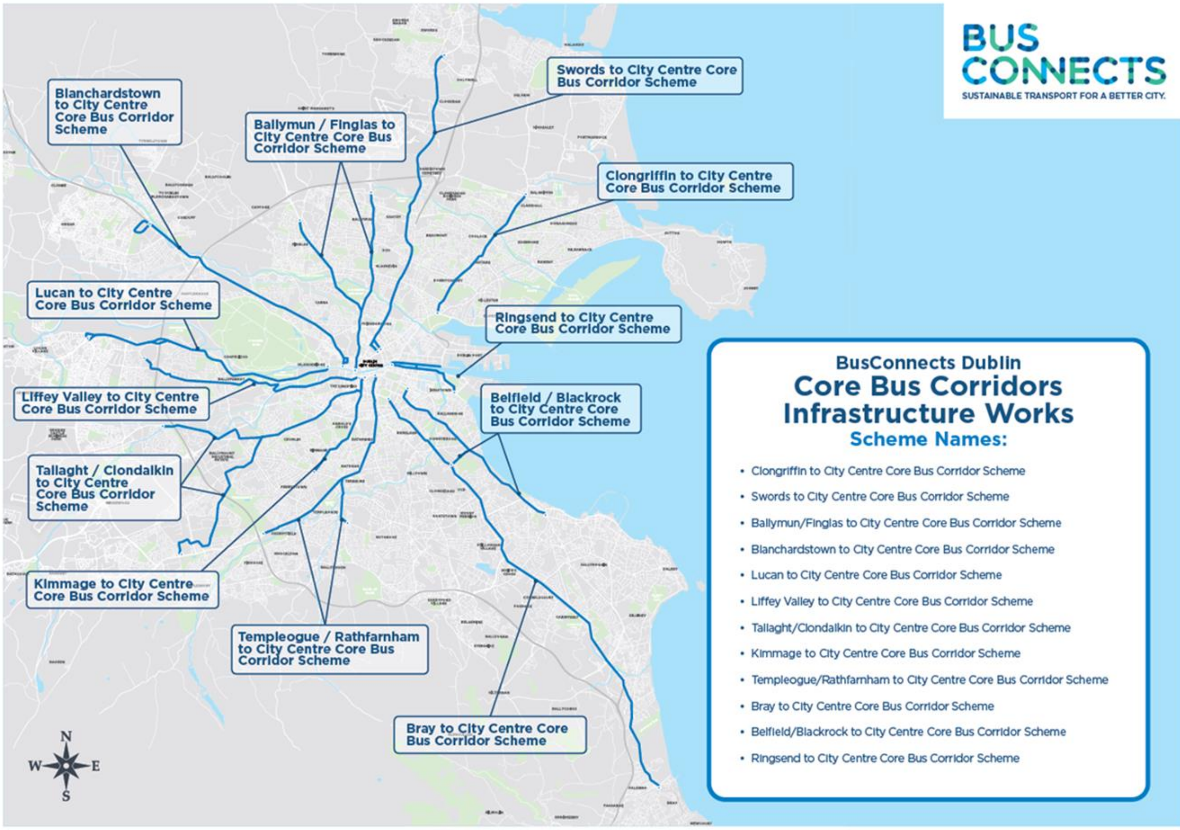

Figure 1.3: BusConnects Radial CBC Network

1.4 Proposed Construction Procurement Method

The Proposed Scheme will proceed on the basis of procurement through a DesignBuild tender process.

Consequently, the design information presented in this report ensures that the objectives of the Proposed Scheme are met, in accordance with current design standards and guidance documents. It further ensures that sufficient land will be acquired during the Compulsory Purchase Order process in order to construct a CBC that will fulfil the design requirements.

1.5 Stakeholder Consultation

Throughout the development of the design there has been extensive stakeholder consultation including three rounds of Non-Statutory Public Consultation have taken place over the following dates:

- November 2018 to May 2019 - Consultation on Emerging Preferred Route;
- 4th March 2020 - 17th April 2020 - Consultation on the Draft Preferred Route Option; and
- 4th November 2020 - 16th December 2020 - Consultation on the Updated Draft Preferred Route Option.

Consultation with the principal project stakeholders (i.e. Dublin City Council (DCC), South Dublin County Council (SDCC), Transport Infrastructure Ireland (TII), Office of Public Works (OPW) and statutory undertakers/utility companies) has taken place to date in order to:

- Inform the scheme development process at particular locations;
- Identify constraints and opportunities within the study area, scheme corridor and route options considered;
- Further refine the scheme objectives;
- Discuss potential mitigation measures and options; and
- Identify planning requirements, conditions and implications with respect to the Proposed Scheme design measures.

Specific scheme requirements have been discussed and agreed during workshops, with the Local Authorities, and meetings, at Steering Group and Programme level. The BusConnects Infrastructure team has taken cognisance of any specific requirements and recommendations emerging from this process when exploring feasible scheme options and preparing the preliminary design.

In addition to the principal project stakeholders, consultations have taken place with:

- Representative groups;
- Chartered landowners (i.e. owners of lands at any specific locations); and
- Directly impacted landowners.

1.6 Audit of the Existing Situation

The following surveys and desktop studies have been conducted to inform the preliminary design of the Proposed Scheme.

- Problem Identification Audit;
- Accessibility Audit;
- Route Infrastructure Audit;;
- Existing Structures Study;
- Existing Route Collision Analysis;

- Private Landings Study;
- Baseline Tree Survey;
- Cycle Journey Time Study;
- Phase 1 Utility Survey;
- Bus Stop Study;
- Traffic Surveys (JTC, ATC, pedestrian and cyclists counts);
- Parking Study; and
- Bus Journey Time Study.

These surveys have been supplemented with secondary record data including utility record information, OPW Catchment Flood Risk Assessment and Management (CFRAM) Flood Models, Irish Water (IW) drainage models and existing traffic signal data from DCC.

1.7 Purpose of the Preliminary Design Report

The purpose of the Preliminary Design Report (PDR) is to outline the design intent of the scheme. In particular, the PDR outlines the following:

- Sets out the context for the Proposed Scheme, the justification for the Proposed Scheme, the basis for selecting the Proposed Scheme improvements, and the design criteria;
- Describes the elements of the Proposed Scheme listed in the preliminary design drawings;
- Summarises the existing physical conditions, addressing, in particular, ground conditions in general and particularly in areas of new construction, existing pavement quality, tree survey information, utility information, road traffic information including existing bus patterns, bus stop usage, traffic signal system, and other relevant information;
- Details and summarises the surveys and studies undertaken in developing the design,
- Sets out traffic management proposals, i.e. permanent changes required as part of the Proposed Scheme (and associated traffic modelling);
- Provides details of the traffic modelling undertaken along the route and the outputs from junction modelling undertaken;
- Summarises the land use and land acquisition requirements, includes details of affected landowners and property owners, and provides details of proposed accommodation works;
- Sets out particular considerations in the context of the urban landscape of the Proposed Scheme, and the criteria influencing the associated design;
- Sets out the benefits of the Proposed Scheme; and
- Supports the Environmental Impact Assessment Report (EIAR).

During the preparation of the preliminary design, designers' risk assessments were undertaken, details of these are included in **Appendix A**.

1.8 Preliminary Design Drawings

A set of preliminary design drawings have been prepared to convey the scheme design principles for each discipline and should be read in conjunction with this PDR. The following table provides a description of the drawings and relevant design content displayed in each of the series as applicable for the scheme. The drawings have been included in **Appendix B** for reference.

Table 1-1: Preliminary Design Drawings

Drawing Series Volume Code	Drawing Series Description/Scale	Design Content
SPW_KP/SPW_ZZ	Site Location Map (1:12,500@ A1) and Site Location Plans (1:2,500@A1)	Defines the full extent of the works & planning red line boundary. Outlines the scheme chainage structure and provides context for the locality of adjacent Schemes and other notable locations along the route.
SPW_BW	Fencing and Boundary Treatment Plans (1:500@A1)	To be read in conjunction with the GEO_GA General Arrangement series and GEO_CS Typical Cross Section series. Provides an indication of the locations for the proposed boundary modification works along the route.
GEO_GA	General Arrangement Plans (1:500 @ A1)	Displays information for conveying the overarching scheme design intent , providing information on the proposed pedestrian/cycle/ bus/traffic regime, indicative ultimate tree arrangement (existing trees retained and proposed trees), bus stop/shelter locations, key heritage feature locations, parking and loading arrangements, turn bans, side road treatments in addition to identification of specific items of note to the scheme (structures or significant features which may be further described on other drawing series).
GEO_CS	Typical Cross Sections (1:50 @ A1)	To be read in conjunction with the GEO_GA General Arrangement series. Provides an indication of the proposed cross section works in comparison to the existing road geometry. Indicative pavement/kerbing, boundary treatments and key street furniture are also provided for context.
GEO_HV	Mainline Plan and Profile Drawings (1:500@A1)	To be read in conjunction with the GEO_GA General Arrangement series. Provides an indication of the proposed modification works to the mainline vertical alignment with supplementary information on earthworks/retaining walls and other notable structures along the route (as required).
ENV_LA	Landscaping General Arrangement Plans (1:500@A1)	Provides information relating to urban realm and landscaping proposals including identification of trees to be removed resulting from the arborist assessments, proposed tree/planting regime, proposed footway surface finishes, locations of proposed Sustainable (urban) Drainage Systems (SuDS) features and proposed boundary treatment and key street furniture notes.
DNG_RD	Proposed Surface Water Drainage	Displays information for conveying the design intent for the drainage portion of the works including identification of SuDS measures, requirements for peak

Drawing Series Volume Code	Drawing Series Description/Scale	Design Content
	Plans (1:500@A1)	discharge management measures (attenuation/detention/flow control) where applicable, catchment assessments and proposed notable trunk network modifications and outline design for the proposed drainage discharge strategy along the route.
UTL_UC	Combined Existing Utilities Record Plans (1:500@A1)	Displays information regarding existing statutory undertakers records along the length of the scheme with the Proposed Scheme features shown as background information for context.
UTL_UD	Irish Water Foul Sewer Alteration Plans (1:500@A1)	Provides an indication of the existing trunk foul sewer network and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
UTL_UW	Irish Water Potable Water Alteration Plans (1:500@A1)	Provides an indication of the existing trunk potable water network and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
UTL_UE	ESB Asset Alteration Plans (1:500@A1)	Provides an indication of the existing trunk electrical network (above and below ground) and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
UTL_UL	Telecommunications Asset Alteration Plans (1:500@A1)	Provides an indication of the existing trunk telecommunications network and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
UTL_UG	Gas Networks Ireland Asset Alteration Plans (1:500@A1)	Provides an indication of the existing trunk gas network and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
LHT_RL	Street Lighting Plans (1:500@A1)	Provides an indication of the proposed modification works to the existing street lighting infrastructure along the route in addition to identification of any key heritage light column features.
TSM_SJ	Junction System Design Plans (1:250@A1)	Provides a more detailed overview of the proposed junction arrangements for pedestrians, cyclists, buses and general traffic with an indication of the proposed junction staging and associated signal head

Drawing Series Volume Code	Drawing Series Description/Scale	Design Content
		arrangements for key signalised junctions/signalised crossings along the route.
TSM_GA	Traffic Signs and Road Markings Plans (1:500@A1)	Provides an indication of the proposed key signage (information/directional/regulatory) design requirements and the design intent for the proposed lane marking arrangements along the route.
PAV_PV	Pavement Treatment Plans (1:500@A1)	Provides an indication of the proposed pavement treatment works along the length of the route
STR_GA	Bridges and Retaining Structures (Varies)	Whilst part of this series, Bridges is not applicable to the Liffey Valley Scheme, but Retaining Structures is applicable and provides an indication of the proposed retaining structure locations, types and approximate proposed heights along the route.
BLD_ZZ	**Bus Interchange (Varies)**	**Whilst this series is not applicable to the Liffey Valley Scheme it has been used on other routes to provide additional details relating to proposed bus interchange details including architectural layouts and site elevations and sections.**

It should be noted that a significant volume of other drawings and sketches have also been prepared as required to facilitate the design development process. The information shown on the PDR drawings has been deemed sufficient for the purposes of conveying the design intent of the Proposed Scheme in addition to outlining the extent of works in conjunction with the planning red line boundary extents and CPO documentation.

The planning red line boundary has been displayed on the Site Location Plans in drawing series SPW_ZZ as designated by the solid red line 'SITE EXTENTS'. For clarity the various discipline general arrangement drawing series have been displayed with the permanent extent of works boundary line as designated by the solid red line 'SITE BOUNDARY LINE'. Where construction access or accommodation works are required to facilitate the permanent works, this has been displayed by the dashed red line 'TEMPORARY LAND ACQUISITION'.

It is noted that the contractor will be restricted to what works can be carried out in the dashed red line areas, i.e., to be limited to access and or accommodation works only. Storage of materials/stockpiling and/or temporary traffic management proposals will not be permitted for extended periods of time in these areas unless otherwise agreed with landowners and the NTA.

Full details of the compulsory land acquisition required to construct the scheme are provided on the various deposit maps, server maps and associated CPO schedules/documentation for the Proposed Scheme as part of the statutory application documentation.

1.9 Report Structure

The structure for the remainder of this report is set out as follows:

- **Chapter 2: Policy Context and Design Standards –** This chapter briefly identifies the policies and overview of the approach taken for application of design standards which have been applied to the preliminary design.

- **Chapter 3: The Scheme –** This chapter provides an overview of the design intent at various locations along the Proposed Scheme, providing a description of the route in more detailed subsections. An outline of the key interactions with other infrastructure projects is also provided.
- **Chapter 4: Preliminary Design –** This chapter provides an overview of the key design parameters used for the geometric designs and more detailed descriptions of the design elements for pedestrians, cyclists and buses.
- **Chapter 5: Junction Design –** The junction design methodology and modelling process is set out for all key junctions along the length of the route in this chapter
- **Chapter 6: Ground Investigation and Ground Condition –** This chapter provides an overview of the ground investigation process and existing ground conditions
- **Chapter 7: Pavement, Kerbs, Footways and Paved Areas –** This chapter gives an overview of the existing pavement situation and proposed pavement design for the scheme
- **Chapter 8: Structures –** In this chapter an overview of the structures strategy is provided, along with a summary of principal and minor structures, retaining walls and embankments, where applicable.
- **Chapter 9: Drainage, Hydrology and Flood Risk –** This chapter is an overview of the drainage strategy includes descriptions of existing watercourses and culverts alongside a summary of the drainage design for each catchment along the scheme, including the consideration of drainage at structures and the maximisation of SuDS features
- **Chapter 10: Services and Utilities –** This chapter shows the utilities design strategy documents surveys undertaken to date, identifies conflicts and recommends a number of diversions
- **Chapter 11: Waste Quantities –** This chapter provides an overview of the waste quantities for the Proposed Scheme.
- **Chapter 12: Traffic Signs, Lighting and Communications –** In this chapter the design strategy for traffic signs, road markings, lighting and communications equipment is outlined, alongside descriptions of how these elements can be maintained and monitored safely and securely
- **Chapter 13: Land Use and Accommodation Works -** This chapter outlines land use and acquisition requirements, affected land and property owners, and proposed accommodation works
- **Chapter 14: Landscape and Urban Realm –** This chapter is an overview of the landscape and urban realm design strategy focussing on the existing trees and proposed mitigation
- **Chapter 15: Scheme Benefits/How are we Achieving the Objectives –** In this chapter benefits provided by the scheme are summarised against the scheme objectives.
- **Appendices –** Various appendices and background information as referenced throughout the report.

2. Policy Context and Design Standards

2.1 Policy Context

The following national, regional and local policies have been reviewed and considered in the development of the Proposed Scheme:

- Project Ireland 2040;
- Department of Transport: Statement of Strategy (2016 - 2019);
- Smarter Travel: A Sustainable Transport Future (2009 – 2020);
- National Cycle Policy Framework (2009);
- Road Safety Strategy (2013 – 2020);
- Building on Recovery: Infrastructure and Capital Investment Plan (2016-2021);
- The Sustainable Development Goals National Implementation Plan (2018-2020);
- Climate Action Plan (2019);
- Eastern & Midland Regional Assembly, Regional Spatial & Economic Strategy (2019-2031);
- Greater Dublin Area Cycle Network Plan;
- Transport Strategy for the Greater Dublin Area (2016-2035);
- Draft Dublin City Development Plan 2022 – 2028;
- Dublin City Development Plan 2016 – 2022;
- Draft South Dublin County Council Development Plan 2022 – 2028;
- South Dublin County Council Development Plan (SDCCDP) 2016 – 2022;
- Liffey Valley Local Area Plan;
- Liberties Local Area Plan; and
- Park West - Cherry Orchard Local Area Plan.

For further information on how the Proposed Scheme meets the policies outlined above, refer to Liffey Valley to City Centre Core Bus Corridor Planning Compliance Report (BCIDE-JAC-ENV_ZZ-0007_XX_00_RP_ES_0002).

2.2 Design Standards

Design standards applied on the Proposed Scheme are stated within the applicable chapters of this report. In addition to national design standards the CBC Infrastructure Works has developed the BusConnects Preliminary Design Guidance Booklet (BCPDGB). Its purpose is to provide guidance for the various design teams involved in CBC Infrastructure Works, to ensure a consistent design approach across the twelve Proposed Schemes.

The BCPDGB focuses on the engineering geometry and Proposed Scheme operation. It is recognised that the Proposed Scheme is being planned and designed within the context of an existing city, with known constraints. The BCPDGB provides guidance, however a more flexible approach to the design of the Proposed Scheme, utilising engineering judgement, may be necessary in some locations due to these constraints.

Where it has been necessary to deviate from the parameters set out in the relevant national design standards and the Preliminary Design Guidance these deviations have been noted within **Section 4.16**.

3. The Scheme

3.1 Scheme Description

The Proposed Scheme will commence on the Fonthill Road at the tie in point with the new Liffey Valley Shopping Centre Bus Interchange and Road Improvement Scheme. The Proposed Scheme will continue along Fonthill Road where it will turn left onto Coldcut Road and continues to the bridge over the M50, subsequently turning right onto Ballyfermot Road. The Proposed Scheme will travel through Ballyfermot Village and continue onto Sarsfield Road, whilst city bound general traffic will be diverted via Le Fanu Road and Kylemore Road.

The Proposed Scheme will continue along Sarsfield Road, turning right at the junction with Con Colbert Road before turning right again onto Grattan Crescent. The Proposed Scheme will then turn left onto Emmet Road and will continue along Old Kilmainham, Mount Brown, James's Street and Thomas Street. At Cornmarket, the Proposed Scheme will turn right onto High Street. At the junction with Nicholas Street and Winetavern Street the Proposed Scheme will tie into the existing traffic management regime in the City Centre.

The Proposed Scheme is described below, split into the following three sections to align with the previous Options and Feasibility Report and the Preferred Route Options Report.

- Section 1: Liffey Valley to Le Fanu Road;
- Section 2: Le Fanu Road to Sarsfield Road; and
- Section 3: Sarsfield Road to City Centre.

3.1.1 Section 1 - Liffey Valley to Le Fanu Road

The Proposed Scheme commences on Fonthill Road at the tie in with the Liffey Valley Shopping Centre Bus Interchange and Road Improvement Scheme. Between Fonthill Road and the junction with Coldcut Road, it is proposed to provide a continuous bus lane, cycle tracks and an improved footway in each direction. These proposals can be provided by widening into the central median, modifying the existing junctions and utilising existing green space adjacent to the road.

Two existing roundabouts on the Fonthill Road will be developed into signalised junctions to improve bus priorty and will provide improved infrastructure for cyclists and pedestrians.

Temporary land acquisition will be required for the Construction Compound on land adjacent to the Fonthill Road. Reinstatement of the proposed Construction Compound will be required in this area following completion of the works.

Either side of the M50 bridge on Coldcut Road, it is proposed to provide a continuous bus lane, cycle tracks and an improved footway in each direction. As Coldcut Road crosses over the M50, the carriageway width is restricted. To overcome this restriction and maintain bus priority over this section, it is proposed to provide Signal Controlled Priority on both sides of the bridge. The traffic signals at this location will be sequenced to ensure bus priority. To accommodate these changes, it is proposed to encroach on the green space to the east and west of the existing structure.

It is proposed to modify the Cloverhill Road and Kennelsfort Road junctions to provide improved facilities for cyclists and pedestrians. To accommodate these changes, it is proposed to utilise limited land take along the green space adjacent to Palmers Walk, Palmers Court and Palmers Drive area.

On Ballyfermot Road, it is proposed provide a bus lane, general traffic lane, cycle track and footway in both directions. To accommodate this improved infrastructure, it will be necessary to acquire limited land take at the following locations:

- Cherry Orchard Industrial Estate;
- Cherry Orchard Hospital;

- Entrance Cherry Orchard Filling Station; and
- At junction with Le Fanu Road.

It is also proposed to amalgamate the main Ballyfermot Road and the access roads. This would provide sufficient space to improve the existing public transport infrastructure. Public Realm works, additional tree planting and provision for parallel parking are proposed where the access road will be modified.

3.1.2 Section 2 - Le Fanu Road to Sarsfield Road

At the Le Fanu Road junction, it is proposed to divert city bound general traffic on to Le Fanu Road. The section of Ballyfermot Road between Le Fanu Road and Kylemore Junction will be restricted to one bus lane in both directions and one outbound general traffic lane. Local access on Ballyfermot Road between La Fanu Road and Colepark Road will be maintained. City bound traffic will be redirected along Le Fanu Road and Kylemore Road where it will then re-join the corridor at Ballyfermot Road. It is intended to provide segregated cycle tracks and footways in both directions on this section of the Ballyfermot Road and on Kylemore Road.

It is proposed to upgrade the existing roundabout at Kylemore Road / Ballyfermot Road to a signalised junction. Between Kylemore Road and Markiewicz Park, it is intended to provide a continuous bus lane with a single general traffic lane in each direction. Segregated cycle tracks and footways will be provided through this section. To accommodate this, some areas of land acquisition will be required at the following locations:

- Limited green space from St. Raphael’s and St. Gabriel’s Primary School;
- Ballyfermot Resource Centre; and
- Limited green space from the former De La Salle National School / Mount La Salle.

To reduce the impact on Markiewicz Park and the adjacent residential properties, it is proposed to provide Signal Controlled Bus Priority for citybound buses with the traffic signals sequenced to ensure full bus priority. The citybound bus lane would then be reintroduced at St. Laurence’s Road. To accommodate the revised arrangements, it is intended to close the junction of O’Hogan Road and Ballyfermot Road as part of the implementation of the Signal Controlled Bus Priority on Ballyfermot Road. O’Hogan Road can still be accessed via Garryowen Road and Decies Road. Dedicated cycle tracks and footpath facilities will be provided through this section. The proposals will require land take at the following locations:

- Limited land take at Markiewicz Park;
- Boundary lands at the Steeples Estate;
- Private frontages between O’Hogan Road and St. Laurence’s Road;
- Boundary lands on Longmeadows Pitch and Putt / Longmeadow Park; and
- Private frontages between First Avenue and Saint Mary’s Avenue West.

Between Sarsfield Road and Chapelizod Bypass it is proposed to extend the proposed cycle track to tie into the proposed cycle infrastructure that forms part of the Lucan to City CBC Scheme. If the cycling infrastructure proposed as part of the Lucan to City Centre CBC Scheme is not in place when the Proposed Scheme is being implemented, cyclist have an alternative route to the City Centre via Sarsfield Road, Inchicore Road, Kilmainham Lane and Bow Lane where they will re-join the Proposed Scheme.

3.1.3 Section 3 - Sarsfield Road to City Centre

It is proposed to change Memorial Road from one way to two way for general traffic. Eastbound traffic will also be able to turn right from the Chapelizod Bypass to Memorial Road. It is intended to provide a cycle track in both directions on Memorial Road. On Inchicore Road, between Memorial Road and Grattan Crescent, it is proposed to retain the existing lane configuration.

The junction of Grattan Cresent / Sarsfield Road / Inchicore Road will be upgraded to provide better walking and cycling facilities. The improved cycle facilities at this junction also facilitate the primary cycle route 7A which travels along Sarsfield Road and Inchicore Road and provides an alternative cycle route to the city centre before re-joining the corridor at Bow Lane.

On Grattan Crescent, it is proposed to provide bus lanes in both directions and one general traffic lane in a southbound direction. Northbound traffic will be permitted up to the junction with the Córas Iompair Éireann (CIÉ) Inchicore Works to maintain local access. The existing footway will be widened, and a new crossing will be provided between Grattan Crescent Park and Inchicore National School and the existing mature trees will be retained. Several of the car parking spaces adjacent to the entrance to Grattan Park will be retained. This design has been implemented following feedback received as part of the Non-Statutory Public Consultation carried out on the Emerging Preferred Route (EPR) published in January 2019 where the local community raised concerns with the proposals to widen Grattan Crescent and remove the mature trees.

At the junction of Emmet Road and Tyrconnell Road, general traffic turning right from Emmet Road to Grattan Crescent will be for local access to the CIÉ Inchicore Works only.

Between St. Vincent's Street West and South Circular Road, Emmet Road is proposed to be reconfigured to provide a bus lane and general traffic lane in both directions. To facilitate this wider road configuration some local on-street parking will need to be removed, but the focus has been to retain as much of the existing parking as practicable.

To maintain bus priority on Old Kilmainham / Mount Brown, it is proposed to provide a bus gate. Following concerns raised during the Non-Statutory Public Consultation regarding access to Mount Brown, Old Kilmainham, St James's Hospital and the local area, the design was refined to reduce these impacts. The bus gate was amended with the eastbound bus gate being relocated to the St James's Street entrance to the hospital campus. The westbound bus gate location was retained but the length was shortened. The operational hours were also refined with the eastbound bus gate operating in the AM and the westbound bus gate operating in the PM. This revised arrangement for the bus gate will allow access at all times to Ceannt Fort, the Children's Hospital, Adult hospital, and local area from all directions.

Between the St. James's Adult Hospital Entrance and the junction with Bow Lane West, it is proposed to retain the existing road layout. From Bow Lane West to High Street, it is intended to provide continuous cycle tracks, a bus lane where practicable and general traffic lane in both directions. The existing footways along this section are being retained. Bus priority is provided via a combinations of bus lanes, Signals Controlled Priority and by the reduction in general traffic in the area as a result of the bus gate in Mount Brown.

At the Cornmarket junction the priority has been changed from High Street / Thomas Street to High Street / Bridge Street Upper. The junction has also been refined to remove the existing islands and provide improved walking and cycling facilities. The Proposed Scheme will join the prevailing City Centre traffic management regime at the junction with Nicholas Street and Winetavern Street.

3.2 Associated Infrastructure Projects and Developments

A number of infrastructure projects are planned within the vicinity of the Proposed Scheme which will interface with the proposals. These are outlined in the following sections.

3.2.1 Liffey Valley Bus Interchange

The Liffey Valley bus interchange has received planning approval and is currently under construction. An overview of the proposals is shown in **Figure 3.1**.

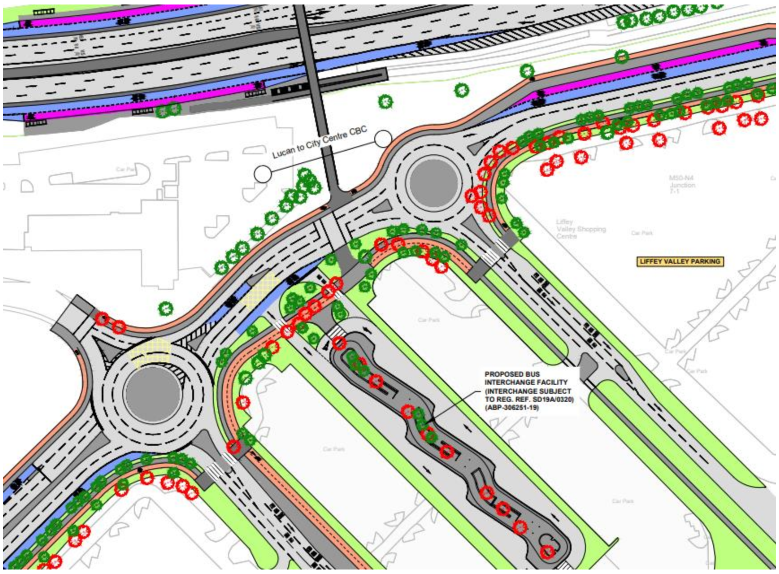

Figure 3.1: Liffey Valley Bus Interchange

3.2.2 Liffey Valley Shopping Centre Developments

The proposed expansion of the Liffey Valley Shopping Centre is shown on **Figure 3.2** below. This scheme has received planning approval (SDCC Planning Reg Ref SD20A/0089).

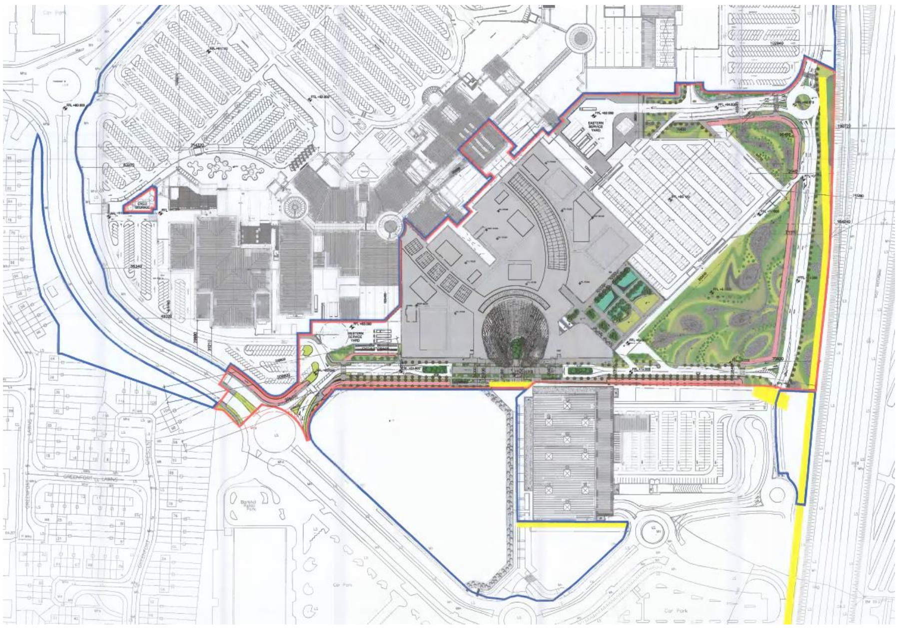

Figure 3.2: Liffey Valley Shopping Centre Developments

3.2.3 Ballyfermot People's Park Improvements

Improvements to the existing park adjacent to the scheme in Ballyfermot are proposed as shown on **Figure 3.3** below. This project is currently at the construction phase; further information can be found at: https://consultation.dublincity.ie/parks/ballyfermot-peoples-park/

Figure 3.3: Ballyfermot People's Park Improvements

3.2.4 New Amalgamated Secondary School in Ballyfermot

St. John's College, Caritas College and St. Dominic's College are planning for the amalgamation of the three schools into one secondary school with the proposed opening date in September 2022. The proposed school will be located at the St. John's College site on Le Fanu Road. The existing layout on Le Fanu Road has been retained as part of the Proposed Scheme, however the school's plans should consider access arrangements, including cycle facilities, footpaths and pedestrian road crossings, as well as drop-off areas near the school entrance. Provision of connecting cycle tracks from the school entrance back to the cycle tracks that will be installed on Ballyfermot Road under the Proposed Scheme plans, should be an objective of the planning for the development of the school. Shown in **Figure 3.4**.

Figure 3.4: Amalgamation of Existing Schools

3.2.5 De La Salle / Mount La Salle

A new development is planned on the former grounds of De La Salle / Mount La Salle on Ballyfermot Road, including approximately 950 new homes. The developer is currently in pre-application discussions with Dublin City Council (DCC) and An Bord Pleanála. Discussions are ongoing with the developer and their design team to ensure that the Proposed Scheme design ties into the De La Salle / Mount La Salle proposals. Shown in **Figure 3.5** below.

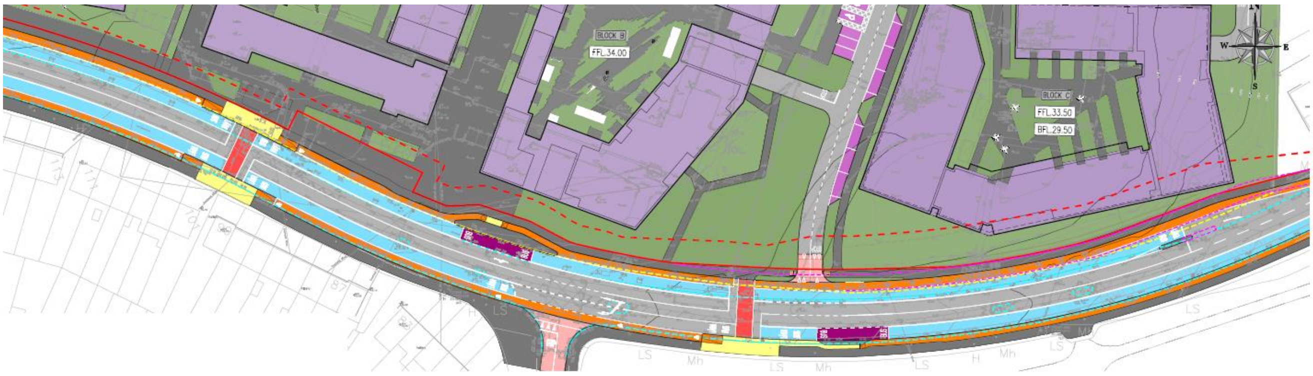

Figure 3.5: De La Salle / Mount La Salle

3.2.6 St Michael's Estate, Emmet Road

DCC have plans for a major regeneration of the St. Michael's estate. The project is currently at consultation and design stage. Further information is available at: https://www.dublincity.ie/residential/housing/strategies-policies-and-initiatives/housing-land-initiative/emmet-road-formerly-saint-michaels-estate.

3.3 Integration

As part of the design of the Proposed Scheme, consideration has been given to the potential coordination required in relation to other schemes within the BusConnects CBC Infrastructure Works. This section outlines potential interactions of the Proposed Scheme with adjacent schemes and identifies any procedures within the construction strategies that may be required in order to account for various sequencing scenarios in the construction of the schemes.

The Lucan to City Centre CBC Scheme (the Lucan Scheme), interfaces with the Proposed Scheme at Con Colbert Road, Memorial Road and Inchicore Road. The Tallaght / Clondalkin to City Centre CBC Scheme (the Tallaght / Clondalkin Scheme), also interfaces with the Proposed Scheme at the High Street / Winetavern Street junction. The BusConnects Infrastructure Team has coordinated the design tie-ins at all locations to ensure a holistic design has been achieved, so that each scheme can be implemented, and integrated, regardless of the sequencing of their construction.

All CBC Schemes are subject to separate planning processes, the timing of which is independent of that of the Proposed Scheme, and as such no exact sequencing of construction works can be determined at this stage.

3.3.1 Con Colbert Road

The Proposed Scheme intends to tie-in with the Lucan Scheme at Con Colbert Road in order to provide a cycling connection between the Proposed Scheme and the Lucan Scheme. This cycling connection will provide an alternative segregated cycling facility to the City Centre. **Figure 3.6** shows an extract of the preliminary design of the Proposed Scheme on the Con Colbert Road tie in with the existing layout.

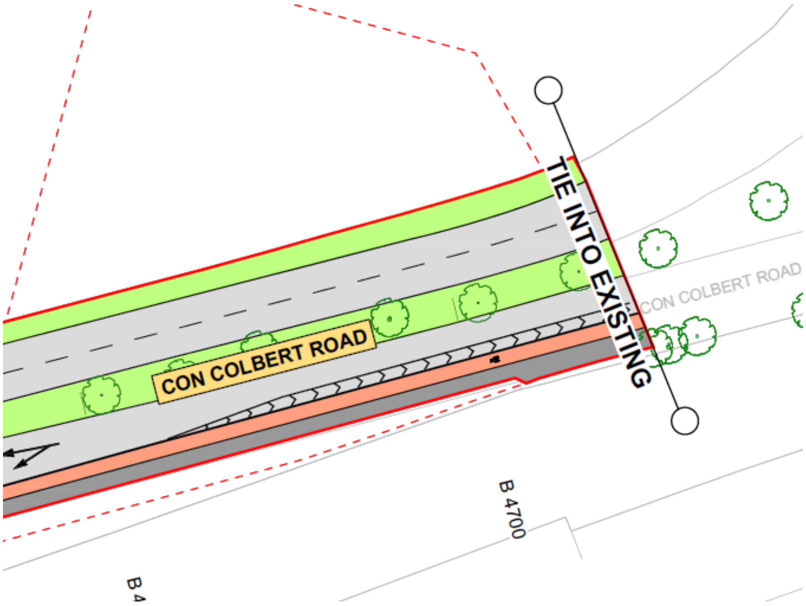

Figure 3.6: Preliminary Design of the Proposed Scheme Tie-In with the Lucan to City Centre Core Bus Corridor Scheme

Figure 3.7 shows an indicative coordinated design of the expected overall arrangement in a scenario in which both schemes have been implemented.

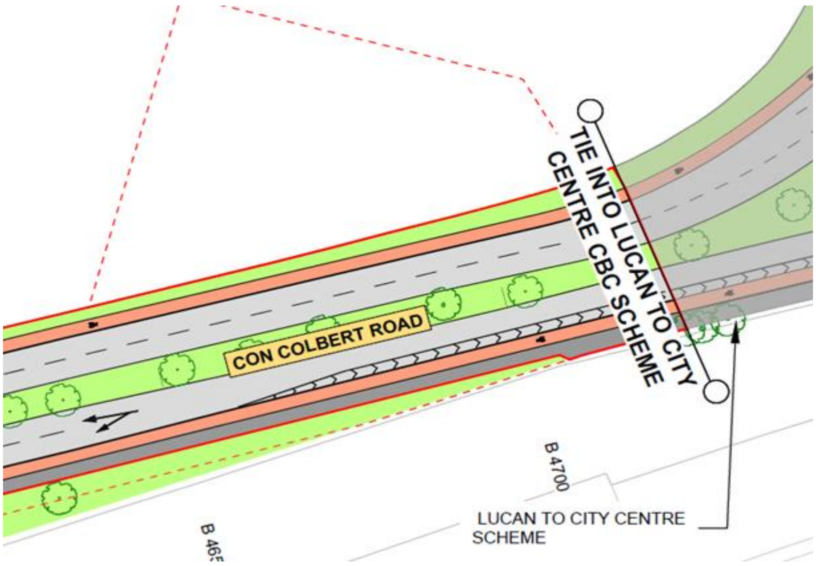

Figure 3.7: Preliminary Design of the Lucan to City Centre Core Bus Corridor Scheme at Con Colbert Road

Table 3-1 presents a matrix of potential interactions and impacts associated with various potential sequencing scenarios in relation to construction and operation of both schemes.

Table 3-1: Matrix of Potential Interactions and Impacts Associated with Different Sequencing Scenarios

	Lucan Scheme: Not Yet Commenced	Lucan Scheme: Under Construction	Lucan Scheme: Completed
Proposed Scheme: Not Yet Commenced	N/A	Construction of the proposed Lucan Scheme shall be carried out in accordance with the Construction Strategy within that scheme's planning application, without any potential interaction with works associated with the Proposed Scheme.	The Lucan Scheme shall be in full operation, designed in accordance with its planning application which will allow for the Liffey Valley Scheme to tie in at a future date.
Proposed Scheme: Under Construction	Construction of the Proposed Scheme will be carried out in accordance with the Construction Strategy within that scheme's planning application, without any potential interaction with works associated with the Lucan Scheme.	It is not envisaged that both schemes will be under construction at the same time at this location.	The Lucan Scheme will be completed and the Proposed Scheme will tie into the revised layout on the Con Colbert Road. The proposed cycling connection to the Lucan Scheme will be implemented.
Proposed Scheme: Completed	The Proposed Scheme shall be in full operation, designed in accordance with its planning application as Figure 3.6 which will allow for the Lucan Scheme to tie in a at a future date.	The Proposed Scheme will have been completed and the Lucan Scheme will tie into the revised layout on the Con Colbert Road which will provide a cycling connection between the two schemes.	The arrangement will be as per Figure 3.7.

3.3.2 Memorial Road

The Proposed Scheme intends to tie-in to the Lucan Scheme at the Chapelizod Bypass in order to provide a right turn lane to accommodate the revised two-way layout on Memorial Road. **Figure 3.8** shows an extract of the preliminary design of the Proposed Scheme at the Chapelizod Bypass which ties in with the existing layout.

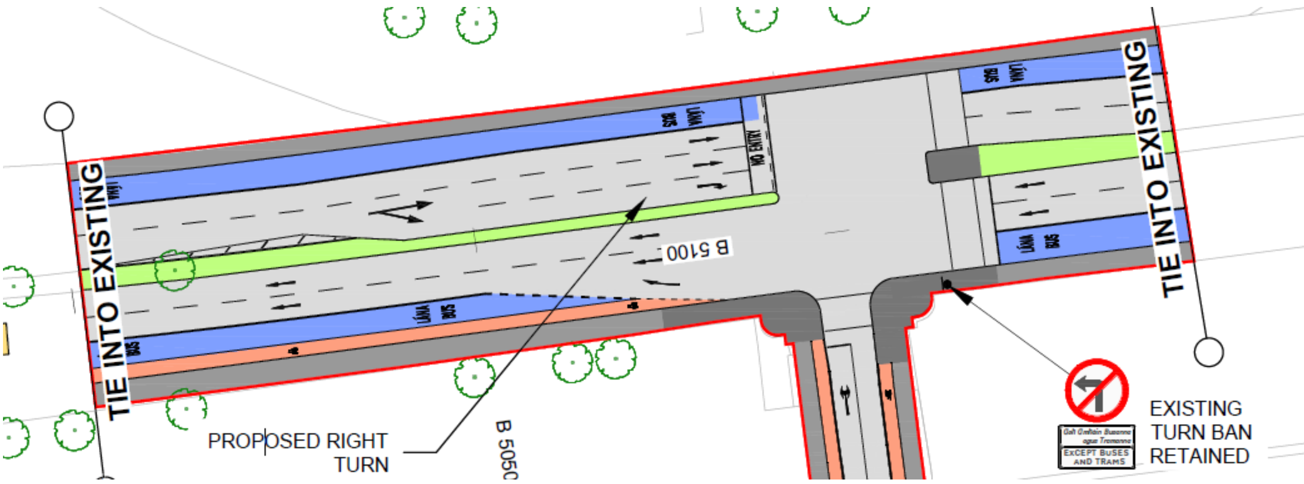

Figure 3.8: The Preliminary Design of the Proposed Scheme at the Chapelizod Bypass which Ties in with the Existing Layout

Figure 3.9 shows an indicative coordinated design of the expected overall arrangement in a scenario in which both schemes have been implemented.

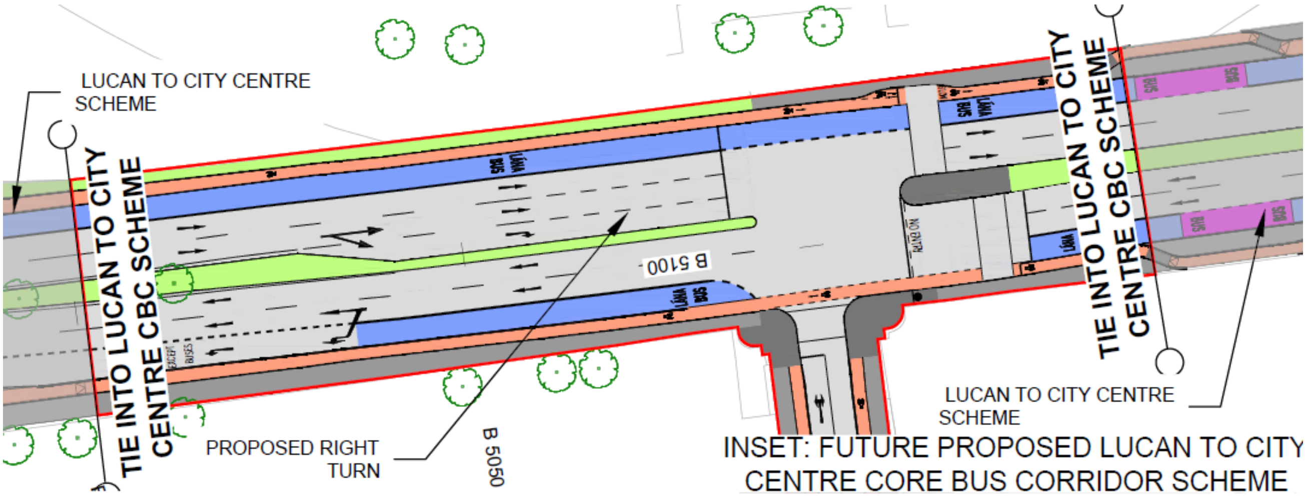

Figure 3.9: Indicative Coordinated Design of the Expected Overall Arrangement in a Scenario in which Both Schemes have Been Implemented

Table 3-2 presents a matrix of potential interactions and impacts associated with various potential sequencing scenarios in relation to construction and operation of both schemes.

Table 3-2: Matrix of Potential Interactions and Impacts Associated with Different Sequencing Scenarios

	Lucan Scheme: Not Yet Commenced	Lucan Scheme: Under Construction	Lucan Scheme: Completed
Proposed Scheme: Not Yet Commenced	N/A	Construction of the proposed Lucan Scheme shall be carried out in accordance with the Construction Strategy within that scheme's planning application. The right turn lane and associated works on the Chapelizod Bypass will be constructed but hatched out with road markings.	The Lucan Scheme shall be in full operation, designed in accordance with its planning application which will allow for the Liffey Valley Scheme to tie in a at a future date. The right turn lane and associated works on the Chapelizod Bypass will be completed but hatched out with road markings.
Proposed Scheme: Under Construction	Construction of the Proposed Scheme will be carried out in accordance with the Construction Strategy within that scheme's planning application, as shown in **Figure 3.8**.	It is not envisaged that both schemes will be under construction at the same time at this location.	The Lucan scheme will be completed, and the Proposed Scheme will make the right turn lane on the Chapelizod Bypass operational.
Proposed Scheme: Completed	The Proposed Scheme shall be in full operation, designed in accordance with its planning application as per **Figure 3.8**	The Proposed Scheme will have been completed and the Lucan Scheme will tie into the revised layout.	The arrangement will be as per **Figure 3.9.**

3.3.3 Island Bridge

The Proposed Scheme intends to tie-in to the Lucan Scheme at Island Bridge in order to provide a right turn lane which will provide an alternative route to the City Centre which avoids the Mount Brown bus gate. **Figure 3.10** shows an extract of the preliminary design of the Proposed Scheme at Island Bridge which ties in with the existing layout.

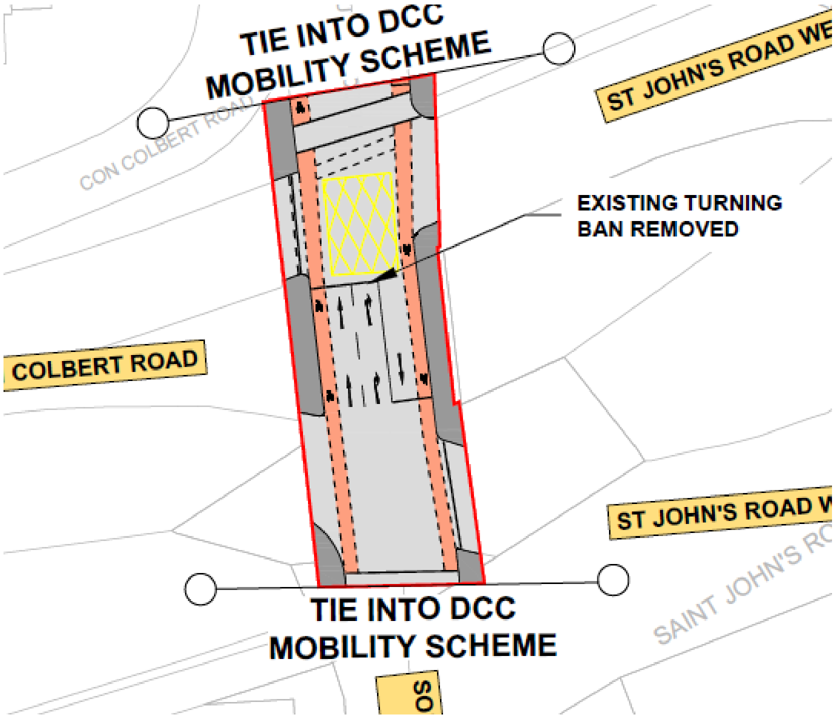

Figure 3.10: The Preliminary Design of the Proposed Scheme at Island Bridge which Ties in with the Existing Layout

Figure 3.11 shows an indicative coordinated design of the expected overall arrangement in a scenario in which both schemes have been implemented.

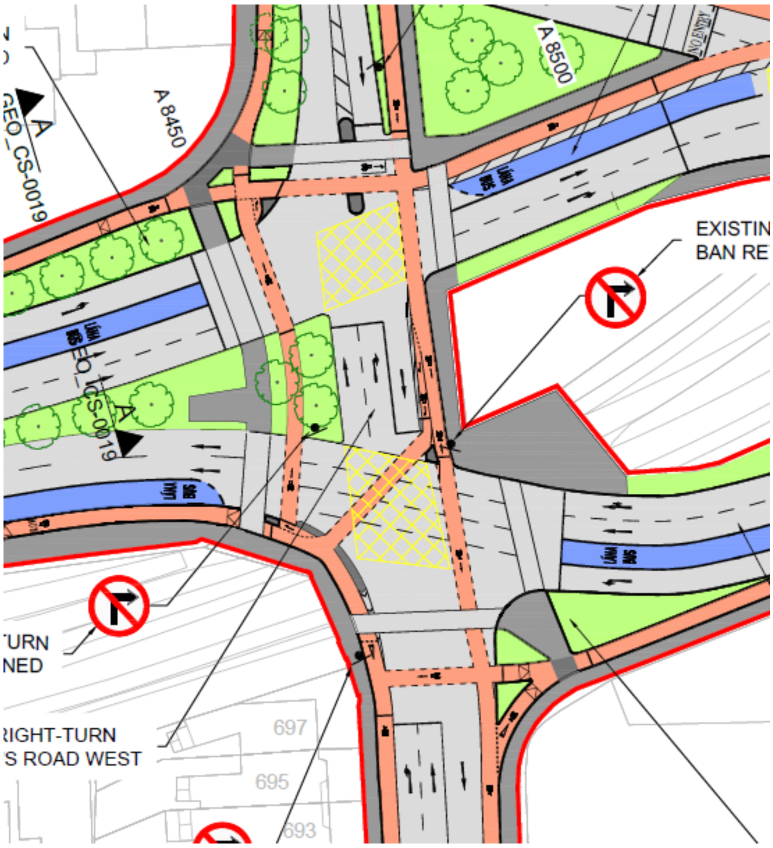

Figure 3.11: Expected Overall Arrangement in a Scenario in which Both Schemes Have Been Implemented

Table 3-3 presents a matrix of potential interactions and impacts associated with various potential sequencing scenarios in relation to construction and operation of both schemes.

Table 3-3: Matrix of Potential Interactions and Impacts Associated with Different Sequencing Scenarios

	Lucan Scheme: Not Yet Commenced	Lucan Scheme: Under Construction	Lucan Scheme: Completed
Proposed Scheme: Not Yet Commenced	N/A	Construction of the proposed Lucan Scheme shall be carried out in accordance with the Construction Strategy within that scheme's planning application. The right turn lane and associated works at Island Bridge will be implemented therefore no works will be required as part of the Proposed Scheme.	The Lucan Scheme shall be in full operation, designed in accordance with its planning application. The right turn lane and associated works at Island Bridge will be implemented therefore no works will be required as part of the Proposed Scheme.
Proposed Scheme: Under Construction	Construction of the Proposed Scheme will be carried out in accordance with the Construction Strategy within that scheme's planning application, as shown in **Figure 3.10.**	N/A	The Lucan Scheme will be completed and the right turn lane will be implemented, therefore no works will be required as part of the Proposed Scheme.
Proposed Scheme: Completed	The Proposed Scheme shall be in full operation, designed in accordance with its planning application as per **Figure 3.10.**	The Lucan Scheme will tie into the revised layout.	The arrangement will be as per **Figure 3.11**.

3.3.4 High Street / Winetavern Street Junction

The Proposed Scheme intends to tie-in to the Tallaght / Clondalkin Scheme at the junction of High Street and Winetavern Street. **Figure 3.12** shows an extract of the preliminary design of the Proposed Scheme at the junction of High Street and Winetavern Street with the existing layout.

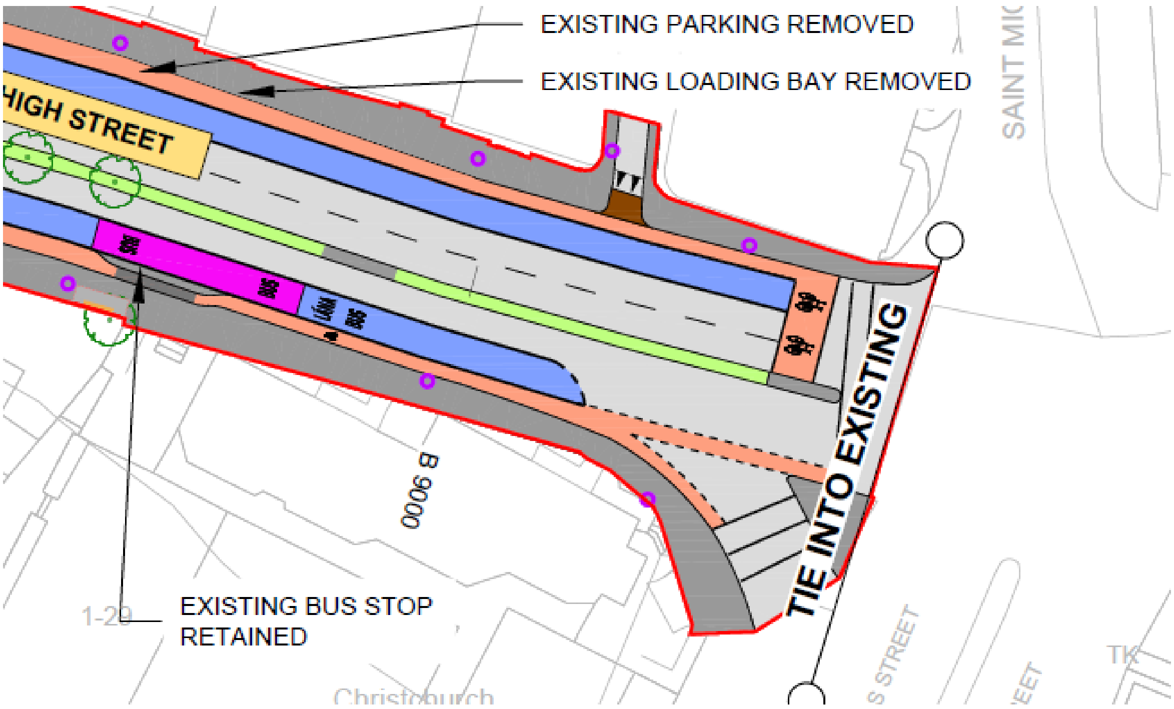

Figure 3.12: The Preliminary Design of the Proposed Scheme at the Junction of High Street and Winetavern Street with the Existing Layout

Figure 3.13 shows an indicative coordinated design of the expected overall arrangement in a scenario in which both schemes have been implemented.

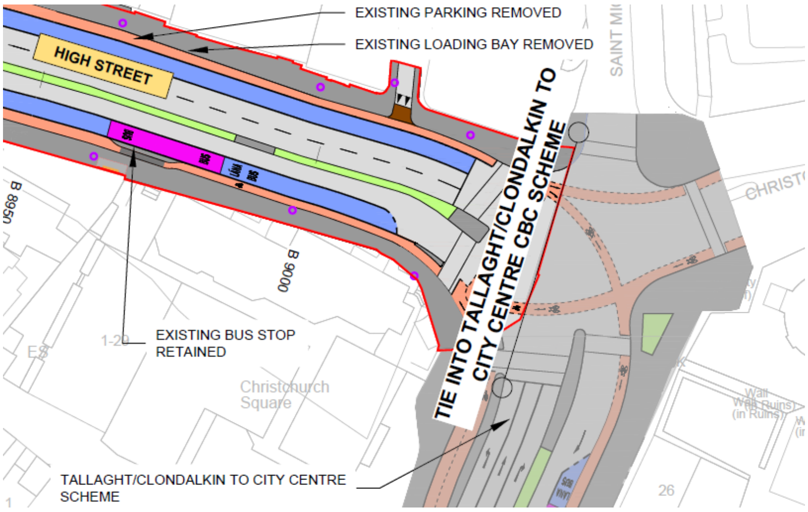

Figure 3.13: Indicative Coordinated Design of the Expected Overall Arrangement in a Scenario in which Both Schemes Have Been Implemented

Table 3-4 presents a matrix of potential interactions and impacts associated with various potential sequencing scenarios in relation to construction and operation of both schemes.

Table 3-4: Matrix of Potential Interactions and Impacts Associated with Different Sequencing Scenarios

	Tallaght / Clondalkin Scheme: Not Yet Commenced	Tallaght / Clondalkin Scheme: Under Construction	Tallaght / Clondalkin Scheme: Completed
Proposed Scheme: Not Yet Commenced	N/A	Construction of the proposed Tallaght / Clondalkin Scheme shall be carried out in accordance with the Construction Strategy within that scheme's planning application.	The Tallaght / Clondalkin Scheme shall be in full operation, designed in accordance with its planning application which will allow for the Liffey Valley Scheme to tie in at a future date.
Proposed Scheme: Under Construction	Construction of the Proposed Scheme will be carried out in accordance with the Construction Strategy within that scheme's planning application, as shown in **Figure 3.12.**	It is not envisaged that both schemes will be under construction at the same time at this location.	The Tallaght / Clondalkin Scheme will be completed, and the Proposed Scheme will tie into the revised layout at the junction.
Proposed Scheme: Completed	The Proposed Scheme shall be in full operation, designed in accordance with its planning application as per **Figure 3.12** which will allow for the Tallaght / Clondalkin Scheme to tie in at a future date.	The Proposed Scheme will have been completed and the Tallaght / Clondalkin Scheme will tie into the revised layout.	The arrangement will be as per **Figure 3.13.**

4. Preliminary Design

4.1 Principal Geometric Parameters

As a safety improvement, junction improvement and traffic management scheme within an urban area, the Proposed Scheme has generally been designed to urban standards in accordance with the Design Manual for Urban Roads and Streets (DMURS), published by the Department of Transport, Tourism and Sport and the Department of Environment, Community and Local Government in 2013.

DMURS provides guidance in the design of urban roads and streets. DMURS recognises the challenges of fully applying its standards on schemes that involve the retrofitting of new facilities to existing roads and streets, as is the case for this scheme.

The design philosophy adopted for the scheme has applied a balanced and integrated approach to road and street design by applying as far as practicable the four design principles of DMURS, i.e. with respect to connected networks, multi-functional streets, pedestrian focus, and multidisciplinary approach.

In addition to DMURS, criteria from other documents have been considered to provide the most appropriate design application including the National Cycle Manual, the Transport Infrastructure Ireland (TII) Design Manual for Roads and Bridges (DMRB), Building for Everyone: A Universal Design Approach and the BCPDGB.

Published design standards and guides have been utilised to inform the geometrical design of the Proposed Scheme, as listed below:

- TII's Design Manual for Roads and Bridges (DMRB)
- Design Manual for Urban Roads and Streets (DMURS)
- National Cycle Manual (NCM)
- Traffic Sign Manual (TSM)
- Traffic Management Guidelines (TMG)
- NDA's Building for Everyone: A Universal Design Approach
- Guidance on the use of Tactile Paving
- Construction Standards for Road and Street Works in Dublin City Council; and
- BusConnects Preliminary Design Guidance Booklet (BCPDGB) – See **Appendix O.**

Table 4-1 details the key design parameters which have been generally adopted to inform the Proposed Scheme design layout. The table describes the relevant geometric features set out in order of functional geometrical requirements for each road user including pedestrians (footpaths), cyclists (cycle tracks), bus lanes, general traffic lanes, junctions and parking/loading areas. In designing the geometrical elements of the Proposed Scheme, a balanced approach to the requirements for each of the road functions from a people movement perspective is needed, noting that the aim of the Proposed Scheme is to provide enhanced walking, cycling and bus infrastructure. It should be noted that the development of the urban realm proposals along the corridor have also informed the key geometrical layouts for the Proposed Scheme which are further discussed in **Chapter 14.**

Table 4-1: BusConnects Key Design Parameters

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
All	Road Type	The Proposed Scheme and adjoining street network function in line with DMURS		Link Street/Local Streets	DMURS (Figure 3.3)
Footpath	Footway widths	Nominal footway widths in low pedestrian activity areas and pinch point areas		• 2m desirable minimum width • 1.8m minimum nominal width (low pedestrian activity area or localised restrictions) • 1.2m absolute minimum width at pinch points (e.g. trees over 2m length)	NDA[1] (Section 1.5.1) DMURS (Figure 4.34)
		Nominal footway widths in moderate – high pedestrian activity areas		• 2.5m-3m desirable width (moderate to high pedestrian activity area) • 3m-4m desirable width (high pedestrian activity area)	NDA[1] (Section 1.5.1) DMURS (Figure 4.34)
	Footway longitudinal gradient	New road sections or new offline footpaths		• 0.5% (1 in 200) absolute minimum • 3% (1 in 33) desirable maximum • 5% (1 in 20) absolute maximum (where constrained by road geometry and other factors)	DMURS (Section 4.4.6)
		Existing footpaths with localised adjustments		• Generally, in line with existing site constraints to a maximum of 5% (1 in 20) gradient with no less than 0.5% (1 in 200)	DMURS (Section 4.4.6)
		Ramp gradients – urban realm		• Nominal gradient of 1 in 25 with landings at maximum 19m intervals and routes with a gradient of 1 in 33 should have landings at no more than 25m intervals with linear interpolation between gradients as required • Desirable maximum gradient 1 in 20 with 0.45m maximum rise over 9m length between landings	NDA[1] (Section 1.5.2) DN-STR-03005 (Section 6.9, 6.14, 6.15)

[1] National Disability Authority: *Building for Everyone: A Universal Design Approach - External environment and approach*

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
		Ramp gradients – bridge structures		• Desirable maximum gradient 1 in 20 with 2.5m maximum rise between landings • Absolute maximum 1 in 15 – 1 in 12 with 0.65m maximum rise between landings where 1 in 20 is not practical	
	Footway crossfall gradient	Fully reconstructed road sections or new offline footpaths		• 1 in 50 nominal gradient	NDA[1] (Section 1.5.1.1)
		Existing footpaths with localised adjustments		• Generally, in line with existing site constraints to a maximum of 3.3% (1 in 33) gradient with no less than 1.5% (1 in 65)	DN-PAV-03026 (Table 2.3)
Cycle Track	Cycle track width	Optimum cycle track width (two abreast cycling): single-direction, with-flow, raised-adjacent cycle track		• 2m desirable minimum width	BCPDG (Section 5)
		Minimum cycle track (single-file cycling): single-direction, with-flow, raised-adjacent cycle track		• 1.5m minimum width • 1m absolute minimum width at constrained island bus stop locations	BCPDG (Section 5.3, 11.2)
		Two-way cycle track (single-file cycling)		• 3.25m desirable minimum cycle track with additional desirable minimum 0.5m buffer and absolute minimum 0.3m buffer	BCPDG (Section 5.3)
		Pedestrian priority zone areas (pedestrian and cyclist) for constrained locations		• 3m minimum width	NCM 1.9.3
	Horizontal curvature	Minimum horizontal radius (general alignment)	20km/h	• 10m radius (urban areas)	NCM 4.10.3
			30km/h	• 20m	NCM 4.10.3
			40km/h	• 25m	NCM 4.10.3
		Minimum horizontal radius (island bus stops)		• 4m radius (entry deflection radius) • 6m radius (exit deflection radius)	BCPDG (Figure 34)

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
		Nominal deflection – parking and loading bays		• 1 in 3 horizontal taper at cycle protected parking	BCPDG (Figure 12)
		Nominal deflection – island bus stops		• 1 in 1.5 horizontal taper at island bus stops	BCPDG (Figure 34)
	Longitudinal gradient	Acceptable gradient range		• 0.5% to 5.0% (1:200 to 1:20)	NCM 5.2.3.4
	Ramps	Transition to cycle track to carriageway		• 60mm drop at 1:20 gradient (2.4m long)	NCM 4.10
		Transition from carriageway to pedestrian priority zone		• 120mm at 1:20 gradient (4.8m long)	NCM 4.10
		Transition from cycle track to pedestrian priority zone		• 60mm rise at 1:20 gradient (2.4m long)	NCM 4.10
	Crossfall gradient	Acceptable gradient range		• 1.25% to 2.5% (1:80 to 1:40)	NCM 5.2.3.4
Bus lane	Shared bus/cycle lane	Lane widths (collector/link roads – low speed) in constrained environments	50km/h	• 3m maximum width (consideration for cycle and bus (including taxis + other permitted vehicles) volumes required in addition to bus lane operation hours)	NCM 4.3.3
	Nominal with flow bus lane widths	Nominal lane widths adjacent to cycle track/footpath		• 3m minimum width and lane widening as required by vehicle tracking assessment on tight bends	BCPDG (Section 5.1)
		Bus lanes adjacent to on street parking (no cycle track/footpath)		• 3m minimum width with consideration for designated buffer zones and delineated parking areas	BCPDG (Figure 12)
	Design speed	Design speed for vehicles in bus lane along the Proposed Scheme		• 50km/h	DMURS (Section 4.1.1 and Table 4.1)
	Visibility	Forward visibility stopping sight distance (SSD) (buses and Heavy Goods Vehicles (HGVs)).	50km/h	• 49m	DMURS (Table 4.2 – 50km/h)
	Headroom	Headroom vertical clearance for different structures		• Overbridges – 5.3m (new construction), 5.03m (maintained headroom)	DN-GEO-03036 (Table 5.1)

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
				• Footbridges and sign/signal gantries – 5.7m (new construction), 5.41m (maintained headroom)	
Traffic lane	Design speed	Design speed for vehicles in general traffic lanes along the Proposed Scheme		• 50km/h	DMURS (Section 4.1.1 and Table 4.1)
	Traffic lane width	Minimum carriageway lane width	50km/h	• 3m minimum width and lane widening as required by vehicle tracking assessment on tight bends	BCPDG (Section 5.1)
			60km/h	• 3.25m minimum width	
	Visibility	Forward visibility SSD (cars and smaller vehicles).	50km/h	• 45m	DMURS (Table 4.2 – 50km/h)
		Forward visibility SSD (buses and HGVs).	50km/h	• 49m	DMURS (Table 4.2 – 50km/h)
		Visibility to regulatory signage	Up to 50km/h	• 60m recommended clear	TSM (Table 5.1)
	Horizontal curvature	Minimum radius with adverse camber of 2.5%	50km/h	• 104m	DMURS (Table 4.3)
	Vertical curvature	Crest curve K value	50km/h	• 4.7	DMURS (Table 4.3)
		Sag curve K value	50km/h	• 6.4	DMURS (Table 4.3)
	Longitudinal gradient	Longitudinal gradient		• 0.5% minimum grade • 5% desirable maximum grade • 8.3% absolute maximum grade	DMURS (Section 4.4.6)
	Crossfall	Crossfall		• 2.5% nominal	DMURS (Section 4.4.6)
All - junctions	Visibility	Intra-junction visibility envelope		• 2.5m behind stop lines, inclusive of all signal heads	DN-GEO-03044 (TII DMRB TD50/04) Section 2.10 and 2.14. Figs 2/2 and 2/3.

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
		Priority junction side road visibility distance (safe gap stopping distance)		• X Value = 2.4m • 45m SSD (cars and smaller vehicles) • 49m SSD (HGV/buses)	DMURS (Figure 4.63) DMURS (Figure 4.63 / Para 4.4.5)
		Visibility to primary traffic signals	50km/h	• 70m desirable minimum • 50m absolute minimum	TSM (Table 9.1)
	Corner radii	Few larger vehicles (local streets)		• 1m -3m radius (subject to vehicle tracking assessment and balance of junction form/function)	DMURS (Section 4.4.3)
		Occasional larger vehicles including buses and rigid body trucks (between arterial and or link streets)		• 6m maximum radius (subject to vehicle tracking assessment and balance of junction form/function)	DMURS (Section 4.4.3)
		Occasional larger vehicles including buses and rigid body trucks (arterial/link to local streets)		• 4.5m – 6m radius (subject to vehicle tracking assessment and balance of junction form/function)	DMURS (Section 4.4.3)
		Frequent larger vehicles (industrial estates)		• 9m radius (subject to vehicle tracking assessment)	DMURS (Section 4.4.3)
	Pedestrian crossings	Signalised crossing type/length *(subject to confirmation by traffic modelling and site constraints)*		• Preferred for all locations: single-stage direct crossing up to 19m length • Alternative for primary/distributor/dual carriageway roads: two-stage staggered crossings with ideally minimum 3m staggered offset refuge island (ideally stagger to face oncoming traffic) and ideally minimum 3m (2m absolute minimum) wide refuge island. • Alternative for primary/distributor/dual carriageway: two-stage crossing in straight crossing with 4m wide refuge island. • Alternative: single-stage direct crossing greater than 19m length (urban centres)	BCPDG (Section 5) TMG (Section 10.7, Diagram 10.15) DMURS (Section 4.3.2)

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
		Signalised pedestrian/toucan crossing width		• Absolute minimum width 2m • Desirable minimum width 2.4m (4m to be considered for urban centres) • Toucan crossing width minimum 4m	TMG (Section 10.7) DMURS (Section 4.3.2)
Parking/Loading	On-street parking dimensions	Accessible parking and child/parent parking		• 7m x 3.6m with appropriate drop kerb and tactile paving • Cycle buffer zone (0.75m preferred)	NDA[1] (Figure 1.4)
		Parallel parking (preferred arrangement)		• 6m x 2.1m desirable minimum. • 6m x 2.4m preferred • Cycle buffer zone (0.75m preferred)	BCPDG (Section 6) DMURS (Section 4.4.9)
		Angled parking		• 60 degree parking: 4.8m-5m x 2.4m @ 4.2m depth • 45 degree parking: 4.8m-5m x 2.4m @ 3.6m depth	DMURS (Section 4.4.9)
		Perpendicular parking		• 4.8m – 5m x 2.4m desirable minimum. • Buffer zone (0.3m minimum)	DMURS (Section 4.4.9)
		Loading bay (parallel)		• 6m x 2.8m (large vans) • Cycle buffer zone (0.75m preferred)	DMURS (Section 4.4.9)

4.2 Mainline Cross-Section

Utilising Section 4.4.1 of DMURS, a design strategy was implemented to determine the appropriate cross-section for the Proposed Scheme, taking account of the design speed and nature of the locations.

Traffic lane widths have been considered in line with the guidance outlined in DMURS. The preferred widths of traffic lanes on the Proposed Scheme are:

- 3.0m in areas with a posted speed limit ≤60km/h.

Traffic lane widths of 2.75m are permissible but not desirable and only on roads with very low HGV percentage. In some locations these lane widths have been considered for auxiliary turning lanes where appropriate.

The desirable minimum width for a single-direction, with-flow, raised-adjacent cycle track is 2.0m. Based on NCM this allows for overtaking within the cycle track. The minimum width is 1.5m.
The desirable width for a two-way cycle track is 3.25m with a 0.5m buffer between the cycle track and the carriageway. 2m is a desirable minimum width for footpaths with 1.2m being a minimum width at pinch points. A typical CBC cross section is shown on **Figure 4.1**.

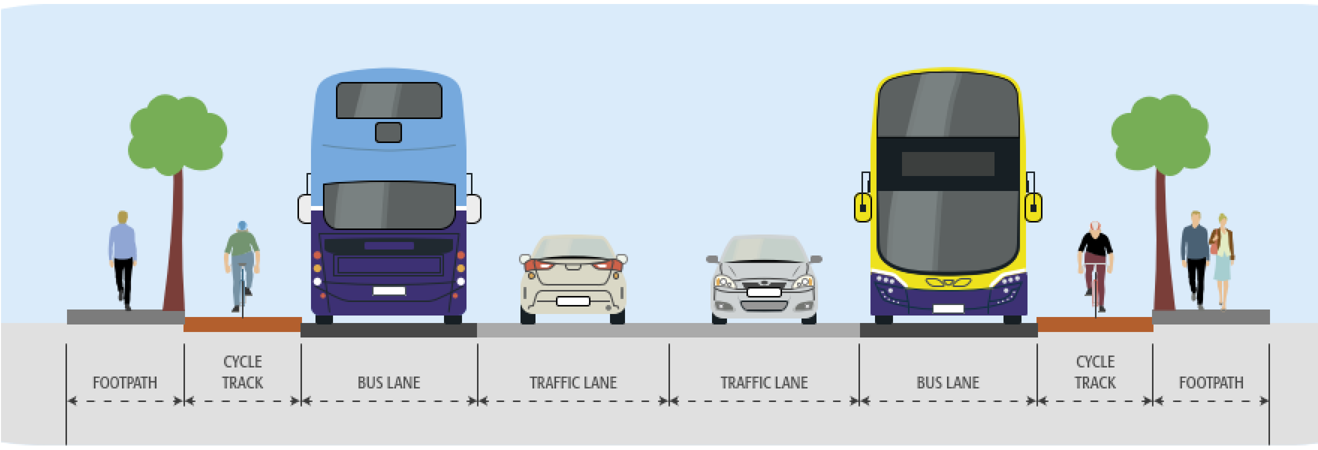

Figure 4.1: Typical CBC Cross Section

A detailed scheme breakdown of the proposed road cross-section elements is provided in **Table 4-2.** This provides information on the pedestrians, cyclists, bus lanes and general traffic lanes between junctions along the route. A detailed description of the proposed junction arrangements is provided in **Chapter 5**. The table below is intended to provide supplementary information alongside the information presented on the General Arrangement (GEO_GA), Typical Cross Sections (GEO_CS) and Pavement Treatment Plans (PAV_PV) available in **Appendix B**.

Table 4-2: Proposed Scheme Cross-Section Widths

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
Fonthill Road (Alignment A)									
CH. A0+530 to CH. A0+490	2.0	2.0	3.0	2 x 3.0	2x 3.0 minimum**	3.0	2.0	2.0	** lane width tapering into grassed median to introduce additional lanes on approach to junction Grass median separates contra-flow traffic lanes
CH. A0+490 to CH. A0+445	2.0	2.0	3.0	2 x 3.0	3 x 3.0	3.0	2.0	2.0	Grassed median widens to allow a 4m wide pedestrian refuge due to crossing distances
Fonthill Road Upper Junction (Alignment A)									
CH. A0+445 to CH. A0+375	2.0	2.0	3.0	3x3.0	2x3.0	3.0	2.0	2.0	Grassed median widens to allow a 4m wide pedestrian refuge due to crossing distances

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. A0+375 to CH. A0+180	2.0	2.0	3.0	2 x 3.0 minimum**	2x 3.0	3.0	2.0	2.0	**Outbound general lane width tapering into grassed median to introduce additional lanes on approach to junction. Grassed median widens to allow a 4m wide pedestrian refuge due to crossing distances Drainage features to be constructed in the inbound verge and within the median
Fonthill Road Lower Junction (Alignment A)									
CH. A0+180 to CH. A0+120	2.0	2.0	3.0	2 x 3.0	2 x 3.0	2 x 3.0	2.0	2.0	Grassed median widens to allow a 4m wide pedestrian refuge due to crossing distances Attenuation ponds to be constructed in the verge
CH. A0+120 to CH. A0+000	2.0	2.0	3.0	3.0 minimum**	2 x 3.0	2 x 3.0	2.0	2.0	** lane width tapering into grassed median to introduce additional lanes on approach to junction.

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
									Attenuation ponds to be constructed in the verge Grassed median widens to allow a 4m wide pedestrian refuge due to crossing distances
Coldcut Junction (Alignment B)									
CH. B0+000 to CH. B0+120	2.0	2.0	3.0	2 x 3.0 minimum	3.0	3.0	2.0	2.0	Grassed median to be constructed Grassed median widens to allow a 4m wide pedestrian refuge due to crossing distances
CH. B0+120 to CH. B0+165	2.0	2.0	3.0	3.0 minimum**	3.0	3.0	2.0	2.0	Lane width tapering to introduce additional lanes on approach to junction. Grassed median to be constructed
CH. B0+165 to CH.	2.0 minimum*	1.75*	N/A	3.0 minimum**	3.0 minimum**	N/A	2.0	2.0 minimum*	*Cycle track and footpath become shared space over the bridge.

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
B0+325 (Overbridge)									** Lane width tapering to introduce additional lanes either side of the bridge
CH. B0+325 to CH. B0+380	2.0	2.0	3.0	3.0	3.0 minimum**	3.0	2.0	2.0	lane width tapering to introduce additional lanes on approach to junction.
CH. B0+380 to CH. B0+485	2.0 minimum	2.0	3.0	3.0	2 x 3.0	3.0	2.0	2.0 minimum	
Cloverhill Road Junction (Alignment B)									
CH. B0+485 to CH. B0+750	2.0 minimum	2.0	3.0	3.0	3.0	3.0	2.0	2.0 minimum	
Kennelsfort Road Junction (Alignment B)									
CH. B0+750 to CH. B0+800	2.0 minimum**	2.0	3.0	2 x 3.0	3.0	3.0	2.0	2.0 minimum	**Terminates at pedestrian crossing

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B0+800 to CH. B1+245	2.0**	2.0	3.0	3.0	3.0 minimum***	3.0	2.0	2.0 minimum	**Footpath diverges into cul de sac on approach to the junction Lane tapers to create right turn pocket into hospital before tapering in again Lane width tapering to introduce additional lanes on approach to junction
CH. B1+245 to CH. B1+315	2.0	2.0	3.0	3.0	2 x 3.0	3.0	2.0	1.8-2.0**	**Tapers to allow for protected cycle tracks at the junction
Cherry Orchard Junction (Alignment B)									
CH. B1+314 to CH. B1+455	2.0	2.0	3.0	3.0	3.0	3.0	2.0	1.8-2.0**	**Tapers to allow for protected cycle tracks at the junction
CH. B1+455 to CH. B1+780	2 minimum	2.0	3.0	3.0	3.0	3.0	2.0**	2.0	2.1m parallel parking provision separating cycle track from bus lane **0.75m minimum protective kerb between on street parking and cycle track

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B1+780 to CH. B1+865	3.8 minimum	2.0*	3.0	3.0	3.0	3.0	2.0*	2.5 minimum	2.1m parallel parking provision separating cycle track from bus lane *0.75m minimum protective kerb between on street parking and cycle track
CH. B1+865 to CH. B2+010	2.5 minimum	2.0*	3.0	3.0	3.0	3.0	2.0	2.0 minimum	2.1m parallel parking provision separating cycle track from bus lane *0.75m minimum protective kerb between on street parking and cycle track
Clifden Road Junction (Alignment B)									
CH. B2+010 to CH. B2+105	2.0 minimum	2.0*	3.0	3.0	3.0	3.0	2.0*	2.0 minimum	
Drumfinn Road Junction (Alignment B)									
CH. B2+105 to CH. B2+150	2.0 minimum	1.5*	3.0	2 x 3.0	3.0	3.0	1.5*	2.0 minimum	

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B2+150 to CH. B2+245	2.0 minimum	1.5-2.0**	3.0	3.0 minimum***	3.0	3.0	1.5-2.0*	2.0 minimum	**Converges to carriageway after parking and bus island. *** lane width tapering to introduce additional lanes on approach to junction
CH. B2+245 to CH. B2+350	3.0 minimum	1.5-2.0**	3.0	3.0	3.0 minimum***	3.0	1.5-2.0	2.0 minimum	**2.1m parallel parking provision separating cycle track from bus lane **0.75m minimum protective kerb between on street parking and cycle track *** lane width tapering to introduce additional lanes on approach to junction
CH. B2+350 to CH. B2+390	3.0 minimum	1.5**	3.0	3.0	2 x 3.0	3.0	1.5-2.0	2.0 minimum	**Cycle track diverges to back of parking after junction **2.1m parallel parking provision separating cycle track from bus lane **0.75m minimum protective kerb between on street parking and cycle track

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
									**Narrow cycle track used so pedestrians have more space along shop fronts
CH. B2+390 to CH. B2+490	1.8**	1.5	3.0	3.0	3.0	N/A	1.5*	1.8**	*Narrow cycle track used due to prevent land acquisition and retain private parking for residents ** Narrow footpaths used due to prevent land acquisition and retain private parking for residents
CH. B2+490 to CH. B2+810	2.0 minimum	1.5-2.0	3.0	3.0	N/A	3.0	1.5-2.0*	2.0 minimum	*Cycle track narrows to 1.5m at Father Lemass Court to prevent land acquisition from private properties with short front gardens
CH. B2+810 to CH. B2+885	2.0 minimum	1.5-2.0*	N/A	3.0 minimum**	N/A	3.0	1.5-2.0*	2.0 minimum	*Cycle track narrows to 1.5m at Father Lemass Court to avoid land acquisition from private properties with short front gardens **Traffic lane tapers to create bus lane

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
Ballyfermot Roundabout (Alignment B)									
CH. B2+885 to CH. B3+475	2.0 minimum	2.0*	3.0	3.0	3.0	3.0	2.0*	2.0 minimum	
CH. B3+475 to CH. B3+850	1.8-2.0**	1.5-2.0	3.0	3.0	3.0 minimum***	N/A	1.5-2.0*	1.8-2.0**	*1.5m used for the majority of the widths to limit the impact on surrounding properties **Footpath narrow to 1.5m at the entrance to Saint Laurence's Glen to prevent impacting the retaining wall ***Bus lane tapers into traffic lane after priority signals ***Lane width tapering to reintroduce bus lane at St. Laurence Road junction.
CH. B3+850 to CH. B4+165	2.0 minimum	2.0	3.0	3.0	3.0	3.0	2.0*	2.0 minimum	

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B4+165 to CH. B4+285	2.0 minimum	1.5-2.0	N/A	3.0 minimum**	3.0	3.0	1.5-2.0*	1.8 minimum	*Narrow to remove impact on residential properties **Lane width tapering to reintroduce bus lane
Landen Road Junction (Alignment B)									
CH. B4+285to CH. B4+390	2.0 minimum	1.5-2.0	3.0	2 x 3.0**	3.0	3.0	2.0*	2.0 minimum	**Right turn lane for St. Mary's Avenue terminates and becomes 4m pedestrian refuge for staggered crossing at the junction. Staggered crossing needed due to property entrances
CH. B4+390 to CH. B4+475	2.0 minimum	2.0	3.0 minimum**	3.0 minimum**	3.0 minimum**	3.0	2.0*	2.0 minimum	**Lane width tapering to introduce additional lanes on approach to junction

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
Sarsfield Road Junction (Alignment B)									
CH. B4+475 to CH. B4+635	2.0 minimum	2.0	N/A	2 x 3.0	2 x 3.0 minimum	N/A	2.0**	2.0 minimum***	**Cycle tract terminates 20m after the junction, with cyclists joining the carriageway. Future cycle track tie-in to Lucan to City Centre scheme ***Footpath terminates at entrance to East Timor Park
CH. B4+635 to CH. B4+722	2.0 minimum	2.0	N/A	3.0**	2 x 3.0***	N/A	N/A	N/A	Tie-in to existing ** lane width tapering to introduce additional lanes on approach to junction. Tie-in to existing *** Tie-in to existing

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B4+722 to CH. B5+000	Existing carriageway to be maintained								
CH. B5+000 to CH. B5+050	2.0 minimum	2.0	3.0 minimum	2 x 3.0 minimum	2 x 3.0 minimum*	3.0 minimum	N/A	2.0 minimum	* Lane width tapering to introduce additional lanes on approach to junction
CH. B5+050 to CH. B5+095	2.0 minimum	2.0*	N/A	2 x 3.0 minimum**	3 x 3.0 minimum	3.0 minimum	N/A	2.0 minimum	*Cycle track tapers out from shared area ** Lane width tapering to introduce bus lane
Con Colbert Road Junction (Alignment B)									
CH. B5+095 to CH. B5+215	2.0 minimum	2.0	N/A	2.75 minimum*	2.75 minimum*	N/A	2.0	2.0 minimum	*Due to constraints over the rail bridge
Memorial Road Junction (Alignment B)									
CH. B5+215 to CH. B5+335	2.0 minimum	1.4*	N/A	3.0	3.0	N/A	N/A	2.0 minimum	Existing parking retained *Road markings to show cycle lane

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B5+335 to CH. B5+480	2.0 minimum	1.4*	N/A	3.0	3.0	N/A	2.0	2.0 minimum	*Road markings to show cycle lane
Inchicore Road Junction (Alignment B)									
CH. B5+480 to CH. B5+500	1.8 minimum	N/A	3.0	N/A	3.0	3.0*	N/A*	2.0 minimum	*Cycle track merges with bus lane after junction
CH. B5+500 to CH. B5+645	2.0 minimum	N/A	N/A	3.0	3.0	3.0	N/A	2.0 minimum	
Emmet Road Junction (Alignment B)									
CH. B5+645 to CH. B5+715	2.0 minimum	N/A	N/A	3.0	2 x 3.0	N/A	N/A	2.0 minimum	

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B5+715 to CH. B5+825	2.0 minimum	N/A	N/A	3.0 minimum*	3.0 min	N/A	N/A	2.0 minimum	* lane width tapering to introduce additional lanes on approach to junction.
St. Vincent Street West Junction (Alignment B)									
CH. B5+825 to CH. B6+365	2.0 minimum	N/A	3.0	3.0	3.0	3.0	N/A	2.0 minimum	
CH. B6+365 to CH. B6+565	2.0 minimum	N/A	N/A	3.0	3.0	3.0	N/A	1.8 minimum	
South Circular Road Junction (Alignment B)									
CH. B6+565 to CH. B7+040	1.2 minimum*	N/A	N/A	3.0 minimum*	3.0 minimum*	N/A	N/A	1.5 minimum*	*Existing to be retained
CH. B7+040 to CH. B7+120	2.0	N/A	N/A	3.0 minimum**	3.0 min	N/A	N/A	2.0 minimum*	*Existing to be retained ** Lane width tapering to introduce slip road into National Children's Hospital underground parking

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B7+120 to CH. B7+480	2.0	N/A	N/A	3.0 minimum	3.0 minimum*	N/A	N/A	2.0 minimum	* Lane width tapering to introduce bus lanes on approach to bus gate
CH. B7+480 to CH. B7+605	2.0 minimum	1.2*	N/A	3.0 minimum**	3.0 minimum	3.0	N/A	2.0 minimum	*Existing cycle track. Tie-in to be created to Newington Lane **Luas shares outbound traffic lane Luas has a dedicated lane inbound
CH. B7+605 to CH. B7+735	2.0 minimum*	N/A	N/A	3.0 minimum**	3.0 min	N/A	N/A	2.0 minimum*	*Existing footpath to be retained **Luas shares outbound traffic lane Luas has a dedicated lane inbound
CH. B7+735 to CH. B7+800	2.0 minimum*	2.0*	N/A	3.0 minimum	3.0 minimum**	N/A	2.0*	2.0 minimum*	*Existing footpath to be retained ** Lane width tapering to introduce bus lane at Bow Lane ** Lane width tapering to introduce cycle track
CH. B7+800 to CH. B7+860	3.8 minimum	2.0	N/A	2 x 3.0	3.0	3.0	2.0 minimum*	2.5 minimum	

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B7+860 to CH. B7+920	4.0 minimum	2.0	N/A	3.0**	3.0	3.0	2.0*	3.0 minimum	** Lane width tapering to introduce additional lanes on approach to Bow Lane
CH. B7+860 to CH. B8+025	2.1 minimum	2.0	3.0	3.0	3.0	3.0	2.0	2.7 minimum	
CH. B8+025 to CH. B8+140	3.0 minimum	2.0	N/A	3.0**	3.0	3.0	2.0	2.1 minimum	** Lane width tapering to introduce bus lane
Watling Street Junction (Alignment B)									
CH. B8+140 to CH. B8+235	1.8 minimum**	2.0	N/A	3.0	3.0 minimum	3.0	2.0	1.6 minimum**	** Existing to be retained
CH. B8+235 to CH. B8+265	2.4 minimum**	2.0	N/A	5.5 minimum***	3.5 minimum***	N/A	2.0	4.9 minimum**	** Existing to be retained *** Lane width tapering to introduce bus lane
CH. B8+256 to CH. B8+400	2.0 minimum**	2.0	N/A	3.0 minimum	3.0 minimum	3.0	2.0	3.0 minimum**	** Localised widening of footpaths

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B8+400 to CH. B8+445	2.8 minimum	2.0	3.0	5.5 minimum	3.0	N/A	2.0	3.4 minimum**	** Existing to be retained
CH. B8+445 to CH. B8+540	3.2 minimum	2.0	N/A	3.0	3.0	N/A	2.0	2.5 minimum**	** Existing to be retained
Meath Street Junction (Alignment B)									
CH. B8+540 to CH. B8+740	1.6 minimum**	2.0	N/A	3.0 minimum	3.0	3.0	2.0	3.2 minimum**	** Existing to be retained
CH. B8+740 to CH. B8+820	2.5 minimum	2.0	3.0 minimum	3.0 minimum	3.0 minimum	3.0 minimum	2.0**	2.8 minimum	**2.5m parallel loading bays separating cycle track from bus lane **0.75m minimum protective kerb between on street parking and cycle track
Cornmarket Junction (Alignment B)									

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. B8+820 to CH. B8+875	2.0 minimum	1.5-2.0*	3.0	2 x 3.0	2 x 3.0 minimum**	N/A	1.5-2.0*	2.1 minimum	*Includes 0.25m kerb. 1.5m used at the junction to reduce crossing distance ** Lane width tapering to introduce bus lane
CH. B8+875 to CH. B9+035	2.3 minimum	1.5-2.0	3.0	3.0 minimum**	2 x 3.0	3.0	1.5-2.0	2.0 minimum	** Lane width tapering to introduce additional lanes on approach to junction
Chapelizod Hill Junction (Alignment D)									
CH. D0+428 to CH. D0+410	7.5 minimum	N/A	N/A	3.0	3.0	N/A	N/A	5.5 minimum	
CH. D0+410 to CH. D0+330	3.0 minimum	2.0	N/A	3.0	3.0	N/A	2.0	3.0 minimum	*Cycle track diverges to back of parking
CH. D0+330 to CH. D0+110	3.0 minimum	2.0*	N/A	3.0	3.0	N/A	2.0*	3.0 minimum	*2.1m parallel parking provision separating cycle track from bus lane *0.75m minimum protective kerb between on street parking and cycle track

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. D0+110 to CH. D0+040	3.0 minimum	2.0**	N/A	3.0 minimum	3.0 minimum***	N/A	2.0*	3.0 minimum	*Includes 0.25m kerb. Cycle track diverges to back of parking **2.1m parallel parking provision separating cycle track from bus lane **0.75m minimum protective kerb between on street parking and cycle track ***Lane width tapering to introduce additional lanes on approach to junction
CH. D0+040 to CH. D0+000	2.0 minimum	2.0	N/A	3.0 minimum	2 x 3.0 minimum***	N/A	2.0	2.0 minimum	
Ballyfermot Roundabout (Alignment B)									
CH. D0+000 to CH. D0-045	2.0 minimum	2.0	N/A	2 x 3.0**	3.0 minimum	N/A	2.0	2.0 minimum	
CH. D0-045 to CH. D0-070	2.0 minimum	2.0	N/A	3.0 minimum**	3.0 minimum	N/A	2.0	2.0 minimum	*Tie into local access road **Lane width tapering to introduce additional lanes on approach to junction

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
Sarsfield Road Junction (Alignment D)									
CH. E0+000 to CH. E0+035	2.0 minimum**	2.0	N/A	3.0 minimum	3.0 minimum	N/A	2.0	2.0 minimum	**Footpath terminates at pedestrian crossing
CH. E0+035 to CH. E0+050	2.0 minimum**	N/A	N/A	3.0 minimum**	3.0 minimum	N/A	N/A	2.0 minimum	**Footpath terminates at pedestrian crossing
CH. E0+050 to CH. E0+110	2.0 minimum**	N/A	N/A	3.0 minimum	N/A**	N/A	N/A	2.0 minimum	*Footpath terminates at before rail bridge **Traffic lane tapers into single lane under the rail bridge
CH. E0+110 to CH. E0+350	2.0 minimum*	N/A	N/A	3.0 minimum*	3.0 minimum*	N/A	N/A	2.0 minimum*	*Existing retained
CH. E0+350 to CH. E0+450	2.0 minimum	N/A	3.0 minimum	N/A	3.0 minimum	N/A	N/A	2.0 minimum	
Bow Lane West (Alignment K)									

Chainage Reference	Proposed Westbound/Outbound Carriageway				Proposed Eastbound/Inbound Carriageway				Proposed Scheme Notes
	Footpath Width (m)	Cycle Lane/Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Traffic Lane Width (m)	Bus Lane Width (m)	Cycle Lane/Track Width (m)	Footpath Width (m)	
CH. K0+100 to CH. E0+065	2.0 minimum*	N/A	N/A	3.0 minimum*	3.0 minimum*	N/A	N/A	2.0 minimum*	*Tie into existing
CH. E0+065 to CH. E0+000	2.0 minimum	N/A	N/A	3.0 minimum	3.0 minimum	N/A	2.0*	2.0 minimum	*2.1m parallel parking provision separating cycle track from bus lane *0.75m minimum protective kerb between on street parking and cycle track

4.3 Design Speed

The design speed to which the horizontal and vertical alignment of the Proposed Scheme has been developed has been governed by DMURS and the guidance provided by the DTTAS in the document Guidelines for Setting and Managing Speed Limits in Ireland.

As outlined in DMURS '*Design Speed is the maximum speed at which it is envisaged/intended that the majority of vehicles will travel under normal conditions*' for the urban road sections. DMURS recommends that '*in most cases the posted or intended speed limit should be aligned with the design speed*' and that the design speed of a road or street must not be '*up designed*' so that it is higher than the posted speed limit. DMURS sets out that designers '*must balance speed management, the values of place and reasonable expectations of appropriate speed according to context and function*'.

Consideration for selection of an appropriate design speed is undertaken in light of the 'Function and Importance of Movement' and 'Context' of the street network, as explained further in DMURS Section 3.2. The 'Design Speed Selection Matrix' as shown in **Figure 4.2** below is also used to inform the appropriate design speed, extracted from DMURS Chapter 4.

PEDESTRIAN PRIORITY — VEHICLE PRIORITY

FUNCTION					
ARTERIAL	30-40 KM/H	40-50 KM/H	40-50 KM/H	50-60 KM/H	60-80 KM/H
LINK	30 KM/H	30-50 KM/H	30-50 KM/H	50-60 KM/H	60-80 KM/H
LOCAL	10-30 KM/H	10-30 KM/H	10-30 KM/H	30-50 KM/H	60 KM/H
CONTEXT	CENTRE	N'HOOD	SUBURBAN	BUSINESS/ INDUSTRIAL	RURAL FRINGE

Figure 4.2: Design Speed Selection Matrix

The design speeds used for the existing and proposed mandatory speed limits on the Proposed Scheme are detailed in **Table 4-3** below. The Proposed Scheme will introduce a reduced speed limit from 50km/h to 30km/h from the South Circular Road junction to the city centre. This has been proposed due to width constraints, cyclists will be required to share the carriageway with buses, general traffic and trams through this section.

Table 4-3: Existing and Proposed Design Speeds

Chainage Reference	Road / Junction Name	DMURS Road Function	DMURS Place Context	Existing Design Speed (km/h)	Proposed Design Speed (km/h)	Proposed Posted Speed Limit (km/h)
A1339 to A450	Fonthill Road	Urban Link	Urban Link	50	50	50
A450 to A150	Fonthill Road - Liffey Valley Retail Park Roundabout to Tesco/B&Q Roundabout	Urban Link	Urban Link	50	50	50

Chainage Reference	Road / Junction Name	DMURS Road Function	DMURS Place Context	Existing Design Speed (km/h)	Proposed Design Speed (km/h)	Proposed Posted Speed Limit (km/h)
A150 to A0	Fonthill Road - Tesco/B&Q Roundabout to Coldcut Road	Urban Link	Urban Link	50	50	50
B-82 to B220	Coldcut Road – Fonthill Road to M50 Overbridge	Urban Arterial	Urban Arterial	50	50	50
B220 to B280	M50 Overbridge	Urban Arterial	Urban Arterial	50	50	50
B280 to B480	Coldcut Road - M50 Overbridge to Cloverhill Road	Urban Arterial	Urban Arterial	50	50	50
B480 to B770	Coldcut Road - Cloverhill Road to Kennelsfort Road Upper	Urban Link	Urban Link	50	50	50
B770 to B1515	Ballyfermot Road - Kennelsfort Road Upper to Cleegan Road	Urban Arterial	Urban Arterial	50	50	50
B1515 to B2010	Ballyfermot Road - Cleegan Road to Clifden Road	Urban Arterial	Urban Arterial	50	50	50
B2010 to B2385	Ballyfermot Road - Clifden Road to Le Fanu Road	Urban Arterial	Urban Arterial	50	50	50
-	Le Fanu Road	Local	Local	50	50	50
B2385 to B2885	Ballyfermot Road - Le Fanu Road to Kylemore Road	Urban Arterial	Urban Arterial	50	50	50
-	Le Fanu Road	Local	Local	50	50	50
D448 to D0	Kylemore Road	Local	Local	50	50	50
-	Ballyfermot Road	Urban Arterial	Urban Arterial	50	50	50
B2885 to B3565	Ballyfermot Road - Kylemore Road to O’Hogan	Urban Arterial	Urban Arterial	50	50	50
B3565 to B3835	Ballyfermot Road - O'Hogan Road to St. Laurence Road	Urban Arterial	Urban Arterial	50	50	50
-	St. Laurence Road	Link	Link	50	50	50
B3835 to B4285	Sarsfield Road – St. Laurence Road to Landen Road	Urban Arterial	Urban Arterial	50	50	50
B4285 to B5100	Sarsfield Road – Landen Road to Con Colbert Road signalised junction	Urban Arterial	Urban Arterial	50	50	50

Chainage Reference	Road / Junction Name	DMURS Road Function	DMURS Place Context	Existing Design Speed (km/h)	Proposed Design Speed (km/h)	Proposed Posted Speed Limit (km/h)
-	Con Colbert Road	Urban Arterial	Urban Arterial	50	50	50
E0 to E457	Sarsfield Road - Sarsfield Road to Grattan Crescent/Inchicore Road Junction	Urban Link	Urban Link	50	50	50
B5200 to B5400	Inchicore Road	Urban Link	Urban Link	50	50	50
B5100 to B5200	Memorial Road	Urban Link	Urban Link	50	50	50
B5400 to B5650	Grattan Crescent	Urban Link	Urban Link	50	50	50
B5640 to B5825	Emmet Road – Grattan Crescent to St. Vincent Street West	Urban Link	Urban Link	50	50	50
B5825 to B6025	Emmet Road - St. Vincent Street West to Bulfin Road	Urban Link	Urban Link	50	50	50
B6025 to B6565	Emmet Road – Bulfin Road to South Circular Road	Urban Link	Urban Link	50	50	50
B6565 to B6950	Old Kilmainham	Urban Link	Urban Link	50	50	30
B6950 to B7300	Mount Brown	Urban Link	Urban Link	50	50	30
B7300 to B7700	James's Street	Urban Link	Urban Link	50	50	30
-	James's Street (West)	Urban Link	Urban Link	50	50	30
-	Bow Lane West	Urban Link	Urban Link	50	50	30
B7700 to B7850	James's Street/Bow Lane West junction	Urban Link	Urban Link	50	50	30
B7850 to B7900	James's Street (East)	Urban Link	Urban Link	50	50	30
B7900 to B8150	Thomas Street - Echlin Street to Watling Street	Urban Arterial	Urban Arterial	30 - 40	30 - 40	30
B8150 to B8375	Thomas Street – Watling Street to Bridgefoot Street	Urban Arterial	Urban Arterial	30 - 40	30 - 40	30
B8375 to B8525	Thomas Street - Bridgefoot Street to Meath Street	Urban Arterial	Urban Arterial	30 - 40	30 - 40	30
B8525 to B8665	Thomas Street - Meath Street to John Street	Urban Arterial	Urban Arterial	30 - 40	30 - 40	30

Chainage Reference	Road / Junction Name	DMURS Road Function	DMURS Place Context	Existing Design Speed (km/h)	Proposed Design Speed (km/h)	Proposed Posted Speed Limit (km/h)
B8665 to B8735	Thomas Street - John Street to St. Augustine Street	Urban Arterial	Urban Arterial	30 - 40	30 - 40	30
B8735 to B8825	Thomas Street - St. Augustine Street to Cornmarket Junction	Urban Arterial	Urban Arterial	30 - 40	30 - 40	30
B8825 to B9035	High Street	Urban Arterial	Urban Arterial	30- 40	30- 40	30

4.4 Alignment Modelling Strategy

The 3D model design, including the horizontal and vertical alignments, 3D modelling corridors and the associated design features have been developed using the Autodesk Civil 3D software in accordance with the BCID BIM Execution Plan. The models have been developed for the purposes of informing the scheme extents and informing the preliminary design for the requirement for any significant earthworks/ retaining structures along the Proposed Scheme.

As part of the alignment design process, the horizontal and vertical design has been optimised to minimise impact to the existing road network and adjoining properties where feasible. Horizontal and vertical alignments have been developed to define the road centrelines for the proposed route layout while also taking cognisance of the existing road network. In terms of the horizontal alignments, due consideration has been given to aligning the centrelines as close to existing as practicable. However the overriding determining factor for locating the horizontal alignment is to ensure it is positioned in the centre of the proposed carriageway. This is ideally along a central lane marking on the carriageway, in order to minimise rideability issues for vehicles crossing the crown line.

In the case of developing the vertical alignment along the route, a refinement process has been undertaken to minimise impacts to the existing road network and develop the proposed carriageway levels as close to existing as practicable. In most circumstances however, due to a change in cross-section, due consideration is given to the resulting level difference at the outer extents of the carriageway, particularly through urban areas where a difference in existing and proposed footpath levels will require additional temporary landtake to facilitate tie-in.

Existing ground levels have been determined using the existing ground model produced for the Proposed Scheme from the topographical survey. This existing ground model informs the differences between the proposed design and the existing road levels along the route, while at junctions it is also used to determine dwell area gradients and lengths to facilitate junction realignment.

The developed alignment design sets parameters for development of other design elements such as drainage, determination of earthworks, utility/services placement etc.

4.5 Summary of Horizontal Alignment

Existing alignments and crossfalls along the Proposed Scheme have been generally retained wherever practical. DMURS provides the following guidance in relation to modifications of existing arterial and link road geometry:

'Designers should avoid major changes in the alignment of Arterial and Link streets as these routes will generally need to be directional in order to efficiently link destinations.

Major changes in horizontal alignment of Arterial and Link streets should be restricted to where required in response to the topography or constraints of a site.'

In some areas, minor adjustments will be required to the horizontal alignment to deliver the requisite width to ensure the provision of the necessary traffic lanes, bus lanes, cyclist and pedestrian facilities which would also allow the drainage of surface water into new/relocated road gullies.

In areas where road widening and minor changes to the horizontal alignment will not be practicable due to constraints (environmental, residential, geometrical etc.), new construction has been provided through greenfield areas to ensure the provision of continuity of design throughout the scheme.

In light of the above, the horizontal and vertical alignment of the mainline are generally as per the existing parameters and surveys. The alignment of the scheme is generally compatible with the selected design speed and associated safe Stopping Sight Distance, notwithstanding localised adjustments in the horizontal alignment at Ch A500 to A400, A200 to A100 and B2850 to B2950. These have been undertaken to facilitate the conversion of the existing Fonthill Road, Fonthill Road / Coldcut Road and Ballyfermot Road roundabouts to new signalised junctions.

4.6 Summary of Vertical Alignment

Due to the nature of the proposed design (i.e. the majority of the design proposals involve widening of the existing roadway in order to accommodate additional facilities), every effort has been made to ensure the vertical alignment adheres as closely as practicable to the existing arrangement.

DMURS defines the vertical alignment of a road as follows:

'*A vertical alignment consists of a series of straight-line gradients that are connected by curves, usually parabolic curves. Vertical alignment is less of an issue on urban streets that carry traffic at moderate design speeds and changes in vertical alignment should be considered at the network level as a response to the topography of a site.*'

Visibility concerns associated with adverse vertical crest and sag curves have not been identified on the Proposed Scheme due to the nature of the existing urban road network. Notwithstanding, the vertical alignment of the proposed road development has also been assessed to ensure hard standing areas have been designed above the minimum gradient of 0.5% to mitigate localised surface water ponding and facilitate surface run-off drainage measures.

4.7 Forward Visibility

Forward visibility is the distance along the street which a driver of a vehicle can see. The minimum level of forward visibility required along a street for a driver to stop safely, should an object enter its path, is based on the Stopping Sight Distance (SSD).

The SSD is the theoretical minimum forward sight distance required by a driver travelling at free speed (i.e. not influenced by other drivers) in order to stop the car when faced with an unexpected hazard on the carriageway. This is calculated as the total distance it takes the driver driving at the design speed to stop safely. It is measured along the centreline of the lane in which the vehicle is travelling, and a rule of thumb is that a driver sitting in a low vehicle (eye height 1.05m) must be able to see an object 0.26m high from the SSD distance.

SSD = perception distance + reaction distance + braking distance.

The SSD standards which have been applied to the proposed design in accordance with the design guidance given within DMURS are shown in **Table 4-4.**

Table 4-4: SSD Design Standards

SSD STANDARDS

Design Speed (km/h)	SSD Standard (metres)
10	7
20	14
30	23
40	33
50	45
60	59

Forward Visibility

Design Speed (km/h)	SSD Standard (metres)
10	8
20	15
30	24
40	36
50	49
60	65

Forward Visibility on Bus Routes

The desirable minimum forward visibility requirements are being achieved across the majority of the Proposed Scheme. A summary of the location experiencing a reduction in forward visibility is noted in **Table 4-5** below.

Table 4-5: Location where reduced forward visibility is provided

Road Name	Direction	Chainage	Desirable Minimum SSD	Achieved SSD
Emmet Road	Eastbound	Ch 5+710 Ch 5+750	49m	39m

4.7.1 Junction Visibility

An assessment of visibility at major and minor junctions has been completed along the route. In accordance with DMURS, the SSD parameters for relevant design speeds has been adopted as the Y-Distance visibility to be achieved while an X-Distance of 2.4m (reduced to 2.0m as a relaxation) has been implemented.

An assessment of the junction visibility at accesses serving individual properties and single dwellings has been undertaken, ensuring that the existing visibility splay “X” and “Y” are maintained or improved.

4.7.2 Junction Intervisibility

In the absence of DMURS guidance with respect to visibility at signalised junctions, the principles and parameters of ‘Junction Intervisibility’ from DNGEO-03044 (The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts) has been adopted as a benchmark to assess the intervisibility at all signalised junctions.

As many of the junctions along the Proposed Scheme will involve retrofitting of the existing layout in an urban environment to provide additional NMU provisions in addition to the requirements to facilitate vehicle swept-paths, junction intervisibility will be impacted.

4.8 Corner Radii and Swept Path

In line with the Proposed Scheme objectives of improving facilities for walking and cycling, corner radii along the route are to be reduced where appropriate in order to lower the speed at which vehicles can turn corners, and to increase inter-visibility between users.

Junctions are where the actual and perceived risk to both cyclists and pedestrians are highest and usually represent the most uncomfortable parts of any journey. In order to provide a design whereby vehicles navigate through turns at a reduced speed, thereby reducing the risk of serious collisions, kerb and footway buildouts have been included on the majority of the designed junctions along the route thus adhering to design guidance given within the DMURS document where it is stated:

> *'Build-outs should be used on approaches to junctions and pedestrian crossings in order to tighten corner radii, reinforce visibility splays and reduce crossing distances.'*

The corner radius in urban settings is often determined by swept path analysis. Whilst swept path analysis should be considered, the analysis may overestimate the amount of space needed and/or the speed at which the corner is taken. The design balanced the size of the corner radii with user needs, pedestrian and cyclist safety and the promotion of lower operating speeds. In general, on junctions between Arterial and/or Link streets a maximum corner radius of 6m was applied, which will generally allow larger vehicles, such as buses and rigid body trucks, to turn corners without crossing the centre line of the intersecting road.

A suite of vehicles was collated for consideration in assessment of alignment/ junction designs and entrances to private properties as shown below in **Figure 4.3**.

Name	Width	Length	W/W Rad
'Standard' Articulated Bus	2.520	18.020	11.400
15m 6WS Luxury Coach	2.500	15.000	12.490
DB32 Fire Appliance	2.180	8.680	8.821
DB32 Private Car	1.715	4.223	6.207
DB32 Refuse Vehicle	2.400	7.900	10.323
Double Decker City Bus	2.520	10.704	10.856
Double Decker Regional Bus	2.550	14.145	12.150
FTA Design Articulated Vehicle (1998)	2.550	16.480	7.314
FTA Design Drawbar Vehicle (1998)	2.550	18.751	10.708
Low Entry Regional Commuter Bus	2.550	13.490	12.200
Rigid Truck	2.500	12.000	12.677
Single Deck City Bus	2.445	11.505	11.948
Single Deck Midi Bus	2.445	10.280	11.577

Figure 4.3: Standard Suite of Vehicles Used for Assessment of the Proposed Scheme

In general vehicle tracking/swept path analysis was carried out using the following principles:

- **DB32 Private Car –** Analysis undertaken at impacted private residential properties/car parking areas;
- **DB32 Refuse Vehicle –** Analysis undertaken to ensure refuse vehicles can make turns in/out of all side roads and entries concerning residential/commercial properties;
- **14.1m Double Decker Regional Bus –** Analysis undertaken along the main alignment of the route concerning bus lanes, including the bus interchange area and at junctions;
- **Rigid Truck –** Analysis undertaken along the main alignment of the route;
- **FTA Design Articulated Vehicle (1998) –** Analysis undertaken along the regional roads of the Proposed Scheme.

Section 4.15 of this report details areas of turning bans along the Proposed Scheme.

The following issues were found when carrying out the swept path analysis:

- Buses and lorries/trucks cannot make turns out of Fonthill Road together. Priority signals have been included to allow buses to exit first.
- Lorries entering Cloverhill Road from Coldcut Road westbound would clash with vehicles at the existing kerb line. The stop line has been moved back to accommodate this.
- Buses and lorries/trucks cannot turn at the same time between Coldcut Road / Kennelsfort Road / Ballyfermot Road. Priority signals have been included to allow buses to exit first.

- The stop line has been moved back to accommodate the swept path of buses turning into Grattan Crescent from Emmet Road.

4.9 Pedestrian Provision

DMURS defines the footpath cross section by three distinct areas. The 'footway' area is designated as the main throughfare within the footpath designated for pedestrian movement along the street. The 'verge' area provides an area that can be used for street furniture as well as an overflow area for pedestrian movement. In some circumstances the verge area can also provide a buffer for high speed traffic, however for the majority of the Proposed Scheme a cycle track will perform a similar function for separation from motorised traffic. The 'strip' area is designated as a specific location for which retail/commercial/private premises may undertake certain outdoor activities including dining, stalls or outdoor seating etc. These areas often have specific licenses or agreements in place with the Council or have dedicated legal interests (private landings) over this area of the footpath. The assessment of these areas is further discussed in Chapter 13.

Figure 4.4 provides an extract from DMURS demonstrating the relevant components of the footpath.

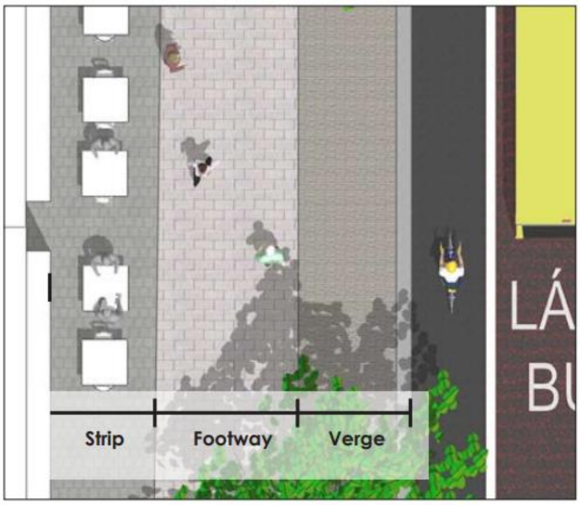

Figure 4.4: Key Components of the Footpath

4.9.1 Footway Widths

The adopted footway design width parameters have been provided in **Table 4-1.**The desirable minimum footway width for the Proposed Scheme is 2m and an absolute minimum width of 1.8m has been adopted at constrained sections.

At specific pinch points, Building for Everyone: A Universal Design Approach, defines acceptable minimum footpath widths as being 1.2m wide over a 2m length of path.

In line with the Road User Hierarchy designated within DMURS, at pinch points, the width of the general traffic lane should be reduced first, then the width of the cycle track should be reduced before the width of the pedestrian footpath is reduced. For the majority of the Proposed Scheme extents minimum lane widths have been adopted throughout.

Throughout the scheme, footway widths of 2m or wider have been proposed, with the exception of a limited number of stretches where a width of 1.8m or greater is proposed due to the presence of localised space constraints. The existing and Proposed Scheme nominal footway widths over the length of the corridor have been provided in **Table 4-2.**

4.9.2 Footway Crossfall

The adopted footway design crossfall parameters have been provided in **Table 4-6**. The footpath crossfall is recommended to be 2% - 3.3% as per DN-PAV-03026.

Table 4-6: DN-PAV-03026, *Figure 2.3 Geometric Parameters for Footways*

Parameter	Recommended Limits	Extreme Limits
Longitudinal gradient (normally the same as adjacent highway)	1.25% to 5%	8% maximum*
Width	2m minimum	1.3m minimum
Crossfall	2% to 3.3%	1.5% minimum to 7% maximum at crossings

Note: *In some cases it may be necessary to construct a footway with a gradient of more than 8 per cent. Provision of a handrail is recommended if site constraints necessitate a gradient steeper than 10 per cent.

Building for Everyone: A Universal Design Approach recommends that crossfalls should ideally be limited to 1:50 or 2% gradient as steeper gradients can tend to misdirect prams, pushchairs and wheelchairs. This approach has been generally adopted to within the constraints of the existing footpath extents.

4.9.3 Longitudinal Gradient

The adopted footway design longitudinal grading parameters have been provided in **Table 4-1**. The footway longitudinal gradient follows the gradient of the proposed carriageway. DN-PAV-03026, Table 2.3 shown in **Table 4-6** recommends a longitudinal gradient of 1.25%-5%.

Similar to cycle tracks throughout the scheme, longitudinal gradients of footway are likely to be constrained by the longitudinal gradient of the adjacent carriageway with little scope to vary the footway separately. There are no designated ramps for the Proposed Scheme with longitudinal grading generally falling within the acceptable range.

4.9.4 Pedestrian Crossings

The adopted pedestrian crossing design parameters have been provided in **Table 4-1**. Where practicable, DMURS recommends that designers provide pedestrian crossings that allow pedestrians to cross the street in a single, direct movement. To facilitate road users who cannot cross in a reasonable time, the desirable maximum crossing length without providing a refuge island is 18m. This may be increased to 19m as an absolute maximum. This is applicable at stand-alone pedestrian crossings as well as at junctions.

Refuge islands should be a minimum width of 2m. Larger refuge islands should be considered by designers in locations where the balance of place and movement is weighted towards vehicle movements, such as where the speed limit is 60kph or greater, in suburban areas or where there is an increased pedestrian safety risk due to particular traffic movements. Straight crossings can be provided through refuge islands only where the island is 4m wide or more. Islands of less than 4m in width should provide for staggered crossings.

Where space allows, crossing lengths can be minimised by accommodating a suitable landing area for pedestrians between the road carriageway and cycle track, with the cycle track crossing controlled by mini-zebra markings. This reduced pedestrian crossing distance will have the added benefit of improving overall junction performance due to reduced intergreen times.

Along the Proposed Scheme, pedestrian crossings varying from 2.4m and 4m in width have been incorporated throughout the design. Larger pedestrian crossing widths have been allocated in areas that are expected to accommodate a high number of non-motorised users.

At signalised junctions and standalone pedestrian crossings, the footway is to be ramped down to carriageway level to facilitate pedestrians who require an unobstructed crossing. At minor junctions, raised tables are provided to raise the road level up to footway level and facilitate unimpeded crossing. Tactile paving is provided at the mouth of each pedestrian crossing and is to be designed in accordance with standards. Audio units are to be provided on each traffic signal push-button.

Formal crossing points are to be provided on the upstream side of bus stop islands, consisting of an on-demand signalised pedestrian crossing with appropriate tactile paving, push buttons and LED warning studs. A secondary informal crossing should be provided on the desire line on the downstream side of the island.

4.10 Accessibility for Mobility Impaired Users

The aim of the Proposed Scheme is to provide enhanced walking, cycling and bus infrastructure along the corridor. In achieving this aim, the Proposed Scheme has generally been developed in accordance with the principles of DMURS and Building for Everyone: A Universal Design Approach.

The following non exhaustive list of relevant standards and guidelines have informed the approach to Universal Design in developing the Proposed Scheme:

- Building for Everyone: A Universal Design Approach; Centre for Excellence in Universal Design at the National Disability Authority (NDA CEUD);
- How Walkable is Your Town, (NDA CEUD, 2015);
- Shared Space, Shared Surfaces and Home Zones from a Universal Design Approach for the Urban Environment in Ireland CEUD;
- Best Practice Guidelines, Designing Accessible Environments. Irish Wheelchair Association;
- DfT Inclusive Mobility;
- UK DfT Guidance on the use of tactile paving surfaces; and
- BS8300:2018 Volume 1 Design of an accessible and inclusive built environment. External Environment-code of practice.

The Disability Act 2005 places a statutory obligation on public service providers to consider the needs of disabled people. A specialist consultant was engaged to undertake an Accessibility Audit of the existing environment along the corridor. The Audit provided a description of the key accessibility features and potential barriers to disabled people based on the Universal Design standards of good practice listed above. A copy of the audit has been provided in **Appendix I**, it should be noted that the audit was undertaken in the early design stages with the view to implementing any key measures identified as part of the design development process.

The audit provided a description of the key accessibility features and potential barriers to mobility impaired people based on good practice, and identified the following issues to be addressed in the design process:

- Accessible Parking - On-street Disabled Parking Space layout should be to the appropriate standard, with dropped kerb access between the parking space and footpath;
- Access Routes on Footpaths - Width of footpaths should be clear of clutter, such as street furniture, and allow unimpeded access for the mobility impaired, and in doing so, meet the minimum standards for widths;
- Drainage - All footpaths should have sufficient cross-fall for drainage purposes but without affecting the ability of mobility-impaired people to move safely along the corridor;
- Guardrails - Guardrails should be located only where needed for safety purposes – and care should be taken not to create narrow spaces which create difficulties for movement;

- Pedestrian Crossing Points - Pedestrian crossing points should be laid out in accordance with standards and make it convenient and safe for mobility impaired users to negotiate crossing of carriageways;
- Controlled and Uncontrolled Crossings - Controlled and Uncontrolled Crossings should have tactile paving laid out correctly to provide tactile and visual assistance to mobility-impaired users approaching crossing points;
- Changes in Level - Any changes in level should be addressed in the design process to ensure that all changes in level, where practicable, comply with standards;
- Shared pedestrian/cyclist areas - Shared pedestrian/cyclist areas should be well laid out, with clear visual and tactile elements included, to ensure that these areas are safe for mobility-impaired users, pedestrians and cyclists;
- Surface Material - Footpath materials should be selected to ensure surfaces are free of undulations, with no trip hazards where there is a transition between surface materials – or where the Proposed Scheme ties into the existing infrastructure; and
- Street Furniture - All poles for signs and street lighting should be carefully located to minimise the effect on the safe and convenient passage of pedestrians and cyclists, with due cognisance to the safe movement of mobility impaired users.

A detailed scheme breakdown of the relevant existing and proposed footways have been provided in **Table 4-2.** In achieving the enhanced pedestrian facilities there has been a concerted effort made to provide clear segregation of modes at key interaction points along the corridor which was highlighted as a potential mobility constraint in the audit of the existing situation, particularly for people with vision impairments. In addressing one of the key aspects to segregation, the use of the 60mm set down kerb between the footway and the cycle track is of particular importance for guide dogs, where by the use of white line segregation is not as effective for establishing a clear understanding of the change of pavement use and potential for cyclist/pedestrian interactions.

One of the other key areas that was focused on was the interaction between pedestrians, cyclists and buses at bus stops. The Proposed Scheme has implemented the use of island bus stops to manage the interaction between the various modes with the view to providing a balanced safe solution for all modes. This is further discussed in **Section 4.13**.

4.11 Cycling Provision

One of the core objectives of the Proposed Scheme is to enhance the potential for cycling by providing safe infrastructure for cycling, segregated from general traffic wherever practicable. Physical segregation ensures that cyclists are protected from motorised traffic as well as independent of vehicular congestion, thus improving cyclist safety and reliability of journey times for cyclists. Physical segregation can be provided in the form of vertical segregation, (e.g. raised kerbs), horizontal segregation, (e.g. parking/verge protected cycle tracks), or both.

The 'preferred cross-section template' developed for the Proposed Scheme consists of protected cycle tracks, providing vertical segregation from the carriageway to the cycle track and vertical segregation from the cycle track to the footway.

The principal source for guidance on the design of cycle facilities is the NCM published by the NTA.

The desirable minimum width for a single-direction, with-flow, raised-adjacent cycle track is 2m. This arrangement allows for two-abreast cycling. Based on the NCM width calculator, this allows for overtaking within the cycle track. The minimum width is 1.5m, which based on the NCM width calculator, allows for single file cycling. Localised narrowing of the cycle track below 1.5m may be necessary over very short distances to cater for local constraints (e.g. mature trees).

The desirable minimum width for a two-way cycle track is 3.25m. In addition to this, a buffer of 0.5m should be provided between the two-way cycle track and the carriageway. Using the NCM width calculator, reduction of these desirable minimum widths can be considered on a case-by-case basis, with due cognisance of the volume of cyclists anticipated to use the route as well as the level of service required.

The Proposed Scheme is approximately 9.2km long. The preliminary design drawings included within **Appendix B** show the improved extent of cycle provision, which is summarised below:

- 37% Existing cycle priority (outbound) (9% cycle track, 28% advisory cycle lane,);
- 47% Existing cycle priority (citybound) (15% cycle track, 32% advisory cycle lane);
- 70% Proposed cycle priority (outbound) (72% cycle track, 2% quiet street); and
- 70% Proposed cycle priority (citybound) (70% cycle track).

4.11.1 Segregated Cycle Tracks

A segregated cycle track is a cycle track which is physically segregated from the adjacent traffic lane and/or bus lane horizontally and/or vertically as shown in **Figure 4.5** below, taken from the BCPDGB.

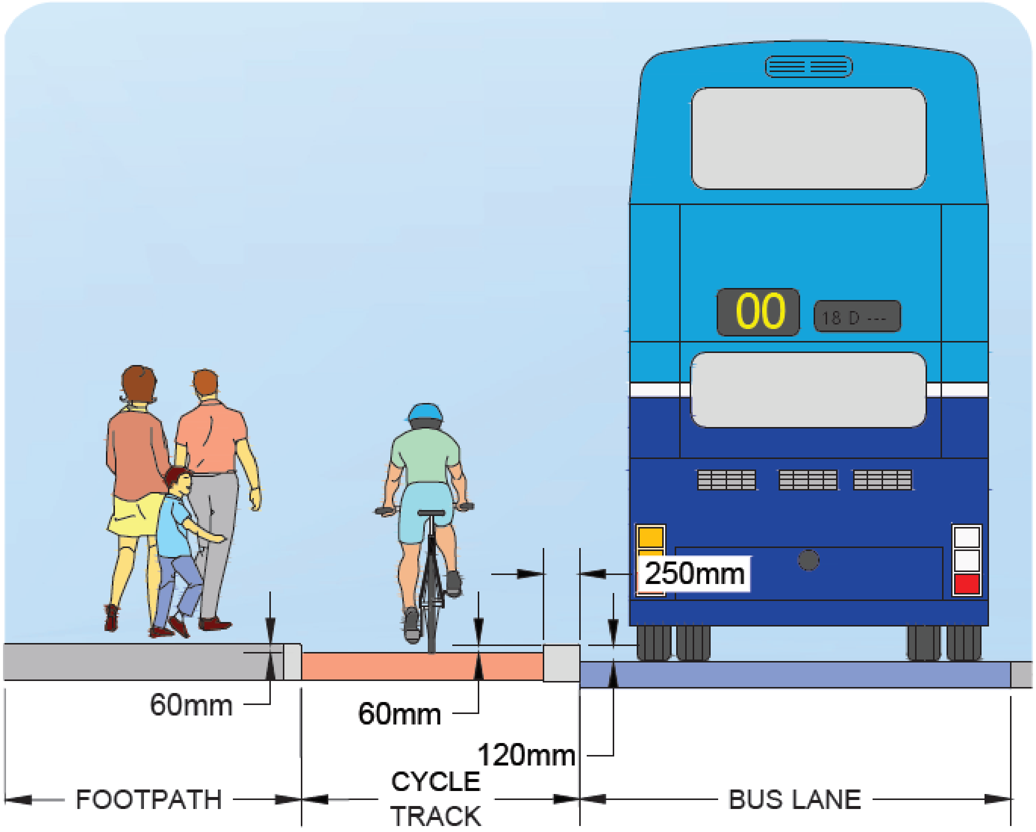

Figure 4.5: Fully Segregated Cycle Track

Wherever practicable, the Proposed Scheme design has endeavoured to incorporate segregated cycle tracks, and has done so in the following locations:

- Fonthill Road;
- Coldcut Road;
- Ballyfermot Road;
- Sarsfield Road;
- Kylemore Road;
- Memorial Road; and

- High Street

The desirable minimum width for a single-direction, with-flow, raised-adjacent cycle track is 2.0m. This is based on the NCM width calculator and allows for overtaking within the cycle track. The minimum width is 1.5m, based on the NCM width calculator, and allows for single-file cycling. Localised narrowing of the cycle track below 1.5m may be necessary over very short distances to cater for local constraints (e.g. mature trees).

At grade cycle tracks (as per NCM Section 4.3.4) have been used to maintain the existing kerb lines as the route approaches the City Centre in order to maintain the existing street layout and kerb lines. The cycle tracks will be at carriageway level and segregated from general traffic. At-grade cycle tracks have been proposed in the following locations:

- James's Street; and
- Thomas Street.

Between Sarsfield Road and Chapelizod Bypass it is proposed to extend the proposed cycle track to tie into the proposed cycle infrastructure that forms part of the Lucan to City Centre CBC Scheme. If the cycling infrastructure proposed as part of the Lucan to City Centre CBC Scheme is not in place when the Proposed Scheme is being implemented, cyclist have an alternative route to the City Centre via Sarsfield Road, Inchicore Road, Kilmainham Lane and Bow Lane where they will re-join the Proposed Scheme

4.11.2 Cycle Lane

Cycle lanes are designated lanes on the carriageway that are reserved either exclusively or primarily for the passage of cyclists. Standard cycle lanes include mandatory cycle lanes and advisory cycle lanes. Mandatory cycle lanes are marked by a continuous white line which prohibits motorised traffic from entering the lane, except for access, and parking is not permitted on them. Mandatory cycle lanes are 24-hour unless time-plated in which case they are no longer cycle lanes. Advisory cycle lanes are marked by a broken white line which allows motorised traffic to enter or cross the lane. They are used where a mandatory cycle lane leaves insufficient residual road space for traffic, and at junctions where traffic needs to turn across the cycle lane. Parking is not permitted on advisory cycle lanes other than for set down and loading. Advisory cycle lanes are 24-hour unless time-plated.

Cycle tracks are the preferred cycling infrastructure proposed along the length of the scheme. Where necessary the use of cycle lanes has been limited to the following locations typically along the route:

- Transitions to existing cycle lanes, typically on side roads of the main corridor alignment;
- At grade junction crossings; and
- For side road crossings where the cycle track is locally reduced to road level.

4.11.3 Offline Cycle Track

There are no offline cycle tracks provided as part of the Proposed Scheme.

4.11.4 Quiet Street Treatment

Where the Proposed Scheme cannot facilitate cyclists without significant impact on bus priority, alternative cycle routes are explored for short distances away from the Proposed Scheme. Such offline options may include directing cyclists along streets with minimal general traffic other than car users who live on the street. Guidance in this regard has been provided within the BCPDGB which states:

> *'Diversions of proposed cycle facilities on to quieter parallel routes, to avoid localised narrowing of cycle tracks on the main CBC route, is to be considered in the context of the CBC route being listed as a primary cycle route as per the Greater Dublin Area Cycle Network Plan. These diversions, however, may also be considered where appropriate cycle facilities cannot be provided along the CBC route without significant impact.'*

So-called quiet streets (due to the low amount of general traffic) are deemed suitable for cyclists sharing the roadway with the general traffic without the need to construct segregated cycle tracks or painted cycle lanes. The quiet street treatment would involve appropriate advisory signage and lane marking for both the general road users and cyclists..

Quiet street treatment has been proposed on Newington Lane, Basin View, St James's Avenue, Grand Canal Place and Echlin Street to allow westbound cyclists to avoid the Luas tracks on James's Street.

4.11.5 Treatment of Constrained Areas

At some locations along the Proposed Scheme, the desired cycleway width cannot be achieved, and localised narrowing is required.

Providing a standard width would require additional land take from either surrounding private properties or pedestrian areas. Due to the high foot traffic in this area, it is preferable to provide a reduced cycleway width; This has occurred in locations such as -

- Ballyfermot Shopping Village between B2200 to B2670: Providing a standard width would require additional land take from either surrounding private properties or pedestrian areas. Due to the high foot traffic in this area, it is preferable to provide a reduced cycle track width of 1.5m over short section; and
- Markievicz Park between B3325 to B3575: To limit impact on Markievicz Park and the existing mature trees, a reduced cycleway width of 1.5m is proposed.

It is also noted that cycle tracks narrow to minimum 1.5m width to slow the flow of cyclists when approaching mini bus islands and 1m at the bus stop island.

4.11.6 Cycle Parking Provision

As noted in **Section 4.13** bike racks will generally be provided, where practicable, at island bus stops and key additional locations as noted in the Landscape drawings.

4.12 Bus Provision

One of the main objectives of the Proposed Scheme is to enhance the capacity and potential of the public transport system by improving bus speeds, reliability and punctuality through the provision of bus lanes and other measures to provide priority to bus movement over general traffic movements.

The proposed bus provision is shown on the General Arrangement drawings within **Appendix B**. This provision will increase the bus priority along the Proposed Scheme and is shown below as a percentage of the overall scheme length (9.2km)

- 20% existing bus priority (outbound);
- 25% existing bus priority (citybound);
- 100% proposed bus priority (outbound) (65% physical – 35% virtual); and
- 100% proposed bus priority (citybound) (70% physical – 30% virtual).

This increased bus priority will enhance the capacity and potential of the public transport system meeting one of the main objectives of this Proposed Scheme.

4.12.1 Bus Priority

Bus priority for the Proposed Scheme is based on provision of a dedicated lane within the carriageway for the bus to travel unhindered by the general traffic along the road corridors between junctions. At junctions, bus lane provision can be provided up to the stop line wherein adaptive signalling solutions could request a green signal for buses or similarly a short, generally less than 20m section of shared bus/traffic lane in advance of the junction stop line can be provided and configured in a similar manner using adaptive signalling methods to communicate the arrival of a bus on approach to the junction. Both methods provide a high level of bus priority with the latter solution implemented where left turning traffic volumes are relatively low and/or scenarios where less stages/phases are more desirable for junction capacity and bus priority in a fixed time cycle approach where adaptive bus signalling solutions are not appropriate. This is further discussed in Chapter 5 and Chapter 11.

Over the majority of the route, as per the guidance for traffic lane widths outlined in DMURS, a minimum 3m wide lane is provided for bus only. Larger lane widths are needed in some instances where the swept path of the bus needs more space.

4.12.2 Signal-Controlled Bus Priority

Signal-Controlled Priority uses traffic signals to enable buses to get priority ahead of other traffic on single lane road sections, but it is only effective for short distances. This typically arises where the bus lane cannot continue due to obstructions on the roadway. An example might be pinch-points in a road where it narrows due to existing buildings or structures that cannot be demolished to widen the road to make space for a bus lane. It works through the use of traffic signal controls (typically at junctions) where the bus lane and general traffic lane must merge ahead and share the road space for a short distance until the bus lane recommences downstream. The general traffic will be stopped at the signal to allow the bus to pass through the narrow section first and when the bus has passed the general traffic will be allowed through the lights. In considering signal-controlled priority it is necessary to look at the traffic implications both upstream and downstream of the area under consideration. For the signal-controlled priority to operate successfully, queues or tailbacks on the single (shared bus/traffic) lane portion, cannot be allowed to develop as this will result in delays on the bus service.

Locations where Signal-Controlled Bus Priority has been provided on the Proposed Scheme are highlighted in **Table 4-7.**

Table 4-7: Signal-Controlled Bus Priority Locations

Location	Reason for Mitigation
M50 overbridge; buses travelling in either direction.	Major works to the existing structure or a new bridge would be needed to facilitate extra lanes over the M50. *Approximate Chainage B183 to B325, in both directions.*
Between Markievicz Park and St. Laurence Road; buses travelling eastbound. *Note: to facilitate bus priority on this section, it is also proposed to close the junction of O'Hogan Road and Ballyfermot Road.*	Avoids impacting the retaining wall at St. Laurence Glen. Significantly reduces the land acquisition through this section of the route. Acquiring this land would remove private parking from residential properties which cannot be easily relocated. *Approximate Chainage B3476 to B3850*
Emmet Road at St. Vincent Street West; buses travelling westbound.	The existing building line on both sides of the road do not allow for more than two lanes through this section. *Approximate Chainage B5840 to 5730*
Multiple locations along James's Street and Thomas Street West; buses travelling in both directions.	The bus gate in Mount Brown reduces the number of vehicles travelling along James's Street and Thomas Street which in turn facilities bus priority along this section. The existing road corridor is narrow in places due to the existing building lines.

Location	Reason for Mitigation
	The existing footways are being retained and segregated cycling facilities are being provided. *Approximate Chainage B7920 to B8750, intermittent in both directions.*

4.12.3 Bus Gate

A bus gate is a sign-posted short length of stand-alone bus lane. This short length of road is restricted exclusively to buses, taxis and cyclists plus emergency vehicles. It facilitates bus priority by removing general through traffic along the overall road where the bus gate is located. General traffic will be directed by signage to divert away to other roads before they arrive at the bus gate.

Locations where bus gates have been provided on the Proposed Scheme have been summarised within **Table 4-8**.

Table 4-8: Bus Gate Locations

Location	Reason for Mitigation
Mount Brown – National Children's Hospital – Outbound	Mount Brown and Old Kilmainham are constrained due to the narrow nature of the existing road and the fact that buildings front onto the road on both sides, which limits the options to provide bus priority. As a result, a bus gate has been proposed in order to provide bus priority along this section of the Proposed Scheme. *Approximate Chainage B7060*
James's Street – St. James's Hospital Entrance - Inbound	Mount Brown and Old Kilmainham are constrained due to the narrow nature of the existing road and the fact that buildings front onto the road on both sides, which limits the options to provide bus priority. As a result, a Bus Gate has been proposed in order to provide bus priority along this section of the Proposed Scheme. *Approximate Chainage B7500*

As part of the Non-Statutory Public Consultation on the Proposed Scheme, the bus gate in Mount Brown was raised as an issue for local residents due to the impact on access to and from the area with the bus gate in operation, particularly those living in Ceannt Fort. Meetings were held with local residents and representatives to discuss their concerns with the proposed bus gate. Having considered the feedback, the design and operating hours of the bus gate was refined to minimise the impacts.

It is proposed to provide a bus gate in the westbound direction at the proposed entrance to National Children's Hospital underground car park which will operate in the PM period as the traffic analysis has indicated this period to have the greatest impact on westbound bus journey times. It is also proposed to provide a bus gate in the eastbound direction at the St James's Street entrance to the hospital campus which will operate in the AM period as the traffic analysis has indicated this period to have the greatest impact on eastbound bus journey times. This bus gate will prevent general through-traffic using Old Kilmainham / Mount Brown. By staggering the bus gate, there will be no impact on access to the local area including the Children's Hospital and the Adult hospital at the St James's hospital campus.

4.13 Bus Stops

The below flow chart outlines the process for examining the Proposed Scheme and assessing and reporting on the bus stops along the route, as shown in **Figure 4.6**, below. The Core Bus Network Report concluded that increasing spacing between bus stops was part of the solution to reduce delays along the corridors. For BusConnects it is proposed that bus stops should be spaced approximately 400m apart on typical suburban sections on route, dropping to approximately 250m in urban centres. This spacing should be seen as recommended rather than an absolute minimum spacing.

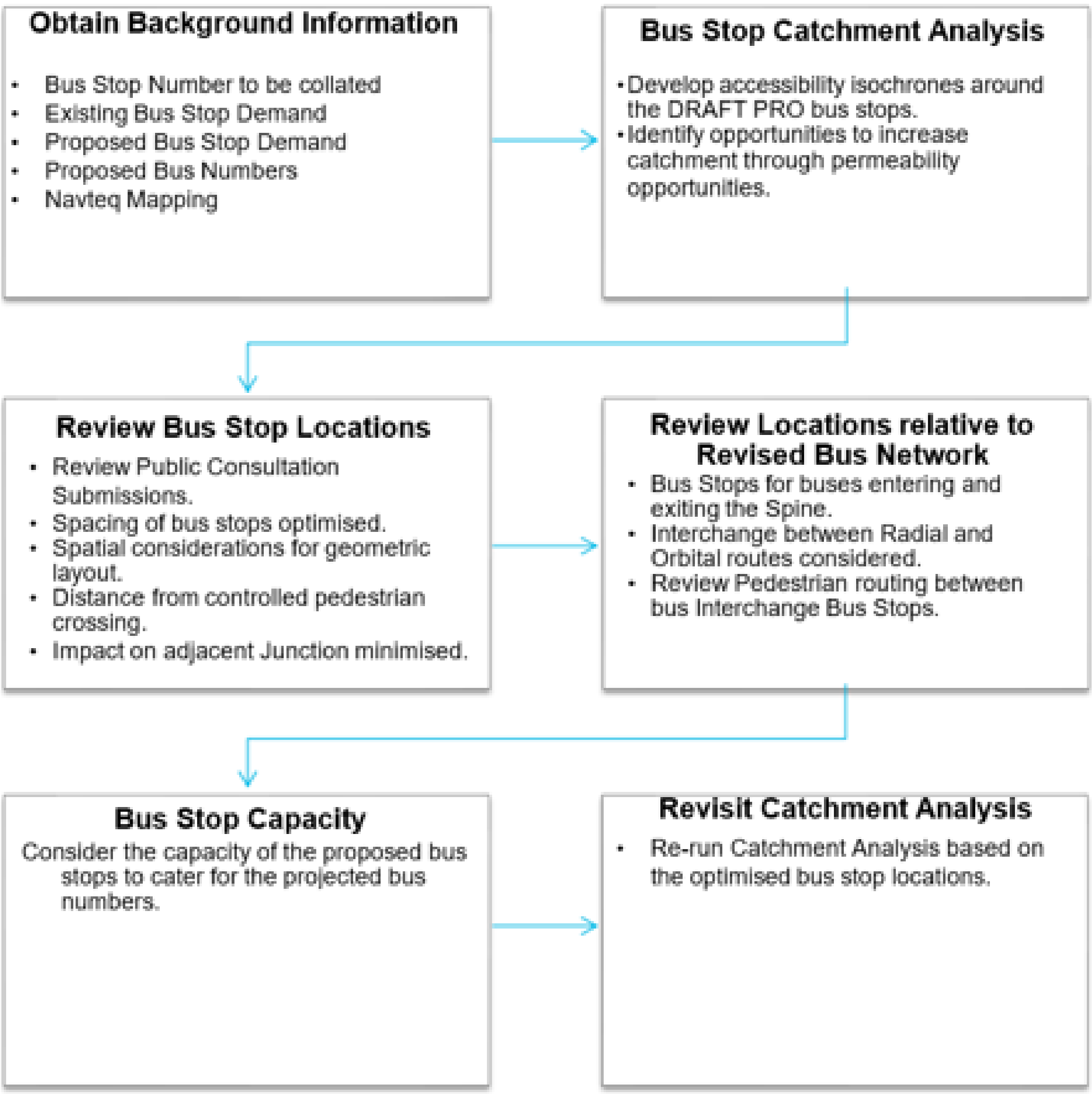

Figure 4.6: Bus Stop Location Assessment Process

The procedure for the assessment undertaken was set out in the Bus Stop Review Methodology document provided in **Appendix H.1.**

The basic criteria for consideration when locating a bus stop are as follows:

- Driver and waiting passengers are clearly visible to each other;
- Located close to key facilities;
- Located close to main junctions without affecting road safety or junction operation;
- Located to minimise walking distance between interchange stops;

- Where there is space for a bus shelter;
- Located in pairs, 'tail to tail' on opposite sides of the road;
- Close to (and on exit side of) pedestrian crossings;
- Away from sites likely to be obstructed; and
- Adequate footway width.

Boarding of passengers and layout of stations is not being examined as they are either not relevant in this case or dealt with elsewhere as part of the overall BusConnects programme.

It is important that bus stops are not located too far from pedestrian crossings as by nature pedestrians will take the quickest route. This may be hazardous and result in jaywalking. Locations with no or indirect pedestrian crossings should be avoided. Their optimum location is a short distance from a controlled crossing point.

4.13.1 Bus Stop Summary

Table 4-9 below provides an overview of the key changes to the locations for bus stops along the route. A more detailed breakdown of the bus stop review in addition to the catchment analysis outputs is provided in **Appendix H.2.** Where specific feedback in relation to bus stops from the public consultation process has been provided this has been acknowledged in the assessment.

Table 4-9: Liffey Valley to City Centre Bus Stop Summary

Inbound							
Existing				Proposed			
No.	Bus Stop Number	Chainage	Distance between Stops (m)	No.	Bus Stop Number / Location	Chainage	Distance between Stops (m)
1	2686	B88	297	1	**New**	**A220**	**291**
2	7510	B385	445	2	2686	B71	314
3	4799	B830	138	3	7510	B385	290
4	2205	B968	285	4	**New**	**B675**	**365**
5	2687	B1253	325	5	2205	B1040	430
6	2688	B1578	288	6	2688	B1470	370
7	2689	B1866	344	7	2689	B1840	370
8	2696	B2210	380	8	2696	B2210	380
9	5007	D220	300	9	5007	D220	N/A
10	2697	B2590	400	10	2697	B2590	400
11	2713	B2990	360	11	2713	B2990	360
12	2714	B3350	440	12	2714	B3315	480
13	2715	B3690	250	13	2716	B3795	345
14	2716	B4040	320	14	2718	B4140	730
15	2718	B4360	536	15	2719	E371	523
16	2719	E371	531	16	1989	B5789	271
17	1989	B5789	298	17	1990	B6060	440
18	1990	B6087	388	18	1992	B6500	257
19	1992	B6475	282	19	1993	B6757	365
20	1024841			20	1994	B7122	453
21	1993	B6757	365	21	1995	B7575	325
22	1994	B7122	453	22	1996	B7900	200

23	1995	B7575	316	23	1997	B8100	326
24	1996	B7891	209	24	1998	B8426	263
25	1997	B8100	326	25	1999	B8689	236
26	1998	B8426	263	26	2001	B8925	N/A
27	1999	B8689	236				
28	2001	B8925	N/A				
		Average distance:	= 338m			Average distance:	= 365m
Outbound							
Existing				Proposed			
No.	Bus Stop Number	Chainage	Distance between Stops (m)	No.	Bus Stop Number/ Location	Chainage	Distance between Stops (m)
1	1937	B8970	276	1	1937	B8970	276
2	1938	B8694	257	2	1938	B8694	257
3	1939	B8437	347	3	1939	B8437	352
4	1940	B8090	243	4	1940	B8085	245
5	1941	B7847	381	5	1941	B7840	374
6	1942	B7466	266	6	1942	B7466	266
7	1943	B7200	358	7	1943	B7200	358
8	1944	B6842	400	8	1944	B6842	420
9	1945	B6442	459	9	1945	B6422	439
10	1946	B5983	113	10	1946	B5983	243
11	1947	B5870	434	11	1947	B5740	325
12	2642	B5436	200	12	2643	E310	669
13	2643	E310	430	13	2644	B4360	550
14	2644	B4387	425	14	2709	B3810	425
15	2709	B3962	445	15	2711	B3385	455
16	2710	B3517	137	16	2712	B2930	330
17	2711	B3380	280	17	4414	D280	N/A
18	2712	B3100	500	18	2655	B2605	380
19	4414	D225	780	19	2656	B2225	380
20	2655	B2600	379	20	2668	B1845	355
21	2656	B2221	311	21	2672	B1490	440
22	2668	B1910	303	22	2206	B1050	385
23	2672	B1607	339	23	4798	B665	315
24	2673	B1268	179	24	**New**	**B350**	**290**
25	2206	B1089	424	25	2674	B60	290
26	4798	B665	605	26	**New**	**A230**	**N/A**
27	2674	B60	390				
		Average distance:	= 358m			Average distance:	= 367m

4.13.2 Island Bus Stops

The preferred bus stop arrangement for the Proposed Scheme is the island bus stop arrangement, Figure 34 of the BCPDGB, is shown below in **Figure 4.7**.

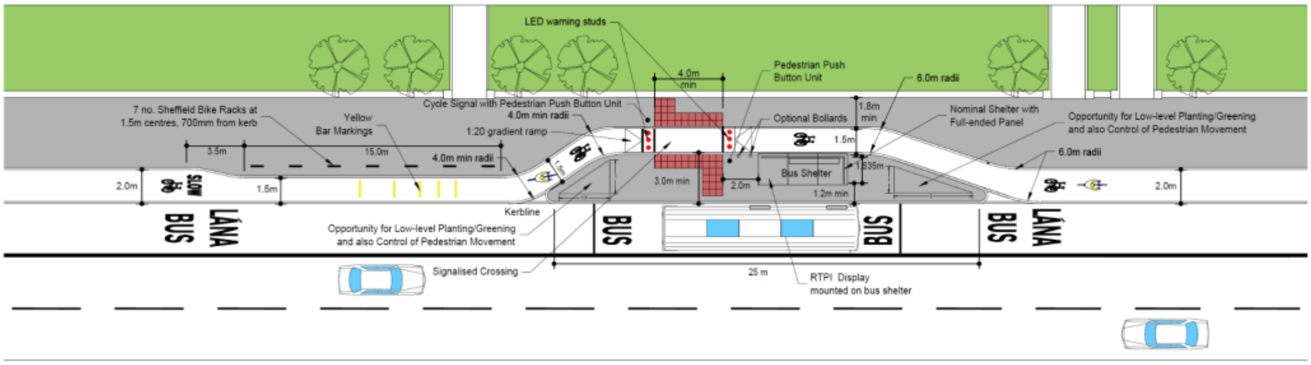

Figure 4.7: Example of an Island Bus Stop

This arrangement will reduce the potential for conflict between pedestrians, cyclists and stopping buses by deflecting cyclists behind the bus stop, thus creating an island area for boarding and alighting passengers. On approach to the bus stop island the cycle track is intentionally narrowed with yellow bar markings also used to promote a low speed single file cycling arrangement on approach to the bus stop. Similarly, a 1 in 1.5 typical cycle track deflection is implemented on the approach to the island to reduce speeds for cyclists on approach to the controlled pedestrian crossing point on the island. To address the potential pedestrian/cyclist conflict, a pedestrian priority crossing point is provided for pedestrians accessing the bus stop island area. At these locations a 'nested Pelican' sequence similar to what has been provided on the Grand Canal Cycle Route could be introduced so that visually impaired or partially sighted pedestrians may call for a fixed green signal when necessary and the cycle signal will change to red. Where the pedestrian call button has not been actuated the cyclists will be given a flashing amber signal to enforce the requirement to give way to passing pedestrians. A schematic outline of the nested pelican sequence is provided below in **Figure 4.8.** Audible tactile units could also be featured at the crossing points.

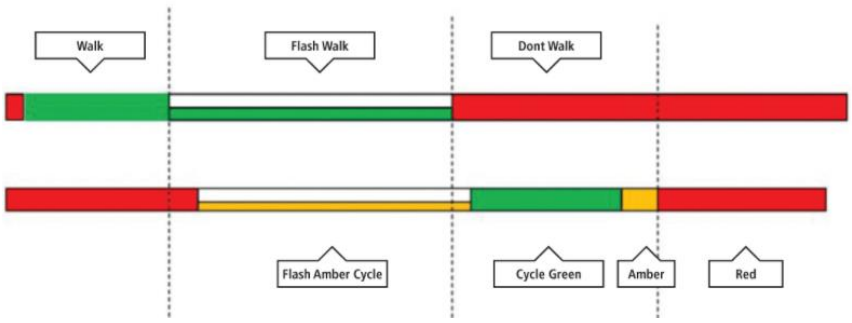

Figure 4.8: Example of a Nested Pelican Sequence

A 1:20 ramp is provided to raise the cycle track to the level of the footpath/island area on a 4m wide crossing. Suitable tactile paving is also provided at the crossing point in addition to a series of LED warning studs which are actuated by bus detector loops in the bus lane. The exit taper for the bus stop has been specified at 1 in 3 to provide for the gradual transition to the cycle track.

The desired minimum island width of 3m has been developed to accommodate the provision of a full end-panel shelter and nominal length of 25m to accommodate a 19m typical bus cage arrangement and adjusted to suit the site constraints (e.g., between driveway entrances). The residual bus stop triangular island arrangements can also be used for areas of planting or SuDS as these areas are not intended for pedestrian circulation and will also help promote directing pedestrians towards the designated crossing point in addition to improving the passenger waiting area environment. Bike racks should also be located, where practicable, in the immediate vicinity as shown in **Figure 4.7** to promote the use of sustainable mode interchange at bus stops for longer distance trips.

Figure 4.9: Example Landscaping Arrangement at Island Bus Stops on Oxford Road, Manchester

The island bus stop design is used for the majority of the bus stops along the Proposed Scheme. Additional information on the island bus stop design principles can be found in the BCPDGB. **Table 4-10** provides a summary of the proposed island bus stop locations.

Table 4-10: List of Island Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Stop Type
Inbound	Liffey Valley Retail Park	-	A220	Island
Inbound	Sports Club	2686	B71	Island
Inbound	Cloverhill Road	7510	B385	Island
Inbound	Coldcut Road	-	B675	Island
Inbound	Cherry Orchard Hospital	2205	B1040	Island
Inbound	Cleggan Park	2688	B1470	Island
Inbound	Blackditch Drive	2689	B1840	Island
Inbound	Ballyfermot Parade	2697	B2590	Island
Inbound	Convent Lawns	5007	D220	Island
Inbound	St. Raphael's National School	2713	B2990	Island
Inbound	Markievicz Park	2714	B3350	Island
Inbound	St. Mary's Avenue	2718	B4140	Island
Outbound	Convent Lawns	4414	D280	Island
Outbound	Ballyfermot	2656	B2225	Island
Outbound	Ballyfermot Community Centre	2668	B1845	Island

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Stop Type
Outbound	Cherry Orchard Hospital	2206	B1040	Island
Outbound	Coldcut Road	4798	B665	Island
Outbound	Dublin Bus Sports	2674	B60	Island
Outbound	N/A	N/A	A230	Island

4.13.3 Shared Landing Area Bus Stops

Where space constraints do not allow for an island bus stop, an option consisting of a shared bus stop landing zone will be considered. The principles of this arrangement are similar to those described in **Section 4.13.2**. The use of corduroy tactile paving on the cycle track is additional in this arrangement to help facilitate awareness and reduce speeds in lieu of the 1:1.5 deflection provision for the island bus stop. The cycle track will also be narrowed when level with the footpath and tactile paving provided to minimise pedestrian/cyclist conflict. Shared landing area bus stops were required in a number of locations along the CBC route due to localised space constraints. See **Table 4-11** for the locations of bus stops of this type. An example of a shared landing area bus stop is shown in **Figure 4.10**.

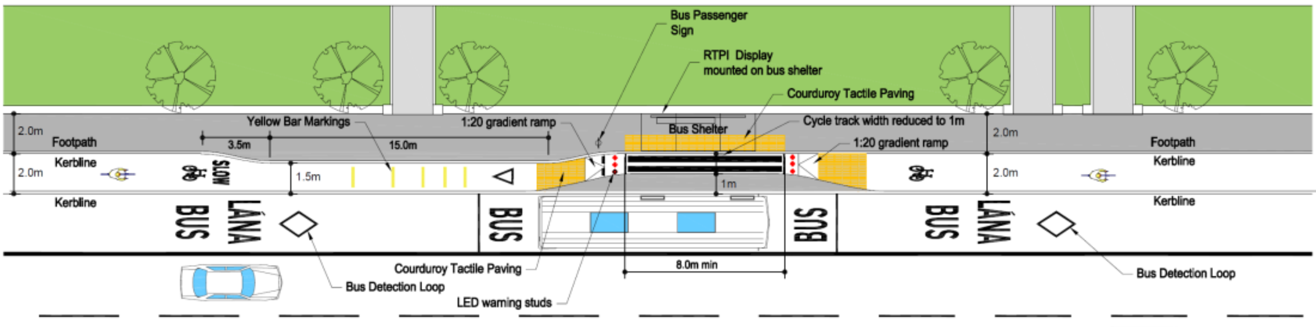

Figure 4.10: Example of a Shared Landing Area Bus Stop

Table 4-11: List of Shared Landing Area Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Stop Type
Inbound	Ballyfermot Road	2696	B2210	Shared
Inbound	Sarsfield Road	2716	B3795	Shared
Inbound	James's Street	1996	B7900	Shared
Inbound	Thomas Street	1997	B8100	Shared
Inbound	Bridgefoot Street	1998	B8426	Shared
Inbound	Francis Street Junction	1999	B8689	Shared
Inbound	High Street	2001	B8900	Shared
Outbound	High Street	1937	B8970	Shared
Outbound	Thomas Street	1938	B8680	Shared
Outbound	Bridgefoot Street	1939	B8437	Shared
Outbound	James's Street	1940	B8070	Shared

Outbound	Steven's Lane	1941	B7840	Shared
Outbound	Sarsfield Medical Centre	2644	B4360	Shared
Outbound	Longmeadows	2709	B3800	Shared
Outbound	Markievicz Park	2711	B3380	Shared
Outbound	St. Raphael's National School	2712	B2930	Shared
Outbound	Ballyfermot Parade	2655	B2605	Shared
Outbound	Cleggan Park	2672	B1490	Shared
Outbound	Cloverhill Road	-	B350	Shared

4.13.4 Inline Bus Stops

Inline bus stops are used on the Proposed Scheme where there are no adjacent cycling facilities provided. Inline bus stops are provided at the following locations listed in **Table 4-11**.

Table 4-12: List of Inline Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Stop Type
Inbound	Woodfield Place	2719	E371	Inline
Inbound	Camac Close	1989	B5789	Inline
Inbound	Myra Cottages	1990	B6055	Inline
Inbound	Inchicore Library	1992	B6460	Inline
Inbound	Old Kilmainham	1993	B6757	Inline
Inbound	Mount Brown	1994	B7122	Inline
Inbound	Basin Street Lower	1995	B7575	Inline
Outbound	St. James's Hospital	1942	B7466	Inline
Outbound	Mount Brown	1943	B7200	Inline
Outbound	Old Kilmainham	1944	B6842	Inline
Outbound	Emmet Road	1945	B6422	Inline
Outbound	Richmond Park	1946	B5983	Inline
Outbound	Camac Close	1947	B5740	Inline
Outbound	Sarsfield Road	2643	E310	Inline

4.13.5 Layby Bus Stops

There are no layby bus stops provided as part of the Proposed Scheme.

4.13.6 Bus Shelters

Bus shelters provide an important function in the design of bus stops. The shelter will offer protection for people from poor weather, with lighting to help them feel more secure, seating is provided to assist ambulant disabled and older passengers and accompanied with Real Time Passenger Information (RTPI) signage to provide information on the bus services. The locations of the bus shelters have been presented on the GEO_GA General

Arrangement drawing series in **Appendix B**. The optimum configuration that provides maximum comfort and protection from the elements to the traveling public is the 3-Bay Reliance 'mark' configuration with full width roof. This shelter is a relatively new arrangement which has been developed by JCDecaux in conjunction with the NTA. The shelter consists mainly of a stainless-steel structure with toughened safety glass and extruded aluminium roof beams. **Figure 4.11** provides an example image of the preferred full end-panel shelter arrangement. The desirable minimum footpath/island widths required to accommodate the full end-panel shelter is 3.3m with an absolute minimum width of 3m to facilitate a minimum 1.2m clearance at the end-panel for pedestrians. Alternative arrangements for more constrained footpath widths are considered in the following sections.

Figure 4.11: Example of a 3-Bay Reliance Full End-Panel Bus Shelter (Source: JCDecaux)

The cantilever shelter using full width roof and half end-panel arrangement provides a second alternative solution for bus shelters in constrained footpath locations. **Figure 4.12** provides an example of this type of shelter. Advertising panels in this arrangement are normally located on the back façade of the shelter compared to the full end-panel arrangement. The desirable minimum footpath/island widths required to accommodate the full end-panel shelter is 2.75m with an absolute minimum width of 2.4m to facilitate a minimum. 1.2m clearance at the end-panels for pedestrians.

Figure 4.12: Example of a 3-Bay Reliance Cantilever Shelter with Full Width Roof and Half End-Panels (Source: JCDecaux)

Two alternative narrow roof shelter configurations are also available which offer reduced protection against the elements compared to the full width roof arrangements. These shelter configurations are not preferred but do provide an alternative solution for particularly constrained locations where cycle track narrowing to minimum 1m width has already been considered and 2.4m widths cannot be achieved to facilitate the full width roof with half end-panel shelter, or for locations where the surrounding environment may offer protection against the elements. The desirable minimum footpath widths for the narrow roof configuration are 2.75m (with end-panel) and 2.1m (no end-panel). The absolute minimum footpath widths for these shelters are 2.4m (with end-panel) and 1.8m (no end-panel) to allow for boarding and alighting passengers in consideration of wheelchair, pram, luggage and other such similar spatial requirements.

Figure 4.13: Example of a 3-Bay Reliance Cantilever Shelter with Narrow Roof Configuration with and without Half End-Panels (Source: JCDecaux)

The siting of bus shelters also requires due consideration on a case by case basis. Ideally bus shelters should be located on the island bus stop boarding/alighting area where space permits. Where this is not feasible, the shelters should be located parallel to the island to the rear of the footpath. Where bus shelters cannot be located directly on the dedicated island or parallel to the island due to spatial and/or other constraints, they should ideally be located downstream of the stop area. This will inherently promote eye to eye contact between boarding passengers and oncoming cyclists and buses when signalling the bus; and also improve the courtesy arrangement for segregation of boarding and alighting passengers. Examples from each of these scenarios are shown below.

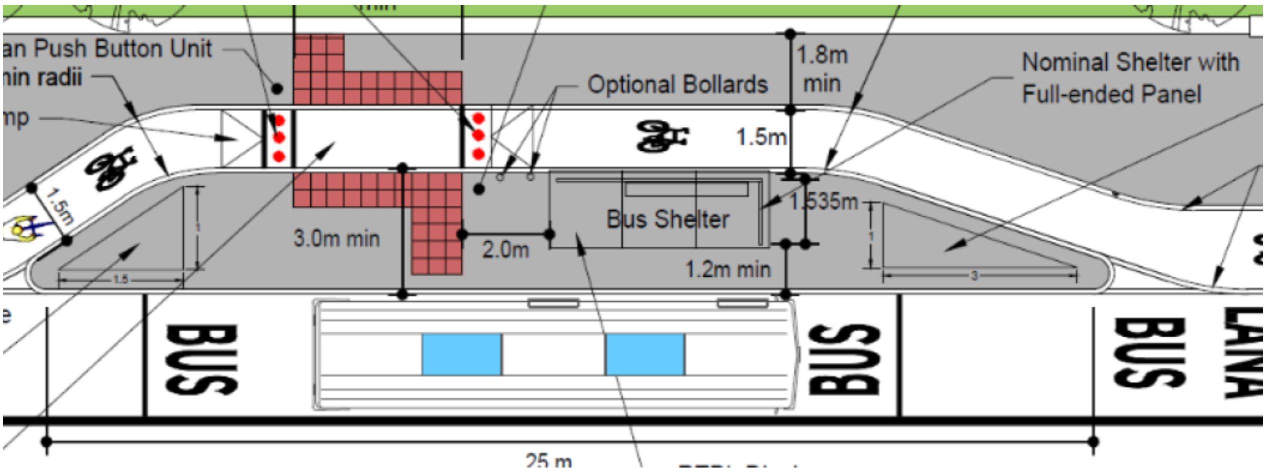

Figure 4.14: Preferred Shelter Location (On Island)

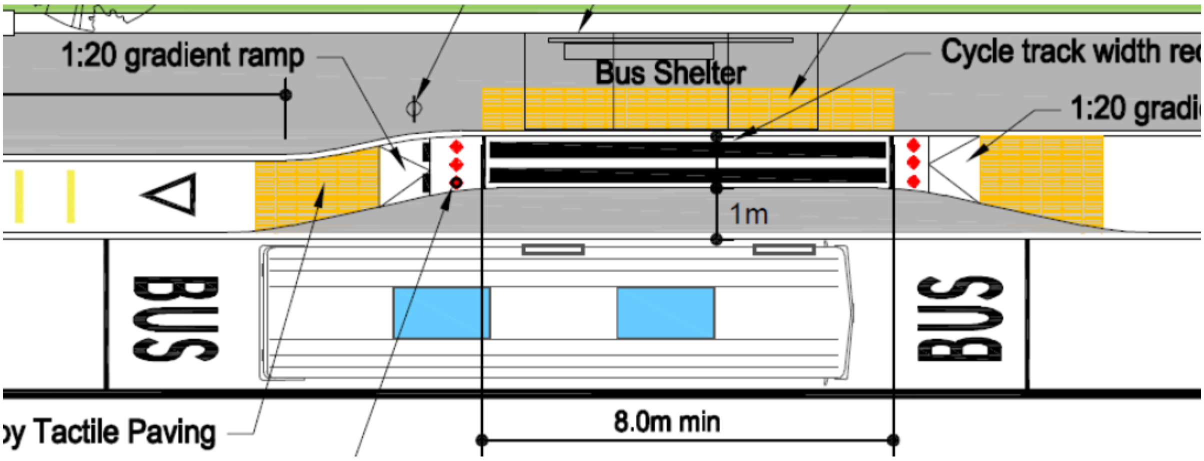

Figure 4.15: Alternative Shelter Location Back of Footpath (Narrow Island with Adequate Footpath Widths)

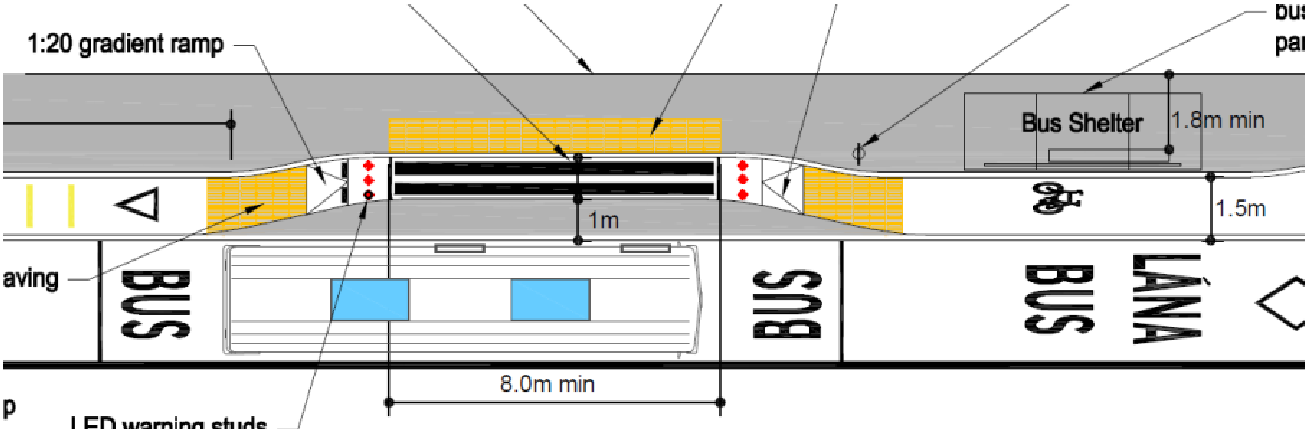

Figure 4.16: Alternative Shelter Location Downstream of Island (Narrow Island with Narrow Footpath Widths at Landing Area)

4.14 Parking and Loading

As part of the ongoing assessment of existing conditions to support the development of the engineering design along the Proposed Scheme, a parking survey assessment was undertaken to assess the existing loading and parking arrangements and potential alternatives. **Appendix G** provides the details of the Parking and Loading Report.

The report was prepared in the absence of parking survey data, which could not be obtained due to ongoing movement restrictions as a result of the international Covid-19 pandemic, information was obtained by site visits and desktop studies. Quantification of the number of existing parking spaces and their potential removal along the scheme is a critically important task, as removal of parking without provision of viable replacement options may result in a reduction in the cross-sectional width of the design.

Below is an overview of the methodology in assessing the parking impacts along the Proposed Scheme:

- Review the existing parking arrangements on the road network or immediately adjacent to the Proposed Scheme;
- Assess the impacts associated with the current design proposals;
- Identify possible mitigation measures / alternative parking arrangements;
- Analyse mitigation measure to inform the optimum recommendation; and

- Provide recommendations and identify residual parking impacts.

In assessing the Proposed Scheme the following parking/loading classifications were adopted :

- Designated Paid Parking;
- Permit Parking;
- Disabled Permit Parking;
- Loading/Unloading (in designated Loading Bays);
- Loading/Unloading (outside designated Loading Bays);
- Taxi Parking (Taxi Ranks);
- Commercial vehicles parked for display (car sales); and
- Illegal Parking

In addition to the above consideration for other parking usage/ behaviour has been analysed under the following classifications:

- Informal Parking: On-street parking in which spaces may or may not be marked and in which the Local Authority does not charge for use; and
- Adjacent Parking: Parking which is located in close proximity to the street. This parking includes free and pay parking and also highlights car parks which may be affected by future design proposals.

4.14.1 Summary of Parking Amendments

The locations for existing and proposed parking/loading modifications in line with the Proposed Scheme have been identified on the GEO_GA General Arrangement drawings and further discussed in detail in **Appendix G.** The following table provides a summary of the key residual parking/loading impacted areas along the Proposed Scheme.

The proposed changes in parking provision are summarised in Table 4-13 below.

Table 4-13: Summary of Parking Amendments

Location	Type of Parking	Existing	Proposed	Change
Ballyfermot Road and Access Roads	Designated Paid	37	15	-22
	Informal	147	112	-35
	Disabled	1	1	0
Ballyfermot Parade, Le Fanu Road, Kylemore Road	Designated Paid	63	57	-6
	Informal	141	144	3
	Disabled	2	2	0
	Taxi	5	5	0
Ballyfermot Road and Sarsfield Road	Informal	35	27	-8
Sarsfield Road, Grattan Crescent, Inchicore Road	Designated Paid	17	9	-8
	Disabled	3	3	0
	Taxi	5	5	0
	Informal	14	14	0

Location	Type of Parking	Existing	Proposed	Change
Emmet Road	Designated Paid	10	7	-3
	Permit	118	90	-28
	Disabled	1	1	0
Old Kilmainham to Lower Basin	Permit	42	42	0
	Disabled	1	1	0
James's Street	Designated Paid	13	0	-13
Thomas Street, High Street	Designated Paid	22	0	-22
	Disabled	3	2	-1
	Taxi	12	12	0

4.14.2 Summary of Parking Changes

With the Proposed Scheme in place, the impacts of the change in on-street parking have been considered and are itemised below (in summary); the associated mitigation effects and other measures are also summarised:

- At Ballyfermot Village, the revised layout will result in the loss of 28 parking spaces.
- On Grattan Crescent, the revised layout will result in the loss of 8 on street parking spaces.
- On Emmet Road, the revised road layout will result in the loss of 31 on street parking spaces.
- On James's Street, the revised road layout will result in the loss of 13 on street parking spaces.
- On Thomas Street and High Street, the revised road layout will result in the loss of 24 on street parking space. As part of the design of the Proposed Scheme, an assessment has been carried out into the impact on existing parking, looking at the following types of parking:

4.15 Turning Bans and Traffic Management Measures

Turning bans and restricted movements along the route are shown on the General Arrangement Drawings within **Appendix B**.

A summary of the turning bans along the Proposed Scheme are shown in **Table 4-14**.

Table 4-14: Summary of Turning Bans and Traffic Management Measures

Chainage	Minor Road	Major Road	Existing or Proposed	TM Measure Implemented	Reason for Mitigation	Impact of Mitigation
B2400	Le Fanu Road Junction (North Arm)	Ballyfermot Road	Proposed	No left turn, except for buses and access, onto major road	No inbound general traffic lane proposed through Ballyfermot village centre	Improved reliability for bus journey times along the corridor
B2350	Le Fanu Road Junction (South Arm)	Ballyfermot Road	Proposed	No right turn, except for buses and access, onto major road	No inbound general traffic lane proposed through Ballyfermot village centre	Improved reliability for bus journey times along the corridor
B2330	Le Fanu Road Junction (West Arm)	Ballyfermot Road	Proposed	No straight ahead, except for buses and access, citybound on major road	No inbound general traffic lane proposed through Ballyfermot village centre	Improved reliability for bus journey times along the corridor

Chainage	Minor Road	Major Road	Existing or Proposed	TM Measure Implemented	Reason for Mitigation	Impact of Mitigation
B2410	Le Fanu Road Junction (East Arm)	Ballyfermot Road	Existing	No right turn, onto minor road		
B2490	Colepark Road	Ballyfermot Road	Proposed	No left turn, onto major road	No inbound general traffic lane proposed through Ballyfermot village centre	Improved reliability for bus journey times along the corridor
B2490	Colepark Road	Ballyfermot Road	Proposed	No straight ahead, except for buses, on major road	No inbound general traffic lane proposed through Ballyfermot village centre	Improved reliability for bus journey times along the corridor
B2765	Colepark Drive	Ballyfermot Road	Proposed	No left turn, onto minor road	No inbound general traffic lane proposed through Ballyfermot village centre	Improved reliability for bus journey times along the corridor
B5110	Memorial Road	Con Colbert Road	Existing	No left turn, except for buses and cycles, onto minor road		
E415	Sarsfield Road	Grattan Crescent	Proposed	No right turn, except for buses and cycles, onto major road	No outbound general traffic lane on Sarsfield Road East	Improved reliability for bus journey times along the corridor
B5360	Sarsfield Road	Inchicore Road	Existing	No right turn, except for buses and cycles, onto minor road	No outbound general traffic lane on Sarsfield Road East	
B5545	Inchicore Terrace South	Grattan Crescent	Proposed	No left turn, except cyclists, onto major road	No outbound general traffic lane on Grattan Crescent North	Improved reliability for bus journey times along the corridor
B5555	Inchicore Terrace South	Grattan Crescent	Proposed	No straight ahead, except for buses and cycles, along major road	No outbound general traffic lane on Grattan Crescent North	Improved reliability for bus journey times along the corridor
B6335	Luby Road	Emmet Road	Existing	No right turn, onto minor road		
B6370	Luby Road	Emmet Road	Existing	No left turn, onto minor road		
B6590	South Circular Road	Old Kilmainham	Existing	No right turn, onto minor road		
B7080	National Children's Hospital Access	Mount Brown	Proposed	No straight ahead, except buses and bicycles 16:00 – 20:00 Monday – Sunday, on major road	The existing building line on both sides of the road does not allow for more than two lanes through this section. Reduces traffic through residential areas during peak hours	Improved reliability for bus journey times along the corridor

Chainage	Minor Road	Major Road	Existing or Proposed	TM Measure Implemented	Reason for Mitigation	Impact of Mitigation
B7565	St. James's Hospital Access	James's Street	Proposed	No straight ahead, except buses and bicycles 06:00 – 10:00 Monday – Sunday, on major road	The existing building line on both sides of the road do not allow for more than two lanes through this section. Reduces traffic through residential areas during peak hours	Improved reliability for bus journey times along the corridor
B7500	St. James's Hospital Access	James's Street	Proposed	No left turn, except buses and bicycles 16:00 – 20:00 Monday – Sunday, onto major road	The existing building line on both sides of the road do not allow for more than two lanes through this section. Reduces traffic through residential areas during peak hours	Improved reliability for bus journey times along the corridor
B7510	St. James's Hospital Access	James's Street	Proposed	No right turn, except buses and bicycles 06:00 – 10:00 Monday – Sunday, onto major road	The existing building line on both sides of the road do not allow for more than two lanes through this section. Reduces traffic through residential areas during peak hours	Improved reliability for bus journey times along the corridor
B7540	James's Luas Stop Access Road	James's Street	Existing	No straight ahead, except trams, onto minor road		
B7550	James's Luas Stop Access Road	James's Street	Existing	No left turn, onto minor road		
B7550	James's Luas Stop Access Road	James's Street	Existing	No straight ahead, except trams, onto minor road		
B7710 and B7720	Bow Lane West	James's Street	Existing	No straight ahead, except Trams, onto minor road		
B7715 and B7725	Bow Lane West	James's Street	Proposed	No straight ahead, except buses and trams	To facilitate south bound buses along the LUAS Tracks from Heuston Station	Improved reliability for bus journey times along the corridor
B7750	Bow Lane West	James's Street	Existing	No right turn, onto minor road		
B8125	Watling Street	Thomas Street	Existing	No left turn, onto minor road		
B8150	Watling Street	Thomas Street	Existing	No right turn, onto minor road		

Chainage	Minor Road	Major Road	Existing or Proposed	TM Measure Implemented	Reason for Mitigation	Impact of Mitigation
B8200	Crane Street	Thomas Street	Existing	No right turn, onto minor road		
B8220	Crane Street	Thomas Street	Existing	No left turn, onto minor road		
B8400	Bridgefoot Street	Thomas Street	Existing	No right turn, onto minor road		
B8520	Meath Street	Thomas Street	Existing	No right turn, onto minor road		
B8540	Meath Street	Thomas Street	Existing	No left turn, onto minor road		
B8715	St Augustine Street	Thomas Street / Cornmarket	Existing	No left turn, onto minor road		
B8725	St Augustine Street	Thomas Street / Cornmarket	Existing	No right turn, onto major road		
B8735	St Augustine Street	Thomas Street / Cornmarket	Existing	No left turn, onto major road		
B8740 and B8750	St Augustine Street	Thomas Street / Cornmarket	Existing	No right turn, onto minor road		
B8890	Back Lane	High Street	Existing	No left turn, onto minor road		

4.16 Relaxations and Deviations from Standard

The design has been developed in accordance with the standards and guidance listed within **Section 4.1**. However, in some circumstances it has been necessary to digress from the desirable minimum geometric parameters identified.

4.16.1 DMURS Design Compliance Statement

The Proposed Scheme has been designed in line with the principles and guidance outlined within DMURS 2019. The scheme proposals have been developed in direct response to the aims and objectives set out in **Section 1.2** which have common synergies with the Core Design Principles of DMURS.

The adopted design approach successfully achieves the appropriate balance between the functional requirements of different network users whilst enhancing the sense of place. The implementation of enhanced pedestrian, cycling and bus infrastructure actively manages movement by offering real modal and route choices in a low speed high-quality mixed-use self-regulating environment. Specific attributes of the Proposed Scheme design which contribute to achieving this DMURS objective include;

- Prioritising pedestrians and cyclists through the implementation of designated footpaths, and cycle tracks and limiting vehicles' speed through the use of tight kerb radii on all internal junctions within the development;

- Providing cycle-protected junctions to control the speed at which vehicles can travel through the junction and incorporating tight kerb radii to limit vehicles' speed but also allowing occasional larger vehicles to manoeuvre safely through the junction, while also reducing pedestrian crossing distances;

- The inclusion of new and enhanced pedestrian crossing facilities to promote increased pedestrian activity along the scheme, providing safe desire lines for pedestrians to and from all directions. The

Proposed Scheme also removes the existing lengthy uncontrolled crossings and the associated safety risks that they present to pedestrians at these vehicle dominated locations;

- Introduction of designated cycle protected parking along the scheme to improve the interaction between parked vehicles, pedestrians and cyclists; and
- The implementation of traffic calming measures and side entry treatments to promote pedestrian activity on the junction side arms.

The scheme proposals are the outcome of an integrated urban design and landscaping strategy to enhance the function of the surrounding area and thereby facilitating a safer environment for pedestrians and cyclists.

The design has been progressed in accordance with the design standards within **Section 4.1** as far as practicable, but in some instances it has been necessary to deviate away from these.

4.17 Road Safety and Road User Audit

In line with The TII Publication 'GE-STY-01024 Road Safety Audit' document, a Stage F Road Safety Audit (RSA) was undertaken as part of the Emerging Preferred Route (EPR) selection process and a Stage 1 RSA was undertaken as part of the Preliminary Design development. Both RSAs have been included in **Appendix M** complete with the proposed designers' responses.

The Stage F RSA was reviewed in light of the scheme development and had identified various elements of the EPR scheme that were subsequently improved with design development, including the introduction of cycle protected junctions, tie-ins for cycle infrastructure on side roads and buffer zones for parking and pedestrian segregation measures.

The Stage 1 RSA represents the response of an independent audit team to various aspects of the scheme. The recommendations contained within the document are the opinions of the audit team and are intended as a guide to the designers on how the scheme as constructed can be improved to address issues of road safety.

5. Junction Design

5.1 Overview of Transport Modelling Strategy

The design and modelling of junctions has been an iterative process to optimise the number of people that can pass through each junction, with priority given to pedestrian, cycle and bus movements.

The design for each junction within the Proposed Scheme was developed to meet the underlying objectives of the project and to align with the geometric parameters set out in **Section 4.1** in conjunction with the junction operation principles described in the BCPDG. Various traffic modelling tools were used to assess the impact of the proposals on a local, corridor and surrounding road network level which is further described in **Section 5.4.**

A traffic impact assessment has been undertaken for the Proposed Scheme in order to determine the predicted magnitude of impact the Proposed Scheme measures may have against the likely receiving environment. The impact assessments have been carried out using the following scenarios:

- 'Do Minimum' (DM) – This scenario represents the likely conditions of the road network with all major committed transportation schemes in place that will impact on the use of public transport and private cars, without the Proposed Scheme; and
- 'Do Something' (DS) – This scenario represents the likely conditions of the road network with all major committed transportation schemes in place that will impact on the use of public transport and private cars, with the Proposed Scheme (i.e. the 'DM' scenario with the addition of the Proposed Scheme).

Both scenarios above comprised an assessment at opening year (2028) and opening year +15 years (2043). In developing the design proposals for the Proposed Scheme, the 2028-year flows were determined to provide the higher volume of traffic flows for the most part and as such has been generally adopted as the design case scenario for junction development. Where design flows from the 2028 DS model were not deemed appropriate for a specific location the flows associated with the DM and or base 2019 survey flows have been considered. Similarly, the final junction designs have been supplemented with additional cycle volumes to try to ensure a minimum 10% cycle mode share in terms of people movement at each junction can be achieved in line with the National Cycle Policy Framework (NCPF)

5.2 Overview of Junction Design

The purpose of traffic signals is to regulate movements safely with allocation of priority in line with transportation policy. For the Proposed Scheme, a key policy is to ensure appropriate capacity and reliability for the bus services so as to maximise the overall throughput of people in an efficient manner. The junctions will provide safe and convenient crossing facilities for pedestrians with as little delay as practicable. Particular provisions are required for the protection of cyclists from turning traffic, as well as ensuring suitable capacity for a rapidly increasing demand by this mode.

The design of signalised junctions, or series of junctions, as part of the Proposed Scheme has been approached on a case-by-case basis. There have been a number of components of the design development process that have influenced the preliminary junction designs including:

- The junction operational and geometrical principles described in the BCPDGB;
- Integration of pedestrian and cycle movements at junctions;
- Geometrical junction design for optimal layouts for pedestrians, cyclists and bus priority whilst minimising general traffic dispersion where practicable;
- PMSC to inform junction staging and design development;
- LINSIG junction modelling to assess junction design performance and refinement;

- Micro-Sim modelling to assess and refine bus priority designs; and
- Cyclist quantification.

5.3 Junction Geometry Design

5.3.1 Pedestrians

The junction design approach is to minimise delay for pedestrians at junctions, whilst ensuring high quality infrastructure to ensure pedestrians of all ages including vulnerable users can cross in a safe and convenient manner. Pedestrian crossings have been placed as close to pedestrian desire lines as practicable. Where pedestrians are required to cross a cycle track, this is proposed to be controlled by traffic signals to manage potential conflicts.

The preferred arrangement for pedestrians at junctions is to have a wrap-around pedestrian signal stage at the start of the cycle. In some instances, this has not been feasible, for example due to crossing distances and the associated intergreen time for pedestrians to safely clear the junction. A 'walk with traffic' system is therefore proposed at certain junctions, in particular where refuge islands have been introduced for a two-stage pedestrian crossing. At these locations, controlled crossing for pedestrians is provided across part of the junction, whilst some of the traffic movements that are now in conflict with the pedestrian movement, are allowed to run at the same time. This facility has the advantage to allowing pedestrians to cross during the cycle whilst having less effect on traffic capacity.

To minimise pedestrian delays at junctions, it was important that proposed junction cycle times are kept as short as practicable. The cycle times at all signalised junctions in the DS scenarios as shown in the summary **Table 5-1**.

Table 5-1: Do Minimum and Do Something Cycle Times

Junction Name	Cycle Time (Seconds)	
	Do Minimum	Do Something
Fonthill Road / Retail Park Shopping Centre Junction	Roundabout	120
Fonthill Road	Roundabout	120
Coldcut Road / Fonthill Road Junction	120	120
M50 Signal-Controlled Bus Priority	No junction	60
Coldcut Road / Cloverhill Road Junction	93	120
Coldcut Road / Kennelsfort Road / Ballyfermot Road Junction	93	120
Ballyfermot Road / Primary Health Care Centre	120	120
Ballyfermot Road / Clifden Road Junction	120	120
Ballyfermot Road / Drumfinn Road Junction	120	120
Ballyfermot Road / Le Fanu Road Junction	120	120
Le Fanu / Kylemore Road / Chapelizod Hill Junction	No data	120
Ballyfermot Road / Commercial Centre Junction	120	60
Ballyfermot Road / Kylemore Road Junction	Roundabout	120
Sarsfield Road / Landen Road Junction	95	120
Sarsfield Road / Con Colbert Road Junction	80	120
Inchicore Road / Memorial Road Junction	Mid-Block	120
Sarsfield Road / Inchicore Road / Grattan Crescent	90	120
Grattan Crescent / Tyrconnell Road / Emmet Road	118	120
Emmet Road / St. Vincent Street West Junction	Priority	60
Emmet Road / South Circular Road / Old Kilmainham Junction	120	120
James's Street / St. James's Hospital Junction	60	60
James's Street / Bow Lane West Junction	86	120
James's Street / Thomas Street / Watling Street	120	120
Thomas Street / Bridgefoot Street / Thomas Court	120	120
Thomas Street / Meath Street Junction	120	60

Junction Name	Cycle Time (Seconds)	
	Do Minimum	Do Something
Thomas Street / Cornmarket / Augustine Street / Francis Street Junction	120	60
Cornmarket / High Street / Bridge Street Upper	120	120

5.3.2 Cyclists

The provision for cyclists at junctions is a critical factor in managing conflict and providing safe junctions for all road users. The primary conflict for cyclists is with left turning traffic.

Based on international best practice, the preferred layout for signalised junctions is the 'Protected Junction', which provides physical kerb build outs to protect cyclists at junctions. The key design features and considerations relating to this junction type are listed below:

- The traffic signal arrangement removes any uncontrolled conflict between pedestrians and cyclists, assigning clear priority to all users at different stages within a traffic cycle;
- Kerbed corner islands should be provided to force turning vehicles into a wide turn and remove the risk of vehicles cutting into the cycle route at the corner, which is a cause of serious accidents at junctions. The raised islands create a protective ring for cyclists navigating the junction, improving safety for right-turning cyclists;
- Cycle tracks that are protected behind parking or loading bays, return to run along the edge of the carriageway approaching the junction. Consideration has been given to remove any parking or loading located immediately at junctions to enhance visibility between motorists and cyclists;
- The cycle track is typically ramped down to carriageway level on approach to the junction and proceeds to a forward stop line. A secondary cycle stop line is also proposed at an advanced location to the vehicular stop line at a number of junctions to cater for right-turning cyclists, which also places the cyclists within viewing of traffic waiting at the junction. Cycle signals will control the movement of cyclists including the second stage movement, i.e. right-turners; and
- Cyclist and pedestrian crossings have been kept as close as practicable to the mainline desire line. While pedestrian and cyclist crossings are to be separated where feasible, in this instance 2-3m separation should be provided between crossings. This is to ensure motorists infer a clear differentiation between cycle lane crossing through the junction and the pedestrian crossing across the same arm.

In some instances, protected junctions have not been incorporated into the design of a signalised junction. In these instances, this has been limited to minor signalised junctions where left-turning movements by general traffic are projected to be few, and cyclists' desire line is projected to be straight through the junction.

5.3.3 Bus Priority

The scheme incorporates four different types of bus priority design which have been outlined in the BCPDGB and referred to as Junction Types 1-4. The subsections below provide an overview of each junction type design and the principles for applying this junction type.

5.3.3.1 Junction Type 1

Junction Type 1, as described in Section 7.4.1 of BCPDGB comprises a dedicated bus lane on both inbound and outbound directions, continuing up to the junction stop line. Due to space constraints, general traffic travelling both straight ahead and turning left is restricted to one lane. Junction Type 1 is typically chosen for the following reasons:

- Volume of left-turning vehicles greater than 100 passenger car units (PCUs) per hour; and
- Urban setting, no space available for dedicated left-turning lane / pocket.

In this instance, mainline cyclists proceed with the bus phase. The bus lane gets a red light, allowing the general traffic lane to proceed. If the volume of turning vehicles is greater than 150 PCUs, then the cyclists should also be held on red. If the volume of left-turners is approximately 100 – 150 PCUs, left-turners will be controlled by a flashing amber arrow and cyclists should receive an early start.

Junction Type 1 as shown in **Figure 5.1** below, has been applied to the majority of junctions along the Proposed Scheme.

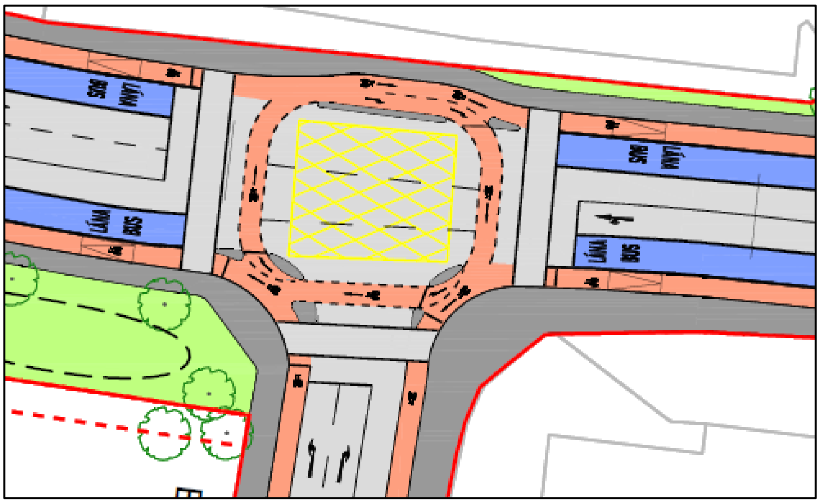

Figure 5.1: Junction Type 1

5.3.3.2 Junction Type 2

Junction Type 2, as described in Section 7.4.2 of BCPDGB, comprises a signalised junction in a suburban context where there is room for additional lanes. Dedicated bus lanes both inbound and outbound, continue up to the junction stop line. At approximately 30m back from the stop line there is a yellow box to allow left-turners to cross the bus lane to enter a dedicated left-turn pocket, where space permits. Junction Type 2 has been chosen for the following reasons:

- Suburban setting where space is available for a dedicated left-turning lane / pocket; and
- High volume of left-turning traffic which can be controlled separately with exiting traffic from side roads.

In this instance, left turners are held and mainline cyclists proceed with the bus phases. Mainline cyclists can proceed also with the straight-ahead general traffic if left turners are held. If the volume of left-tuning traffic is fewer than 150 PCUs per hour, then mainline cyclists could still proceed with left turnings from the left turning pocket on a flashing amber arrow.

There are no Type 2 junctions on the Proposed Scheme.

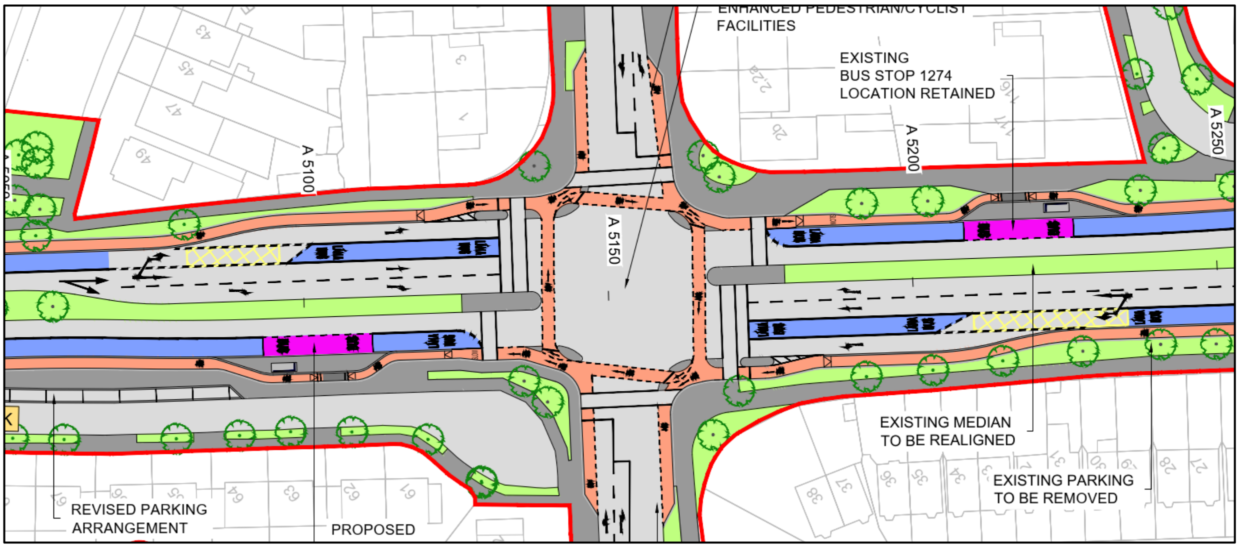

Figure 5.2: Junction Type 2

5.3.3.3 Junction Type 3

Junction Type 3, as described in Section 7.4.3 of BCPDGB, illustrates a signalised junciton where the inbound and outbound bus lane terminates just short of the junction to allow left-turners to turn left from a short left-turn pocket in front of the bus lane. Buses can continue straight ahead from this pocket where a receiving bus lane is proposed. A Junction Type 3 is chosen for the following reasons:

- Volume of left turning vehicles is fewer than 100 PCUs per hour; and
- Urban setting, no space available for a dedicated left-turning lane / pocket.

In this instance, mainline buses and general traffic (including left turners) proceed together, but before they do, mainline cyclists are given an early start of approxiately five seconds to assist with cyclist priority and to minimise potential conflicts. When this early start is complete, the mainline cyclists can still proceed, assuming turning volumes are fewer than 150 PCUs per hour. Left-turners from the left-turn pocket are given a flashing amber.

There are no Type 3 junctions on the Proposed Scheme.

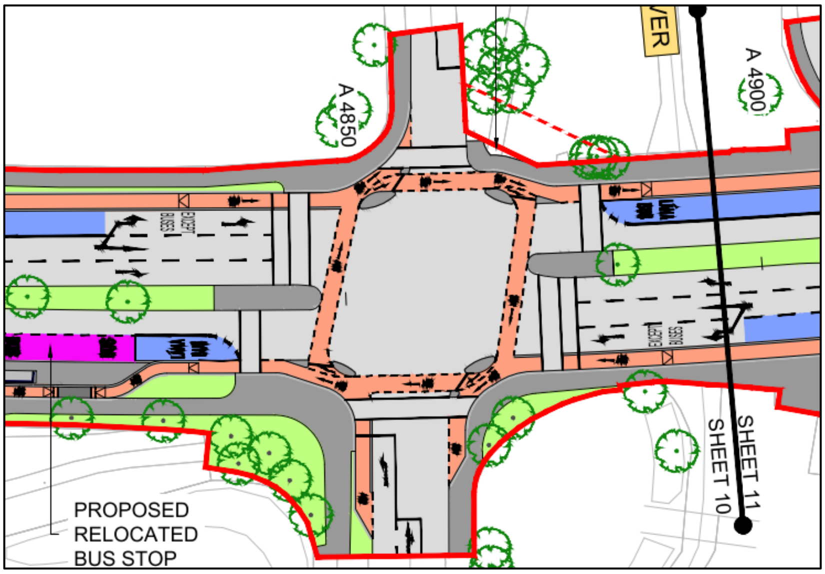

Figure 5.3: Junction Type 3

5.3.3.4 Junction Type 4

Junction Type 4, as described in Section 7.4.4 of BCPDGB, illustrates a signalised junction with an inbound and outbound bus lane, but also positions the pedestrian crossings on the inside of the cycle lanes across the arms of the junction. Pedestrian crossing distances are minimised as a result. Signalised pedestrian crossings are proposed across the cycle tracks to allow pedestrians to cross from the footpath to the pedestrian crossing landing areas, thus avoiding uncontrolled pedestrian – cyclist conflict. The key design features and considerations relating to this junction type are as follows:

- An orbital cycle track is provided, with controlled crossing points to allow pedestrians to cross to large islands within a central signal controlled area;
- Left-turning cyclists can effectively bypass the junction, while giving way to pedestrians crossing as well as cyclists already on the orbital cycle track;
- Pedestrians and cyclists can cross at the same time due to the segregated and nonconflicting crossings; and
- Signal-controlled pedestrian crossing distances are reduced when compared to traditional junction layouts, due to the fact that pedestrians cross the cycle track in a separate signalised movement. Pedestrian crossings are also close to the pedestrian desire line. However the number of crossings for pedestrians is increased as they must cross the cycle track to access the central signal-controlled area.

Junction Type 4 is chosen for the following reasons:

- High incidence of HGV movements e.g. at industrial estates or where two major regional roads meet; and
- Suburban setting and lower pedestrian volumes.

In this instance, mainline buses and left-turning from the mainline proceed together.

There are no Type 4 junctions on the Proposed Scheme.

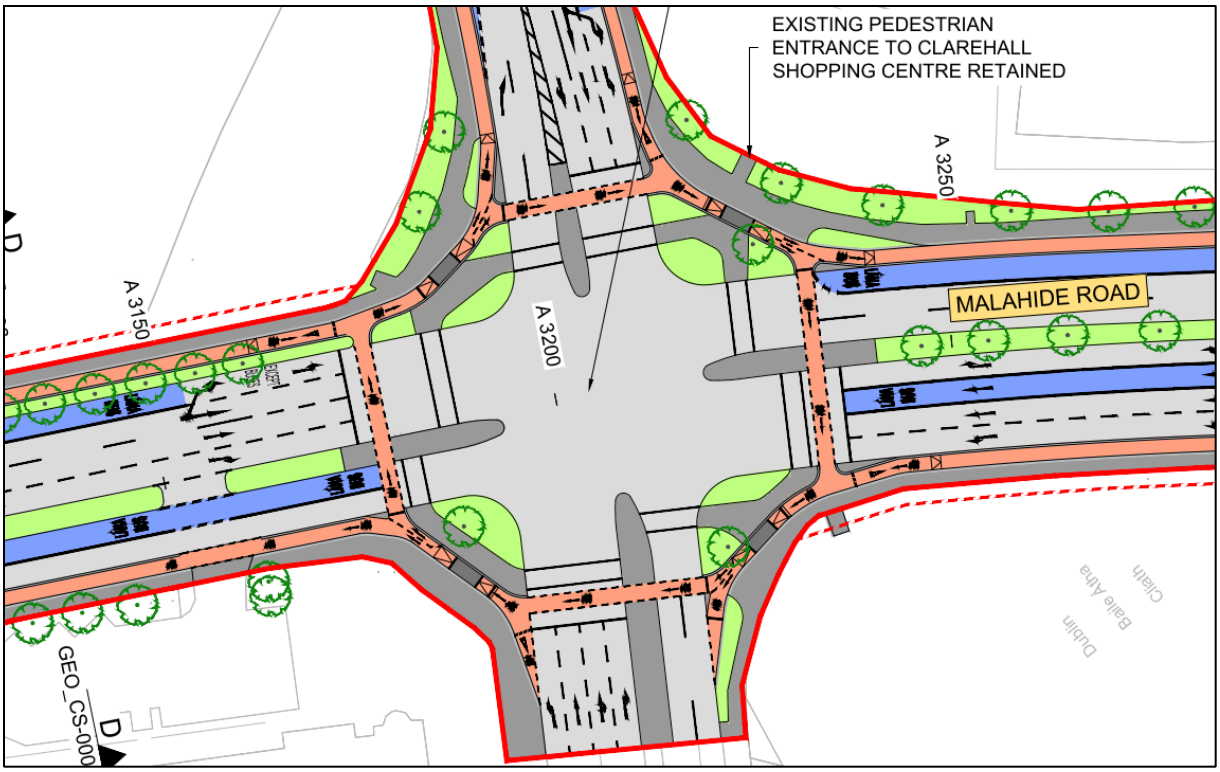

Figure 5.4: Junction Type 4

5.3.4 Staging and Phasing

The optimum staging for each junction will be determined by the required junction operational parameters and local site conditions. One of the key considerations in the design of signalised junctions is the conflict between left-turning traffic and buses, cyclists and pedestrians continuing along the main corridor. The following points present an overview of the design of junction staging. A junction-specific assessment can be found in the Junction Design Report in **Appendix L:**

- Cyclists travelling through the junction across the side road will run with straight-ahead traffic movements, including buses in a dedicated bus lane;
- A short early start will enable cyclists to advance before general traffic. The amount of green given to cyclists is subject to junction dimensions and signal operation. A 5 seconds early start has been proposed on the main arms of the majority of junctions, with 3 seconds minimum at certain junctions;
- Cycle movements crossing a side road can run simultaneously with the bus stage in the same direction, so long as they are not permitted to turn left from the bus lane in this scenario; and
- Cycle movements at junctions are to be controlled by cycle signal aspects where there is an advance stop line ahead of the traffic signals including for hook turns at the far side of the side street crossing. Additional cycle signals have been provided for right-turning cyclists.

5.3.5 Junction Design Summary

A detailed junction assessment has been undertaken in line with the principles described previously. The following summary tables, **Table 5-2** and **Table 5-3**, provide an overview of the key design principles adopted at each junction location. More detailed information for each junction location can be found in the Junction Design Report in **Appendix L.**

Table 5-2: Overview of Major Junctions

Number	Junction Location	Description
1	Fonthill Road Liffey Valley Shopping Centre Liffey Valley Retail Park	New traffic signal crossroads replacing roundabout
2	Fonthill Road to Coldcut Road Fonthill Road to east Fonthill Road to west	New traffic signal crossroads replacing roundabout
3	Coldcut Road Fonthill Road	Modified and fully refurbished traffic signal T-junction
4	Ballyfermot Road Kylemore Road	New traffic signal crossroads replacing roundabout

Table 5-3: Overview of Moderate Junctions

Number	Junction Location	Description
1	Coldcut Road M50 Overbridge	Dual signal-controlled priority for separate inbound and outbound bus movements

Number	Junction Location	Description
2	Coldcut Road Cloverhill Road	Modified and fully refurbished traffic signal T-junction
3	Coldcut Road Ballyfermot Road Kennelsfort Road Upper	Modified and fully refurbished traffic signal T-junction
4	Ballyfermot Road Ballyfermot Primary Care Centre	Modified and fully refurbished traffic signal T-junction
5	Ballyfermot Road Clifden Road	Modified and fully refurbished traffic signal T-junction
6	Ballyfermot Road Drumfinn Road	Modified and fully refurbished traffic signal T-junction
7	Ballyfermot Road Le Fanu Road	Modified and fully refurbished traffic signal crossroads
8	Le Fanu Road Kylemore Road Chapelizod Hill Road	Modified and fully refurbished traffic signal crossroads
9	Ballyfermot Road Ballyfermot Commercial Centre	Modified and fully refurbished traffic signal T-junction
10	Sarsfield Road Landen Road	Modified and fully refurbished traffic signal T-junction
11	Sarsfield Road (dual carriageway) Con Colbert Road (dual carriageway) Sarsfield Road (single carriageway)	Modified and fully refurbished traffic signal T-junction
12	Inchicore Road Memorial Road	Modified and fully refurbished traffic signal T-junction
13	Sarsfield Road Inchicore Road Grattan Crescent	Modified and fully refurbished traffic signal T-junction
14	Grattan Crescent Tyrconnell Road Emmet Road	Modified and fully refurbished traffic signal T-junction
15	Emmet Road St Vincent Street West	New traffic signal T-junction
16	Emmet Road Old Kilmainham South Circular Road	Modified and fully refurbished traffic signal crossroads

Number	Junction Location	Description
17	James's Street Saint James's Hospital	Modified and fully refurbished traffic signal T-junction
18	James's Street west arm James's Street east arm Bow Lane West west arm Bow Lane West east arm St. Patrick's Hospital access Unnamed north arm	Modified and fully refurbished traffic signal T-junction
19	James's Street Thomas Street Watling Street	Modified and fully refurbished traffic signal T-junction
20	Thomas Street Bridgefoot Street Thomas Court exit only	Modified and fully refurbished traffic signal crossroads
21	Thomas Street Meath Street	Modified and fully refurbished traffic signal T-junction
22	Thomas Street Cornmarket St. Augustine Street Francis Street exit only	Modified and fully refurbished traffic signal crossroads
23	Cornmarket Bridge Street Upper High Street	Modified and fully refurbished traffic signal T-junction

5.3.5.1 **Minor and Priority Junctions**

A total of 40 major and minor junctions (not including minor access points for properties) are without signal control across the Proposed Scheme. These are shown on the General Arrangement Drawings contained within **Appendix B.**

5.3.5.2 **Roundabouts**

No roundabouts are proposed as part of the Proposed Scheme.

5.4 Junction Modelling

5.4.1 Overview

Junction modelling was undertaken to enable understanding of the likely impact of the proposed route design on traffic operation on the surrounding road network. The focus of the assessment was to ensure bus priority was maximised, whilst ensuring the overall movement of people through the junctions was maximised in particular via sustainable modes i.e. walking and cycling, whilst mitigating any resulting adverse traffic impacts.

The traffic modelling steps can be summarised as follows and further discussed in the subsequent sections:

- People Movement Calculator Assessment: The draft designs were assessed using a high level PMSC to provide a preliminary understanding of the typical green time proportion for each mode and provided an initial input for the Local Area Model (LAM) modelling which was further refined using LinSig and Microsimulation tools;

- Saturn Modelling - LAM: The Proposed Scheme design and traffic signal operation was assessed within the LAM which is a subset model of the NTA's Eastern Regional Model (ERM). The LAM outputs provided projected traffic flows for the DS Operational Year for the peak periods. In addition, traffic dispersion plots were provided, comparing the DS vs the DM to identify where any traffic dispersion is likely to occur off the Proposed Scheme;

- Design Optimisation: The proposed junction designs and signal timings were optimised in LinSig, in order to maximise people movement through the corridor and to minimise traffic dispersion off the corridor. Where performance issues such as poor overall capacity, inefficient stage green allocation or specific queues were identified, the junction layout was reviewed and a suitable mitigation or design solution was applied;

- Iterative process: The optimised junction designs and signal timings were fed back into the LAM and the above steps were repeated as part of an iterative process until a suitable level of dispersion was achieved;

- LinSig and Microsimulation: The optimised LinSig timings were used to inform the microsimulation model developed for the Proposed Scheme. The micro simulation assisted in supporting the junction designs and traffic control strategies and provided journey time information. The junction designs and signal timings were further optimised where necessary as a result of the microsimulation modelling; and

- Final Iterations: As part of the iterative process the optimised junction designs and signal timings were fed back into the LAM and the above steps were repeated to inform the final design and signal timings. Final LinSig junction models were undertaken using the final flows and supplemented with projected cycle flows to accommodate a minimum 10% cycle mode share in terms of people movement at each junction.

Figure 5.5 illustrates an overview of the traffic modelling process for the Proposed Scheme.

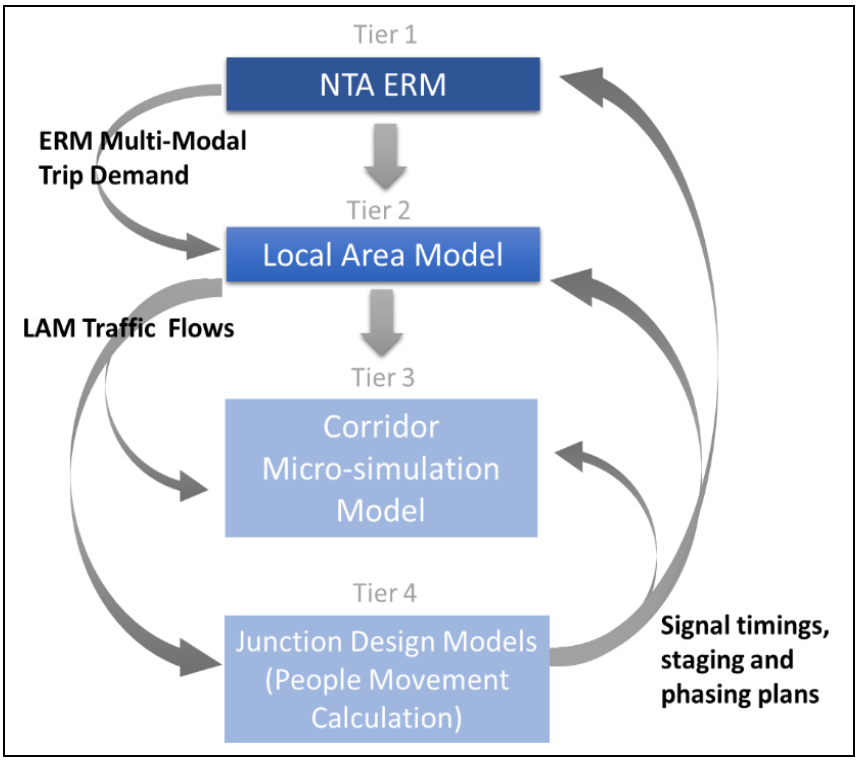

Figure 5.5: Proposed Scheme Traffic Modelling Hierarchy

5.4.2 People Movement

An assessment has been carried out to determine the potential people movement the Proposed Scheme will generate. This adopts a policy-led approach to the design of junctions, which prioritises the people movement and maximisation of sustainable modes, i.e. walking, cycling and bus in advance of the consideration and management of general traffic movements at junctions. The outputs of the calculator provide an estimate of people movement per mode per junction and the respective percentage mode share. **Figure 5.6** illustrates the People Movement Formulae.

People Movement Formulae	
Cyclists	$\sum(\frac{Green\ Time}{headway})(\frac{3600}{Cycle\ Time})(\frac{CT\ Width}{1.5})$
Buses	$\sum(No.of\ Buses)(Occupancy)(Direction)$
General Traffic	$\sum LinSig\ PCU\ Capacity\ Outputs$
Pedestrians	$\sum(Green\ Time)(\frac{Walking\ Speed}{Ped.Walking\ Buffer})(\frac{Crossing\ Width}{2})(\frac{3600}{Cycle\ Time})(No.Crossing\ Points)$

Figure 5.6: People Movement Formulae

The emerging proposed designs were inputted to the PMSC tool, which produced initial people movement outputs and indicative green times per mode. The results provided an initial starting point to facilitate a review of the junction designs, where necessary pedestrian, cyclist and bus infrastructure was optimised accordingly to facilitate additional capacity. The revised designs were then added into the LAM to facilitate traffic modelling.

The LAM outputs provided traffic flows for the operational year (2028) and operational year +15 (2043). The traffic flows were fed into the LinSig models to facilitate a detailed analysis of the proposed junction operation. The LinSig and Dublin Local Area Model (DLAM) analysis required multiple traffic modelling iterations to arrive at a balanced solution for prioritising sustainable modes and minimising traffic dispersion. The people movement results were also re-evaluated during the iteration process, and the results were also used to inform the projected number of cyclists in the operational year, as discussed in the following section.

5.4.3 Local Area Model (LAM)

As noted previously, the Proposed Scheme design and traffic signal operation were assessed within the LAM. The LAM outputs provided projected traffic flows for the DS Operational Year 2028 and Future Year 2043 for the respective AM and PM peak periods. In addition, traffic dispersion plots were produced, comparing the DS vs the DM to identify where any occurred onto the adjoining road network, and where necessary to review and apply traffic management, to retain traffic on the corridor and to minimise dispersion at inappropriate locations.

The results of the LAM were used to inform the proposed junction designs and optimise signal timings, in order to maximise people movement through the corridor and to minimise traffic dispersion off the corridor. Where performance issues such as poor overall capacity, inefficient stage green allocation or specific queues were identified, the junction layout was reviewed and a suitable mitigation or design solution was applied.

To demonstrate the benefits of this iterative process, **Figure 5.7** illustrates an initial 2028 AM distribution plot, whilst **Figure 5.8** illustrates a final iteration distribution plot. **Figure 5.7** illustrates more significant traffic dispersion onto the surrounding road network, whilst **Figure 5.8** demonstrates a refined, more optimised Proposed Scheme, where traffic dispersion has been minimised without compromising the sustainable modes.

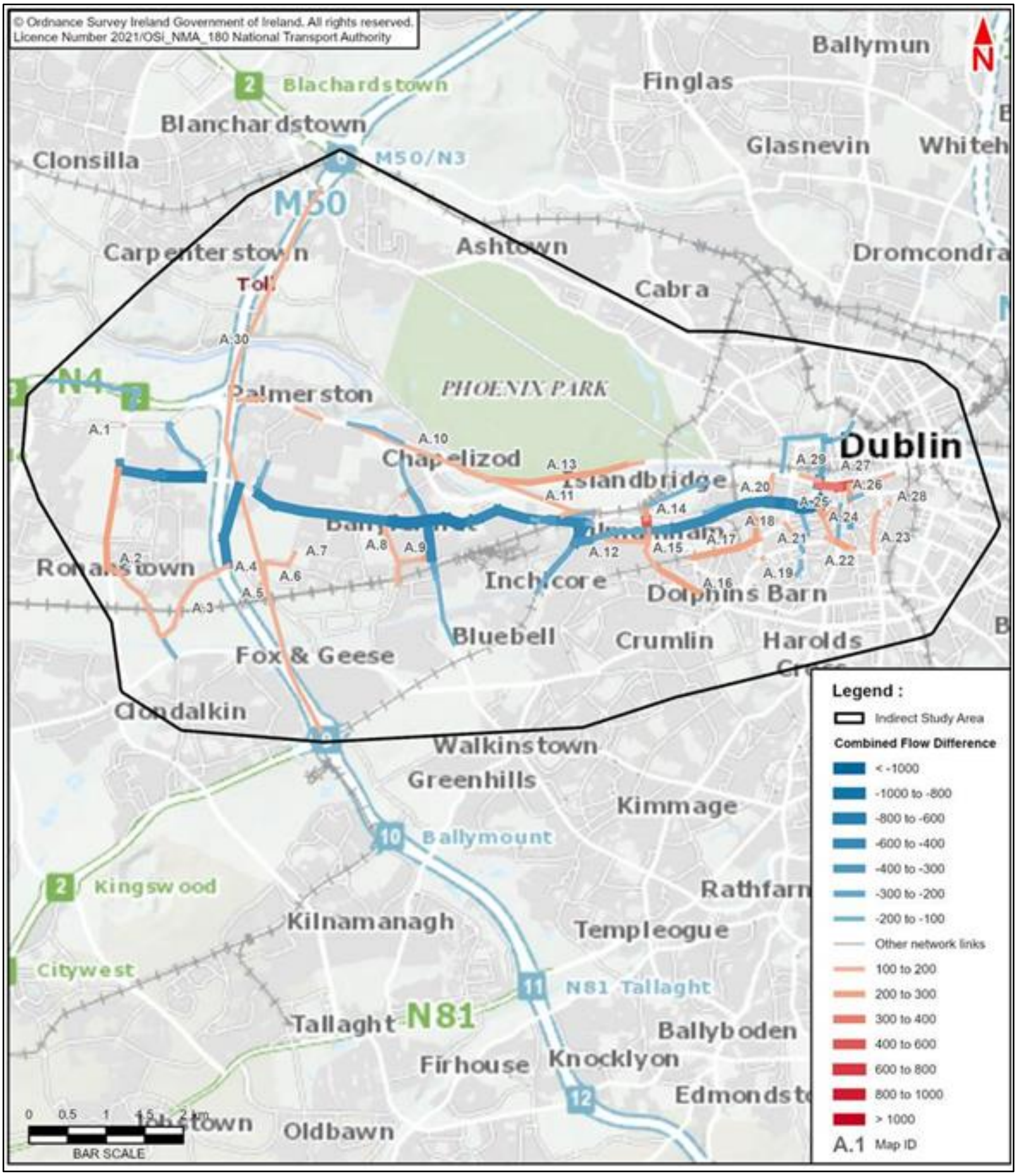

Figure 5.7: Flow Difference on Road Links (DM versus DS), AM Peak Hour, 2028 Opening Year

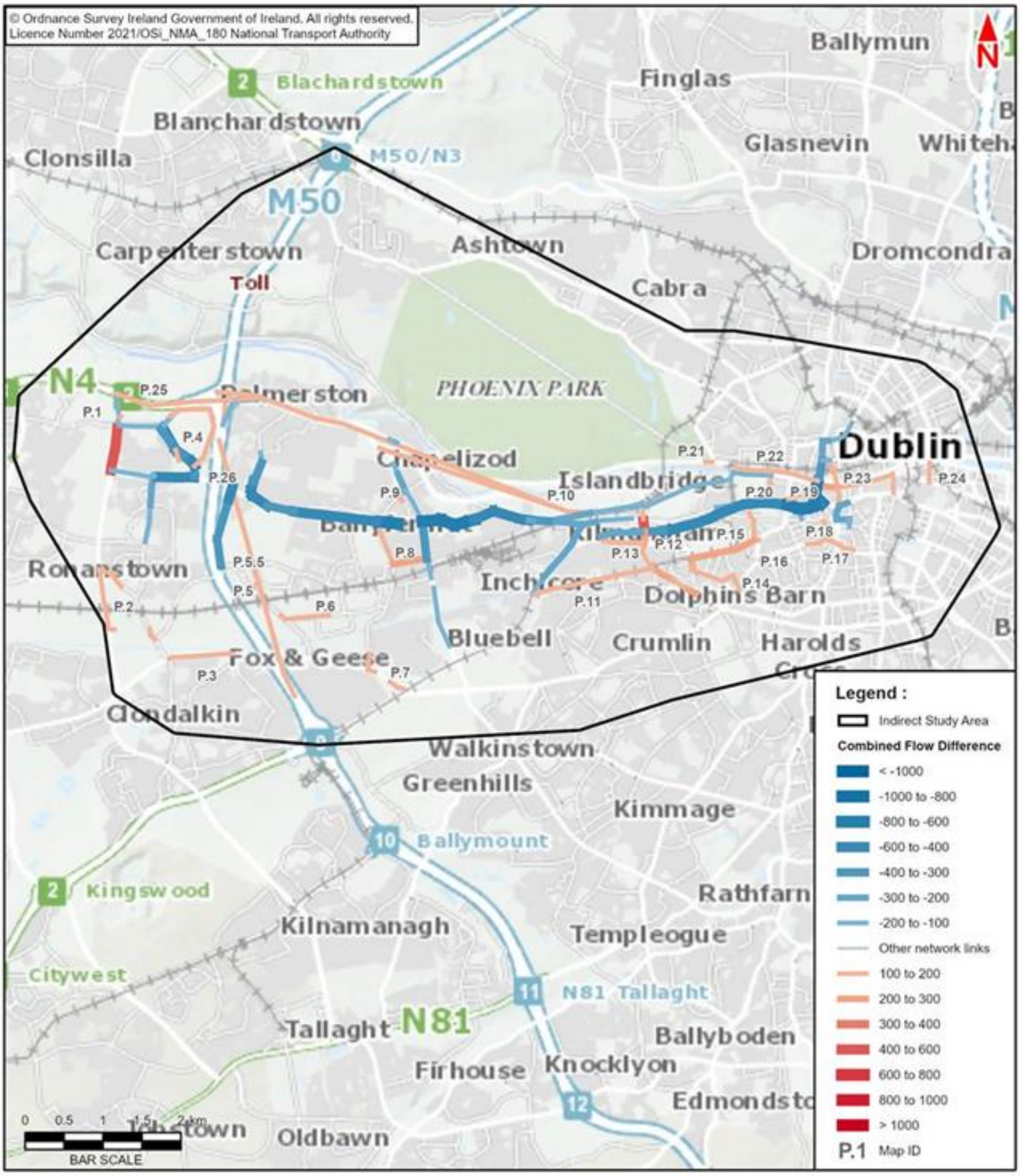

Figure 5.8: Flow Difference on Road Links (DM versus DS), PM Peak Hour, 2028 Opening Year

5.4.4 LinSig Modelling

Detailed junction modelling analysis using LinSig 3.2.40 was undertaken on the emerging design proposals at each signalised junction until the DLAM model iterations had been concluded and a final preliminary design was achieved. The LinSig modelling adopted the future year traffic flows from the Saturn DLAM model runs for the DS scenario for the Opening Year 2028.

5.4.4.1 LinSig Assumptions

The following LinSig assumptions were applied in the modelling:

Cycle Time

- 120s (max) cycle time permitted.

Pedestrian

- Green time: 6s minimum green time for pedestrians; and
- Intergreen: based on a walking speed of 1.2m per second plus a two-second safety buffer using AutoCAD.

Cyclist

- Cruise speed: 15km/h or 4.16m per second;
- Cyclist early start: 5s on the majority of main arms, with 3s minimum. On the side roads of junctions, 3s cyclist early start; and
- Modelled cyclist flows based on cycle quantification exercise.

5.4.4.2 Cycle Quantification

The vision of the NCPF is that '*10% of all trips will be by bike*'.

Each junction along the Proposed Scheme has been designed to be consistent with the above objective to accommodate a minimum 10% cycle mode share in terms of people movement at each junction. This will mean that in practice, the junctions should be designed to have capacity to provide for at least the existing levels of cycling demand or levels of cycling that provide for a minimum 10% mode share in future years (whichever is the greater).

A cycle demand quantification assessment was undertaken in order to identify projected cycling demand in the Opening Year (2028) to inform the design of cycle facilities at each junction along the Proposed Scheme in line with the NCPF. The level of cycle demand informs the level of priority and the requirements for geometric design for cyclists. This also has implications for the green time allocation to be provided for cycle movements modelled in LinSig and then in turn in VISSIM traffic flow simulation software.

The cycle demand calculation illustrated in **Figure 5.6** is based on the capacity provided rather than being informed by existing or modelled future year cycling numbers. It was noted that using the maximum pedestrian capacity calculation skewed the mode share calculations, therefore the existing pedestrian counts plus an uplift factor of 20% has been applied.

The calculation accounts for the green time provided in a typical signal cycle, the number of cycles within the hour and an assumption on headway between cyclists. The calculation also considers the capacity benefit of wider lane provision, whereby cyclists can overtake each other with greater widths.

Using the cycle quantification and people movement spreadsheet, the following checks were undertaken to ensure cycle demand is catered for at an appropriate level and that each of the criteria is satisfied:

- A minimum 10% cycle mode share is provided for when summing people movement across all arms (including side roads);

- The calculated cycle capacity (calculated from above) exceeds existing cycling flow; and
- If the calculated mode share of 10% is less than the existing flow, the minimum target is the existing flow plus design buffer level of 20%.

To quantify the cycle demand numbers for input into LinSig, the following approach was applied:

- Cycle Design Target demand for the junction, calculated based on achieving the above criteria (10% of total people movement at junction, or existing plus 20% buffer);
- This Design Target total for whole junction is distributed across turning movements based on existing observed 2019 survey data for cycling;
- A minimum turning demand of 10 cyclists per hour to be allowed for;
- Cycle demand turning flows input to LinSig models with green times and phasing and staging plans adjusted as appropriate; and
- Resulting LinSig models provided for input to VISSIM models which will model the same cycling flows.

Table 5-4 presents a summary of the projected number of cyclists per junction identified as a Design Target and a total number of cyclists modelled in LinSig per junction. The detailed analysis is also included in **Appendix L.**

Table 5-4: Cyclist People Movement Quantification

Junction Name	Cycle Quantification (Number of Cyclists)			
	2028 AM Peak Hour		2028 PM Peak Hour	
	Design Target	Total Modelled	Design Target	Total Modelled
Fonthill Road / Retail Park Shopping Centre Junction	450	450	450	450
Fonthill Road	445	445	445	445
Coldcut Road / Fonthill Road Junction	982	982	982	982
M50 Signal-Controlled Bus Priority	NA	NA	NA	NA
Coldcut Road / Cloverhill Road Junction	1,083	888	1,092	839
Coldcut Road / Kennelsfort Road / Upper Ballyfermot Road Junction	975	716	985	862
Ballyfermot Road / Primary Health Care Centre	1,212	1,212	1,202	1,202
Ballyfermot Road / Clifden Road Junction	937	855	925	925
Ballyfermot Road / Drumfinn Road Junction	937	855	925	925
Ballyfermot Road / Le Fanu Road Junction	603	603	603	603
Le Fanu / Kylemore Road / Chapelizod Hill Junction	No protected cycle facilities			
Ballyfermot Road / Commercial Centre Junction				
Ballyfermot Road / Kylemore Road Junction	635	635	625	625
Sarsfield Road / Landen Road Junction	1,057	1,057	1,057	1,057
Sarsfield Road / Con Colbert Road Junction	658	658	658	658
Inchicore Road / Memorial Road Junction	684	684	684	684
Sarsfield Road / Inchicore Road / Grattan Crescent	1,032	1,032	1,030	1,030
Grattan Crescent / Tyrconnell Road / Emmet Road	No protected cycle facilities			
Emmet Road / St. Vincent Street West Junction				
Emmet Road / South Circular Road / Old Kilmainham				
James's Street / St. James's Hospital Junction				
James's Street / Bow Lane West Junction				

Junction Name	Cycle Quantification (Number of Cyclists)			
	2028 AM Peak Hour		2028 PM Peak Hour	
	Design Target	Total Modelled	Design Target	Total Modelled
James's Street / Thomas Street / Watling Street	1,028	1,028	1,029	1,029
Thomas Street / Bridgefoot Street / Thomas Court	1,190	1,160	1,198	1,168
Thomas Street / Meath Street Junction	965	965	966	966
Thomas Street / Cornmarket / Augustine Street / Francis Street	1,144	1,114	1,151	1,121
Cornmarket / High Street / Bridge Street Upper	622	622	677	677

5.4.4.3 LinSig Results

Table 5-5 provides an overview of the junction analysis results.

Table 5-5: Liffey Valley to City Centre Signalised Junctions

Junction Name	Cycle Time (Seconds)		2028 Peak Hour	
	Do Minimum	Do Something	AM Peak	PM Peak
Fonthill Road / Retail Park Shopping Centre Junction	Roundabout	120	+43.6%	+43.6%
Fonthill Road	Roundabout	120	+147.63	+20.95
Coldcut Road / Fonthill Road Junction		120	+13.31	+15.43
M50 Signal-Controlled Bus Priority	No junction	60		
Coldcut Road / Cloverhill Road Junction	93	120	+17.56	+11.3
Coldcut Road / Kennelsfort Road / Upper Ballyfermot Road Junction	93	120	+13.7%	+0.7%
Ballyfermot Road / Primary Health Care Centre	120	120	+85.9%	+53.87
Ballyfermot Road / Clifden Road Junction	120	120	+65.3%	+54.2%
Ballyfermot Road / Drumfinn Road Junction	120	120		
Ballyfermot Road / Le Fanu Road Junction	120	120	+1.4%	+3.6%
Le Fanu / Kylemore Road / Chapelizod Hill Junction	No data	120	+16.42%	+22.76%
Ballyfermot Road / Commercial Centre Junction	120	60		
Ballyfermot Road / Kylemore Road Junction	Roundabout	120	+4.6%	+9.16%
Sarsfield Road / Landen Road Junction	95	120	+45.6%	+35.5%
Sarsfield Road / Con Colbert Road Junction	80	120	+29.5%	+41%
Inchicore Road / Memorial Road Junction	Mid-Block	120	+49.5%	+104.2%
Sarsfield Road / Inchicore Road / Grattan Crescent	90	120	+122.8%	+37.04%
Grattan Crescent / Tyrconnell Road / Emmet Road	118	120	+7.73%	+2.24%
Emmet Road / St. Vincent Street West Junction	Priority	60	+30.7%	20.74%
Emmet Road / South Circular Road / Old Kilmainham Junction	120	120	+16.1%	+14.1%
James's Street / St. James's Hospital Junction		60	+120%	+244%
James's Street / Bow Lane West Junction	86	120	+40%	+40%
James's Street / Thomas Street / Watling Street	120	120	+31.5%	+7.5%
Thomas Street / Bridgefoot Street / Thomas Court	120	120	+7.4%	+1.7%
Thomas Street / Meath Street Junction	120	60	+42.3%	+278%

Junction Name	Cycle Time (Seconds)		2028 Peak Hour	
	Do Minimum	Do Something	AM Peak	PM Peak
Thomas Street / Cornmarket / Augustine Street / Francis Street Junction	120	60	+66%	+39.34%
Cornmarket / High Street / Bridge Street Upper	120	120	-3.1%	+15.73

6. Ground Investigation and Ground Condition

6.1 Introduction and Desktop Review

A high-level desk study of available information was undertaken for the Proposed Scheme were obtained from publicly available information. The publicly available sources of information reviewed include:

- 1836 – 1842 Historic map 6 inch (Geohive)
- 1888 – 1913 Historic map 25 inch (Geohive)
- 1830 – 1930 Historic map 6 inch – Cassini (Geohive)
- Contour map (EPA) • Geological Survey of Ireland (GSI)
- Quaternary Sediments and Geomorphology map (GSI)
- Teagasc Soils map (GSI)
- Bedrock, Geology100k map (GSI)
- Karst Features map (GSI)
- Depth to Bedrock map (GSI)
- Groundwater Aquifer map (GSI)
- Groundwater Vulnerability map (GSI)
- Groundwater Wells and Springs map (GSI)
- Groundwater Recharge map (GSI)
- Subsoil Permeability map (GSI)
- Active and Historic Pits and Quarries map (GSI)
- Mineral localities map (GSI)
- Historic Ground Investigations map (GSI)

A detailed overview of all desk study information reviewed is presented within Chapter 14 Land, Soils, Geology & Hydrogeology, Environmental Impact Assessment Report (EIAR) Volume 2 of 4 Main Report, July 2021.

6.2 Summary of Ground Investigation Contract

The ground investigation (GI) works for the Proposed Scheme are being undertaken in a phased manner. The design of a preliminary ground investigation focused on significant structures (bridges, underpasses and retaining walls with >3m retained height) where no historical boreholes were available and abnormal conditions were anticipated. Employing this rationale there were no significant structures which required investigation at this stage of design. Further investigation is required at detailed design stage.

6.3 Ground Investigation

No specific ground investigation has been undertaken to date.

6.4 Soils and Geology

A summary of anticipated soils and geology based on desk study information and the results of the ground investigation is presented below. For further details refer to:

- Chapter 14 Land, Soils, Geology & Hydrogeology, Environmental Impact Assessment Report (EIAR) Volume 2 of 4 Main Report, July 2021.

6.4.1 Quaternary Deposits

The naturally occurring Quaternary deposits recorded along the route consist of the following:

- Irish Sea Glacial Till derived from limestone;
- Gravels derived from limestone;
- Urban deposits; and
- Localised Alluvial deposits.

Made ground is anticipated across the scheme with variable thickness dependent on the historic land use of the area.

6.4.2 Bedrock

The bedrock geology along the route consists of:

- Dark limestone and shale (Lucan Formation).

6.5 Preliminary Engineering Assessment

Construction of the Liffey Valley route will require a small number of relatively low-height retaining walls and minor structures. Further details are provided in **Section 8.**

6.5.1 Foundations and Retaining Walls

The underlying geology comprising gravels or stiff Glacial Till is expected to have sufficient bearing capacity for normal shallow foundations to be adopted for these structures. Further consideration of the ground conditions is only expected to be required at locations where thick deposits of Made Ground or Alluvial deposits are present. This is only expected at locations where:

- It is necessary to widen an existing embankment;
- A structure is in an area previously developed and is underlain by demolition rubble;
- Current ground level has been raised in the past for some other reason, most likely to occur near a river but it may also have been done to level a hillside; or
- The ground has been previously disturbed to construct a deep sewer, fuel tank or other buried structure.

6.5.2 Pavement Design

Refer to **Section 7** for pavement design proposals. Limited ground condition information is available at this stage in the design in relation to pavement proposals. Due to the nature of the scheme which largely consists of widening adjacent to existing pavements, and other works to existing pavements, the design is anticipated to align with existing pavement formations.

7. Pavement, Kerbs, Footways and Paved Areas

7.1 Pavement

This section identifies the proposed pavement strategy, setting out the design development considerations for the pavement works in current and future design stages. It also outlines the key elements for consideration for future testing requirements, and considerations for the use of recycled aggregates in the detailed design stage.

7.2 Overview of Pavement

The pavement design for the CBC Infrastructure Works addresses problems identified on previous bus corridor schemes in terms of rutting and ongoing maintenance issues. The prevailing principle followed is the provision of a low maintenance 'stiff' pavement construction.

Designs and inputs have been prepared in accordance with the reference codes outlined in the basis of design documents. The designs will comply with Transport Infrastructure Ireland (TII) Publications, the National Cycling Manual and Design Manual for Urban Roads and Streets.

This report presents the preliminary design for the Proposed Scheme and includes the following:

- Design scope and strategy;
- Network Asset Management and Maintenance;
- Pavement Survey and Condition Assessment;
- Preliminary design;
- Rehabilitation of existing road pavements;
- New full depth road pavement construction;
- Future pavement investigation; and
- Recycling and reuse of site-won pavement materials.

7.2.1 Design Scope

The pavement works include new pavement for the offline section and rehabilitation or pavement strengthening works for the online section where the existing pavement will be disturbed by construction works. In the case where no works are required to accommodate a bus lane, the local authority will remain responsible for the maintenance and repairs to the existing carriageway.

- Where the existing bus lane pavement is being utilised as part of the scheme, a visual inspection and appropriate testing will be carried out to assess the condition of the pavement.
- Where required, full depth pavement reconstruction will be carried out.
- The refurbishment of existing pavements will be designed for a 20-year life and new full depth construction designed for a 40-year life. Pavements will be constructed in accordance with TII Publications and relevant local authority standards.
- A five-year surface renewal schedule should be established for existing road surfaces currently in good condition. A 10-year renewal and/or treatment schedule for all new road surfaces should be established.

- Road pavements should be constructed of traditional bitumen/asphalt materials or a flexible composite construction comprising asphalt over cement-bound granular base.
- Cycle tracks should be constructed in compliance with the National Cycle Manual.
- Pedestrian footways should be constructed in accordance with TII standard details. The surface finish may be asphalt, concrete, concrete flags, concrete blocks or natural stone paving. The choice of surface finish will be dependent on environmental and public realm requirements.
- At all bus stop areas (and in their vicinity) as well as at some key junctions, concrete pavement (rigid or rigid composite) may be considered.
- Pavement profile shall be designed and constructed or reconstructed to provide a uniform standard of high ride-quality.
- Where a combination of new and existing pavements is used, joints shall be made in accordance with TII's Publications and relevant local authority road design standards. In particular, longitudinal construction joints should not be located in known wheel paths.
- Where schemes cross under existing road bridge structures that are retained by the scheme proposals, then no increase in pavement levels/vertical design levels will be allowed by the design over the structural footprint of the bridge.
- The pavement design will ensure that the subgrade is adequately compacted, by means of reprofiling or other proposed method, where:
  - The existing pavement is to be widened by the provision of additional new pavement construction; and
  - The new pavement results in the new subgrade being at a lower level than the existing subgrade.
- Locations for site investigations works will be determined (for areas affected by the design), in order to:
  - Ensure a robust design that takes cognisance of ground conditions present within the study area;
  - Determine the existing ground conditions; and
  - Inform the final detailed pavement design (e.g. pavement material types and construction depths will be specified).
- Cognisance will be taken of:
  - TRL Report 250: Design of long-life flexible pavements for heavy traffic; and
  - TRL Report 615: Development of more versatile approach to flexible and flexible composite pavement design.

7.2.2 Design Standards

The standards and manuals used throughout the pavement evaluation, include, but are not limited to the following:

- TII PE-SMG-02002 Traffic Assessment (HD 24/06);
- TII DN-PAV-03021 Pavement and Foundation Design (NRA HD 25-26);
- TII AM-PAV-06050 Pavement Assessment, Repair and Renewal;

- TRL Report 615, 'Development of a more versatile approach to flexible and flexible composite pavement design', Transport for London, 2004;
- TRL Report LR1132, 'The structural design of bituminous roads', Transport and Road Research Laboratory, 1984;
- TRL 386 'Design guide and specification for structural maintenance of highway pavements by cold in-situ recycling', 1999;
- TRL 611 'A guide to the use and specification of cold recycled materials for the maintenance of road pavements', 2004;
- TII Road Pavement Standards Details;
- TII Footway standard details; and
- Preliminary Design Guidance Booklet for BusConnects Core Bus Corridors.

7.2.3 Design Strategy

Refurbishment of the existing road will be considered during the design. Investigation into ground conditions will be required in areas where widening of the existing carriageway or construction offline is necessary. Design for the refurbishment of existing pavements and new full-depth flexible, flexible composite and rigid pavements will be considered. The strategy aims to accomplish the following objectives:

Existing pavements

- Assess the construction and condition of the bound pavement layers;
- Ascertain the underlying foundation performance;
- Assign pavement exhibiting similar properties to homogeneous sections;
- Calculate the predicted design traffic in terms of million standard axles;
- Calculate the residual life of the pavement; and
- Design structural treatments to strengthen the pavement where necessary and ensure the pavement can withstand the future predicted traffic.

New offline full depth construction

- Locate trial pits in areas where the road is to be widened;
- Determine in-situ strength of the soils to 1.2m depth below finished pavement level;
- Recover soils samples for classification and determination of in-service strength;
- Determine foundation type and depth; and
- Determine depth of a new pavement.

7.2.4 Geometry

Changes to the horizontal and vertical alignment may be restricted by the threshold constraints. Changes to vertical alignments will require the construction of a new surface course and depending upon the magnitude of change a new binder course may also be required. A change to horizontal alignment will require new full-depth construction.

For widening, a new full-depth pavement will be required. Continuity of drainage must be maintained over the profile of the earthworks between the existing carriageway and the proposed widening to prevent moisture/water becoming trapped in the pavement foundation.

7.2.5 Network Asset Management and Maintenance

The extents of the Proposed Scheme are covered by two local authorities. These are:

- Dublin City Council; and
- South Dublin County Council.

In general, the local authorities take a similar approach to pavement management. The local authorities use this information to rank the network condition. Data is used to inform pavement maintenance and prioritisation although a significant proportion of local authority repair work is constrained by available budget. Road Condition Index (RCI) is determined from machine-driven surveys. RCI is a form of ranking of pavement condition and can be simplified into red, amber and green categories. Typical authority RCI ranking is shown in **Table 7-1** below. The majority of maintenance carried out by the local authorities is limited to repair of the surface course layer only.

Table 7-1: Typical Authority RCI Ranking for Network Asset Management of Pavements

Typical RCI Ranking	
Red	Poor overall condition. Plan maintenance soon
Amber	Some deterioration is apparent. Plan investigation soon
Green	Generally, in good condition.

7.3 Pavement Condition Survey and Assessment

7.3.1 Visual Survey

A visual condition survey was carried out along the length of the route during February 2020. Weather conditions at the time of the survey were mainly dry with occasional showers. The location, photograph, type and severity of the observed defects or features, with a brief description and photograph of each observation, was recorded in ArcGIS interactive mapping software.

7.3.2 High-Level Ranking of Pavements

The condition assessment and ranking of pavement condition is based on a visual survey and supported by ROW condition data.

Each observed defect or feature was assigned a symbol and plotted on a general arrangement plan of the Proposed Scheme. The plotted information was used to identify and assign pavements exhibiting similar properties to homogeneous sections for ranking and treatment. The condition of the pavement was ranked into three categories according to the number and types of defect which occurred in an area of pavement. The three categories are major defect, minor defect and no visual defect. These defects were recorded as major in purple and minor in red for the individual defects. In cases where there were a large number of minor defects they were assigned to the major colour zone along with all major defects, otherwise a minor colour zone was assigned.

Figure 7.1 presents an extract from visual inspection which shows the ranking of pavement condition and visual observations. The ranking is identified as a red dash line indicating major defects; in this case deteriorating asphalt over distressed concrete pavement. The plan also shows core locations for a proposed pavement investigation.

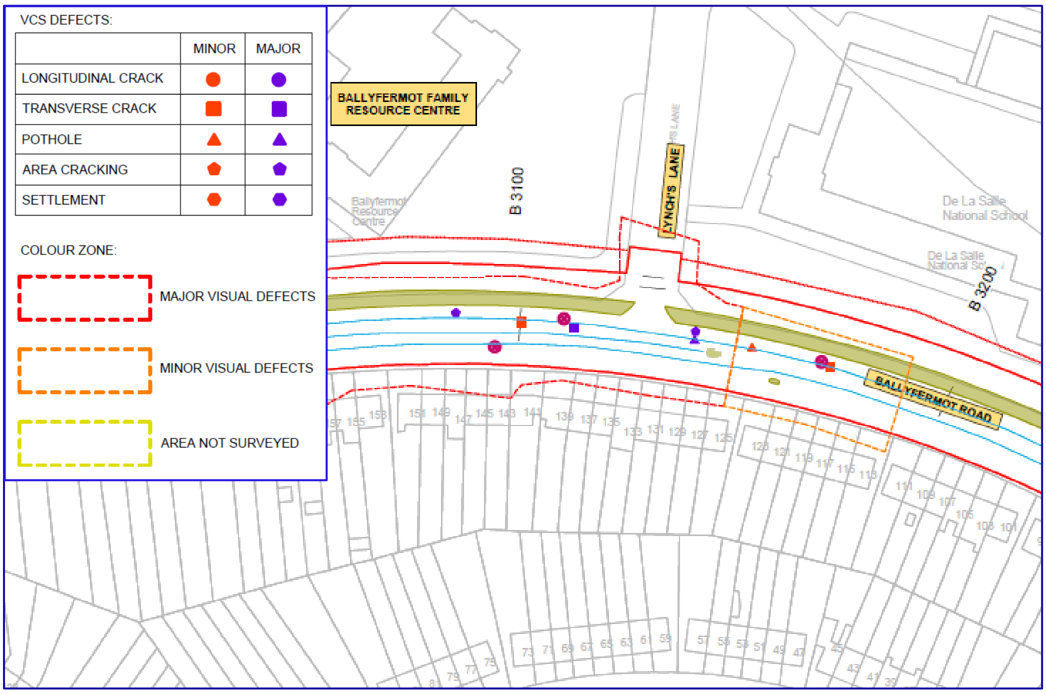

Figure 7.1: Example Ranking of Pavement Condition and the Type and Location of Defects Observed

Having completed the visual assessment, the maps generated through the ArcGIS mapper were then used to inform the proposed pavement design, in **Appendix B.**

7.4 Pavement Design

7.4.1 Refurbishment of Existing Pavements

The preliminary refurbishment design is based on the information recorded during the visual condition survey supplemented by information received from the authorities responsible for maintenance. The type of defect or combination of defects was assessed as described previously. The type of treatment proposed is dependent on the severity and number of observed defects and overall condition of the pavement.

7.4.1.1 **Treatment Options**

In the absence of information on the type, thickness and strength of the existing pavements, the types of construction presented in is based solely on visual condition information gathered during a visual survey and limited local authority condition data.

Table 7-2: Typical Treatments for New and Refurbished Pavements

Road Repair/ Maintenance	Depth (mm)	Material Type	Specification Clause
Profile and lay 45mm			
New surface course only	45	Hot Rolled Asphalt (HRA) 35/14 F surf 40/60 des	SPW 0900 cl. 4.1.2
Profile and lay 130mm			
Surface course (Note 1)	40	HRA 30/14 F surf 40/60 des	SPW 0900 cl. 4.1.1
Binder course	90	AC20 dense bin 40/60 des	SPW 0900 cl. 3.1.4
Profile and lay 200mm			
Surface course (Note 1)	40	HRA 30/14 F surf 40/60 des	SPW 0900 cl. 4.1.1
Binder course	60	AC20 dense bin 40/60 des	SPW 0900 cl. 3.1.4
Base	100	AC32 dense base 40/60 des	SPW 0900 cl. 3.1.1
Note 1: SMA surf PMB 65/105-60 SPW 0900 Clause 5.1.1 may be used in place of HRA surface course			

7.4.1.2 Presence of Tar-Bound Materials at Depth

It is probable that tar will be present in the lower layers of the bound pavement of older roads. This should only affect materials recovered from the deeper excavations (200mm) for new binder course and base. In the absence of any factual information an estimate of 1% tar-bound materials from the deeper excavation would be reasonable.

7.4.2 Design of New Full-Depth Pavement

7.4.2.1 Depth of Asphalt for New Full Depth Pavement

The design pavement thickness for a new full-depth pavement comprising asphalt concrete with 40/60 bitumen binder has been determined in accordance with DN-PAV-03021 – Pavement and Foundation Design (NRA HD 25-26) for a 20-year and 40-year design period. The traffic design has been separated into bus/coach and HGV traffic volumes and is applicable for new and refurbished pavement design.

Table 7-3 presents the range in asphalt thickness comprising AC 40/60 for new full-depth pavement in areas of widening and full-depth repair to existing pavements.

Table 7-3: Range in Thickness for a New Full-Depth Asphalt Pavement

Design Life	Vehicle	Traffic Lane	Maximum (mm)	Minimum (mm)	Average (mm)
20 years	Bus/coach	Bus/coach only	270	210	230
	HGV	Other traffic lanes	220	200	200
40 years	Bus/coach	Bus/coach only	300	240	250
	HGV	Other traffic lanes	260	200	210

7.4.2.2 Pavement Foundation Design for New Full-Depth Pavement

The foundation design is based on an assumed in-service California Bearing Ratio (CBR) of 3% at formation level. In accordance with TII DN-PAV-03021 – Pavement and Foundation Design (NRA HD 25-26) the required thickness of Type B Subbase is 300mm.

7.4.2.3 New Full-Depth Construction for Bus Lanes

New pavement design should comply with the requirements of TII DN-PAV-03021 – Pavement and Foundation Design (NRA HD 25-26). The required asphalt pavement depth along the Proposed Scheme ranges between 240mm and 300mm, with an average thickness of 250mm AC 40/60 for a 40-year design life.

Table 7-4: New Full-Depth Construction for Bus Lanes

Road Repair/ Maintenance	Depth (mm)	Material Type	Specification Clause
Surface course	40	SMA surf PMB 65/105-60	SPW 0900 cl. 5.1.1
Binder course	60	AC20 dense bin 40/60 des	SPW 0900 cl. 3.1.4
Base	140 to 200	AC32 dense base 40/60 des	SPW 0900 cl. 3.1.1
Subbase	300	Type B Subbase	SPW 0800 cl. 804
Total depth	540 to 600	Assumed CBR≥3%	
Alternative construction with EME2			
Surface course	40	SMA surf PMB 65/105-60	SPW 0900 cl. 5.1.1
Binder course/base	160 to 200	AC10 EME2 15/25 des	DN-PAV-03021
Subbase	300	Type B Subbase	SPW 0800 cl. 804
Total depth	500 to 540	Assumed CBR≥3%	

7.4.2.4 Long-Stay Offline Bus Layby

Although modified asphalts provide good rut resistance, stationary vehicles with their engines running can deform asphalt in a relatively short time. An alternative option outlined below should also be considered:

- A grouted macadam is a proprietary process whereby an open-graded asphalt surface layer is constructed over a competent substrate. A new full-depth construction is preferable. A high-strength cementitious grout is applied to the surface to completely fill all the voids. The resultant product is a strong and rut-resistant surface which is not prone to the plastic deformation associated with conventional asphalt. This process should be considered for both online and offline bus stops; or

- Pavement-quality concrete continually reinforced with no joints in accordance with HD26, minimum thickness 200mm, would provide a robust pavement surface and structure. Concrete pavements should be constructed over a cement-bound base.

7.5 Construction of New Cycleways and Footways

The typical standard designs for new cycleways and footways below are extracted from TII standard details.

7.5.1 Cycleway

A typical cycleway construction is shown in **Table 7-5** below.

Table 7-5: Typical Cycleway Construction

New Cycleway	Depth (mm)	Material Type	Specification Clause
Asphalt – no vehicle overrun			
Surface course	30	Red colour, AC10 dense surf 70/100 des	SPW 0900 cl. 3.1.13
Binder course	50	AC20 dense bin 70/100 des	SPW 0900 cl. 3.1.5
Subbase	225	Type B Subbase	SPW 0800 cl. 804

7.5.2 Footpath

Table 7.7 presents a range of typical options for new footway construction. The full range of options are provided in TII standard details.

Heritage paving – design and construction will be to a bespoke design, dependent on the type and dimension of paving modules specified.

Table 7-6: Typical Footway Construction

New Footway	Depth (mm)	Material Type	Specification Clause
Asphalt – light vehicle overrun			
Surface course	20	AC6 dense surf 70/100 des	SPW 0900 cl. 3.1.15
Binder course	50	AC20 dense bin 70/100 des	SPW 0900 cl. 3.1.5

New Footway	Depth (mm)	Material Type	Specification Clause
Subbase	225	Type B Subbase	SPW 0800 cl. 804
Concrete – light vehicle overrun			
Surface layer	150	C25/30 unreinforced concrete	SPW 1000 cl. 1001
Subbase	150	Type B Subbase	SPW 0800 cl. 804
Pavers – light vehicle overrun			
Surface layer	60	Concrete block paver	BS 7533
Bedding sand	30	Bedding sand	BS 7533
Base	70	AC20 dense bin 70/100 des	SPW 0900 cl. 3.1.5
Subbase	150	Type B Subbase	SPW 0800 cl. 804
Flags – light vehicle overrun			
Surface layer	65	Flags	BS 7533
Bedding layer	25	Mortar	BS 7533
Base	70	AC20 dense bin 70/100 des	SPW 0900 cl. 3.1.5
Subbase	150	Type B Subbase	SPW 0800 cl. 804

7.6 Future Pavement Assessment

Pavement assessments should be carried out in accordance with TII AM-PAV-06050 Pavement Assessment Repair and Renewal Principles.

A high-level visual condition survey has been completed. Further investigation, inspection and testing is required to complete the investigation. Buried services may restrict the location and depth of in-situ tests and recovery of samples.

7.7 Incorporation of Recycled Aggregates into Pavement Materials

7.7.1 Carbon Footprint

The purpose of in-situ recycling is to effectively restore a failed road pavement by recycling and reusing existing construction materials to construct a new pavement with strength and life expectancy that is equivalent to that of traditional construction. The need to dispose of large volumes of waste materials and import processed virgin aggregates and hot bitumen binder is greatly reduced, resulting in a lower carbon footprint. In addition to a reduced environmental impact, in-situ recycling can often be a lower-cost solution in both urban and rural environments. The design and process of construction should follow the guidelines in:

- TRL 386 Design guide and specification for structural maintenance of highway pavements by cold in-situ recycling; and

- TRL 611 A guide to the use and specification of cold recycled materials for the maintenance of road pavements.

7.7.2 Processes

The following types of reuse and recycling of site-won materials are common practice in the industry.

7.7.2.1 Unbound Mixture Produced as Part of the Works

EN 13285 includes manufactured (such as slags and ashes) and recycled aggregates within its scope without specific mention in the requirement clauses. The approach adopted is blind to the source of the aggregate used in the mixture. The suitability of mixtures containing manufactured and recycled aggregates for use in subbase should be assessed in accordance with the requirements of the project specification.

EN 13242 and EN 13285 specify the operation of a factory production control system to confirm conformance with the relevant requirements of the standards. Although unbound mixtures produced on site as part of the permanent works are not placed on the market, a factory production control system (or a quality plan with equivalent requirements) is still required to provide the necessary level of assurance.

7.7.2.2 Unbound Subbase

EN 13285 applies to unbound mixtures of natural, manufactured aggregates such as slags and recycled aggregates. The materials may comprise the following:

- 100% recycled coarse aggregate and concrete aggregates with up to 50% asphalt planings; or
- 100% asphalt planings – the effects of using this material on the surrounding environment should be fully assessed.

7.7.2.3 Bound Subbase

The different parts of EN 14227 require aggregates to conform to EN 13242 which applies to aggregates obtained by processing natural or manufactured or recycled materials. Recycled coarse aggregate, concrete aggregate and asphalt planings may be incorporated into the mixture. The standard includes the use of a wide range of binders including:

- Cement;
- Slag;
- Fly ash; and
- Hydraulic road binder.

The properties and the appropriate categories of the aggregates should be specified depending on the position of the bound granular mixture in the pavement structure and the traffic to be carried.

7.7.2.4 Capping

Capping material may comprise any material or combination of materials including recycled aggregates and recycled concrete with not more than 50% by mass of recycled bituminous planings and granulated asphalt, but excluding materials contaminated with tar and tar-bitumen binders.

7.7.2.5 In-situ and Plant Recycling Processes

The types of in-situ and plant recycling processes include:

- **Repave and remix**: these are in-situ processes which conserve/restore the surface layers of structurally sound pavements;

- **Cold deep recycling**: pavement layers can be recycled in-situ to form a foundation or main structural layers of a new pavement;
- **Low-energy bound mixtures**: the requirements and processes for plant base cold recycling are specified in TII CC-SPW-00900; and
- **Central plant hot recycling**: good quality unbound aggregates such as subbase and drainage materials and reclaimed asphalt can be fed into the hot mix process.

8. Structures

8.1 Overview of Structures Strategy

A number of structures are proposed along the length of the route, the design of which is in accordance with the various phases as outlined in Transport Infrastructure Ireland (TII) Publications and Manual of Contract Documents for Road Works (MCDRW).

The design of structures is developed to a level of detail sufficient to describe the major elements of the structure and obtain preliminary approval in accordance with DN-STR-03001 Technical Acceptance of Road Structures on Motorways and Other National Roads (Formerly NRA BD 2). This chapter of the report provides an overview of the structures envisaged, which are presented in more detail in the Structures Option Reports listed in **Table 8-1**. The Structures Options Reports and associated drawings are contained in **Appendix J**.

Table 8-1: Tabular Summary of Structures Options Reports

Structures	Reference	Appendix
Structures Options Report, Route 7: Liffey Valley to City Centre, Dublin City Council	BCIDB-JAC-STR_ZZ-0007_RW_00-RP-CB-0001	**Appendix J**
Structures Options Report, Route 7: Liffey Valley to City Centre, South Dublin County Council	BCIDB-JAC-STR_ZZ-0007_RW_00-RP-CB-0002	**Appendix J**

Throughout the development of the options in the subsequent phases of the scheme, the following authorities will be kept appraised of the aspects of the proposals which will impact them:

- Dublin County Council; and
- South Dublin County Council.

TII Regional Bridge Management are responsible for Technical Acceptance of any works proposed to M50 Overbridge/ Coldcut Road Bridge (M50-003.00), as well as management and maintenance of the structure.

8.2 Summary of Principal Structures

Three Principal Structures exist along the length of the scheme. Their location and type is indicated in **Table 8-2**.

Table 8-2: Tabular Summary of Principal Structures

Identity	Irish OS Grid	ITM Grid	Chainage(m)	Description
M50 Overbridge/ Coldcut Road Bridge	307498E 234204N	707439E 734229N	B 0+260	The M50/Coldcut Road Overbridge crosses the M50. Raised verges are to be widened to accommodate the highway design without any structural widening (carriageway over structure narrowed). Approach Vehicle Restraint System (VRS) transitions will also require realignment.

Identity	Irish OS Grid	ITM Grid	Chainage(m)	Description
Sarsfield Road Bridge	311637E 233668N	711578E 733692N	E 0+080	The Sarsfield Road Bridge crosses the railway line. It is a single span simply supported steel bridge. No proposed widening at this location.
Emmet Road Culvert	311934E 233420N	711875E 733444N	B 5+715	Brick arch culvert construction carries the R810 (Emmet Road) over an unnamed stream. The internal span is approximately 4m. No widening is required at this location.

8.3 Summary of Minor Structures

Minor structures are defined as Category 0 structures in accordance with DN-STR-03001:

- Single span simply supported structures with span less than 5m;
- Buried concrete boxes or buried rigid pipes greater than 2m clear but less than 3m span/diameter and having more than 1m cover; and
- Environmental barriers less than 2.0m in height.

8.4 Summary of Retaining Walls

There are a number of proposed retaining walls along the length of the scheme. The location and type of structure is indicated in the **Table 8-3** below. In accordance with DN-STR-03001 Section 3.4 all walls with a retained height less than 5m are classified as a Category 1 structure, except those of height less than 1.5m (that are not subject to Technical Acceptance).

Table 8-3: Tabular Summary of Retaining Structures

Wall Reference	Structure Type Preferred Option	Retained Height (m)			Chainage Start	Chainage End	Length (m)	Category
R7-RW013	Precast RC	varies	1	max	B 0+295	B 0+395	100	N/A
R7-RW008	Precast RC	varies	1	max	B 3+495	B 3+555	60	N/A
R7-RW009	Precast RC	varies	1	max	B 3+800	B 3+820	20	N/A
R7-RW010	Precast RC	varies	3	max	B 3+840	B 3+910	80	1
R7-RW011	Precast RC	varies	2.5	max	B 3+920	B 4+180	260	1

9. Drainage, Hydrology and Flood Risk

9.1 Overview of Drainage Strategy

The drainage preliminary design was developed following consultation with the relevant local authority and Irish Water where applicable. The strategy and design parameters to be adopted throughout Dublin BusConnects is summarised in the Drainage Design Basis Document No. BCIDX_ARP-PMG_PS0000_XX_00-SD-ZZ-0002 included in **Appendix K.**

The design basis statement was developed whilst taking the Greater Dublin Regional Code of Practice (GDRCoP), Greater Dublin Strategic Drainage Study (GDSDS), Planning requirements of Local Authorities within the Dublin region, TII requirements and international best practices such as CIRIA The SuDS Manual (C753).

The principal objectives of drainage design are as follows:

- To drain surface water from existing and proposed pavement areas throughout the BusConnects development and maintain the existing standard of service.
- To maintain existing runoff rates from existing and newly paved surfaces using SuDS.
- To minimise the impact of the runoff from the roadways on the surrounding environment using SuDS, silt traps and/or oil/petrol interceptors. The drainage system should ensure that surface water drains from existing and new pavement areas be limited by the capacity of the existing highway drainage network.
- No drainage features like gullies or manholes are to be located at, or any ponding will be allowed to occur at, pedestrian cross-walk locations or at bus-stop locations. Where any such drainage features currently exist at such locations they will be relocated.

Drainage of newly paved areas will include SuDS measures to treat and attenuate any additional runoff. These measures will ensure that there is:

- No increase in existing run off rates from newly paved areas; and
- Appropriate treatment to ensure runoff quality.

A hierarchical approach to the selection of SuDS measures has been adopted with 'Source' type measures e.g. tree pits implemented in preference to catchment type measures e.g. attenuation tanks. Further details of the SuDS hierarchy are provided in the Drainage Design Basis.

9.2 Existing Watercourses and Culverts

The Proposed Scheme crosses the Camac River. The watercourse is in culvert where they pass beneath the existing highway. No works are proposed to change the width of the highway at the crossing; therefore, the existing culvert will be retained without modification.

The EPA website indicates that the Poddle River crosses under the Proposed Scheme on Thomas Street. However, on further investigation of more detailed maps it has been determined that the Poddle River does not cross the scheme.

Stage 1 and 2 Flood Risk Assessments have been completed on the Preliminary Design and are summarised in **Section 9.6.**

9.3 Existing Drainage Description

The existing highway along the Proposed Scheme is served by both surface water and foul/combined drainage networks. Flows are typically collected in standard gulley grates and routed via a gravity network to outfall. There are no SuDS/attenuation measures on the existing drainage networks to treat or attenuate runoff from the existing highway.

The existing drainage network along the Proposed Scheme can be split into the three catchment areas based on topography and the existing pipe network supplied by Irish Water. The approximate catchment areas, existing sewer networks, outfalls and watercourses are shown on the existing catchment drawings (refer to drawings **BCIDB-JAC-DNG_RD-0007_XX_00-DR-CD-0001-01** to **BCIDB-JAC-DNG_RD-0007_XX_00-DR-CD-0001-04** within **Appendix B**). The catchments are summarised in **Table 9-1** below.

Table 9-1: Proposed Scheme Existing Drainage

Existing Catchment Reference	Approximate Drainage Catchment Area (km^2)	Existing Network Type	Existing Outfalls
Catchment 1	1.514	Surface water (storm)	Network outfalls to the Quarryvale Stream
Catchment 2	12.96	Surface water (storm)	Network outfalls to the River Liffey
Catchment 3	Ringsend Wastewater Treatment Plant (WwTP) Catchment	Surface water (storm) and combined sewer (foul and storm)	Some stormwater network outfalls to the River Camac. Foul/combined network drains to Ringsend WwTP with sewer overflows to the River Liffey.

- Catchment 1 covers the scheme where it runs adjacent to the Liffey Valley Shopping Centre. This area is served by a surface water network, which discharges to the Quarryvale Watercourse, a small tributary of the River Liffey. The approximate total network catchment area is 1.5km2.

- Catchment 2 covers the scheme from the Liffey Valley Shopping Centre to Kilmainham. This area is served by a surface water network, which discharges to River Liffey via 12 outfalls. The total network catchment area is 13.0km2.

- Catchment 3 encompasses the inner city. This area is mainly drained by the foul/combined sewer network, which discharges to the Ringsend WwTP.

9.4 Overview of Impacts of Proposed Works on Drainage/Runoff

The Preliminary Drainage Design for the Proposed Scheme has been developed with reference to the *BusConnects Core Bus Corridor Drainage Design Basis*. The principles for the design as set out in the Drainage Design Basis are as follows:

- All drainage structures for newly paved areas are designed with a minimum return period of no flooding in 1:30 years with a 20% climate change allowance. Unless informed otherwise via hydraulic models or anecdotal advice, drainage structures for existing paved areas are assumed to have been designed with a return period of no flooding in 1:5 years.

- A SuDS drainage design has been developed for all newly paved areas in accordance with the SuDS hierarchy set out in the Drainage Design Basis. SuDS are provided to ensure no increase on existing runoff rates from new or existing paved areas.

- Knowing the largely impermeable nature of soils across Dublin, infiltration rates were assumed to be zero for calculating the required attenuation volumes of any SuDS measures. This is a conservative approach and ensures SuDS measures are not knowingly undersized at this stage of the design. Where necessary, permeability tests will need to be completed so that infiltration rates can be considered in a future design stage.

- All runoff from road pavement or any other paved areas is collected in a positive drainage system. Over-the-edge discharges are not permitted.
- Narrow filter drains or fin drains are not expected for inner city roads that are typical of the Liffey Valley Scheme. An assessment of the provision of any sub-grade drainage will be undertaken during the next design stage.

Each catchment area has been broken down into sub-catchments in order to define the change in impermeable surface area as a result of the Proposed Scheme. Where there is a net increase in impermeable surface area, a form of attenuation will be required prior to discharge. Where there is no net change or net decrease, then no form of attenuation will be required prior to discharge. A summary list of the sub-catchments, the associated chainage, and impermeable surface area differential is given in **Table 9-2**. Note, permeability factors have been applied to the impermeable and permeable areas. These factors are described in the Design Basis Statement and are required due to the difference in the calculated runoff rate from an impermeable surface, such as a road, when compared with a permeable surface, such as a verge. The following tables contain a column entitled 'Net change' which take account of the applicable permeability factors and the change of use from impermeable to permeable areas and vice versa.

Table 9-2: Proposed Scheme Summary of Increased Permeable and Impermeable Area

Existing Catchment Reference	Chainage	Road Corridor Area (m^2)	Change of use to Impermeable Areas (m^2)	Change of use to Permeable Areas (m^2)	*Net Change (m^2)	Percentage Change (%)
Catchment 1	A00+400 – A00+550	4,595	941	246	695	15.12%
Catchment 2	A00+200 – A00+400	11,278	1,174.9	22.8	1,152.1	10.22%
Catchment 2	A00+200 – B00+200	11,849	3,271.3	484.8	2,786.5	23.52%
Catchment 2	B00+300 - B00-700	6,320	1,802.6	350.7	1,451.9	22.97%
Catchment 2	B00+700-B01+100	7,183	1,791.2	98.5	1,692.7	23.57%
Catchment 2	B01+100 - B01+500	6,607	796.1	52.8	743.3	11.25%
Catchment 2	B01+900 - B02+200	5,203	133	179.4	-46.4	-0.89%
Catchment 2	B02+200 - B02+600	5,901	123	216.4	-93.4	-1.58%
Catchment 2	D00+000 -D00+400	3,340	0	0	0	0.00%
Catchment 2	B02+600 – B02+900	11,563	1,435.5	1,391.5	44	0.38%
Catchment 2	B02+900 – B03+300	5,654	1,184.3	419.7	764.6	13.52%
Catchment 2	B03+300 – B03+700	5,328	1,054.9	0	1,054.9	19.80%
Catchment 2	B03+700 – B04+100	4,811	1,831.9	0	1,831.9	38.08%
Catchment 2	B04+100 – B04+400	6,089	25.8	0	25.8	0.42%
Catchment 2	B04+400 – B04+800	8,474	571.3	926.2	-354.9	-4.19%
Catchment 3	B04+800 – B05+400	6,778	0	0	0	0.00%
Catchment 3	B05+400 – B06+000	7,233	0	0	0	0.00%
Catchment 3	B06+000 – B06+400	5,236	0	0	0	0.00%
Catchment 3	B06+400 – B06+700	4,079	0	0	0	0.00%
Catchment 3	B06+700 – B07+100	4,381	0	0	0	0.00%
Catchment 3	B07+100 – B07+500	4,761	0	0	0	0.00%
Catchment 3	B07+500 – B07+900	7,474	0	0	0	0.00%
Catchment 3	B07+900 – B08+300	6,365	0	0	0	0.00%

Existing Catchment Reference	Chainage	Road Corridor Area (m²)	Change of use to Impermeable Areas (m²)	Change of use to Permeable Areas (m²)	*Net Change (m²)	Percentage Change (%)
Catchment 3	B08+300 – B08+700	7,117	0	0	0	0.00%
Catchment 3	B08+700 – B09+000	10,666	0	0	0	0.00%

9.4.1 Method of Design

The following steps outlined in **Table 9-3** were completed to develop the Preliminary Drainage Design for the Proposed Scheme:

Table 9-3: Proposed Scheme Drainage Design Steps

Design Step	Details
Step 1 – Define Drainage Catchments	The Proposed Scheme was first split into the seven existing catchments based on topography and the existing sewer network as described in section 1.2 above. The Scheme was then split into sub catchments for drainage design. The drainage design sub catchments are based on the road topography, extent of new paved areas and existing highway drainage network
Step 2 – Define Outfalls	The proposed outfall locations for newly paved areas were identified as either: The existing drainage network; or An appropriate watercourse.
Step 3 – Develop Network	A concept design for each catchment drainage network was developed. Where there is no change in the pavement area within a catchment, it was assumed that the existing network would be retained with new gulley connections provided as required.
Step 4 – Design SuDS Requirements	SuDS measures were designed to attenuate runoff for any newly paved areas. SuDS were designed to provide sufficient storage to ensure no increase in existing runoff rates. Where there is no change in the pavement area within a catchment, no SuDS measures are proposed as there will be no change in the runoff rate.
Step 5 – Design Treatment Requirements	Where practicable, runoff treatment from newly paved areas was catered for within the proposed SuDS measures. Where this is not practicable a petrol interceptor was provided. Where there is no change in the pavement area within a catchment, no treatment provision is allowed for.

For this Preliminary Design, the drainage network and SuDS measures for each catchment were determined using hand calculations supported by Preliminary MicroDrainage (WinDes) models.

The parameters that were applied for the Preliminary Design are stated in the Drainage Design Basis and summarised in **Table 9-4** below.

Table 9-4: Drainage Design Parameters

Parameter and Feature	Design Standard
Runoff Permeability Factors	
Paved areas (new and existing)	1.0 (100% runoff)
Greenfield areas (new and existing)	0.3 (based on Dublin Soil Type 2, GDSDS Volume 2)
Rainfall Design Criteria	
FSR Curve Region	Scotland/Ireland
M5-60	16.3 (Met Eireann. Return Period Rainfall Depths for sliding Durations. Irish Grid: Easting 315887, Northing: 234669. Values derived from a Depth Duration Frequency Model)
Ratio R	0.279 (Met Eireann. Return Period Rainfall Depths for sliding Durations. Irish Grid: Easting 315887, Northing: 234669. Values derived from a Depth Duration Frequency Model)
Climate change allowance	20% (Dublin City Council Development Plan 2016-2022 and Drainage Requirements for Planning Applications)
Permitted Discharge Rates	
Newly paved catchment areas	Discharge rates throttled to **2l/s/ha** with minimum flow of **2l/s**
Existing paved catchment areas	Taken as the existing **1 in 5-year flow** unless available network/model information shows an alternative existing rate of discharge
Combined new/existing paved catchment areas	Limited to the existing **1 in 5-year flow** unless available network/model information shows an alternative existing rate of discharge from existing paved areas
Attenuation / SuDS Measures	
Combined new/existing paved areas	Attenuation/SuDS measures sized to contain the **1 in 30-year storm** with a 20% allowance for future climate change
Newly paved (existing greenfield) areas	Attenuation/SuDS measures sized to contain the **1 in 100-year storm** with a 20% allowance for future climate change
Exceptions: • Where attenuation measures are proposed in the floodplain, they shall be sized to contain the 1 in 100-year storm plus climate change; and • The design of attenuation/SuDS measures shall ensure no flooding of properties up to and including the 1 in 100-year storm plus climate change.	

9.5 Preliminary Drainage Design

9.5.1 Proposed Drainage System

The existing drainage network will be maintained and used as the main discharge point for the new drainage system. The purpose of the design will be to replicate the existing situation. Where new multiple gully connections discharge to a combined sewer, a new surface water pipe will be provided where practicable and connected to the combined sewer as per Irish Water requirements.

The following drainage systems were considered for the Proposed Scheme where new paved areas are proposed:

- **Sealed drainage** which collects, conveys and discharges runoff via a sealed pipe network. For the purposes of the CBC Infrastructure Works, this type of drainage comprises of sealed pipes which are connected to split gullies within the kerb line. These gullies will be located in the kerb line between the cycle-track and the bus lane and/or the footpath and the cycle track depending on the highway profile, but with the location of the bicycle and/or bus wheel-track in mind for cycling safety and ride-quality purposes. Attenuation ponds are provided for the short-term detention and treatment of stormwater runoff from the completed CBC Infrastructure Works which allows a controlled release from the structure downstream.

- **Underground stormwater attenuation tanks** collect and store excess surface water runoff from large storm events and release it at a controlled rate, usually by a flow-control device, into a local watercourse minimising the risk of localised flooding.
- **Grass surface water channels, swales, and bio retention areas/rain gardens** are provided as road edge/footpath edge drainage collection systems. They will provide treatment and can provide attenuation if required. A filter drain can be laid below the swales to keep the swale dry during low return period rainfall events.
- **Filter drains** are provided as road edge channels. These comprise a perforated pipe with granular surround and are designed to convey, attenuate and treat runoff prior to discharge.

9.5.2 Summary of Surface Water Drainage

A summary of the proposed drainage measures for the Proposed Scheme are presented in **Table 9-5**.

Table 9-5: Summary of the Proposed Drainage Measures

Drainage Type	Chainage
Asset Owner/Location: South Dublin City Council	
Swales, attenuation pond, filter drain/perforated pipes	A00+200 – A00+500
Swales, filter drain/perforated pipes	A00+200-B00+200
Attenuation pond, filter drain/perforated pipes	B00+300 – B00+500
Underground attenuation, filter drain/perforated pipes	B00+500 – B00+800
Asset Owner/Location: South Dublin City Council/Dublin City Council	
Attenuation pond, filter drain/perforated pipes	B00+800 – B01+400
Asset Owner/Location: Dublin City Council	
Swales and tree pits	B01+875 – B02+000
Filter drain/perforated pipes	B02+100 – B02+300
Filter drain/perforated pipes, underground attenuation	B02+900 – B03+550
Filter drain/perforated pipes, attenuation pond and swales	B03+800 – B04+150
Sealed drainage system	B04+350 – B04+750

9.5.3 Runoff Attenuation and Sustainable Drainage Systems (SuDS)

The Proposed Scheme will create additional impermeable area through widening of the carriageway to provide designated bus lanes and cycle tracks in addition to a footway. Without mitigation, the increased impermeable area would lead to increased runoff rates and faster time to peak flow in the existing drainage network.

A range of storm durations was tested for each catchment from 30 minutes to 1,440 minutes to ensure that the proposed SuDS measures have sufficient capacity to cater for high-intensity, short-duration storms and longer-duration, low-intensity storms where the total runoff volumes are greater. This hierarchy promotes the concept of a SuDS Management Train, where measures are proposed as a sequence of components to collectively manage catchment runoff. A schematic of the SuDS Management Train is provided in **Table 9-6**.

Table 9-6: The SuDS Management Train

Scale		SuDS Management Train
Less Preferred Approach ↓	Source	**Rainwater harvesting –** capture and reuse within the local environment
		Pervious surfacing systems – structural surfaces that allow water to penetrate into the ground, reducing discharge to a drainage system e.g. pervious pavement.
	Site	**Infiltration systems –** structures which encourage infiltration into the ground e.g. bioretention basins.
		Conveyance systems – components that convey and control the discharge of flows to downstream storage components, e.g. swales.
	Regional	**Storage systems –** components that control the flows before discharge, e.g. attenuation ponds, tanks or basins.

For this Preliminary Design, source-scale solutions have been specified where reasonably practicable. Where source-type solutions cannot fully address an increase in runoff from a development, residual flows are discharged to be managed at the site and then regional scales.

9.5.4 Pollution Control

One of the principal objectives of the road drainage system is to minimise the impact of the runoff from the roadways on the surrounding environment via the provision of filter drains, swales, tree pits, oil/petrol interceptors, silt traps and attenuation features, as necessary.

Pollution control measures from the proposed road development will be designed in accordance with TII Publications DN-DNG-03022, DN-DNG-03065 and DN-DNG-03066.

The proposed road drainage system incorporates a variety of drainage measures including kerb and gully drainage, carrier drains, tree pits, sealed pipes, swales, filter drains, attenuation areas and pollution control as required in accordance with the above design standards. Pollution control will be achieved during the conveyance of the road runoff to the attenuation features along the gullies and pipes to grassed swales/carrier drains and filter drains where the drainage is allowed to filter through the vegetation and filter medium.

The attenuation ponds will include a forebay and oil/petrol interceptor at each outfall location. Any section of drainage where there are no swales or filter drains will also have an oil/petrol interceptor installed at the outfall.

The oil/petrol interceptors will be designed as per DN-DNG-03022 CIRIA 142. A minimum class 2 bypass interceptor will be installed where required. Where there is treatment by filtration in a swale, tree pit or filter drain, an oil/petrol interceptor will not be required.

9.5.5 Summary of Attenuation Features, SuDS and Outfalls

The proposed drainage for the Proposed Scheme is summarised for each proposed catchment within **Table 9-7**.

Table 9-7: Proposed Scheme Drainage Design Summary

Chainage	Existing Catchment Reference (Refer to Table 9.1)	Approximate Impermeable Surface Area		SuDS Measures Required	Permitted Discharge (l/s)	SuDS Measures Proposed
		Existing* (m^2)	Proposed (m^2)			
A00+400 – A00+550	Catchment 1	4,595	695	Yes	2	40.8 m^2 oversized pipes
A00+200 – A00+400	Catchment 2	11,278	1,174.9	Yes	2	211.2m^3 capacity swale 125m^3 capacity attenuation pond
A00+200-B00+200	Catchment 2	11,849	3,271.3	Yes	2	518m^3 capacity swale Filter drains
B00+300 – B00+700	Catchment 2	6320	1,802.6	Yes	2	144m^3 capacity attenuation pond Filter drains 42m^3 capacity underground attenuation tank
B00+700 – B01+100	Catchment 2	7183	1,791.2	Yes	2	45m^3 capacity underground attenuation tank Filter drains
B01+100 – B01+500	Catchment 2	6,607	796.1	Yes	2	250m^3 capacity attenuation pond Filter drains
B01+900-B02+200	Catchment 2	5,203	133	Yes	2	6m^3 capacity swale 2m^3 capacity tree pits
B02+200 – B02+600	Catchment 2	5,901	123	Yes	2	Filter drains
D00+000-D00+400	Catchment 2	3,340	0	No	N/A	N/A
B02+600 – B02+900	Catchment 2	11,563	1,435.5	No	N/A	N/A
B02+900 – B03+700	Catchment 2	10,982	2,239.2	Yes	2	Filter drains 360m^3 capacity swale 65m^3 capacity filter drains 298m^3 capacity underground attenuation tank
	Catchment 2	4,811	1,831.19	Yes	2	Filter drains

Chainage	Existing Catchment Reference (Refer to Table 9.1)	Approximate Impermeable Surface Area		SuDS Measures Required	Permitted Discharge (l/s)	SuDS Measures Proposed
		Existing* (m^2)	Proposed (m^2)			
B03+700 – B04+200						129m^3 underground attenuation tank
						35m^3 capacity swale
B04+200-B04+400	Catchment 2	6,089	25.8	Yes	2	Sealed drainage system
B04+400 – B04+800	Catchment 2	8,474	571.3	Yes	2	Sealed drainage system

9.6 Drainage at Structures

The Proposed Scheme crosses the Camac. The watercourse is in culvert where they pass beneath the existing highway. No works are proposed to change the width of the highway at the crossing; therefore, the existing culverts will be retained without modification.

9.7 Flood Risk

9.7.1 Flood Risk Assessment

A Stage 1 and 2 Flood Risk Assessment (FRA) has been prepared for the Preliminary Design of the Proposed Scheme. The outcomes from the FRA are summarised in this section and **Table 9-8**. Refer to **Appendix N** for Site Specific Flood Risk Assessment Liffey Valley to City Centre.

Table 9-8: Flood Risk Summary

Flood Risk Source	Level of Risk	Notes
Fluvial – River Camac	High	The Proposed Scheme crosses the River Camac at Emmet Road Bridge and also runs parallel to the watercourse through Kilmainham. Previous flooding of parts of the Proposed Scheme from the River Camac has been reported.
Fluvial – River Poddle	Low	Office of Public Works (OPW) mapping does not indicate any risk to the Proposed Scheme from the Poddle.
Pluvial	High	A high risk of pluvial flooding is prevalent across Dublin due to the limited capacity of the existing surface water network. It is particularly significant along the Ballyfermot and Kilmainham sections of the Proposed Scheme.
Coastal – River Liffey	Low	The OPW and Irish Coastal Protection Strategy Study flood extents do show any risk of coastal flooding to the Proposed Scheme.

9.7.1.1 River Camac

The Flood Risk Assessment identified parts of the Proposed Scheme that are at risk from the River Camac during a 0.1 and 1% Annual Exceedance Probability (AEP) flood. With reference to the Flood Risk Management Guidelines, these parts of the route will be identified as being located in Flood Zone A.

Section 4.5 of the Strategic Flood Risk Assessment states that it is not appropriate for new highly vulnerable development to be located on greenfield land within Flood Zones A or B. Regeneration of already urbanised areas within zones A and B may be justified.

As the Proposed Scheme comprises extension and adjustment to an existing highway, no works will be undertaken to reduce the existing risk of flooding from the River Camac. The works proposed for the Proposed Scheme will also result in no change in the risk of flooding from the River Camac. A Stage 3 Detailed Risk Assessment is not considered necessary as there will be no change in existing flood risk patterns or process as a consequence of the Proposed Scheme.

9.7.1.2 **Pluvial Flooding**

A high risk of pluvial flooding is prevalent across Dublin including the Proposed Scheme. This is due to the size of the existing surface water network, which typically has a capacity to contain the 20% (1 in 5) AEP storm. Where there are no changes to the catchment area served by the existing network, it is beyond the scope of the CBC Infrastructure Works to increase its capacity to reduce the risk of pluvial flooding.

Where there is an increase in impermeable area as for the Proposed Scheme, SuDS measures are provided to ensure no increase in existing runoff rates. These measures are outlined in **Section 9.5** of this report.

9.7.2 Development of Specific Flood Alleviation Proposal

There is no change in fluvial flood risk as a consequence of the Proposed Scheme. No specific flood risk measures are therefore proposed to reduce fluvial flood risk along the Proposed Scheme. There is the potential for an increase in pluvial flood risk, but the Proposed Scheme will include full mitigation in the form of sustainable drainage and runoff attenuation to ensure no change to the existing runoff rates.

9.8 Section 50 Consents

There are no new, or modifications proposed to existing, culverts/bridges that cross watercourses along the Proposed Scheme. OPW Section 50 consent will therefore not be required as part of the Proposed Scheme.

10. Services and Utilities

10.1 Overview of Utilities Preliminary Design Strategy

Utility records from all providers were sought at an early stage of the scheme design. These records, combined with topographic survey records, GPR Survey, walk over inspections and desktop analysis of the Proposed Scheme identified areas of risk to existing assets. Where risk was initially identified to high value assets, such as high-voltage ESB cables, high-pressure gas mains and trunk water mains, a review was undertaken to ascertain if the risk could be mitigated by amending the highways design whilst still meeting the objectives of the scheme. Some areas of conflict were designed out at this stage; however, some remained and had to be accommodated within the overall scheme Preliminary Design.

10.1.1 Record Information

Available utility records were submitted by service providers and reviewed along the Proposed Scheme. These records have assisted with informing the scheme design. Utility records were received from the following service providers:

- Irish Water;
- Gas Networks Ireland (GNI);
- Electricity Supply Bord (ESB);
- Eir;
- Virgin Media;
- BT;
- Vodafone;
- Enet;
- South Dublin County Council; and
- Dublin City County Council.

10.1.2 Phase 1 Utility Survey

A targeted utility survey to PAS128A, including a ground-penetrating radar survey, was commissioned by the NTA to investigate areas where there is risk identified to existing high value assets such as high voltage ESB cables, high-pressure gas mains and trunk water mains, due to the proposed carriageway alignment. Some areas where there is a high concentration of utility diversions proposed were also surveyed to ensure that adequate spacing is provided for relocation of assets. The results of the utility survey have been reviewed to confirm the adequacy of design provisions made with respect to diversion proposals. Additionally, a more extensive utility survey will be completed to inform the detailed design phase of the Proposed Scheme.

10.1.3 Consultation with Utility Service Providers

Consultation with all relevant utility service providers was undertaken to evaluate the impact of the Proposed Scheme on existing utilities.

Based on records and topographical survey that was available, utility diversions and areas where protection measures might be required were identified. These potential impacts were documented on a set of consultation drawings and a technical note was prepared for each utility company.

Consultation meetings were held with ESB, GNI, Irish Water and Eir. The Proposed Scheme proposals were also outlined to them and scenarios where utility infrastructure might be impacted by the Proposed Scheme were discussed.

10.2 Overview of Service Conflicts

The construction of the Proposed Scheme will result in conflicts with several existing utility assets. These conflicts have been identified, and preliminary consultation has been undertaken with the relevant service providers so that the conflict can be resolved by relocating or diverting the services where necessary and protecting in-situ where appropriate.

The principal statutory and other service providers affected are:

- ESB;
- Irish Water (Water and Public Sewer);
- Gas Networks Ireland (GNI); and
- Telecommunication services – Eir and Virgin Media.

In addition to the above, it will be necessary to relocate and renew some of the existing public lighting and traffic signalling network and equipment along the extents of the Proposed Scheme.

The services conflicts and the associated diversions will need to be considered in the design and construction of the Proposed Scheme. The preliminary design considerations have been taken into account as much as practicable at this stage, but it is likely that design modifications will be required at detailed design stage when further site investigations have taken place.

During construction, it will be necessary to maintain supply to certain services. This will require the retention and protection of existing utility supplies until such time as permanent diversions can be commissioned, or alternatively the construction of temporary diversions to facilitate completion of the works including the permanent diversion of services. The sequence of works must also take into account the need to liaise with service providers and, subject to their availability to carry out diversions, staging of the works may be necessary.

The service diversions required for this development are discussed in the following paragraphs and are summarised in **Tables 10-1, 10-2, 10-3,10-4 and 10-5** of this report.

The locations of all known services from records provided from the service providers are shown on Combined Utility Drawings included in **Appendix B.**

10.3 Summary of Recommended Diversions

10.3.1 ESB Networks

The design team has undertaken consultation with ESB Networks regarding the impact of the Proposed Scheme on their assets and their requirements have been incorporated within the design. No impacts to high-voltage cables have been identified, and no relocations are necessary. There are several locations where medium-voltage (MV) cables and low-voltage (LV) cables are identified which will require diversion along the length of the route. These conflicts are listed in **Table 10-1** and are illustrated on the drawing set BCIDB-JAC-UTL_UE-0007_XX_00-DR-CU-9001 included **within Appendix B**.

Table 10-1: ESB Asset Diversions

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R7 - UE - LV UG - 001	ESB	A 200 – A 420	LV Underground	Diversion of c. 220m of LV underground lines where bus lane is widening into verge within Liffey Valley Retail Park.
R7 - UE - MV - 004	ESB	A 25 – A 100	MV Underground	Diversion of c. 70m of MV cables in verge/footway opposite at junction with Coldcut Road.
R7 - UE - MV - 006	ESB	F0 - F40	MV Underground	Diversion of c. 40m of MV cables in verge/footway at Coldcut Road/ Kennelsfort Road junction.
R7 - UE - MV - 007	ESB	B 1100	MV Underground	Diversion of c. 90m of MV cables in verge/footway on Ballyfermot Road opposite Cherry Orchard Hospital.
R7 - UE - LV - 001	ESB	B 1400	LV Overhead	Relocation of c. 60m of LV overhead lines on Ballyfermot Road outside the Applegreen service station. Single pole relocation required.
R7 - UE - MV - 008	ESB	B 1400	MV Underground	Diversion of c. 50m of MV cables in verge/footway on Ballyfermot Road outside Applegreen service station.
R7 - UE - LV UG - 002	ESB	B1900	LV Underground	Diversion of c. 90m of LV underground lines where bus lane is widening into verge on Ballyfermot Road.
R7 - UE - MV - 009	ESB	B 1850	MV Underground	Diversion of c. 140m of MV cables in verge/ footway on Ballyfermot Road opposite St. Matthew’s Church.
R7 - UE - LV - 002	ESB	B 3125 - 3825	LV Overhead	Relocation of c. 700m of LV overhead lines commencing on Ballyfermot Road adjacent De La Salle National School extending as far as St. Laurence Road intersection. Joins R7 - UE - LV - 003 at this point.
R7 - UE - MV - 012	ESB	B 3900	MV Underground	Diversion of c. 70m of MV cables in verge/footway and private land of Longmeadow's Pitch and Putt course on Sarsfield Road.
R7 - UE - MV - 013	ESB	B 3900	MV Underground	Diversion of c. 90m of MV cables in verge/footway and private land of Longmeadow's Pitch and Putt course on Sarsfield Road.
R7 - UE - LV - 003	ESB	B 3900	LV Overhead	Relocation of c. 150m of LV overhead lines on footway of Sarsfield Road along Longmeadow's Pitch and Putt course.
R7 - UE - LV - 004	ESB	B 3800 – B 4400	LV Overhead	Relocation of c. 520m of LV overhead lines on footway of Sarsfield Road opposite Longmeadow's Pitch and Putt course.
R7 - UE - LV - 005	ESB	B 4000 - 4200	LV Overhead	Relocation of c. 230m of LV overhead lines on footway of Sarsfield Road along Longmeadow's Pitch and Putt course.
R7 - UE - MV - 014	ESB	B 5950	MV Underground	Diversion of c. 70m of MV cables in verge/footway on Emmet Road at the intersection of Camac Close.
R7 - UE - MV - 015	ESB	B 6180	MV Underground	Diversion of c. 100m of MV cables in verge/footway on Emmet Road at the intersection of South Circular Road.

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R7 - UE - LV UG - 004	ESB	B 6200	LV Underground	Diversion of c. 60m of LV underground lines where car parking is extending into footway on Emmet Road.

10.3.2 Irish Water - Water and Foul Sewer

The design team has undertaken consultation with Irish Water regarding the impact of the Proposed Scheme on their assets, and their requirements have been incorporated within the design. There are several water mains along the route where conflicts occur, and diversions are therefore required. There is one section of foul sewer in particular that needs to be carefully considered at detailed design stage and may require specific protection detailing. These items are listed in **Table 10-2** and are illustrated on the drawing set BCIDB-JAC-UTL_UW-0007_XX_00-DR-CU-9001 and BCIDB-JAC-UTL_UD-0007_XX_00-DR-CU-9001 included within **Appendix B**.

Table 10-2: Irish Water Asset Impacts

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R07 - UW - 003	Irish Water - Watermains	B 600	9" CI Watermain	Diversion of c. 160m of a 9" cast iron watermain into verge/footway on Coldcut Road close to intersection of Kennelsfort Road.
R07 - UW - 005	Irish Water - Watermains	B 1180 - 1900	12"/9" AC Watermain	Diversion of c. 835m of a 9/12" asbestos cement trunk watermain into verge/footway on Ballyfermot Road opposite Cherry Orchard Hospital extending as far as St. Matthew's Church.
R07 - UW - 006	Irish Water - Watermains	B 2350	9" AC Watermain	Diversion of c. 75m of a 9" asbestos cement trunk watermain into verge/footway on Ballyfermot Road at the Le Fanu Road intersection.
R07 - UW - 008	Irish Water - Watermains	B 4250	9" AC Watermain	Diversion of c. 75m of a 9" asbestos cement trunk watermain into verge/footway on Sarsfield Road between First Avenue and St. Mary's Avenue West.
R07-FW-001	Foul Sewer	B1500-B1850	300mm Concrete	Further investigation required to determine the precise nature and extent of protection works to reinforce the existing shallow foul network along this 350m section on Ballyfermot Road.

10.3.3 Eir

The design team has undertaken consultation with Eir regarding the impact of the Proposed Scheme on their assets. There are several locations along the route where conflicts with Eir infrastructure occur, and diversions are therefore required. These diversions are listed in **Table 10-3** below and are illustrated on the drawing set BCIDB-JAC-UTL_UX-0007_XX_00-DR-CU-9001 included within **Appendix B**.

Table 10-3: Eir Diversions

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R07 - UX - EIR - 006	Eir	B 480-560	Eir Ducting and Chambers	80m diversion of ten 100mm ducts into verge/ footway - Coldcut Road.
R07 - UX - EIR - 006A	Eir	B 700	Eir Ducting and Chambers	35m diversion of Eir ducts into verge/footway - Coldcut Road.

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R07 - UX - EIR - 007	Eir	B 900-1140	Eir Ducting and Chambers	240m diversion of six 100mm ducts into verge/ footway - Ballyfermot Road opposite Cherry Orchard Hospital.
R07 - UX - EIR - 008	Eir	B 1400 - 1550	Eir Ducting and Chambers	130m diversion of unknown number of ducts (could be up to 20) into verge/footway - Ballyfermot Road opposite Ballyfermot Primary Care Centre.
R07 - UX - EIR - 004A	Eir	B 1500-1875	Eir Ducting and Chambers	350m diversion of unknown number of ducts into verge/footway - Ballyfermot Road.
R07 - UX - EIR - 009	Eir	B 2350 - 2430	Eir Ducting and Chambers	65m diversion of two 100mm ducts into verge/ footway - Ballyfermot Road prior to junction with Le Fanu Road.
R07 - UX - EIR - 011	Eir	B 2950 - 2970	Eir Ducting and Chambers	60m diversion of two 100mm ducts into verge/ footway - Ballyfermot Road.
R07 - UX - EIR - 012	Eir	B 2960 - 3560	Eir Ducting and Chambers	620m diversion of twelve 100mm ducts into verge/ footway - Ballyfermot Road outside Ballyfermot Family Resource Centre and De La Salle National School.
R07 - UX - EIR - 014	Eir	B 3800 - 4350	Eir Ducting and Chambers	550m diversion of twelve 100mm ducts into verge/ footway of Sarsfield Road along Longmeadow's Pitch and Putt course.
R07 - UX - EIR - 016	Eir	B 6230 - 6280	Eir Ducting and Chambers	70m diversion of two 100mm ducts into verge/ footway of Emmet Road beside junction with Myra Close.

10.3.4 Virgin Media

The design team has undertaken consultation with Virgin Media regarding the impact of the Proposed Scheme on their assets. There are two locations along the route where conflicts with Virgin Media infrastructure occur, and diversions are therefore required. These diversions are listed in **Table 10-4** below and are illustrated on the drawing set BCIDB-JAC-UTL_UX-0007_XX_00-DR-CU-9001 included within **Appendix B**.

Table 10-4: Virgin Media Diversions

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R07 - UX - VM - 001	Virgin Media	B 700	Virgin Media Ducting and Chambers	35m diversion of Virgin ducts into verge/ footway - Coldcut Road.
R07 - UX - VM - 006	Virgin Media	B 4220 – B 4290	Virgin Media Ducting and Chambers	35m diversion of Virgin ducts into verge/ footway - Coldcut Road.

10.3.5 Gas Networks Ireland

Jacobs has undertaken consultation with GNI regarding the impact of the Proposed Scheme on their assets, and their requirements have been incorporated within the design. There are several locations where a GNI medium and low-pressure gas mains have been identified that require diversion along the scheme. The conflicts are listed in **Table 10-5** below and are illustrated on the drawing set BCIDB-JAC-UTL_UG-0007_XX_00-DR-CU-9001 included within **Appendix B.**

Table 10-5: GNI Diversions

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R7 - UG - MP - 001	GNI	B 600	180 PE MP Gas Main	Diversion of c. 45m of medium-pressure gas main in verge/footway on Coldcut Road close to intersection of Kennelsfort Road.
R7 - UG - LP - 001	GNI	B 1800 - B2200	90 PE LP Gas Main	Diversion of c. 385m of low-pressure gas main in westbound verge/footway on Ballyfermot Road.
R7 - UG - LP - 002	GNI	B 2800 - B2900	180 PE LP Gas Main	Diversion of c. 60m of low-pressure gas main across roundabout removal on Ballyfermot Road.
R7 - UG - LP - 003	GNI	B 3100	63 PE LP Gas Main	Diversion of c. 15m of low-pressure gas main at the corner of Lynch's Lane and Ballyfermot Road.
R7 - UG - LP - 004	GNI	B 3850- 4300	180 PE LP Gas Main	Diversion of c. 420m of low-pressure gas main in the footway of Sarsfield Road.
R7 - UG - LP - 005	GNI	B 4350- 4500	125 PE LP Gas Main	Diversion of c.160m of low-pressure gas main from the existing central reserve of Sarsfield Road.

11. Waste Quantities

11.1 Overview of Waste

The majority of the waste arisings from the works are likely to accumulate from excavation related activities resulting from road widening and drainage/utility works in addition to proposed public domain street works. A waste calculator was developed for the Proposed Scheme to quantify and classify the likely material types in accordance with Transport Infrastructure Ireland (TII) GE-ENV-01101 and the European Waste Catalogue waste codes. The waste quantities associated with soil and stones (waste code 17 06 02) were further broken down into the likely TII material specification to establish an understanding of the volume of materials that could potentially be reused/recycled. In developing the waste estimate quantities, a number of assumptions were required to undertake the assessment which have been outlined in **Section 11.2.**

Due to the nature of the works in an urban environment there are limited opportunities to provide a cut/fill balance of materials that could be more readily accommodated on a greenfield project where earthworks embankments/ bunds are more common. Material from the existing pavement layers could be sent to a suitable recovery facility for recycling and reuse as recycled aggregate material in the industry. The existing made ground material will need to be tested for quality and contamination and could potentially be sent to a suitable soil recovery facility also for reuse as general fill or general landscape fill material in the industry under the provisions of Article 28. Similarly alternative sites could be identified under the provisions of Article 27 for material re-use during future design stages. No such suitable sites have been identified for the Proposed Scheme during the preliminary design phase.

Future design stages will undertake additional site investigations to inform the detailed pavement design and associated excavation quantity assessment. Various mitigations could be considered during the design and construction works to offset the net volume of material that will be sent off site to a soil recovery facility including stockpiling of existing subbase, capping layer and top soil material on site for direct reuse in the proposed works (subject to quality testing, construction sequencing and material availability versus demand given the intermittent nature of the streetworks). Similarly, there are potentially other opportunities within the proposed pavement design/construction to further offset the net volume of natural aggregate material requirements through consideration for the use of recycled aggregates and reclaimed asphalt material. Suitable recycled aggregates and appropriate site won material could be implemented in the proposed road base/binder layers, subbase layers under footpath/cycle tracks, and capping layer material within the road pavement. Adopting these mitigations in the proposed designs may have significant benefits in offsetting the overall quantity of natural aggregate materials requirements and could potentially realise a significant volume of recycled/reused aggregates to improve the overall sustainability of the Proposed Scheme.

Waste arisings from street furniture, trees and materials from within the public domain (17 01 02 Bricks, 17 04 07 Mixed metals, 17 02 03 Plastic, 17 02 01 Wood, 17 02 02 Glass) are also likely to result from the nature of the works. These materials will need to be segregated by waste classification on site and sent to a suitable recovery facility for recycling. The principles of prevention and minimisation will be further considered in detailed design/construction stages through value engineering, substitution or reuse of materials, and effective methods or control systems (e.g. just in time deliveries/ effective spoil management) so that waste production is minimised.

11.2 Waste Calculation Assumptions

The following tables provide an overview of the various material weights that have been applied in consideration of the overall materials waste estimate quantities for the Proposed Scheme.

Table 11-1: Street Furniture Weight Units

Item	Material	Assumed Nominal Weight	Notes
Timber arising from trees	Timber/ wood	150kg per tree	Average value per tree across the scheme length.
Vegetation (e.g. hedges, shrubs, leaves and branches)	Organic	N/A	Organic material from hedges, shrubs, leaves and branches have not been quantified.
Walls	Masonry / bricks	1.5m height 0.3m width	Nominal assumed dimensions for purposes of assessment
Gates	Metal	100kg/unit	Nominal assumed average weight per gate over scheme
Metal railings	Metal	15kg/m	Nominal assumed average weight per railing over scheme
Fencing	Metal	40kg/m	Nominal assumed average weight per railing over scheme
Traffic signals	Metal	68kg/ 4m pole 15kg per traffic signal head Assumed two heads per pole	*Source: Siemens Helios General Handbook Issue 18.* Nominal assumed average scenario per signal over scheme length
	Plastic	9kg	
Traffic signs	Metal	20kg/ 3m pole 0.75m sign height 0.01m pole thickness	Nominal assumed average scenario per traffic sign over scheme length
Lighting poles	Metal	100kg per 8m pole	Nominal assumed average scenario over scheme length
ESB/EIR poles	Timber/ wood	250kg per 9m pole	Nominal assumed average scenario over scheme length
Bus stops	Plastic	365kg per bus stop	JCDecaux and NTA (2017) *Reliance Bus Shelter information*
	Metal	2,400kg per bus stop	JCDecaux and NTA (2017) *Reliance Bus Shelter information*

Item	Material	Assumed Nominal Weight	Notes
	Glass	54kg per bus stop	JCDecaux and NTA (2017) *Reliance Bus Shelter information*
Litter bins	Metal	60kg per bin	Omos specification Nominal assumed average scenario over scheme length
Safety barrier	Metal	20kg/m	Nominal assumed average scenario over scheme length
Cabinets	Metal	85kg	ESB (2008). *National Code of Practice for Customer Interface 4th Edition.* Available online: https://www.esbnetworks.ie/docs/default-source/publications/national-code-of-practice.pdf (Accessed on 6 May 2021)
Benches	Metal	32kg	Lost Art (2016). *Benches: Product information operation and maintenance instructions.* Available online: https://www.lostart.co.uk/pdf/lost-art-limited-product-information.pdf (Accessed on 6 May 2021)
	Wood	8kg	
Cameras	Metal	35kg	2b Security Systems (2021) *PTZ-7000 Long range IP PTZ camera*. Available online: https://www.2bsecurity.com/product/long-range-ptz-camera/ (Accessed on 6 May 2021)
Overhead gantry (steel)	Metal	7000 in per m^3	TII (nb). *CC- SCD- 01804-02*. Available online:https://www.tiipublications.ie/library/CC-SCD-01804-02.pdf (Accessed on 6 May 2021) TII (nb). *CC- SCD- 0180-02*. Available online: https://www.tiipublications.ie/library/CC-SCD-01805-02.pdf (Accessed on 6 May 2021)
Cast iron bollard	Metal	50kg	Furnitubes (2013) *Cast Iron Bollards: Product Brochure.* Available online: https://www.furnitubes.com/uploads/assets/brochures-2013/furnitubes-e-008-01-13-cast-iron-bollard-brochure.pdf (Accessed on 6 May 2021)
Non-assigned bollard	Metal	40kg	Furnitubes (2013) *Cast Iron Bollards: Product Brochure.* Available online: https://www.furnitubes.com/uploads/assets/brochures-2013/furnitubes-e-008-01-13-cast-iron-bollard-brochure.pdf (Accessed on 6 May 2021)
Stainless steel bollard	Metal	30kg	Furnitubes (2013) *Cast Iron Bollards: Product Brochure.* Available online: https://www.furnitubes.com/uploads/assets/brochures-2013/furnitubes-e-008-01-13-cast-iron-bollard-brochure.pdf (Accessed on 6 May 2021)
Vehicle restraint bollard	Metal	130kg	Furnitubes (2013) *Cast Iron Bollards: Product Brochure.* Available online: https://www.furnitubes.com/uploads/assets/brochures-2013/furnitubes-e-008-01-13-cast-iron-bollard-brochure.pdf (Accessed on 6 May 2021)

Item	Material	Assumed Nominal Weight	Notes
Bike railings / handrails	Metal	16kg	Dublin City Council (2016) *Construction Standards for Road and Street Works in Dublin City Council*
Gully grates	Metal	40kg	PAM Saint-Gobain (2016). *Ductile Iron Access Covers and Gratings: Product selection and specification guide*. Available online: https://www.saint-gobain-pam.co.uk/sites/pamline_uk/files/access_covers_and_gratings_product_guide_0.pdf (Accessed on 6 May 2021) Greater Dublin Region (2012) *Greater Dublin Regional Code of Practice for Drainage works.* Available online: (https://www.sdcc.ie/en/download-it/guidelines/greater-dublin-regional-code-of-practice-for-drainage.pdf (Accessed on 6 May 2021)
Chamber covers and frame	Metal	0.112tonnes	PAM Saint-Gobain (2016). *Ductile Iron Access Covers and Gratings: Product selection and specification guide*. Available online: https://www.saint-gobain-pam.co.uk/sites/pamline_uk/files/access_covers_and_gratings_product_guide_0.pdf (Accessed on 6 May 2021) Greater Dublin Region (2012) *Greater Dublin Regional Code of Practice for Drainage works.* Available online: (https://www.sdcc.ie/en/download-it/guidelines/greater-dublin-regional-code-of-practice-for-drainage.pdf (Accessed on 6 May 2021)
Manholes	Metal	0.04tonnes	PAM Saint-Gobain (2016). *Ductile Iron Access Covers and Gratings: Product selection and specification guide*. Available online: https://www.saint-gobain-pam.co.uk/sites/pamline_uk/files/access_covers_and_gratings_product_guide_0.pdf (Accessed on 6 May 2021) Greater Dublin Region (2012) *Greater Dublin Regional Code of Practice for Drainage works.* Available online: https://www.sdcc.ie/en/download-it/guidelines/greater-dublin-regional-code-of-practice-for-drainage.pdf (Accessed on 6 May 2021)

Table 11-2: In-situ Pavement and Earthworks Densities

Material	Densities (tonnes/m^3)	Notes
Soil	2.2	Professional judgement (Dublin boulder clay), laboratory testing - Nominal assumed average scenario over scheme length
Bitumen containing material	2.4	Professional judgement (Engineering Designers) – Nominal assumed average scenario over scheme length

Material	Densities (tonnes/m^3)	Notes
Concrete	2.4	Professional experience and (Bath Inventory - Version 2.0 (2011)) – Nominal assumed average scenario over scheme length
Granite	2.7	https://pubs.usgs.gov/of/1983/0808/report.pdf - Nominal assumed average scenario over scheme length
Paving stones (assumed concrete or natural stone)	2.4	Professional judgement (Engineering Designers) – Nominal assumed average scenario over scheme length
Granular material	1.6	Nominal assumed average scenario over scheme length

Table 11-3: Utilities Material Excavation Assumptions

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
Drainage Pipe Bedding Excavation Assessment (assumed at 1.2m cover i.e. obvert at 0.35m under capping layer of road)	0.9	Class 2/4/U1 Cohesive subgrade material	1.25	Irish Water (2020) Water Infrastructure Standard Details: Connections and Developer Services. Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
Foul Sewer Pipe Bedding Excavation Assessment (assumed at 1.2m cover i.e. obvert at 0.35m under capping layer of road)	0.9	Class 2/4/U1 Cohesive subgrade material	1.25	Irish Water (2020) Water Infrastructure Standard Details: Connections and Developer Services. Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
Potable water Pipe Bedding Excavation Assessment (assumed at 1.2m cover i.e. obvert at 0.35m under capping layer of road)	0.9	Class 2/4/U1 Cohesive subgrade material	1.25	Irish Water (2020) *Water Infrastructure Standard Details: Connections and Developer Services.* Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
Road Pavement Excavation (extra over in addition to road widening allowances e.g. transverse trenching)	0.9	Bitumen (surface + binder and base)	0.35	Irish Water (2020) *Water Infrastructure Standard Details: Connections and Developer Services.* Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
		Class 1/2 Granular Subbase material	0.3	Irish Water (2020) *Water Infrastructure Standard Details: Connections and Developer Services.* Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
		Class 6 Granular Capping material	0.2	Irish Water (2020) *Water Infrastructure Standard Details: Connections and Developer Services.* Available online: https://www.water.

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
				ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
Electric/Power bedding excavation Assessment (assumed at 0.75m cover under footpath i.e. obvert at 0.55m under subbase layer of footpath/ cycle track)	0.05	Class 2/4/U1 Cohesive subgrade material	0.925	ESB (2008) *Standard Specification for ESB MV/LV Network Duction (Minimum Standards).* Available online: https://www.esbnetworks.ie/docs/default-source/publications/summary-of-standard-specification-for-esb-networks-mvlv-ducting.pdf?sfvrsn=f34b33f0_4 (Accessed on 6 May 2021)
Comms bedding Excavation Assessment (assumed at 0.75m cover under footpath i.e. obvert at 0.55m subbase layer of footpath)	0.5	Class 2/4/U1 Cohesive subgrade material	0.925	ESB (2008) *Standard Specification for ESB MV/LV Network Duction (Minimum Standards).* Available online: https://www.esbnetworks.ie/docs/default-source/publications/summary-of-standard-specification-for-esb-networks-mvlv-ducting.pdf?sfvrsn=f34b33f0_4 (Accessed on 6 May 2021)

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
Street Lighting/Comms/ Traffic Excavation Assessment (assumed at 0.6m cover under footpath i.e. obvert at 0.4m subbase layer of footpath)	0.5	Class 2/4/U1 Cohesive subgrade material	0.56	South Dublin County Council (2016) *Public Lighting Specification.* Available online: https://www.sdcc.ie/en/services/transport/public-lighting/sdcc-public-lighting-specification.pdf (Accessed on 6 May 2021)
Gas Excavation Assessment (assumed at 0.6m cover i.e. obvert at 0.4m under subbase layer of footpath)	0.45	Class 2/4/U1 Cohesive subgrade material	0.7	Gas Network Ireland (2018) *Guidelines for Designers and Builders- Industrial and Commercial (Non-domestic) Sites. Available online: https://www.gasnetworks.ie/Guidelines-for-Designers-and-Builders-Industrial-and-Commercial-Sites.pdf (Accessed 6 May 2021)*

Table 11-4: Footpath and Verge Widening Excavation Assumptions

Layer	Assumed Layer thickness (m)	Assumed material spec. (TII)
Footpath surface treatment due to all works (remove and replace)	0.1	Concrete
FDC new pavement depth	0.85	As per Dublin City Council standard bus corridor detail with 200mm capping assumed
Footpath sub-layer excavation due to Full Depth Construction (FDC) widening (material under footpath)	0.1	Granular material - Class 1/2 Granular Subbase material
	0.75	Soil and stones - Class 2/4/U1 Cohesive subgrade material
	0.3	Soil and stones - Class 5 Topsoil material

Layer	Assumed Layer thickness (m)	Assumed material spec. (TII)
Verge and sub-layer excavation due to FDC widening (material under verge)	0.55	Soil and stones - Class 4/U1 Cohesive subgrade material
Verge and sub-layer excavation due to footpath widening (material under verge)	0.3	Soil and stones - Class 5 Topsoil material
	0	Soil and stones - Class 4/U1 Cohesive subgrade material
Road surface treatment due to road markings and utilities trench reinstatement (mill and re-sheet)	0.05	Bitumen containing material - Bitumen (surface)
Road sub-layer excavation due to FDC (material under road)	0.3	Bitumen containing material - Bitumen (binder and base)
	0.3	Class 1/2 Granular Subbase material
	0.2	Granular material - Class 6 Granular Capping material
	0	Soil and stones - Class 2/4/U1 Cohesive subgrade material

11.3 Waste Estimate Summary

The majority of the waste arisings from the works are likely to accumulate from excavation-related activities resulting from road widening and drainage/utility works in addition to proposed public domain street works.

It is estimated that an order of magnitude of 101,000 tonnes of pavement and made ground material (17 01 01 Concrete/ 17 06 02 non-hazardous bituminous mixture/17 05 04 - Soil and stones (non-contaminated)) will be excavated as part of the works, refer to **Table 11-5**. Due to the nature of the works in an urban environment there are limited opportunities to provide a cut/fill balance of materials that could be more readily accommodated on a greenfield project where earthworks embankments/bunds are more common. Material from the existing pavement layers could be sent to a suitable recovery facility for recycling and reuse as recycled aggregate material in the industry as further described below. The existing made ground material will need to be tested for quality and contamination and could potentially to be sent to a suitable soil recovery facility also for reuse as general fill or landscape fill material in the industry under the provisions of Article 28. There are no known Article 27 sites available at the time of planning for the site, however this could also be considered for reuse of material arisings from the project at a later date.

Potentially up to 100% of concrete and asphalt material could be sent to a suitable aggregate recovery facility for recycling. Under TII specification, crushed concrete material could be used in selected granular fill material under Series 600 for Earthworks (6A,6B,6C,6F, 6G,6H,6I, 6M, 6N) or as Type A Clause 803 unbound subbase material under Series 800 for Road Pavements. Similarly, TII specification allows for use of recycled bituminous planings to be used in capping material and 803 subbase material type A (for use under bituminous footpath) in addition to LEBM pavements for roads with <5MSA or consideration in offline cycle track base material.

Potentially up to 90% of excavated subbase material and capping material could be reused as subbase material under footways and cycle track (subject to quality testing). It is assumed that potentially 10% of this material will contain excessive cohesive material during the excavation process (unsuitable for direct reuse). The 10% excess material would likely be sent to a suitable recovery facility as general fill or landscape fill material (Class 2/4 material) depending on excavation methods employed by the contractor and existing ground conditions.

Future design stage will undertake additional site investigations to inform the detailed pavement design and associated excavation quantity assessment. Various mitigations could be considered during the design and construction works to offset the net volume of material that will be sent off site to a soil recovery facility including stockpiling of existing subbase, capping layer and topsoil material on site for direct reuse in the proposed works (subject to quality testing, construction sequencing and material availability versus demand given the intermittent nature of the street works). Similarly, there are potentially other opportunities within the proposed pavement design/construction to further offset the net volume of natural aggregate material requirements through consideration for the use of recycled aggregates and reclaimed asphalt material. Suitable recycled aggregates and appropriate site-won material could be implemented in the proposed road base/binder layers, subbase layers under footpath/cycle tracks, and capping layer material within the road pavement. Adopting these mitigations in the proposed designs may have significant benefits in offsetting the overall quantity of natural aggregate materials requirements and could potentially realise up to 33,317 tonnes of recycled/reused aggregates to improve the overall sustainability of the scheme.

It is estimated that an order of magnitude of 1,930 tonnes of waste arisings from street furniture, trees and materials from within the public domain (17 01 02 Bricks, 17 04 07 Mixed metals, 17 02 03 Plastic, 17 02 01 wood, 17 02 02 Glass) are also likely to result from the nature of the works. These materials will need to be segregated by waste classification on site and sent to a suitable recovery facility for recycling. The principles of prevention and minimisation will be further considered in detailed design/construction stages through value engineering, substitution or reused of materials, and effective methods or control systems (e.g. just in time deliveries/ effective spoil management) so that waste production is minimised.

Table 11-5 Summary of Excavation Material Type and Quantities

Materials from C&D Sources	Approximate Waste and Material Quantity (Tonnes)
Concrete, bricks, tiles and similar	8,000
Bituminous mixtures	12,000
Soil and stone	81,000
TOTAL	**101,000**

12. Traffic Signs, Lighting and Communications

12.1 Traffic Signs and Road Markings

Signage and road markings will be provided along the extents of the Proposed Scheme to clearly communicate information, regulatory and safety messages to the road user. In addition, the existing lighting and communication equipment along the route has been reviewed and proposals developed to upgrade where necessary. Refer to the preliminary design drawings contained within **Appendix B** for Traffic Signs and Road Markings Drawings and Lighting Drawings.

12.2 Traffic Sign Strategy

A preliminary traffic sign design has been undertaken to identify the requirements of the Proposed Scheme, whilst allowing for further design optimisation at the detailed design phase. A combination of information, regulatory and warning signs has been assessed taking consideration of key destinations and centres, intersections and decision points, built and natural environment, other modes of traffic, visibility of signs and viewing angles, space available for signs, existing street furniture infrastructure and existing signs. In line with DMURS, the signage proposals have been kept to the minimum requirements of the Traffic Signs Manual (TSM).

Prior to assessing the requirements for individual signs, a review was carried out on the impact that proposed traffic restrictions and changes to the road layout will have on the key traffic routes in the vicinity of the Proposed Scheme.

A set of Route Strategy Plans were created which display the following information relating to the five sections above; the existing directions signs in the vicinity of the route, the associated existing traffic routes, the routes which traffic will be directed along as a result of the proposed traffic restrictions and road layout amendments, and the proposed traffic sign locations for the new routes. The proposed traffic signs will be located at the decision points for key destinations, which have been determined using the information displayed on the existing signs.

A review of the existing regulatory and warning signs in the vicinity of the route was carried out to identify unnecessary repetitive and redundant signage to be removed. This includes rationalising signage structures by better utilising individual sign poles and clustering signage together on a single pole.

12.3 Traffic Signage and Road Markings

12.3.1 Traffic Signage General

A preliminary assessment was undertaken which involved an assessment of major road traffic signage, including requirements for all information signs (TSM Chapter 2), regulatory signs (TSM Chapter 5), warning signs (TSM Chapter 6), and road markings (TSM Chapter 7).

As stated in TSM Chapter 1, in urban areas the obstruction caused by posts located in narrow pedestrian footways should be minimised, ensuring that pedestrian and cycle access is unimpeded by any such signage infrastructure. Therefore, where practicable, signs are to be placed on single poles, or larger signs will be cantilevered from a post at the back of the footway using H-frames where necessary. Passively safe posts will be introduced where practicable to eliminate the need for vehicle restraint systems.

12.3.2 Gantry Signage

No gantry signage exists along the route, and the development of the Proposed Route did not identify the requirement for any new gantry signage. One existing gantry is located adjacent to the scheme on the M50 but remains unaffected by the proposals.

12.3.3 Road Marking

A preliminary design of road markings has been undertaken in accordance with TSM Chapter 7. Refer to the preliminary design drawings contained within **Appendix B** for details. This exercise also included the preliminary road marking design of the following items:

- Bus lanes are provided along the Proposed Scheme and will be marked accordingly.
- Cycle tracks have been provided along the Proposed scheme. The pavement will be marked according to best practice guidelines such as DMURS and the NCM with particular attention given to junctions. Advance Stacking Locations (ASLs) have been designed predominantly on the minor side roads, where practicable, to provide a safer passage for cyclists at signal-controlled junction for straight ahead or right turn movements; and
- Pedestrian crossings have been incorporated throughout the design to connect the network of proposed and existing footways. Wider pedestrian crossings have been provided in locations expected to accommodate a high number of pedestrians. DMURS classifies pedestrian crossing widths in areas of low to moderate pedestrian activity as 2.5m and areas of moderate to high pedestrian activity as 3m.

12.4 Public Lighting

A high-level review of the existing lighting provision along the extent of the route has been carried out to understand the impact of the Proposed Scheme on lighting columns and associated infrastructure. A number of existing columns are proposed to be relocated or replaced to accommodate the Proposed Scheme, as shown on the preliminary design drawings within **Appendix B.**

12.4.1 Existing Lighting

Light emitting diode (LED) lanterns will be the light source for any new or relocated public lighting provided. The lighting design will involve works on functional, heritage and contemporary lighting installations on a broad spectrum of lighting infrastructure along the Proposed Scheme. This shall include, but not exclusively, luminaires supplied by underground and overhead cable installations and those located on ESB infrastructure.

In locations where road widening and/or additional space in the road margin is required, it is proposed that the public lighting columns shall be replaced and relocated to the rear of the footpath to eliminate conflict with pedestrians, and the existing removed once the new facility is operational. Where significant alterations are proposed to the existing carriageways, the existing public lighting arrangement shall be reviewed to ensure that the current standard of public lighting is maintained or improved. The New lighting requirement will be designed in accordance with the standards and best practice. To determine whether existing public lighting is to be improved / relocated or where new public lighting is required, an inspection shall be carried out to identify any new column locations required for particular sections of the Proposed Scheme. For existing columns that have specific aesthetic requirements, the intent for the replacement of such columns will include:

- Replacing the existing heritage columns and brackets with identical replica columns and brackets;
- Replacing existing luminaires with approved LED heritage luminaires; and
- Ensuring that the electrical installation is compliant with standards detailed in **Section 12.4.2**.

12.4.2 New Lighting

All new public lighting shall be designed and installed in accordance with the specific lighting and electrical items set out in the following National Standards and guides, including but not limited to:

- Local Authority Guidance Specifications;
- EN 13201: 2014 Road Lighting (all sections);
- ET211:2003 'Code of Practice for Public Lighting Installations in Residential Areas';
- BS 5489-1 'Code of practice for the design of road lighting';

- Volume 1 - TII Specification for Road Works, Series 1300 & 1400;
- Volume 4 - TII Road Construction Details, Series 1300 & 1400;
- IS EN 40 – Lighting Columns; and
- Institution of Lighting Professionals "GN01 Guidance Notes for Reduction of Obtrusive Light".

All new lighting shall aim to minimise the effects of obtrusive light at night and reduce visual impact during daylight. Lighting schemes shall comply with the 'Guidance notes for the Reduction of Light Pollution' issued by the Institution of Lighting Professionals (ILP).

12.4.3 Lighting at Bus Stops

The design shall include for the provision of lighting in covered areas, open areas and passenger waiting areas. The location of the lighting column shall be dictated by light spread of fittings to give the necessary level of illumination.

12.5 Traffic Monitoring Cameras

A network of digital cameras is proposed to be introduced at key locations along the Proposed Scheme. These cameras will enable the monitoring of traffic flows along the route and provide rapid identification of any events that are causing, or are likely to cause, disruption to bus services on the route and to road users in general.

This preliminary design assumes the use of high-definition (1080p or greater) digital cameras with a digital communications network providing transmission of video and camera monitoring/control functionality.

Additionally, a mains power source will be required at each location where a camera is installed. Further details of the requirements for power and data communications are provided below. The cameras may be fixed position or pan, tilt and zoom (PTZ) depending on the most suitable option for a given location as well as general operational preferences for fixed or PTZ.

The requirement for cameras along the Proposed Scheme route and the exact locations for these cameras will be determined at detailed design stage. The initial design assumption has been for the installation of camera(s) at each traffic signal junction although it is practicable that not all such junctions will require a camera and there may also be situations where a camera is required between junctions. However, the design approach outlined below applies irrespective of the camera location or the number of cameras at any given location. The proposed junction signal camera locations are shown on the Junction System Design drawings within **Appendix B**.

12.5.1 Camera Positioning and Mounting

The precise position of a camera at each selected location will be considered on a site-by-site basis to ensure the optimum view of the road network in the vicinity of the site. In some cases, there may be a requirement for more than one camera at a location in order to obtain the required view.

The method of mounting the camera and the height at which it is mounted depends to a large extent on this position. For example, it may be practicable to mount a camera on a traffic signal post (which may require a height extension to that post) or on a street lighting column. If neither of these options is feasible then it will be necessary to consider installation of a dedicated mounting post for the camera. Whichever of these mounting arrangements is used, the camera will typically be mounted at a height between 5m and 10m, with most cameras being mounted at around 6m, although again this depends largely on the scene required to be monitored at each location.

Where a site requires installation of a new mounting post then consideration will be given to using a "tilt-down" post design. This will provide for easier access to the camera for maintenance operatives and will avoid the need for operatives to work at height. However, there may be space restrictions (e.g. other street furniture, nearby trees, walls and buildings) that prevent the safe operation of a tilt-down pole, in which case a "static" post will be proposed. Whichever type of new post is used, where practicable, the design will assume that the post will be mounted in a NAL-type post, or similar, socket installed at footway floor level. This will provide for easier installation as well as replacement, for example where the pole has been damaged and structurally compromised.

12.5.2 Housing of Camera Power and Communication Equipment

The requirements for power and data communications described below require installation of a cabinet and/or feeder pillar to house the termination and control equipment for power and data communications services and for any other camera control equipment that may be needed. Where a camera is located at a traffic signal junction, consideration was initially given to housing the camera power, data comms and camera control equipment within the traffic signal controller cabinet. However, this could lead to practical difficulties in terms of access for maintenance where the traffic signals maintenance provider, the camera maintenance provider and the comms network operator will all require access to the cabinet. This could also lead to operational problems, for example if a camera maintenance operative inadvertently affects traffic signal control by disabling mains power to the cabinet, or if a signals maintenance operative disables camera or comms operation in the same manner.

It was therefore considered appropriate to assume the installation of a separate cabinet for camera equipment from that of the traffic signal control equipment. However, at each traffic signal junction where a camera is installed, consideration will be given to providing a duct between the traffic signal control cabinet and the camera equipment/comms cabinet to allow the connection of the traffic signal control equipment to the data communications network (further details of which are provided below). This would avoid the need for installation of a dedicated comms cabinet for the traffic signal control equipment.

There are sections of the Proposed Scheme where camera locations at or between junctions may be closely spaced. In such cases consideration will be given to using one camera equipment/comms cabinet to serve both camera locations in order to reduce installation costs and minimise the presence of street furniture. This may require positioning the cabinet (and its power supply) between junctions or running ducting from one junction to another. The exact requirement for this will be investigated on a location-specific basis at detailed design stage. In all cases the consideration of the siting of such roadside equipment shall prioritise the access for pedestrians and cyclists in the area and the aesthetics of the street urban landscape.

12.5.3 Camera Power Supply

Modern digital cameras use a low voltage (ELV) supply - typically 12V, 24V or 48V - provided either from a dedicated mains power adapter (converting mains voltage to the required ELV) or a power-over-ethernet (PoE) injector, a device that provides the low voltage over the same cabling (Ethernet) as the data communications for the camera. PoE is generally preferred as it only requires a single cable for both power and communications. In both cases the adapter/injector is located either in the base of the camera mounting post or in a cabinet at the camera location, as described above. Wherever it is located, a mains power supply is required for it.

One advantage of mounting a camera on a street lighting column is that there is a mains power supply readily available such that, subject to availability of space, the camera power adapter may be installed in the lighting column base and connected at that point to the mains supply. There is still, however, a need for a connection from the camera to the data comms network service as described below even though power need not then be provided via the Ethernet connection to this service.

12.5.4 Data Communications

It is increasingly common for operations centres that use digital cameras to require at least high definition (HD) quality (1080p resolution) video images. To achieve this, each camera requires a high bandwidth connection, preferably with a data download speed of 10Mbits/sec or higher. This connection is normally provided at the camera site either as a “private” connection (i.e. provided by the service owner/operator) or by a commercial service such as Eir or Virgin Media. In either case, this connection is normally terminated at a data comms cabinet installed at the camera location, as described above.

For the purpose of this design, it has been assumed that that a new private optical fibre network will be installed along the length of the Proposed Scheme which will pass through each site where a camera is to be located, where practicable existing ducting will be utilised. This will require a duct chamber at each camera location to connect the main optical fibre duct network to the camera equipment/comms cabinet. The cabinet will need to be of a design to allow installation of the required optical fibre termination equipment in addition to any camera power/control equipment and mains power supply. The number of items of equipment, and the space and power supply requirements for it, will vary according to the type of service provided. However, it will require at least one mains supply point in the cabinet, and possibly up to three such points. A standard design for this cabinet will be produced at detailed design stage.

Alternatively, each junction could contain a wireless connection to nearby optical fibre (or copper) backhaul point. However, this would require a detailed (site-by-site) understanding of requirements to determine lines-of sight, equipment mounting options/limitations, etc. both at the junction and at the optical fibre/copper backhaul point. The initial approach will therefore be to assume direct connection of each camera to the main optical fibre network and any additional requirement for wireless communication will be considered on a site-by-site basis if it is considered more appropriate to do so rather than using a direct optical fibre/copper connection.

12.5.5 Camera Ducting and Cabling Requirements

Ducting will be required to link the camera equipment/comms cabinet to the camera at each location. Where the camera is located at a traffic signal junction, the ducting used for connecting the traffic signals can be used wherever practicable and if necessary, additional ducting will then be included in order to link the traffic signal ducting to the camera equipment/comms cabinet and to the camera itself.

As mentioned above, Ethernet cabling is most often used to connect the camera to the comms service and this cable may or may not also carry power to the camera. It is generally accepted that an Ethernet cable run of up to 100m between the cabinet and camera is acceptable but beyond this signal degradation can lead to comms issues. In such cases a PoE signal extender can be introduced into the cable run. This does not need any additional power supply as it draws the power it needs from the PoE input in the cable. These devices can be cascaded along the Ethernet cable run to extend the cable distance considerably although it is sensible to coincide the location of these units with duct chambers for ease of installation and to allow for maintenance access. The detailed design stage will consider the need for this approach on a site-by-site basis where there are cable runs in excess of 100m.

12.6 Real-Time Passenger Information

The design for the Proposed Scheme includes the provision of RTPI at all of the bus stops. This will comprise a “live” display identifying the estimated arrival time of each bus at the stop.

This will require a flag-type display on a dedicated mounting post, as illustrated below.

Figure 12.1: Illustration of RTPI Display at Bus Stop

12.6.1 RTPI Display Positioning and Mounting

The RTPI display, where present, is typically located adjacent to the shelter on the same side as approaching buses so that people waiting at the stop can simultaneously view both the display and the oncoming buses.

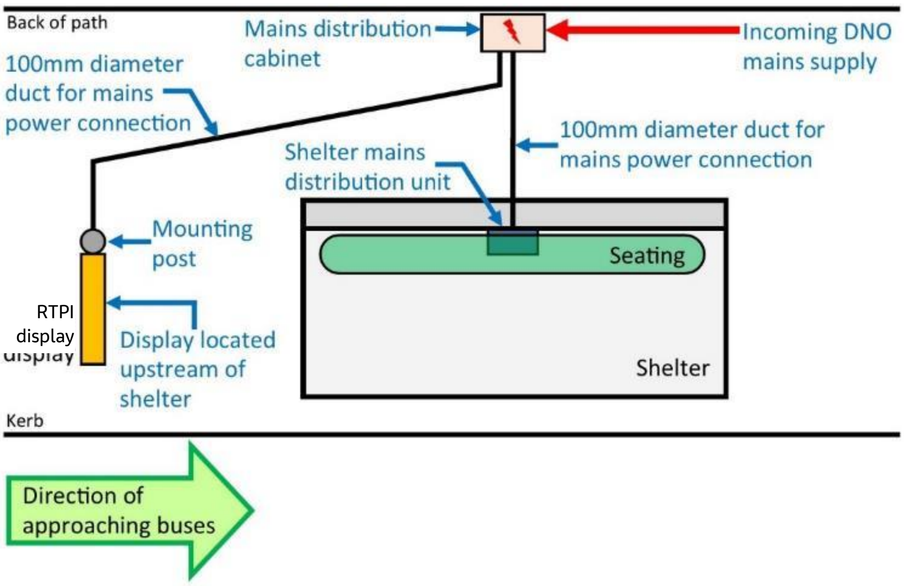

Figure 12.2: Typical Layout for Bus Stop with RTPI Display

The display is often placed around 4-5m from the shelter to maintain pedestrian access to the shelter while also enabling a clear view of the display from within the shelter. However, although this is considered the optimum position for a display, the precise location of it will be dictated by other site-based factors such as pedestrian and cyclist access (both to/from the stop and for those passing by) as well as requirements for other bus stop facilities such as waste bins, cycle storage and signage. Other physical restrictions (e.g. narrow footway, other street furniture, walls and buildings) may also influence the exact location of the display at each stop.

In any case, where an RTPI display is to be installed, the detailed design will assume that the mounting post for the display will be located in a NAL-type, or similar, post socket installed at footway floor level. As for the cameras, this will provide for easier installation as well as replacement, for example where the pole has been damaged and structurally compromised.

12.6.2 Power Supply for RTPI Display and Bus Shelter

The stand-alone design of the proposed RTPI display means that a physical link between the display and the bus shelter is not required. However, the display will nonetheless require a connection to a mains power supply. This can be shared with the supply to the bus shelter, as shown in **Figure 12.2,** from a mains distribution cabinet or feeder pillar located at the bus stop, where the mains service provider (DNO) will terminate its incoming connection. This cabinet /pillar will provide mains power to both the RTPI display and the shelter, assuming the bus shelter needs a mains power supply.

The bus shelter will commonly include a mains power distribution unit for all of the equipment in the shelter that requires mains power - usually lighting and/or advertising. Most often this distribution unit is located under the seating although it can vary according to the shelter design. The shelter installer will provide a connection from this unit to the cabinet/pillar containing the mains power supply for the bus stop, as shown in **Figure 12.2**.

12.6.3 Data Communications for RTPI Display

The majority of RTPI systems currently in operation now use the mobile phone (GPRS/3G/4G/5G) network as the method of data communication between each display and the central ('back office') bus location/passenger information system. This comprises a small mobile network comms device (including the SIM card) installed within the RTPI display housing. It is assumed for the purpose of this design that such connectivity will be used for provision of RTPI on the Proposed Scheme, with the mains power for the display – as described above – also providing power for this comms device. In this case no ducting will be required for data comms at the bus stop and the only physical connection to the display (i.e. ducting and cabling) will therefore be as described above for mains power.

12.7 Roadside Variable Message Signs

Consideration was also given to the inclusion of roadside Variable Message Signs (VMS) to provide traffic information to road users. VMS are proposed to be installed in advance of the Mount Brown bus gate on both sides to warn drivers of the traffic restriction. The South Circular Road / Emmet Road junction, Bow Lane and Cornmarket have been identified as locations for VMS sign.

12.8 Maintenance

Maintenance of signs, lighting and communication infrastructure has been considered and allowed for as part of the design process.

12.9 Traffic Signals

12.9.1 Above Ground Infrastructure

12.9.1.1 Traffic Signal Poles

All traffic signal equipment is designed in accordance with Chapter 9 (Traffic Signals) of the TSM. Traffic signal modelling, including LinSig models, determines the phasing and staging of the traffic signals which determines the design and positioning of the traffic signal heads. The TSM clearly defines the requirements and positioning of traffic signal heads, detection equipment, and associated traffic signal poles.

Traffic signal poles typically come in two lengths, 3m and 6m (as measured from the ground), or single or double height poles. Single height poles will be predominantly used on the Proposed Scheme to mount traffic signal heads, push button units, and other equipment. Double height poles will be used at locations where additional visibility of the signals is required by the motorist, e.g. high-speed approaches.

Where existing traffic signal poles do not provide for a sufficient field of view for above ground detection devices, additional traffic signal poles will be erected to mount that detection equipment.

12.9.1.2 Cantilever Traffic Signal Poles

Cantilever poles will be installed on multi-lane approaches where there is a potential for a high sided vehicle, including buses, to block the clear visibility of the primary traffic signal of vehicles in the outer lanes. They will also be installed at locations where a median island is not available to mount a second primary, required to control separate streams on a particular arm of a junction.

Cantilever poles may also be used to provide a mounting structure for secondary signals, where a median is not available and a position on opposing primary pole is outside the required line of sight.

12.9.1.3 Roadside Cabinets

Most equipment locations will require a roadside cabinet to house and protect electronic, electrical and communications equipment. Due to health and safety, design, space, operational and maintenance constraints it is often necessary to separate these cabinets in accordance with their function, including:

- Traffic signal control cabinets;
- Fibre breakout cabinets; and
- Electricity supply metering, mini and micro pillars.

Cabinets are positioned to allow for ease of access by maintenance personnel and to minimise their impact on the receiving environment. When accessing cabinets, maintenance personnel will require a clear view of the associated equipment and of approaching vehicles, pedestrians, and cyclists. Cabinets are often position at the back of footpaths, to minimise the impact on the effective width of the footpath. In all cases the consideration of the siting of such roadside equipment shall prioritize the access for pedestrians and cyclists in the area and the aesthetics of the street urban landscape. They are often clustered together at a junction to minimise the amount of cabling between cabinets and to allow maintenance personnel to quickly shift operations from one cabinet to another.

12.9.2 Under Ground Infrastructure

12.9.2.1 Ducts

Where practicable, existing chambers and ducting will be reused, each device, mounting structure, and cabinet will have associated underground infrastructure including ducts for:

- Power cables – installed equipment will require a power supply to function, this is facilitated by a ducting connection between the electricity supply point and equipment location. This connection is normally a single power supply duct;
- Communication cables – to facilitate the provision of fibre optic cable along the Proposed Scheme it will be necessary to provide a telecommunication ducting network consisting of two communication ducts, with chambers at 180m centres, along one side of the carriageway. This longitudinal ducting will be continuous along the length of the Proposed Scheme, with local duct spurs to connect to cabinets and devices; and
- Device cables – devices will require cabling between field equipment and control equipment. For example, a ring of six ducts will be provided at each junction to allow for cabling between the traffic signal controller and the traffic signal poles. It is necessary when designing the ducting provision that sufficient spare capacity is provided to allow for changes to the field equipment, deployment of additional equipment, or damage to the ducting provision.

12.9.2.2 **Chambers**

Chambers will be required at the termination points of ducts, at regular intervals along ducts (180m), at changes in direction, and at breakout points for devices. The position of chambers will be designed to be away from carriageways, pedestrian and cycle desire lines, and tactile paving. It is important when positioning chambers that they can be access in a safe manner, without the need, where practicable, for extensive traffic and pedestrian management. Where practicable, existing chambers will be reused.

Individual chambers will be designed and sized with consideration given to the number of ducts and cables that will be routed through the chamber, and the need to provide maintenance loops of cables within the chambers. Unless prior agreement is in place, chambers will not be shared between users.

12.9.2.3 **Foundations**

All cabinets, poles and mounting structures will require a foundation or mounting frame to be constructed to allow for their installation. It is envisaged that for traffic signal poles, 5m -8m CCTV poles, cantilever signal poles and other lightweight mounting structures that retention sockets will be installed to allow for the easy installation, maintenance and replacement of structures.

For larger structures, such a high CCTV masts, bespoke mass concrete foundations will be designed for incorporation into the works. Cabinet mountings will be designed and constructed in accordance with the manufactures and local authorities' standard details, including the incorporation of required vaults, chambers, earthing rods and mats.

12.9.3 Traffic Signal Priority

Further to the information discussed in **Section 4.12** and **Section 5.3.3** it is the intention to provide specific detection for buses located a sufficient distance from the junction to allow the traffic signal junctions to respond efficiently to the requested bus priority request. There will be further back up loop or other above ground detection provided to ensure that all vehicles permitted to use the lane will be detected although these would be standard non-priority demands.

The automatic vehicle locating (AVL) system is configured to detect when buses pass defined georeferenced locations or zones. When a bus enters these zones, a demand will be passed to the traffic signalling system. The current system capability allows this to be achieved either using local or network-based communications where the site is controlled using an overarching urban traffic control (UTC) system.

The system provided can interface with all of the junctions along the corridor, and where required other parts of the network. This will require utilising an existing, or updated version, AVL system that communicates both with the Central Dublin Sydney Coordinated Adaptive Traffic System (SCATS), in an updated version of the DPTIM SCATS centralised priority system. Options for local control include direct from optical sensors or using an AVL system interface.

The Proposed Scheme will operate on a service headway approach rather than on specific timetabled service pattern. To support this the AVL priority will need to be developed to provide priority inputs for those services that fall within the defined headway, with others receiving standard inputs. The detailed approach for implementing priority differs somewhat between the various control system, however the general principle applied is as follows whereby three levels of priority are practicable as shown in **Table 12-1.**

Table 12-1: Levels of Bus Priority

Level of Priority	Normal actions
Low	Add Phase extensions for buses arriving at the end of green.
Medium	Truncation of all non-priority phases to minimum values. Bonus green compensation for all truncated phases during following cycle, where appropriate. Phase extensions for buses arriving at the end of green.
High	Truncation of the non-priority stage to minimum value. Immediate insertion of bus priority stage. Bonus green compensation for all truncated phases during following cycle, where appropriate. Phase extensions for buses arriving at the end of green.

It is proposed that priority will be achieved using either demand dependent bus phases that can appear within the normal cyclic operation, or by configuring some stages to be conditional demand types that would not appear when priority is being demanded. This will achieve the high level of priority without losing the overall coordination and compensation times that are needed to balance the time needed for the skipped stages.

As discussed in Chapter 5, the junction designs for the Proposed Scheme comprise predominately of Junction Type 1 layouts. These junction types facilitate general traffic and bus through movements travelling in unison. This therefore gives BusConnects a high degree of flexibility regarding the level of bus priority applied at the respective junctions along the Proposed Scheme.

12.9.3.1 **Infrastructure**

Public Transport Priority will be provided through a number of passive and active means. The means of passive priority are discussed in **Section 4.12** and are based on the design of the geometry, signing and road markings of the junctions. These include measures such as bus gates and bus lanes. active priority will be facilitated through the detection of the public transport vehicle and communicating their presence to the traffic signal controller for the implementation of measures on site.

The local authorities utilise different controllers and adaptive urban traffic control systems. The systems can operate in several modes including adaptive, linked, vehicle actuated, scheduled plans and fixed time modes. DCC use SCATS traffic signal controllers.

Detection will be based on the use of several different technologies, working in concert to provide comprehensive detection solutions. The detection types will include:

- Embedded Inductive loop detectors – induction detectors will be cut into the road surface at discrete positions around the junction to detect vehicles approaching, or departing from, the junction. The position and number of detectors will be dependent on the lane configuration and the type of traffic signal controller at the junctions;
- Specialised induction detectors can be utilised to detect cyclists on particular approaches to junctions. These detectors use a concentrated induction pattern to detect the passage of cyclists; and
- These embedded induction detectors will require ducting, chambers, and carriageway loop pots, to route the cables associated with the detector to the traffic signal controller.

Above ground detection, including:

- Optical detection – where it is impractical to install embedded inductive loop detectors into the carriageway, optical detection may be installed. Using these devices, a virtual detector is set up in the field of view that trigger alerts to the traffic signal controller. Optical detectors are generally installed on existing traffic signal poles, or cantilever traffic signal masts, to provide a clear view of the approach. Additional poles may need to be installed to provide the optimum field of view for particular approaches; and
- Radar detection – Radar detection is used for pedestrian crossings, pedestrian wait areas, and cycle detection. Similar to the optical detection, virtual detection zones are set up in the radar field of view that trigger alerts to the traffic signal controller. Radar detectors are generally installed on existing traffic signal poles, or cantilever traffic signal masts, to provide a clear view of the approach. Additional poles may need to be installed to provide the optimum field of view for particular approaches.

Push button units (PBU) will be installed on traffic signal poles at pedestrian and cycle crossing points to allow the user to manually alert the traffic signal controller of their presence. The use of on crossing detection can also be configured at key locations to extend pedestrian crossing phases, where necessary.

Additional inputs from the AVL system and dedicated short range communications (DSRC) devices can be provided to notify the Traffic Signal Controller of the presence of particular vehicles.

The traffic signal controllers will detect the presence of vehicles, including identification of particular vehicles classes, and use this data to determine the timing to be applied to the junction in the current and upcoming cycles, including the provision of priority to particular traffic signal phases as programmed into the traffic signal plans.

12.9.4 Communication

The communications will take the form of:

Fibre optic cable network:

- All local authorities operate fibre optic cable networks. It is envisaged that each of these networks will be extended along the length of the Proposed Scheme to provide high bandwidth/low latency communication to traffic signal controllers, CCTV cameras, and other apparatus deployed on the Proposed Scheme;
- Longitudinal ducting, provisionally two communications ducts, shall be provided along the length of the Proposed Scheme with access chambers at 180m centres; and
- Fibre breakout cabinets will be provided at each traffic signal controller, or CCTV camera.

Microwave wireless point-to-point links - Where it is not practicable to install ducting for fibre optic cable, or there is a need to provide a high bandwidth/low latency communication to a remote site or cell, point-to-point microwave communications will be provided to facilitate the communications link.

Cellular subscriber networks (3G/4G/5G) - Cellular communications will be provided to low bandwidth devices such as RTPI and VMS.

12.10 Safety and Security

12.10.1 CCTV

CCTV poles will be placed at positions, within the junction, to minimise the impact of solar glare, and to maximise the field of view of the CCTV. The requirement for CCTV along the Proposed Scheme route and the exact locations for these cameras will be determined at detailed design stage. The locations of CCTV have been indicated in the system design drawing for planning purposes. The initial design assumption has been for the installation of camera(s) at each traffic signal junction although it is practicable that not all such junctions will require a camera and there may also be situations where a camera is required between junctions. However, the design approach adopted applies irrespective of the camera location or the number of cameras at any given location.

12.10.2 Bus Stops

The requirement for a pleasant, safe and secure environment for passengers waiting at Stops and undertaking their journeys is a key component of the proposed public transport service. This is facilitated by the provision of:

- RTPI – each stop will be provided with RTPI showing the estimated time of arrival of subsequent buses; and
- Public lighting – each stop will have public lighting designed to ensure the safe operation of the stops in all lighting conditions and to enhance the sense of security at the stops.

12.11 Maintenance

All traffic signal, CCTV, and communications equipment shall be designed and located to be accessed and maintained frequently. All equipment shall be accessible without disrupting pedestrian, bicycle, or vehicle traffic and without the use of special equipment.

Apparatus will be designed and located to allow for easy access and the safe maintenance of the Proposed Scheme into the future. This will include the provision of:

- Use of retention sockets, where applicable, for the erection of traffic signal, CCTV, above ground detection, and other equipment mounting poles to allow for the ease of installation, maintenance and replacement;
- The use of lightweight equipment poles, where appropriate, such as cantilever signal poles. Consideration will be given to the selection of products that allow for maintenance activities to be undertaken from ground level, such as tilt down poles or poles with wind-down mechanisms;
- Placement of poles and retention sockets within 7m of chambers to provide ease of installation and replacement of cables;
- Locating chambers away from pedestrian desire lines, and areas of tactile paving. This is to provide for a reduced impact of Traffic Management;
- On longitudinal duct runs, chambers to be placed at 180m centres to allow for the ease of installation and replacement of cables;
- Safe areas to be provided for the access and parking of maintenance vehicles; and
- Locating controller, and other, cabinets in positions that allow for safe access and clear visibility of the operation of the junction.

13. Land Use and Accommodation Works

13.1 Summary of Land Use and Land Acquisition Requirements

As part of the proposed works, land is to be acquired at key locations along the proposed route. A list of land to be acquired is shown in **Table 13-1**.

The land use along the Proposed Scheme comprises a mix of residential and commercial properties. The various land uses are described in the sections below. The extent of the impact due to the Proposed Scheme on a landowner's holding is shown on the Protected Road Order Deposit Maps. The total area that lies within the proposed road development boundary is approximately 27ha. including the existing roads and footpaths.

All reasonable precautions to prevent pollution of the site, works and the general environment including streams and waterways will be taken. All demolition waste to be segregated and, where practicable, sent for recycling. All in accordance with guidelines as set out by the National Construction and Demolition Waste Council (NCDWC).

A waste management plan following guidelines as set out by the NCDWC shall be produced outlining the proposals with respect to waste recycling, segregation and details of landfill proposals with target percentage of each element. The following legislation should be noted:

- Protection of the Environment Act 2003;
- Waste Management (Amendment) Act 2001;
- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste;
- EU Council Decision on Waste Acceptance (2003/33/EC);
- WMA Amendment Act (#2) 2001;
- Protection of the Environment Act No. 27 2003;
- Best practice Guidelines on the preparation of Waste Management Plans for Construction and Demolition Waste; and
- Department of Environment, Heritage and Local Government July 2006.

13.2 Summary of Compulsory Land Acquisition

From the outset of the design of the Proposed Scheme every effort was made to avoid compulsory land acquisition. However, there are a number of public and private lands that are necessary for the construction of the proposed road development and to secure the many benefits for the Proposed Scheme.

In total approximately 11.19ha. of land will be required to be permanently acquired, of which approximately 0.76ha is currently in DCC ownership and 0.61ha in SDCC ownership., to construct the Proposed Scheme. There will also be an additional 2.37ha of temporary land required to allow for construction of boundary treatment and surface tie in work and construction compounds. This includes approximately 1.22ha currently in DCC ownership and 0.26ha in SDCC ownership.

Reference should be made to the CPO Documents' prepared as part of the planning application for further details. Summary of Effected Landowners/Properties

The determination of the lands to be acquired for purposes of constructing the Proposed Scheme was as a result of an iterative design process, including non-statutory public consultation and detailed engagement with potentially impacted owners and occupiers.

The list of landowners/properties that are affected by the Proposed Scheme are summarised below.

Table 13-1: Impacted CPO Properties

Address	Permanent land take	Temporary land take
Fonthill Road, Irishtown, Liffey Valley, Dublin 10	N	Y
Fonthill Road, Irishtown, Liffey Valley, Dublin 10	N	Y
Road at Entrance to Liffey Valley Retail Park, Dublin 22	N	Y
Ground to rear of Liffey Valley Shopping Centre, Dublin 22	N	Y
Fonthill Road, Irishtown, Liffey Valley, Dublin 10	Y	Y
Fonthill Road, Irishtown, Liffey Valley, Dublin 10	Y	Y
Fonthill Road, Irishtown, Liffey Valley, Dublin 10	Y	Y
Plot at Liffey Valley Retail Park, Fonthill Road, Liffey Valley, Dublin 10	Y	Y
B. & Q. Warehouse, Liffey Valley Retail Park East, Ascail An Life, Dublin 22, D22E892	Y	Y
Site at Liffey Valley Retail Park, Fonthill Road, Dublin 22	Y	Y
B. & Q. Warehouse, Liffey Valley Retail Park East, Ascail An Life, Dublin 22, D22E892	Y	Y
Grass verge in front of Larkfield House, Dublin 22	Y	N
Grass verge to the front of The Coldcut Club, Coldcut Road, Dublin 22, D22 X210	N	Y
Grass verge infront of The Coldcut Club, Coldcut Road, Dublin 22, D22 X210	Y	Y
Ground at Coldcut Road, Dublin 10	Y	Y
Open space at Palmer's Lawn, Dublin 10	Y	Y
Ground off Coldcut Road, Dublin 10	Y	N
Plot of ground at junction of Coldcut Road & Cloverhill Road, Dublin 10	Y	N
Plot of ground at junction of Coldcut Road & Cloverhill Road, Dublin 10	Y	N
Coldcut Road, Clondalkin, Dublin 22	Y	Y
Coldcut Road, Clondalkin, Dublin 22	Y	Y
Ballyfermot Road, Ballyfermot, Dublin 10	Y	N
Green area along Ballyfermot Road & Coldcut Road, Dublin 10	Y	N
Green area along Ballyfermot Road & Coldcut Road, Dublin 10	Y	N
North Side of Ballyfermot Road, Cherry Orchard Industrial Estate, Dublin 10	Y	Y
North Side of Ballyfermot Road, Cherry Orchard Industrial Estate, Dublin 10	Y	Y
Grass verge in front of Pat the Baker, Ballyfermot Road, Dublin 10	Y	N
Grass verge outside Lidl on Ballyfermot Road, Dublin 10	Y	N
Ground within Cherry Orchard Hospital, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
Cherry Orchard Hospital, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
Applegreen, Cherry Orchard Service Station, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y

Address	Permanent land take	Temporary land take
Applegreen, Cherry Orchard Service Station, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
Car Park at Grange Cross, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
Pavement and bollards at Fowler's Pub, Grange Cross, Ballyfermot Road, Ballyfermot, Dublin 10	Y	N
Plot of ground outside Church of Our Lady of the Assumption, Ballyfermot, Dublin 10	Y	N
St Raphael's, St Gabriel's and St Michael's Primary Schools & Ballyfermot Resource Centre, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
St Raphael's, St Gabriel's and St Michael's Primary Schools & Ballyfermot Resource Centre, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
De La Salle National School, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
Pieta, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
Parkland at junction of Ballyfermot Road and O'Hogan Road, Ballyfermot, Dublin 10	Y	Y
The Steeples Apartments, St. Laurence Road, Chapelizod, Dublin 20	Y	Y
Ground on north side of Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
Laurence Court, Ballyfermot Road, Dublin 10	Y	Y
5 Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
3/3a Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
St. Lawrences Glen Apartments, Ballyfermot Road, Ballyfermot, Dublin 10	Y	Y
Longmeadows Pitch & Putt Club, 253 Sarsfield Road, Dublin 10, D10FT22	Y	Y
Longmeadows Park, Sarsfield Road, Ballyfermot, Dublin 10	Y	Y
Plot at junction of Sarsfield Road and First Avenue, Ballyfermot, Dublin 10	Y	N
1 First Avenue, Dublin 10, D10R324	Y	Y
Meadowview, Sarsfield Road, Inchicore, Dublin 10	Y	Y
Plot of ground between Con Colbert Road & Rail line, Dublin	Y	Y
Plot of ground between Con Colbert Road & Rail Line, Dublin 8	Y	Y
Under Railway Bridge at Inchicore Road, Dublin 8	N	Y
Under Railway Bridge at Inchicore Road, Dublin 8	N	Y
Outside 52A, 52B and De Mazenod Hall, Bulfin Road, and 122, 122A (124), 122 & 120, Emmet Road, Dublin	Y	N
69 - 83 Emmet Road, Dublin 8	Y	N
Plot at St. James's Hospital, Mount Brown, Kilmainham, Dublin 8	Y	Y

13.3 Demolition, if any

There are no buildings proposed to be demolished as part of this Proposed Scheme.

All existing boundary walls and railings will be removed and replaced as part of the works listed in **Table 13-1**.

For boundary treatment requirements the following criteria has been used to calculate the area of temporary land take needed during construction:

- Walls - Typically 2m working room offset for temporary land take;
- Fences - Typically 2m offset for temporary land take;
- Significant retaining walls – the temporary land take was calculated specifically for each retaining wall depending the height and assumed constructions method; and
- Specific structures (bridges etc) –There are no specific structures within this scheme that require temporary land take.

To maintain the character and setting of the Proposed Scheme, the approach to undertaking the new boundary treatment works along the corridor is replacement on a 'like for like' basis in terms of material selection and general aesthetics unless otherwise noted on the drawings.

Modifications to driveways and entrances will be in line with DCC's Parking Cars in Front Gardens Advisory Booklet. The basic dimensions to accommodate the footprint of a car in the front garden are 3m x 5m and a vehicular opening would typically be between 2.5m and 3.6m in width though this may need to be widened to allow for sightlines and manoeuvrability.

Existing gates will be reused where practicable however considerations will be required for the use of bifold/roller gates to mitigate impacts on parking in driveways.

13.4 Summary of Accommodation Works and Boundary Treatment

The locations for proposed new boundary treatments along the Proposed Scheme have been provided in **Table 13-1** and also shown on the SPW_BW Fencing and Boundary Treatment Plans located in **Appendix B.**

For boundary treatment requirements the following criteria has been used to calculate the area of temporary land take needed during construction:

- Walls - Typically 2m working room offset for temporary land take;
- Fences - Typically 2m offset for temporary land take;
- Significant retaining walls – the temporary land take was calculated specifically for each retaining wall depending the height and assumed constructions method; and
- Specific structures (bridges etc) –There are no specific structures within this scheme that require temporary land take.

To maintain the character and setting of the Proposed Scheme, the approach to undertaking the new boundary treatment works along the corridor is replacement on a 'like for like' basis in terms of material selection and general aesthetics unless otherwise noted on the drawings.

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Existing gates will be reused where practicable however considerations will be required for the use of bifold/roller gates to mitigate impacts on parking in driveways.

14. Landscape and Urban Realm

14.1 Overview of Landscape and Urban Realm

Urban Realm refers to the everyday street spaces that are used by people to shop, socialise, play, and use for activities such as walking, exercise or commute to/from work. The Urban Realm encompasses all streets, squares, junctions, whether in residential, commercial or civic use. When well designed and laid out with care in a community setting, it enhances the everyday lives of residents and those passing through. It typically relates to all open-air parts of the built environment where the public has free access. It would include seating, trees, planting and other aspects to enhance the experience for all. Successful urban realms or public open space tend to have certain characteristics.

- They have a distinct identity;
- They are safe and pleasant;
- They are easy to move through; and
- They are welcoming.

The following are the key policy and strategy documents that have been considered as guidance in developing the proposals for the BusConnects landscape and urban realm proposals.

Dublin City Development Plan 2016-2022

Section 9, Sustainable Environmental Infrastructure states in policy SI18 a requirement to use SuDS in all new developments where appropriate, as set out in the GDRCoP.

Section 10.5.6 Biodiversity, states in policy GIO24 a requirement to support the implementation of the Dublin City Biodiversity Action Plan 2015-2020.

Section 10.5.7 Trees. The Dublin City Tree Strategy provides the vision and direction for long-term planning, planting, protection and maintenance of trees, hedgerows and woodlands within Dublin city. Policy GIO28 states the need to identify opportunities for new tree planting.

South Dublin Development Plan Draft 2022- 20228

Section 4 Green infrastructure – GI4 outlines the requirement to use SuDS in all new developments where appropriate

Section 3.1 - The Council supports the implementation of the County Heritage Plan and the County Biodiversity Action Plan.

Policy E11: Green Infrastructure - To ensure the implementation of policy and objectives on tree planting and protection of trees on site.

Dublin City Tree Strategy 2016-2020

A set of policies for the long-term promotion and management of public trees in Dublin. “Within the city, trees clean the air, provide natural flood defences, mask noise and promote a general sense of wellbeing”.

Dublin City Biodiversity Action Plan 2015-2020

Covers all areas of the City including roadsides and footpaths and reflects the Strategic Objectives of Ireland’s National Biodiversity Plan (Actions for Biodiversity 2011-2016)

- Strengthen the knowledge base of decision makers to protect species and habitats;
- Strengthen the effectiveness of collaboration between all stakeholders for the conservation of biodiversity in the greater Dublin region;

- Enhance opportunities for biodiversity conservation through green infrastructure and promote ecosystem services in appropriate locations throughout the City; and
- Develop greater awareness and understanding of biodiversity and identify opportunities for engagement with communities and interest groups.

14.2 Consultation with Local Authority

Consultation has taken place with DCC and SDCC throughout the design process. Stakeholders and statutory bodies including the OPW have been consulted through the process as well as through the Public Consultations and various scheme presentations.

14.3 Landscape and Character Analysis

The landscape and urban realm proposals are derived from analysis of the existing urban realm, including existing character, any heritage features, existing boundaries, existing vegetation and tree planting, and existing materials. The following document BusConnects Dublin - Urban Realm Concept Designs, https://busconnects.ie/media/2089/busconnects-urban-realm-concept-designs.pdf, was also used as guidance in developing the proposals. For each section of the route, a broad overview of typical dwelling age and style, extents of vegetation and tree cover was undertaken. The predominant mixes of paving types, appearance of lighting features, fencing, walls, and street furniture was considered. The purpose of this analysis was to assess the existing character of the area and how the Proposed Scheme may alter this. The outcome of the analysis allowed the urban realm design to consider appropriate enhancement opportunities along the route. The enhancement opportunities include key nodal 'Potential Development Opportunities which focus on locally upgrading the quality of the paving materials, extending planting, decluttering of streetscape and general placemaking along the route. These areas are further discussed in **Section 14.7**.

Where practicable, a SuDS approach will be taken to assist with drainage along the route. SuDS principles will be used as much as practicable to deal with run-off at, or close to, the surface where rainfall lands.

14.4 Arboricultural Survey

14.4.1 Scope of Assessment

- A Preliminary Design Tree Removal Plan that illustrates the impact of the proposal upon trees.

An Arboricultural Impact Assessment Report identified the likely direct and indirect impacts of the Proposed Scheme along with suitable mitigation measures, as appropriate. The Tree Protection Plan identified trees to be removed, and the Arboricultural Method Statement set out how retained trees are to be successfully protected. A copy of the report has been provided in Appendix D and the inputs from the report have been incorporated in the Landscaping Drawings in Appendix B.

The assessment was informed by an extensive tree survey prepared by John Morris Arboricultural Consultancy (JMAC) (ref: 20-092-03), based on the requirements of BS5837:2012 Trees in relation to design demolition and construction – Recommendations (BS5837).

The Arboricultural Impact Assessment set out the likely principal direct and indirect impacts of the Proposed Development on the trees on or immediately adjacent to the Site, and suitable mitigation measures to allow for the successful retention of significant trees, or to compensate for trees to be removed, where appropriate.

The report considered the following:

- Description of the site/route and summary of the trees surveyed;
- Summary of any statutory or non-statutory designations affecting trees within the survey area;
- A brief summary of trees to be removed;
- Outline guidance for the design team and any key considerations, or issues which need to be addressed;

- Schedule of surveyed trees and key;
- Recommendations for tree works and incursions related to the proposed development; and
- Tree constraints plans.

14.5 Hardscape

14.5.1 Design Principals

In the development of the preliminary design proposal, the following elements were analysed and considered:

- The character of each section including building typologies, uses, scale, pedestrian environment, landmarks, landscape character and any other relevant place attributes;
- Assessment of the scheme proposals and any impacts to the local setting that may need mitigation; and
- Preparation of conceptual public realm design responses for each section that are in keeping with the local character and in line with the objectives, in particular, ensure that the public realm is carefully considered in the design and development of the transport infrastructure and seek to enhance key urban focal points where appropriate and feasible.

14.5.2 Typical Material Typologies

Through the process of developing the Preliminary Design a typology and palette of proposed materials was developed to create a consistent design response for various sections of the route. The proposed materials were based on the existing landscape character, existing materials, historical materials while also identifying areas for betterment through the use of higher quality surface materials.

The proposed material typologies employed in the preliminary design are described as:

- **Poured in situ concrete pavement** - Used extensively on existing footpaths. Concrete pavements can be laid without a kerb, can have neatly trowelled edges and textured surface for a clean, durable, slip resistant surface;
- **Asphalt footpath** - Widely used on existing footpaths and will tie in with other sections of public realm. Laid with a road kerb, can have a smooth finish or textured aggregate surface, provides a strong flexible slip resistant surface. Opportunities to retain good quality kerbs have been explored and tie-in points considered;
- **Precast concrete unit paving** - Either concrete paving slabs or concrete block, there is a very wide variety of sizes and colours available to provide an enhanced public realm. The use/reuse of granite kerbs where appropriate will further enhance the public realm. This type of material use is mostly employed in non-inner-city public realm enhancements;
- **Natural stone paving** - Employed for high quality urban realm areas, mostly in city centre locations. This typology represents natural stone surface treatments such as granite and are used to create enhanced public spaces for major urban realm interventions;
- **Stone or Concrete setts** - Proposed for distinguishing pedestrian crossing points either on raised table or at road level;
- **Self-binding gravel** - Proposed for pedestrian paths set away from the road expected to see less traffic. Used for natural areas, for example, paths through wildflower meadows. They provide a defined informal route as an alternative to asphalt or concrete; and
- **No change** - In addition to areas with proposed material changes, there were also areas identified where no change in materials would be required. For example, where pavement has recently been laid and is in good condition. The design also explores opportunities where good quality kerbs such as granite kerbs could be relaid in the same location, which would have both cost and sustainability advantages.

Other design responses include:

- **Boundary treatments** to both commercial and residential properties. Opportunity exists to take the best examples of existing boundary treatment and reinstate them, while improving other sections of the road frontage;
- **Tree pit enhancements** will be undertaken, using materials such as self-binding gravel. Consideration has also been given to the construction of tree pits to include in-ground root protection systems to improve both the vitality of the trees and the life span of the pavements; and
- **Street furniture** is mostly confined to replacing or relocating existing furniture, at locations where there is potential development opportunities there is the prospect to provide additional street furniture where it would most enhance the communal spaces.

14.6 Softscape

14.6.1 Tree Protection and Mitigation

The first priority of the landscape strategy is to protect existing trees along the route. Where practicable, the initial conservation of existing biodiversity has been considered. The arboricultural survey identified the quality of existing trees. The information was overlaid on the proposed routes to inform the design process. The impact of roadworks will be minimised near existing trees by utilising no-dig construction as described in **Appendix D.** Review and re-design of the alignment and extent of proposals through sensitive areas has minimised the loss of high-quality trees.

The following key areas were identified as potential conflicts and the road layout was reconfigured to preserve the trees.

- To the east of Cloiginn Park on Ballyfermot Road, the alignment design was refined to retain the existing trees and make provision for additional tree planting;
- Following the first Non-Statutory Public Consultation, concerns were raised due to the impact on the existing mature trees along Grattan Crescent which were removed in the EPR to facilitate the proposed road widening. As a result, the design was refined to retain the existing mature trees by implementing a one-way system along Grattan Crescent;
- The design along Ballyfermot Road at Markievicz Park was amended to minimise the impact on the park boundary and existing trees;
- Outside the St James's Hospital energy centre building, the design of the bus gate bypass was shortened to reduce the impact on the existing trees;
- At Cornmarket, the design of the central median and kerb line was refined to avoid impacting the existing mature trees; and
- Along Emmet Road, to the west of Turvey Avenue, the alignment design was refined to retain the existing trees.

14.6.2 Tree Loss and Mitigation

Despite the best efforts to protect trees, especially trees of a mature and significant stature there will be inevitable impacts on local trees. In total it is estimated that there will be 179 trees lost and 1,262m^2 of woodland area removed, refer to **Table 14-1** below. This loss has been addressed through mitigation and replanting efforts as outlined in the planting strategy (**Section 14.6.3**) below resulting in a substantial tree planting plan with a net increase of 354 additional semi-mature trees and 504m^2 of woodland area along the Proposed Scheme.

Table 14-1: Summary of Trees Retained, Removed and Proposed as part of the BusConnects Route

Individual Trees				
Do Minimum Tree Count	Do Something Total retained tree count	Do Something Removed tree count	Do Something New tree count	Do Something Total tree count
462	283	179	354	637 (+38%)
Approximate increase in trees within the development area of approximately 38% along proposed scheme				
Woodland Trees				
Do Minimum Tree area (m^2)	Do Something Total Retained Woodland Tree Area (m^2)	Do Something Removed Woodland Tree Area (m^2)	Do Something New Woodland Tree Area (m^2)	Do Something Total Woodland Tree Area (m^2)
6120	4858	1262	504	5362(-12%)
Approximate decrease in woodland planting within the development area of approximately -12% along proposed scheme				

14.6.3 Planting Strategy

The planting strategy has been developed to meet the objectives of the Proposed Scheme and the needs of the Dublin City Tree Strategy and the Dublin Biodiversity Action Plan. To have an influence on the local environment to improve amongst others: air quality; stormwater runoff; health and well-being; and habitat provision.

- Opportunities have been identified to enhance biodiversity through green infrastructure;
- Promote the role of street trees planting consistent with the recommendations of the Dublin City Tree Strategy; and
- Develop the role of SuDS opportunities within the scheme in coordination with the drainage engineers. (Refer the Drainage, Hydrology and Flood Risk section of this report).

14.6.4 Typical Planting Typologies

Several typologies were developed to address the above issues. Details of the proposed tree species and planting regime are provided on the ENV_LA Landscaping General Arrangement Drawings in **Appendix B.** Additional information on suitable plant species is also provided in **Section 14.7.16.**

14.6.4.1 **New Street Trees**

A variety of new tree species and sizes appropriate for their location are to be planted in urban tree pit systems to allow for protection of the soil structure and allow for good root development (see example **Figure 14.1**.)

Figure 14.1: Example of New Tree Planting in an Area of Public Realm

14.6.4.2 **Central Median Planting**

Central median planting varies depending on the context of the landscape character and road. Dual carriageways or wide roads to the edge of settlements are more likely to have wider central medians where tree planting and grass verges can be found. A combination of tree and shrub, or species-rich grassland is practicable, to create a formalised corridor of planting within a wide section of road.

Figure 14.2: Example of Tree Planting within Species-Rich Grassland

14.6.4.3 **Native Planting / Tree Planting**

In some locations, edges of existing wooded and native planted areas have been encroached by road widening. There will be replanting of native trees and understorey shrubs to repair these woodland edges. (See example **Figure 14.3** below).

Figure 14.3: Example of Native Planting Group on Highway Verge

14.6.4.4 **Boundary Planting Associated with Commercial and Community Land Use**

The interfaces with these types of land use vary across the Proposed Scheme from verges adjacent to industrial units, retail frontages, schools, medical centres, churches, and golf course boundaries. The primary function of planting along these boundaries is to enhance the visual setting of these buildings and spaces whilst creating containment and a buffer between adjacent functions. Proposed planting includes linear tree belts, tree avenues and more informal tree groupings in combination with species-rich grassland and SuDS features. (See example **Figure 14.4** below).

Figure 14.4: Example of Commercial Boundary planting

14.6.4.5 Key Areas of Public Realm

Intermittently throughout the scheme there are several key community and civic spaces where small landscape interventions are proposed. These spaces contain formal planting arrangements including large semi-mature street trees, raised planting beds, seating, public art and play spaces. (See example in **Figure 14.5**).

Figure 14.5: Example of Key Public Realm Spaces

14.7 Proposed Design

This section outlines the landscape and urban realm proposals along the various sections of the route. Further detail on these design proposals is available in the Landscaping Design Drawings in **Appendix B**.

14.7.1 Fonthill Road

Existing Character: This is the start of the route and is characterised as being a connector road within the shopping centre precinct. This section typically has wide roads with minimal active interfaces. It is visually dominated by road carriageways and edge tree planting.

Design Proposals: The BusConnects proposal involves kerb realignments on both sides to the eastern part of this section in the lead up to Coldcut Road Bridge but no other significant changes. The preliminary design proposes in-situ materials including poured concrete and asphalt with concrete kerbs to match the existing where kerb realignments occur. SuDS treatments proposed in green spaces and medians. This will be determined by the amount of space available but will typically be integrated as part of new tree pits for proposed street trees. New native planting to mitigate tree loss is proposed on the approach to the bridge along with edge planting management.

14.7.2 Coldcut Road Bridge to Cloiginn Park

Existing Character: This section is characterised by outer suburban residential development with residential edges, high fences and planted edges to the western end, and the Cherry Orchard Industrial Estate with 'big-box' built form and the Cherry Orchard Hospital with high hedges to the eastern end. The existing road has grass verges and tarmac surface materials.

Design Proposals: The proposed design includes asphalt with concrete kerbs for the footways for most of the section, with a concrete paving material to enhance the entrance of Cherry Orchard Hospital. East of the hospital the footway material changes to poured concrete with concrete kerbs to match existing. Replacement fencing is proposed where land take occurs to reinstate the visual screening. New tree planting and species-rich grassland is proposed for the green spaces near Kennelsfort Road Upper junction. SuDS treatment is proposed in two locations close to the Kennelsfort Road Upper junction. The existing hedge boundary planting and boundary wall will be reinstated along the hospital fence. SuDS treatment is proposed within the green space in the Cherry Orchard Hospital site. Trees and reinstated boundary at the junction near the service station, are proposed to mitigate change in boundary treatment.

14.7.3 Cloiginn Park to Ballyfermot Village Centre

Existing Character: Suburban residential character with generally two-storey houses with a variety of boundaries with front gardens. Ballyfermot Community Civic Centre is a landmark in this section.

Design Proposals: This section features a significant realignment of the highway edge adjacent to the residential area with minor kerb realignments by the park. The proposed design includes poured concrete footways with concrete kerbs along the western edge, then concrete paving slabs with concrete kerbs as the route approaches the Ballyfermot Community Civic Centre. The carriageway proposal is to change the entire junction to a raised table. The intent is slow vehicle speeds through this urban centre. Opportunities for new tree planting have been explored where practicable in the residential area (subject to utilities). The forecourt of the medical centre is enhanced with high quality concrete paving and wide granite kerbs. Trees and formal tree grates are proposed at the medical centre forecourt. Cycle racks are provided along the frontage to the Civic Centre. Along the park interface, existing trees have been retained and enhanced with new ground cover shrub planting.

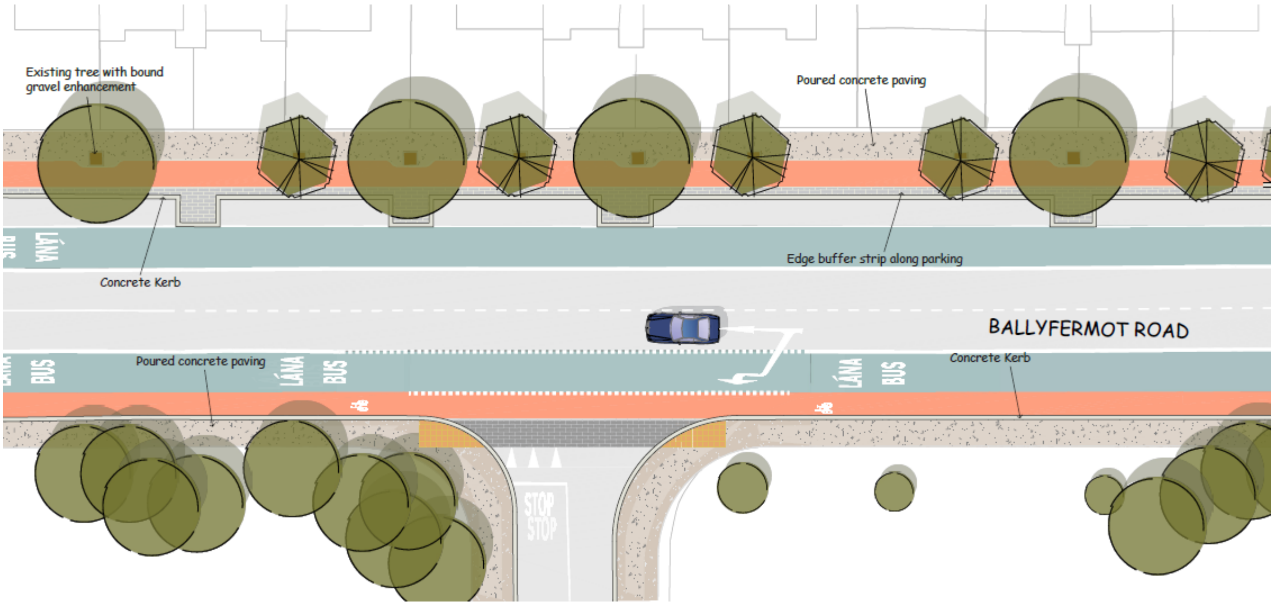

Figure 14.6: Rearranged Parking and Cycle track to Front of Residential Properties East of Cloiginn Park

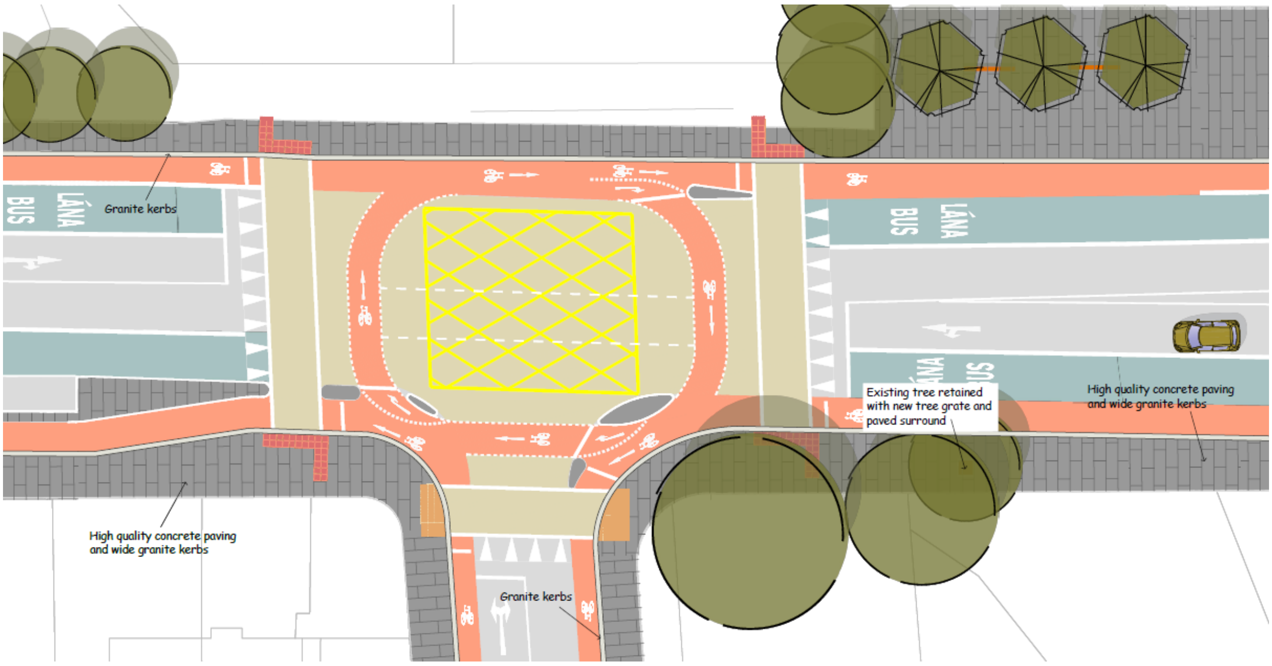

Figure 14.7: Raised table at Junction and Public Realm Upgrade Along Footway in Front Ballyfermot Community Civic Centre

The access road along the residential area west of Le Fanu Road junction is proposed to have some minor adjustments in order to retain the majority of the existing established avenue of trees. A gap in the centre of this tree line has been created to connect the bus stops through to the access road. The existing railings will need to be set back to suit the new back of footway alignment. Concrete paving with concrete kerbs are proposed along the footways adjacent to the new cycle lane to enhance the approach into the retail centre. Raised tables across side streets are proposed to enhance pedestrian priority.

The public realm materials at the shopping parade just west of Le Fanu Road junction have been enhanced with concrete paving and concrete kerbs for the footways. New street trees are proposed on the east side of the junction where the footways are quite wide. An overall declutter of the footways will enhance the approach into Ballyfermot Retail Centre.

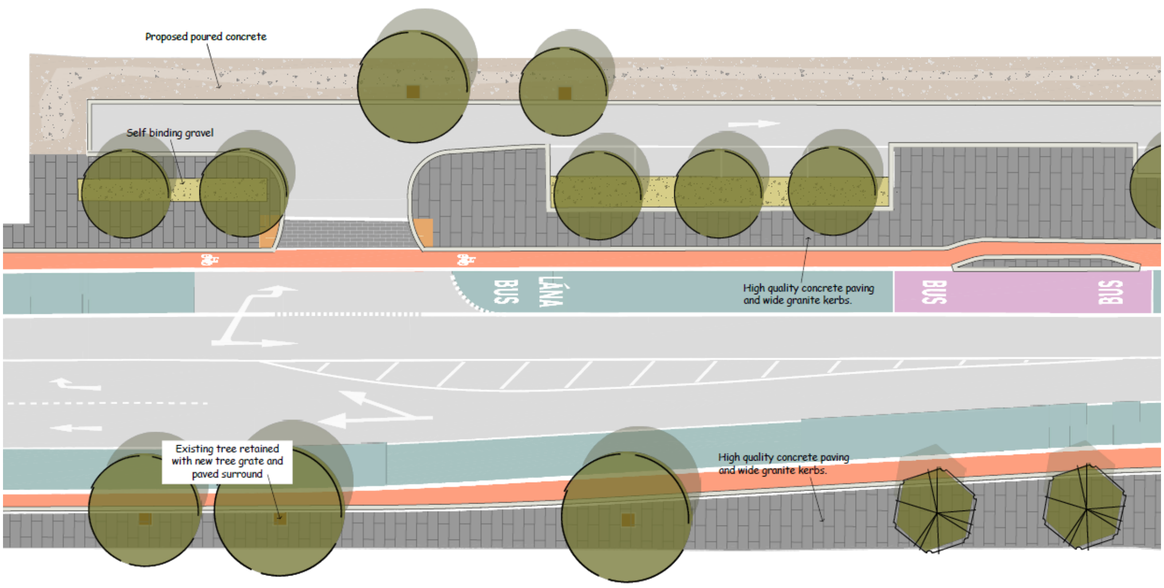

Figure 14.8: House No. 388 to No. 370 Ballyfermot Road

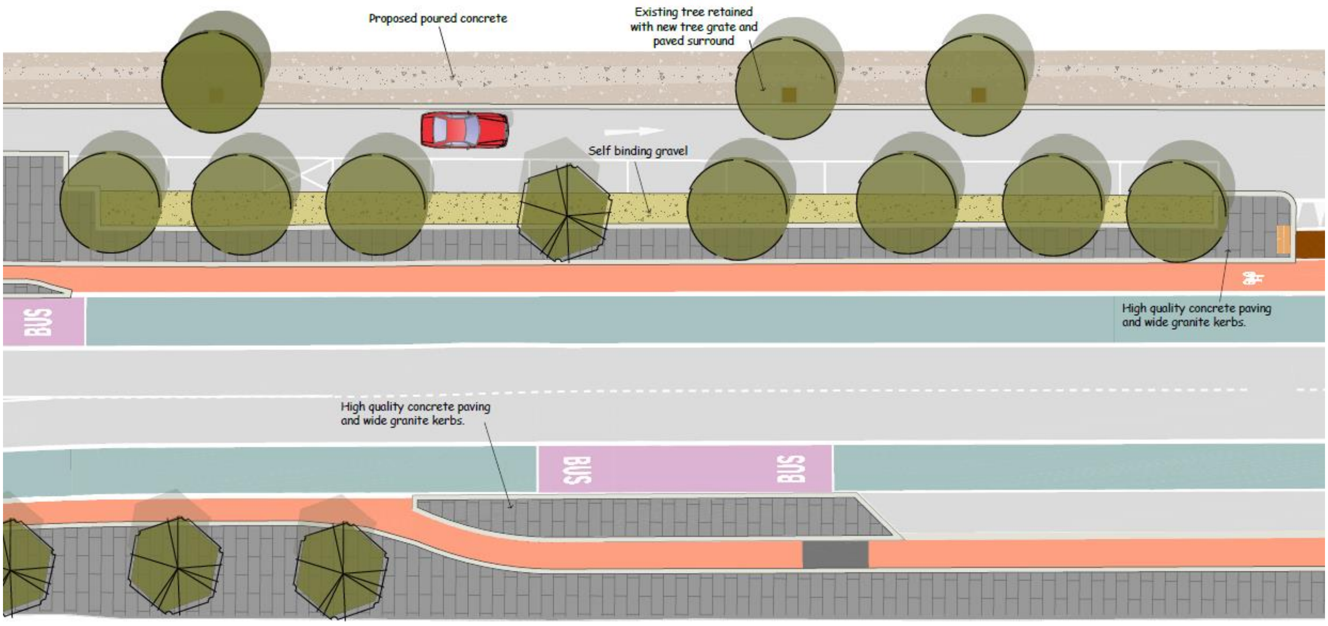

Figure 14.9: House No. 370 to No. 352 Ballyfermot Road

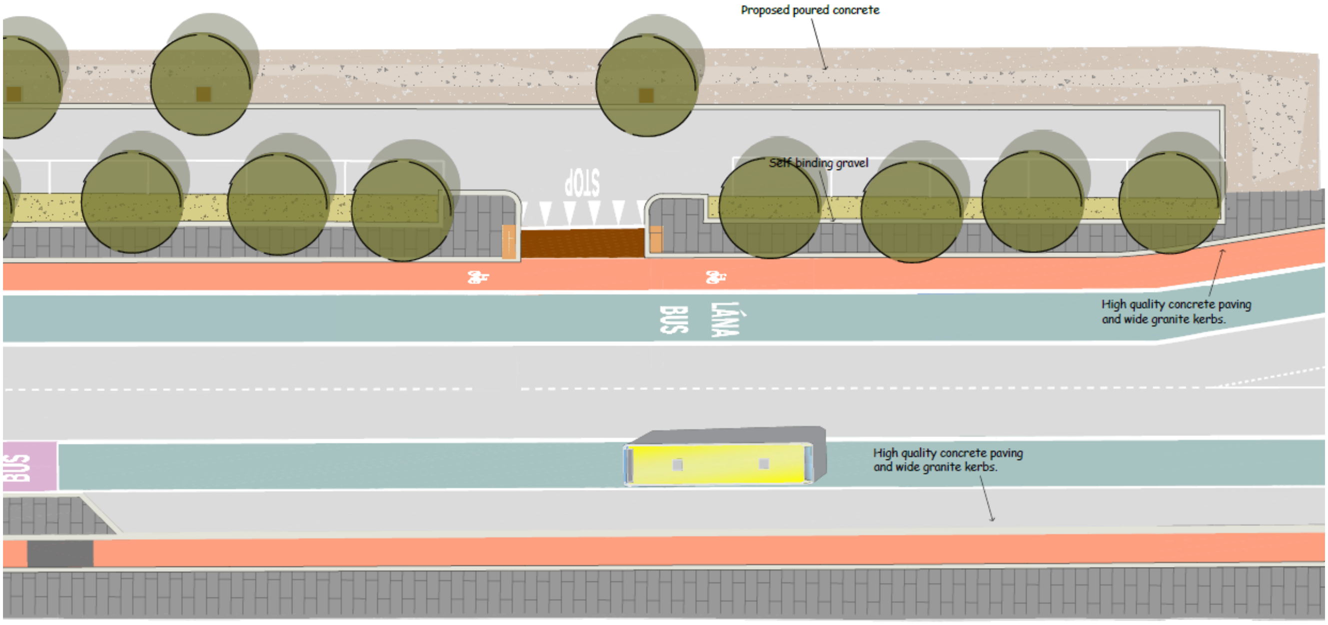

Figure 14.10: House No. 352 to No. 340 Ballyfermot Road

14.7.4 Ballyfermot Retail Centre, Le Fanu and Kylemore Roads and Ballyfermot Roundabout

Existing Character: This is a local retail hub with a two-storey shopping parade along the northern edge and a superstore to the south. An existing access road and parking separates the shopping parade from the main road, with a bus stop located midway. There is minimal existing greening along the retail area and poor pedestrian connections across Ballyfermot Road with a single crossing point. Le Fanu and Kylemore Roads are predominantly suburban residential roads. The Ballyfermot roundabout is currently a wide traffic-dominated space with poor pedestrian crossing areas. The roundabout houses an existing statue and welcome sign as well as seasonal planting. These elements contribute to the local character and have been considered in the proposed design.

Design Proposals: A high quality public realm scheme is proposed to support the retail centre and includes concrete paving combined with natural stone sett bands of paving with wide granite kerbs. The feature banding continues across Ballyfermot Road for visual connectivity. Loss of poor-quality trees through the Ballyfermot retail area has been acknowledged and replacement tree planting proposed in the upgrade to the associated public realm areas. A new suite of street furniture is proposed including seating to provide a resting and meeting place in the retail core. The access road will calm traffic and to enhance pedestrian priority, as will the pedestrian crossing across Ballyfermot Road. Proposed raised tables across side streets are to be finished in concrete setts with asphalt ramps to enhance pedestrian priority. Poured concrete footways to match existing are proposed where kerb realignments occur along Kylemore Road. New trees are proposed along the wide section of footway along Kylemore Road where services allow. Footway surface materials transition to concrete paving at the bottom of Kylemore Road close to the roundabout.

Figure 14.11: High Quality Public Realm Scheme is Proposed to Support the Ballyfermot Retail Centre

The Ballyfermot roundabout acts as the eastern gateway into the retail centre and has been developed as a high-quality public realm scheme with community spaces created as a result of the proposed junction instead of the roundabout. The central green space within the roundabout is reallocated as four distinctly designed quadrants that are more accessible to the community. A new green space and rearranged parking area associated with the Church in the north-western quadrant includes the relocated statue and welcome sign from the roundabout. New tree planting, seasonal planting, seating and feature paving in high quality concrete with granite kerbs, create an attractive and engaging community-orientated public space in this quadrant.

The north-eastern quadrant features species-rich grassland and new tree planting to enhance the school area. Compensatory tree planting is proposed within the school ground and the boundary is reinstated with a rendered wall with railings.

New pocket parks, trees and parking are features of the south-eastern and western quadrants adjacent to the residential properties facing the junction. These spaces incorporate seating areas with small urban play spaces as community enhancements to complement the residential areas.

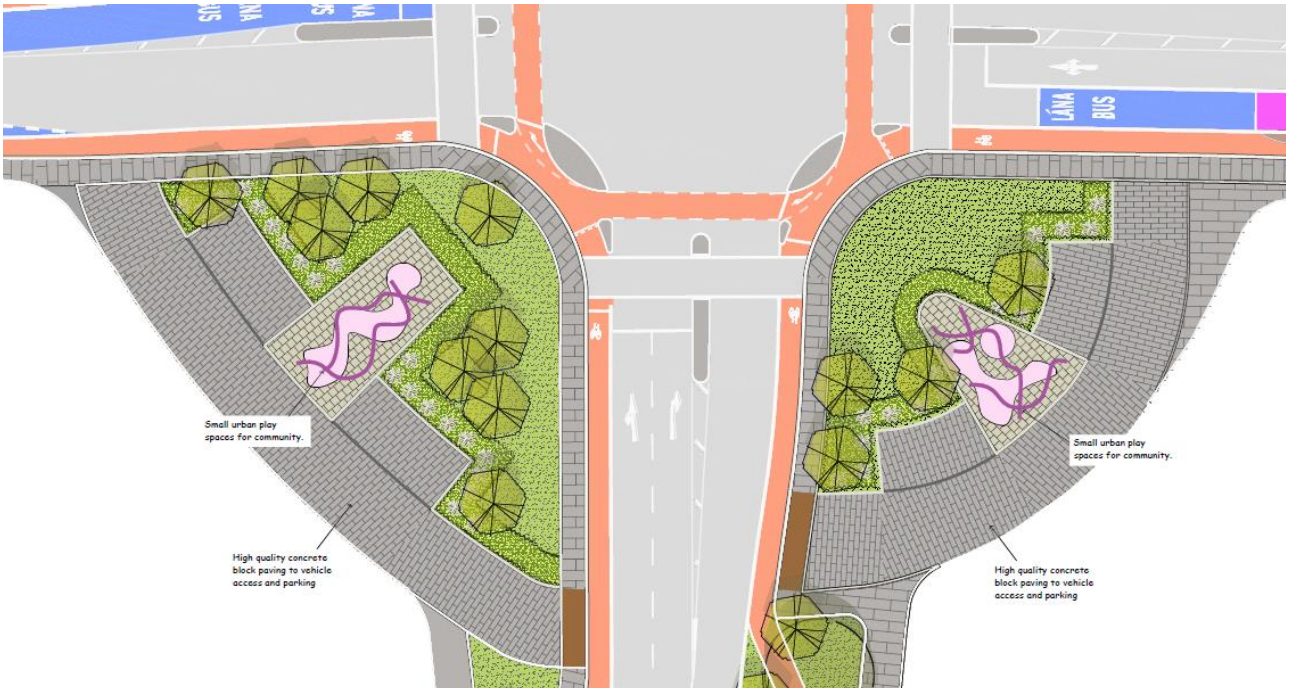

Figure 14.12: Ballyfermot Roundabout South Quadrant, Residents Parking and Pocket Parks

Figure 14.13: Pocket Parks in the South-Western and South-Eastern Quadrants

14.7.5 Ballyfermot Roundabout to St. Laurence Road

Existing Character: Significant school campuses in western section followed by suburban residential character to the east comprising two-storey residential uses with driveways.

Design Proposals: Kerb realignments to the northern side result in tree loss and impacts to boundaries of the school sites. Compensatory tree planting is proposed within the school grounds and boundaries reinstated with rendered walls with railings to match the existing. A poured concrete finish is proposed to realigned footways along the northern edge while the existing footway is retained along the southern edge. A SuDS treatment is proposed in the former De La Salle National School site.

The closing of the northern end of O'Hogan Road creates an opportunity for a small-scale local intervention featuring good quality concrete paving, a proposed tree, ornamental planting and a curved feature bench. This enhancement will complement the park and residential setting while retaining filtered permeability for cycling into O'Hogan Road. Apart from the north end of O'Hogan Road, the eastern end of this section of Ballyfermot Road features poured concrete footways where kerb realignments occur.

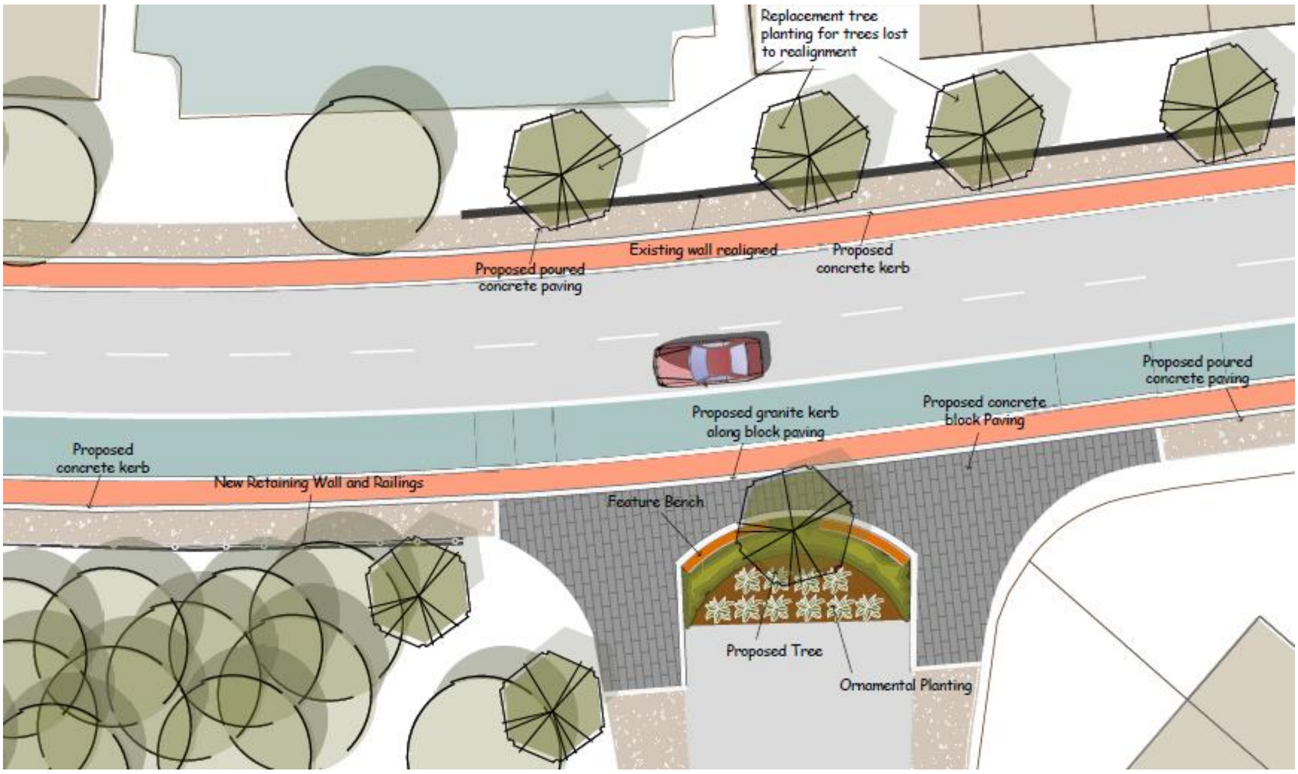

Figure 14.14: Road Closure at End of O'Hogan Road with Local Enhancement

14.7.6 St. Laurence Road to Chapelizod Bypass

Existing Character: Two-storey residential uses along southern edge. Longmeadows Park and Liffey Gaels GAA Club greens along northern edge with the approach to Chapelizod Bypass.

Design Proposals: Poured concrete footways are proposed where kerb realignments occur. A minor local intervention is proposed near Ruby Finnegan's and the shops where land take occurs featuring concrete paving and concrete kerbs with a low brick wall boundary treatment to match the existing. The existing boundary along Longmeadows Pitch and Putt is proposed to be replaced with a new rendered or stone-clad retaining wall with railings to replace the palisade fence and enhance the local setting. A SuDS treatment opportunity is proposed within an area of Long Meadows Park at the junction with Saint Laurence Road.

14.7.7 Sarsfield Road and Chapelizod Bypass

Existing Character: Sarsfield Road is very narrow under the railway bridge followed by residential interfaces to the east. The Chapelizod Bypass is a traffic-dominated environment with low pedestrian movement.

Design Proposals: Poured concrete footways with concrete kerbs are proposed to match the existing materials where kerb realignments occur near Sarsfield Road junction. The existing footways are retained along the rest of the section.

14.7.8 Grattan Crescent and Memorial Road

Existing Character: Inchicore National School campus, significant mature trees and the local park make Grattan Crescent locally significant. This section leads into the local village centre to the south. Memorial Road with its formal tree avenue aligns with the entrance axis into the National War Memorial Park.

Design Proposals: Mature trees are retained along Grattan Crescent. A high-quality public realm is proposed in front of the school with an improved pedestrian crossing between the school and the park. Granite paving with granite kerbs are proposed.

A new meeting place is proposed outside the school with existing tree surrounds incorporating timber seating to reflect the timber cladding material of the school. Parallel parking bays along the park edge will be finished with granite setts. Bus stop areas shall be enhanced with new bus shelters, paving and lighting. All existing trees are to be retained and protected with enhanced tree pits. Detailed design will explore how paving can be laid flexibly to allow for future growth and prevent damage to paving. Paving at the park gate is to be enhanced as a main entrance with raised crossover to footway level and finished in granite setts to enhance pedestrian priority. New tree planting is proposed near the park gate. The western side of Grattan Crescent includes disabled parking provision as an inset bay with concrete blocks that match the footway paving colour and provide a wider footway space when not in use.

Memorial Road contains an avenue of trees that are to be retained, leading towards the National War Memorial Park. A possible root bridge system will be explored at detailed design to avoid further damage to pavement from tree roots. High quality concrete paving and wide granite kerbs are proposed to enhance this avenue and well-used pedestrian corridor.

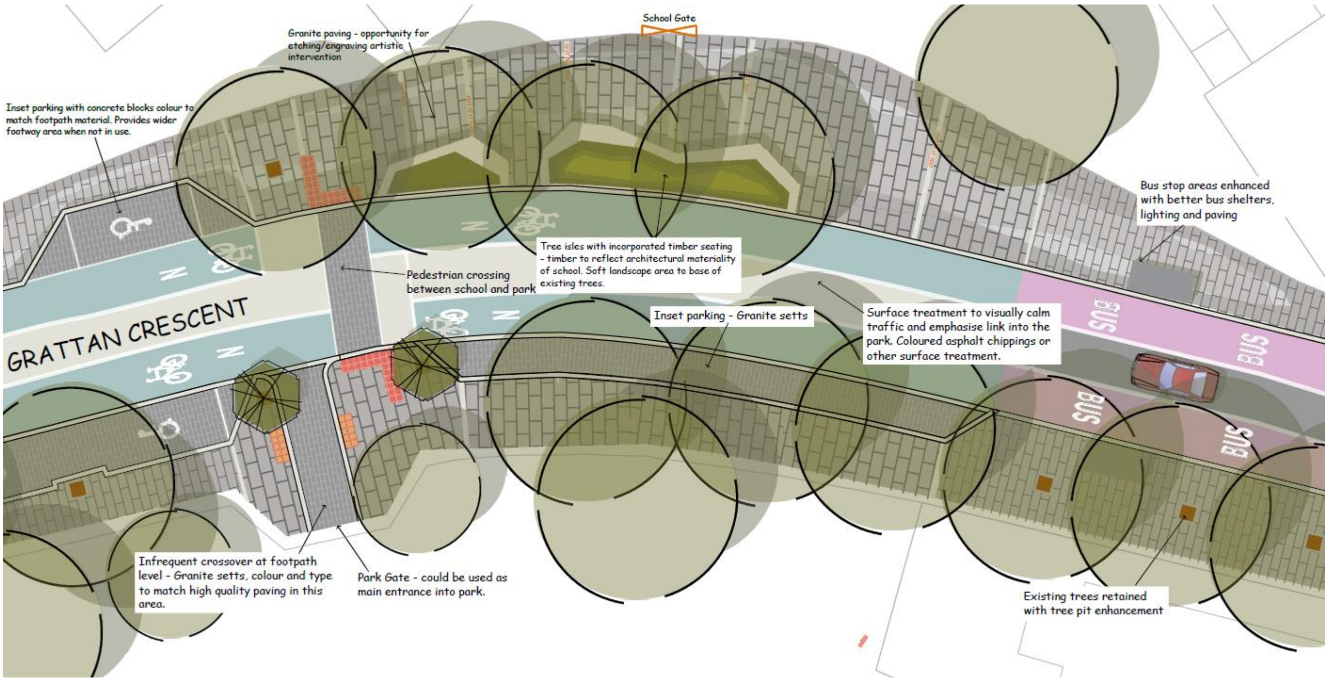

Figure 14.15: Quality Public Realm Proposed to Enhance School and Park Interface

Figure 14.16: Indicative Visualisation of the Grattan Crescent Scheme

14.7.9 Grattan Crescent and Emmet Road Village Centre

Existing Character: Village Centre character with two-to-four-storey buildings. Retail frontages with wide, vehicle-dominated area at Grattan Crescent and Emmet Road junction. Lack of consistency of materials in retail centre.

Design Proposals: Village Centre footways are proposed to be enhanced and unified in terms of materials and details with high quality concrete paving and wide granite kerbs (good quality granite kerbs to be reused). The junction is adjusted with more space given to pedestrians and a general declutter of street furniture is proposed.

14.7.10 Emmet Road Village Centre to South Circular Road

Existing Character: Inner suburban character with mostly two-to-three-storey residential buildings, with some retail, mixed use, community and educational uses. Limited pedestrian crossings. St. Michael's Church, Inchicore and Inchicore College of Further Education are local landmarks.

Design Proposals: Footways with kerb realignments are finished in poured concrete to match the existing surface material. Granite kerbs are to be reused where practicable. A raised pedestrian crossing is proposed leading to St. Michael's Catholic Church with the immediate footways to both sides upgraded with concrete paving. New street trees are proposed where footways are wide enough and below-ground services allow. A small public realm improvement opposite Inchicore College features a new street tree and shrub planting adjacent to a reorganised row of asphalt parking bays with concrete setts to the rear. The existing rear access to properties is retained. Bespoke kerbs adjacent to retained existing trees will be considered at detailed design along with new self-binding gravel tree surrounds. Pedestrian priority thresholds are proposed at side streets to enhance pedestrian movement and priority.

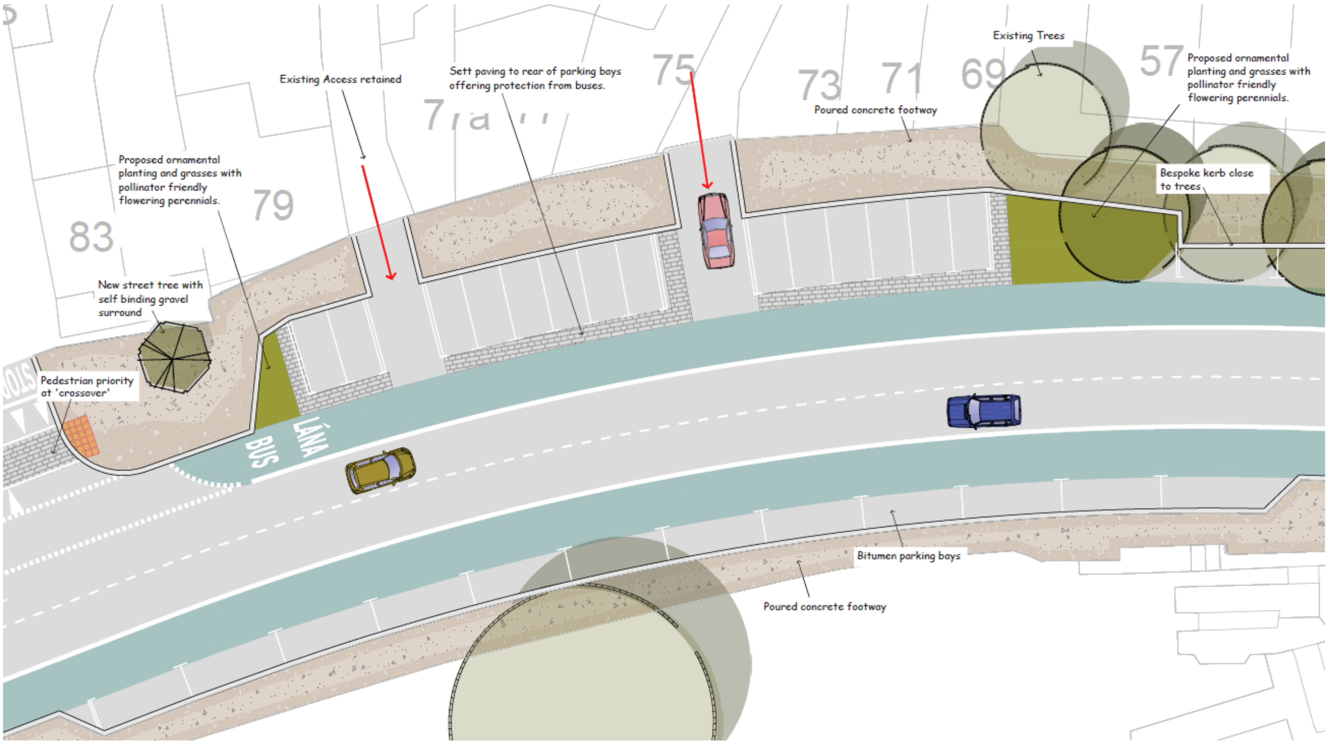

Figure 14.17: Emmet Road Local Enhancement

14.7.11 South Circular Road to St. James's Hospital

Existing Character: Narrow streets with residential and mixed-use edges. Continuous building lines in most sections. Low quality, but important large street trees along the route.

Design Proposals: All footways between South Circular Road and St. James's Hospital proposed to be retained as existing. Localised repairs as needed, in poured concrete to match existing. bus gate proposed near National Children's Hospital to allow only buses, taxis and cyclists.

14.7.12 St. James's Hospital to the Obelisk Fountain

Existing Character: A city street character as the route approaches City Centre. The carriageway is wider with more vehicle and pedestrian movements. The interface with St. James's Hospital precinct and Red Luas line exists.

Design Proposals: This area does not have significant kerb realignments proposed. Local footway repairs where needed with granite kerbs retained and footway materials to match existing.

14.7.13 The Obelisk Fountain to Crane Street

Existing Character: A city street character with high vehicle flows and pedestrian movements. The Obelisk Fountain is a local landmark a with cluster of mature trees. Two-to-five-storey buildings line the street with a mix of period and contemporary architecture. This section provides the interface with the Guinness Storehouse which is a key tourist destination.

Design Proposals: A significant-sized public realm enhancement is proposed at the Obelisk Fountain area. Granite kerbs and granite paving, including a radial paving pattern to enhance the overall setting of the Obelisk Fountain are proposed for the 'island'. High-quality concrete paving and granite kerbs are proposed for the adjoining footways. Adjacent to the island, the carriageway along Bow Lane West and the short connecting road to James's Street will be raised and surfaced in setts to enhance the pedestrian use and aesthetic of this space. Existing granite kerbs are to be reused where practicable. The existing mature trees are retained, and tree surrounds enhanced with a more open self-binding gravel. New seating and tree planting will encourage pedestrians to stop and sit. James's Street and Thomas Street do not have kerb realignments proposed but have new cycle tracks implemented along the carriageway.

14.7.14 Crane Street to John's Lane Church

Existing Character: A city street character with high traffic flows and pedestrian movements. Two-to-five-storey buildings of period and contemporary styles, with key landmark churches and academic facilities. This section is part of a well-used tourist route between City Centre and the Guinness Storehouse precinct.

Design Proposals: This part of the James's Street route does not have kerb realignments but has new cycle tracks implemented along the carriageway.

14.7.15 John's Lane Church to High Street (End of Route)

Existing Character: A city street character with significant traffic flows and high pedestrian movements. Buildings are two-to-six-storey and of period and contemporary architectural styles. This section is part of a well-used tourist route between City Centre and the Guinness Storehouse precinct, with surrounding landmarks such as St. Audoen's Church.

Design Proposals: High quality public realm is proposed at Cornmarket junction with significant junction redesign that creates additional space for the pedestrian environment. High quality granite paving with wide granite kerbs and a coordinated banding feature to visually tie both sides of the junction together. The outline of the historic city wall is interpreted through a granite band on either side of the road. The south side of the junction will see a widened area of footway creating a shady plaza incorporating seating integrated with raised planters and new tree planting. Existing trees are to be retained and along with new wayfinding, cycle racks and bins will enhance this area of public realm and tourist route.

Granite paving is proposed along High Street to enhance the setting of historic buildings and tourist destinations. The design of this part of the route will be integrated into the public realm enhancement scheme at the High Street and Nicholas Street junction being developed as part of the Tallaght / Clondalkin to City Centre CBC scheme. This is proposed to be achieved through common materials and design details to create an integrated public realm response for this key public area. Raised tables are proposed across side streets finished in concrete setts with asphalt ramps to enhance pedestrian priority.

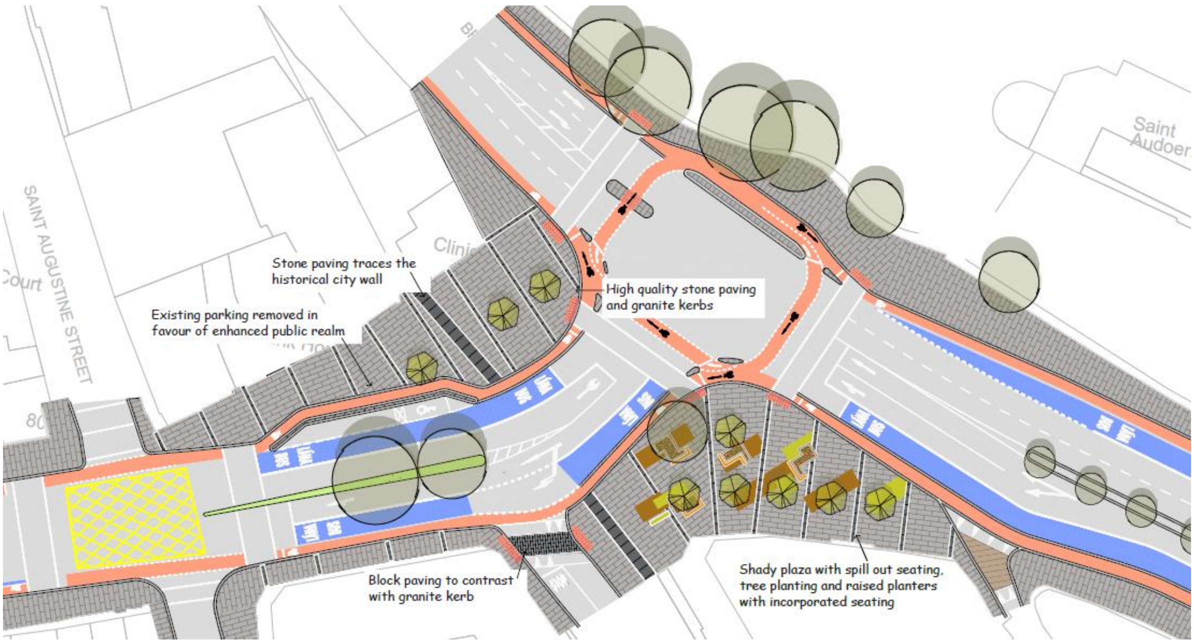

Figure 14.18: High Quality Public Realm Proposed at Cornmarket Junction

14.7.16 Tree Species list

The proposed tree species, sizes and spacings are indicative of the design intent, and subject to availability and further ground investigation at detailed design stage.

Table 13.1: Proposed Tree Species

Species - Scientific Name	Common Names in English - Irish	Size
Acer campestre	Field maple	12/14
Acer campestre	Field maple	8/10
Acer platanoides	Norway maple	14/16
Acer rubrum	Red maple	14/16
Aesculus x carnea	Red horse chestnut	12/14
Alnus glutinosa	Common alder	14/16
Betula pendula	Silver birch / Beith gheal	12/14 14/16
Corylus colurna	Turkish Hazel	20-25
Carpinus betulus	Hornbeam	18-20
Ginkgo biloba		18-20
Picea glauca	White spruce	2.5- 3m
Crataegus monogyna	Hawthorn	12-14
Crataegus laevigata	Paul’s Scarlet	12-14
Sorbus aucuparia ‘Sheerwater Seedling’	Rowan - Caorthann	18-20
Sorbus aucuparia	Rowan - Caorthann	12-14
Prunus 'Sunset boulevard'		18-20
Pyrus calleryana 'Chanticleer'	Ornamental pear	14-16
Liquidambar styraciflua 'Levis'	Sweet gum	14-16
Platanus x hispanica	London plane	14-16
Platanus x hispanica	London plane	30-35
Quercus Ilex		18-20
Quercus robur 'Fastigiata'	English oak	18-20
Quercus robur		10-12, 14-16, 18-20

15. Scheme Benefits / How we are Achieving the Objectives

This section sets out the manner in which the Proposed Scheme described herein will achieve the following Objectives as set out:

- Enhance the capacity and potential of the public transport system by improving bus speeds, reliability and punctuality through the provision of bus lanes and other measures to provide priority to bus movement over general traffic movements;
- Enhance the potential for cycling by providing safe infrastructure for cycling, segregated from general traffic wherever practicable;
- Support the delivery of an efficient, low carbon and climate resilient public transport service, which supports the achievement of Ireland's emission reduction targets;
- Enable compact growth, regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of safe and efficient sustainable transport networks;
- Improve accessibility to jobs, education and other social and economic opportunities through the provision of improved sustainable connectivity and integration with other public transport services; and
- Ensure that the public realm is carefully considered in the design and development of the transport infrastructure and seek to enhance key urban focal points where appropriate and feasible.

Currently, bus priority is characterised by discontinuity. Bus priority is only provided along certain sections and a number of pinch-points cause significant delays which result in a negative impact on the performance of the bus service as a whole. Within the extents of the Proposed Scheme route, bus lanes are currently provided on only approximately 20% and 25% of route outbound and inbound respectively of which significant portions of the route are shared with cyclists and or parking lanes.

Issues related to frequency, reliability and a complex network have persisted for many years and will continue to do so without further intervention. As well as the existing services on the Proposed Scheme there are a number of planned high frequency public bus services along the route which are anticipated to be in operation prior to the Proposed Scheme being implemented, including the G1, G2, S2, S4, W2, LS1, LS3, O, 60, 73 and 80 bus routes. In addition to this there are multiple other bus services which run along this corridor intermittently, providing interchange opportunities with other bus services. The Proposed Scheme interventions will seek to make all these services more reliable, particularly in peak times, thus providing a more attractive and sustainable alternative mode of transport. The introduction of segregated cycle and parking facilities will facilitate optimum bus speeds to improve on the punctuality and reliability of the bus service. Similarly, the use of active bus signalling measures will improve continuity of bus journey times through junctions.

Without the interventions of the Proposed Scheme there would likely be an exacerbation of the issues which informed the need for the Proposed Scheme itself. The capacity and potential of the public transport system would remain restricted by the existing deficient and inconsistent provision of bus lanes and the resulting sub-standard levels of bus priority and journey-time reliability. Thus, the unreliability of bus services would continue. As such the Proposed Scheme is actively enhancing the capacity and potential of the public transport system, and supports the delivery of an efficient, low carbon and climate resilient public transport service, which supports the achievement of Ireland's emission reduction targets.

A key objective of the Proposed Scheme is to enhance the potential for cycling along the route. Without the provision of safe cycling infrastructure, intended as part of the Proposed Scheme, there would continue to be an insufficient level of safe, segregated provision for cyclists who currently, or in the future would be attracted to use the route of the Proposed Scheme.

In terms of the need to improve facilities for cyclists along the route of the Proposed Scheme, the design intent is that segregated facilities should be provided where practicable to do so. Within the extents of the Proposed Scheme, cycle tracks are currently provided on only approximately 9% and 15% of the route both outbound and inbound, while advisory cycle lanes are provided on only approximately 28% and 31% of the route outbound and inbound respectively. The remaining extents have no dedicated cycle provision or cyclists must cycle within the bus lanes provided.

The Proposed Scheme is implementing safe, segregated. infrastructure along the corridor in both directions and as such is greatly enhancing the potential for cycling.

Within the extents of the Proposed Scheme there are a number of amenities, village and urban centres which will be enhanced as part of the proposed works. In order to improve accessibility to jobs, education and other social and economic opportunities through the provision of an integrated sustainable transport system, there needs to be a high quality pedestrian environment, including specifically along the route of the Proposed Scheme. There are a number of uncontrolled crossings along the route of the Proposed Scheme, particularly at side roads which are generally of poor standard, including lack of provision for the mobility and visually impaired. There are multiple incidences of 'patch repairs' along footpaths that in some instance has led to undulating, uneven surfaces caused by settlement of patch repair material. This is often a hazard to pedestrians, particularly the mobility impaired. A number of submissions were also received as part of the non-statutory consultation in which members of the public indicated specific locations where the existing provision is unsafe for pedestrians – many of which are proposed to be addressed by the Proposed Scheme.

The Proposed Scheme includes significant improvements to the pedestrian environment, both along links and at both junctions and crossings by the provision of enhanced footpath widths and additional pedestrian crossing facilities. As such the Proposed Scheme will improve accessibility to jobs, education and other social and economic opportunities not only through improvement to the public transport network and cycling infrastructure but through improvements to the pedestrian environment.

The landscape and urban realm proposals for the Proposed Scheme are based on an urban context and landscape character analysis of the route. The proposals have been informed through discussions with the NTA, local authorities and stakeholders.

The overall landscape and public realm design strategy for the Proposed Scheme was developed to create attractive, consistent, functional and accessible places for people alongside the core bus and cycle facilities. It aims to mitigate any adverse effects that the proposals may have on the streets, spaces, local areas and landscape through the use of appropriate design responses. In addition, opportunities have been sought to enhance the public realm and landscape design where practicable.

Through a combination of the above benefits, such as the provision of safe and efficient sustainable transport networks, improved infrastructure for walking and cycling, and urban realm strategies, the Proposed Scheme specifically facilitates improvements to encourage more journeys generally at a local level by active travel, including connecting to and from bus stops for all pedestrians, and in particular improving facilities for the mobility and visually impaired. Bus stops have also been carefully designed to incorporate cycle parking, where practicable, providing an integrated sustainable solution for combining active travel with longer distance trips by bus. Therefore, it is considered that the Proposed Scheme as described enables compact growth, regeneration opportunities and more effective use of land in Dublin, for present and future generations.

It is therefore considered that the design of the Proposed Scheme wholly achieves the objectives set out herein. In doing so it fulfils the aim of the Proposed Scheme in providing enhanced walking, cycling and bus infrastructure on key access corridors in the Dublin region, enabling the delivery of efficient, safe, and integrated sustainable transport movement along this corridor.