Swords to City Centre Core Bus Corridor Scheme

April 2023

Preliminary Design Report

BUS CONNECTS

SUSTAINABLE TRANSPORT FOR A BETTER CITY.

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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
FCC	Fingal County Council
GDA	Greater Dublin Area
GDACNP	Greater Dublin Area Cycle Network Plan
GDRCoP	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

Acronym	Definition
NTA	National Transport Authority
OPW	Office of Public Works
PDR	Preliminary Design Report
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 Swords to City Centre Core Bus Corridor Scheme and builds on the previous Swords Core Bus Corridor Feasibility and Options Assessment Report and the Preferred Route Options Report for the Swords 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 Swords 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 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 230 km of dedicated bus lanes and 200 km of cycle tracks along 16 of the busiest corridors in Dublin.

The Swords to City Centre Core Bus Corridor Scheme of the CBC Infrastructure Works (hereinafter called the 'Proposed Scheme'), measures approximately 12km end to end.

The Proposed Scheme begins on the R132 Swords Road at the Pinnock Hill junction. The Proposed Scheme is routed via the R132 along Swords Road, Drumcondra Road Upper and Lower and Dorset Street to the junction with North Frederick Street. The Proposed Scheme is then routed via North Frederick Street and Parnell Square East, where it will join the prevailing traffic management regime in the City Centre. Priority for buses is provided along the entire route, consisting primarily of dedicated bus lanes in both directions.

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

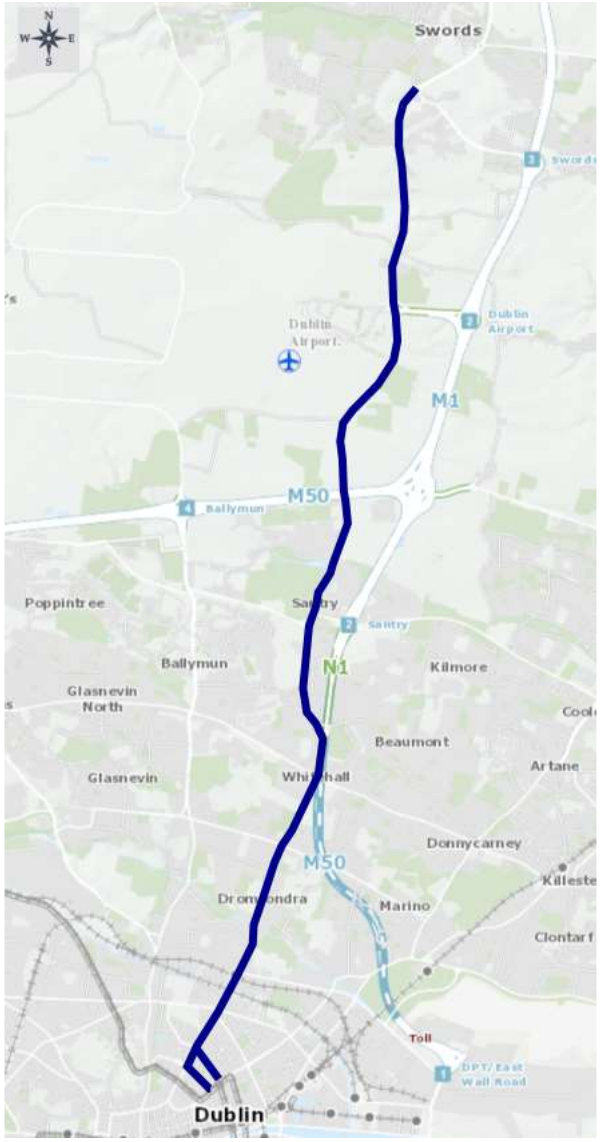

Figure 1.1: Proposed Scheme Route Overview

1.2 Scheme Aims and Objects

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 previous Transport Strategy for the Greater Dublin Area 2016 – 2035 set 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). It is noted that the current Transport Strategy for the Greater Dublin Area 2022-2042 includes the following objective:

*"**Measure BUS1 – Core Bus Corridor Programme***

Subject to receipt of statutory consents, it is the intention of the NTA to implement the 12 Core Bus Corridors as set out in the BusConnects Dublin programme."

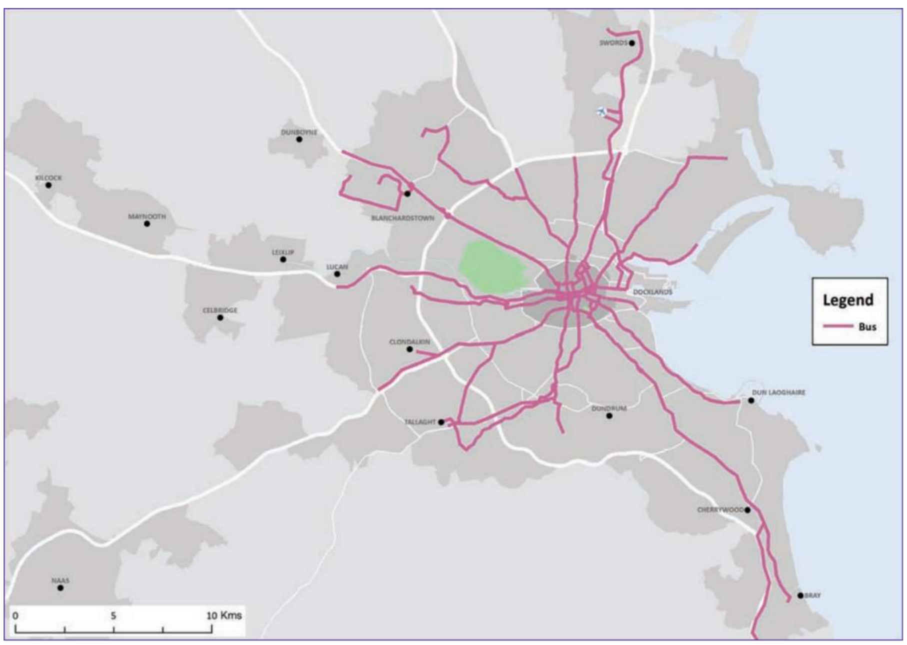

Figure 1.2: 2035 Core Bus Network - Radial Corridors

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 Swords 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.**

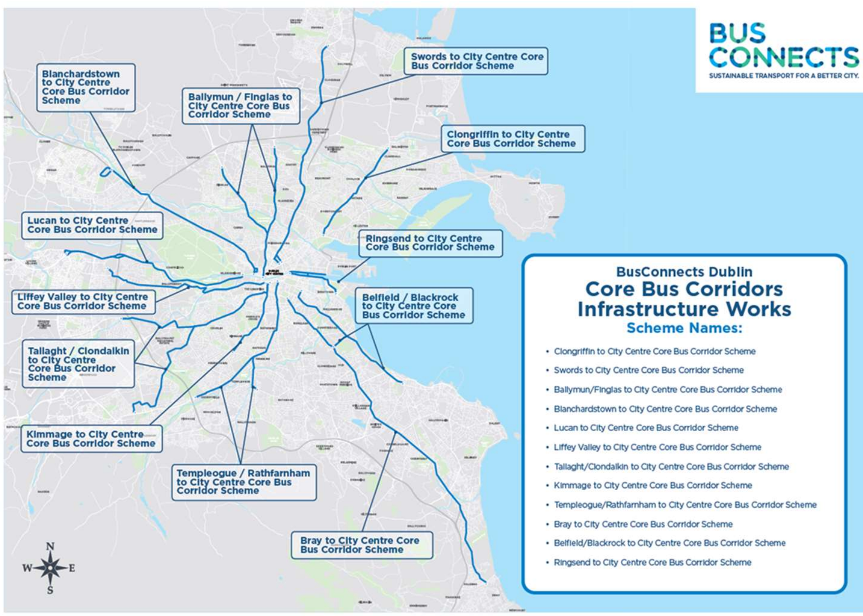

Figure 1.3: BusConnects Radial CBC Network

1.4 Proposed Construction Procurement Method

The Proposed Scheme will proceed on the basis of procurement through a Design-Build 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.

Refer to the Swords to City Centre Core Bus Corridor Preferred Route Option Second and Third Public Consultation Submissions Summary Report for information on the non-statutory consultation.

Consultation with the principal project stakeholders, i.e., Dublin City Council (DCC), Fingal County Council (FCC), Transport Infrastructure Ireland (TII), An Garda Síochána, Office of Public Works (OPW), Statutory Undertakers/Utility companies and the NTA) 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 NTA and 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;
- Cellar Survey;
- 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; and
- Supports the Environmental Impact Assessment Report (EIAR).

1.8 Preliminary Design Drawings

A comprehensive 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 Preliminary Design Report. The following **Table 1.1** 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 (1:12500@ A1) and Site Location Plans (1:2500@A1)	Defines the full extent of the works and 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.

Drawing Series Volume Code	Drawing Series Description/Scale	Design Content
DNG_RD	Proposed Surface Water Drainage Plans (1:500@A1)	Displays information for conveying the design intent for the drainage portion of the works including identification of SuDS measures, requirements for peak 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.

Drawing Series Volume Code	Drawing Series Description/Scale	Design Content
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 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)	Provides an indication of the proposed bridge and retaining structure locations, types and approximate proposed heights along the route.

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'. Construction site compounds outside the 'SITE BOUNDARY LINE' are also captured within the dashed red line 'TEMPORARY LAND ACQUISITION'.

Full details of the compulsory land acquisition required to construct the Proposed 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

This report is structured 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 Layout** – 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 – National Planning Framework;
- Department of Transport: Statement of Strategy 2021 – 2023;
- Smarter Travel – A Sustainable Transport Future: A New Transport Policy for Ireland 2009 – 2020;
- The National Cycle Policy Framework (NCPF) 2009 – 2020;
- Road Safety Strategy 2021 – 2030;
- Building on Recovery: Infrastructure and Capital Investment 2016 – 2021;
- National Implementation Plan for the Sustainable Development Goals 2022 – 2024;
- Climate Action Plan 2023;
- Regional Spatial Economic Strategy for the Eastern and Midland Region 2019 – 2031;
- Greater Dublin Area Cycle Network Plan;
- Transport Strategy for the Greater Dublin Area 2022 – 2042;
- Dublin City Development Plan 2022 – 2028;
- Fingal County Council Development Plan 2023-2029;
- Dublin Airport Local Area Plan 2020; and
- Fosterstown Local Area Plan 2015-2017.

For further information on how the Proposed Scheme meets the policies outlined above refer to the Swords to City Centre Planning Compliance Report.

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) included in Appendix O. 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 complements existing guidance documents relating to the design of urban streets, bus facilities, cycle facilities and urban realm. A non-exhaustive list of these guidelines is as follows:

- The Design Manual for Urban Roads and Streets (DMURS);
- The National Cycle Manual (NCM);
- TII Publications;
- The Traffic Signs Manual (TSM);
- Guidance on the use of Tactile Paving;
- Building for Everyone: A Universal Design Approach, and
- Greater Dublin Strategic Drainage Study (GDSDS).

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 these deviations have been noted within **Section 4.16**.

3. The Scheme

3.1 Scheme Description

The Proposed Scheme commences south of Swords at Pinnock Hill Junction and travels in a southerly direction along the R132 Swords Road past Airside Retail Park, Dublin Airport and Santry Park. The route continues on the R132 past Santry Demesne, where the Swords Road joins the R104 at Coolock Lane. The route continues on the R132 in a southerly direction through Santry village. It continues along the Swords Road past Whitehall to Griffith Avenue. The route follows Drumcondra Road Upper past the DCU St Patrick's Campus to the river Tolka. It continues through Drumcondra, on Drumcondra Road Lower to Binns Bridge on the Royal Canal. From there it continues on Dorset Street Lower as far as Eccles Street, from where it continues on Dorset Street Upper to North Frederick Street.

Inbound buses continue southeast on North Frederick Street and Parnell Square East until the route finishes at Parnell Street. Outbound, the route travels north-east from Parnell Street, past the Rotunda Hospital, along Parnell Square West and Granby Row until it joins with Dorset Street Upper.

The Proposed Scheme is described in greater detail below, split into five discrete sections to align with the previous Options and Feasibility Report and the Preferred Route Options Report.

- Section 1: Pinnock Hill to Airside Junction
- Section 2: Airside junction to Northwood Avenue
- Section 3: Northwood Avenue to Shantalla Road
- Section 4: Shantalla Road to Botanic Avenue
- Section 5: Botanic Avenue to Granby Row

3.1.1 Section 1- Pinnock Hill to Airside Junction

The Proposed Scheme commences south of Swords on the R132 Swords Road at Pinnock Hill. The existing roundabout at Pinnock Hill will be modified to a fully signalised junction with pedestrian and cyclist facilities. New access arrangements are proposed at Swords Veterinary Hospital, while the proposed fully signalised junction has been designed to integrate with the aspirations of the Fosterstown Local Area Plan which recognises the requirement for the provision of the Fosterstown Link Road.

Between the Pinnock Hill and Airside junctions, the existing bus lanes will be maintained, the existing footpath will be upgraded, and segregated cycle lanes provided. These proposals can be provided by eliminating one inbound traffic lane and narrowing the existing carriageway. The existing signalised junction at Airside is proposed to be upgraded to provide improved infrastructure for pedestrians and cyclists.

Bus stops will be upgraded to island bus stops, for improved safety of pedestrians and cyclists in the boarding and alighting zone.

The route of the proposed MetroLink runs along the R132, and the Fosterstown stop is proposed to be located on the east side of the R132 to the south of the Pinnock Hill junction. The proposed scheme facilitates this future interchange.

To accommodate this improved infrastructure, the proposals will require land take at the following locations:

- Swords Veterinary Hospital;
- Land adjacent to the existing bus stop 3695;
- Development Property to the north of Boroimhe Road; and

- Airside Retail Park, Swords.

3.1.2 Section 2 - Airside junction to Northwood Avenue

Between the Airside and Cloghran junctions, the existing bus lanes will be maintained, the existing footpaths will be upgraded and extended, and segregated cycle lanes provided. The junction of the R132 with Kettles Lane will be modified to a fully signalised junction, permitting right turn movements. The existing Cloghran roundabout will be modified to a fully signalised junction with pedestrian and cyclist facilities. South of the Cloghran junction, current provision for cars and buses northbound will remain and a new bus lane will be provided southbound. Segregated one-way cycle facilities are provided on both sides of the R132. Southbound cyclists cross the R132 at the Coachman's Inn to a two-way cycle track on the western side of the R132.

It is proposed to maintain the Airport Roundabout as a signalised junction with some amendments. To provide bus priority southbound through the Airport junction, it is proposed to provide a new signal-controlled priority on the northern approach to the roundabout. The cycle facilities through the Airport junction will be upgraded and cyclists will be accommodated in a two-way cycle track on the western side of the junction, crossing the airport access road via a signalised toucan crossing.

South of the Airport Roundabout the existing northbound shared cycle and pedestrian lane is converted to a dedicated footpath and two-way cycle track as far as the South Corballis Road and from this point the cyclists will cross the R132 to return to the eastern side of the road.

Between Collinstown Cross Industrial Estate and Northwood Avenue, improved cycle facilities will be provided. Localised footpath and cycle track narrowing is required to mitigate land acquisition at the Thatch Cottage, which is a protected structure.

The existing signalised junctions of the Swords Road with Old Airport Road, Turnapin Lane and Northwood Avenue are proposed to be upgraded to provide improved infrastructure for pedestrians and cyclists.

Bus stops will be upgraded to island bus stops, for improved safety of pedestrians and cyclists in the boarding and alighting zone.

To provide this upgraded road infrastructure along this section, some areas of land acquisition will be required. This will be particularly relevant at the following locations:

- Around the Airside junction;
- Limited areas between Airside junction and Kettles Lane;
- Between Stockhole Road and the Airport Roundabout;
- West side of the Airport roundabout junction;
- Individual private properties between Collinstown Cross Industrial Estate & Turnapin Lane;
- Airways Industrial Estate; and
- Furry Park Industrial Estate.

3.1.3 Section 3 - Northwood Avenue to Shantalla Road

Signal Controlled Bus Priority as well as localised narrowing of the cycle track will be provided between Northwood Avenue and Coolock Lane to mitigate impact on the Santry Demesne historical wall and proposed National Heritage Area. A new bus terminus is to be provided in the green space adjacent to the group of retail premises at the junction of the Swords Road and Coolock Lane.

Between Coolock Lane and the entrance to Omni Park Shopping Centre, it is proposed to extend continuous bus lanes and cycle tracks in both directions. This will require some limited land take from adjacent properties on both sides of the existing road and the removal of existing on-street car parking.

Between the Omni Park Shopping Centre entrance and the Shantalla Road junction it is proposed to maintain the two-way general traffic lanes and introduce continuous bus lanes in both directions. A segregated footpath will be maintained on either side. This will require some land take from adjacent properties on both sides of the existing road in Santry village and the removal of existing on-street car parking. Off street parking is proposed at residential properties between the shopping centre and Shanowen Road to offset the loss of on-street parking.

It is proposed to redirect cyclists through Lorcan Road and Shanrath Road as a quiet street. This cycle route commences at the junction with Omni Park Shopping Centre and connects with the Swords Road at the junction with Shantalla Road. A two-way cycle track is proposed to connect the quiet street from Shanrath Road through the Shanrath junction, connecting to the existing quiet street west of the off-slip.

A dedicated bus lane is proposed inbound along the Shantalla Road Bridge and a general traffic lane is maintained in both directions. The Shantalla Road junction will be upgraded to accommodate the bus lane and cycle and pedestrian movements.

Bus stops will be upgraded to island bus stops, for improved safety of pedestrians and cyclists in the boarding and alighting zone.

To facilitate these transport infrastructure improvements, the proposals will require land take at the following locations:

- Santry Villas;
- Santry Park;
- Airvista Office Park;
- T O'Reilly Building (Trade Electric Group);
- Swiss Cottage Apartments;
- AIB, Swords Road;
- Magenta Hall;
- Santry Hall Industrial Estate; and
- Approximately 50 residential properties along Swords Road.

3.1.4 Section 4 - Shantalla Road to Botanic Avenue

From Shantalla Road to Botanic Avenue, a continuous bus lane will be provided in both directions. It is proposed to retain the existing bus lanes and provide a segregated cycle track and footpath between Collins Avenue and Milmount Avenue in both directions. Between Shantalla Road and Collins Avenue the main north/south cycle route and pedestrian route will continue via a quiet street treatment along the Swords Road. An additional south bound segregated cycle track will be provided adjacent to the south bound slip lane of the Shantalla Road junction. A short section of this cycle track is reduced to 1.5m wide in front of the Church of the Holy Child in addition to a reduction of the existing 3.5m wide footpath to 2m wide.

Localised narrowing of the cycle track is also required at Plunket College and Highfield Hospital to avoid land take and impacting a row of high-quality trees along the boundary of Plunket College. Narrowing is also required outbound along Upper Drumcondra Road between St Patrick's College and Griffith Avenue, where providing a standard width would result in significant loss of mature trees.

It is proposed to upgrade the Collins Avenue junction to better facilitate bus priority and provide dedicated, segregated bus lanes to the stop lines with signal-controlled priority. The other key junctions, at Griffith Avenue, Richmond Road / Milmount Avenue and Botanic Avenue, will be upgraded to improve pedestrian and cyclist provision and bring bus lanes closer to the stop lines.

In Drumcondra, an independent pedestrian and cycle bridge over the River Tolka is being provided as part of the scheme to allow the proposed bus lanes to be accommodated over the existing bridge. The proposed bridge would require the removal of two Poplar trees within Our Lady's Park while four new smaller-sized trees have been proposed surrounding the square paved area, subject to underground utilities. Three new small canopy trees are proposed at the west end of the bridge adjacent to Millmount Terrace. The existing square area of paving surrounding the statue on the south side of the river will be replaced and enhanced with a combination of stone and concrete paving together with new seating as a local area enhancement. The path close to the river will be re-aligned and re-surfaced to meet with the new paved square. Additional planting is to be provided on the eastern side of the path to prevent access to the narrow embankments leading to the river side beneath the structure.

Bus stops will be upgraded to island bus stops, for improved safety of pedestrians and cyclists in the boarding and alighting zone.

To facilitate these transport infrastructure improvements, the proposals will require land take at the following locations:

- Clúid Development, Collins Avenue;
- Whitehall Colmcille GAA;
- Plunket College;
- Highfield Health Care;
- 2 properties on Drumcondra Road;
- 1 property on Griffith Avenue;
- Millmount Terrace; and
- Our Lady's Park.

3.1.5 Section 5 - Botanic Avenue to Granby Row

To facilitate bus lanes and cycle tracks in each direction it is necessary to remove one inbound and one outbound traffic lane between Clonliffe Road and Eccles Street. In addition, the landscaped central reserve will be removed between Portland Avenue and Belvedere Road to facilitate the required cross-section. South of Belvidere Road, the existing landscaped central reserve will be maintained.

Continuous bus lanes will be provided throughout, with the exception of a short section of signalised bus priority inbound between Whitworth Place and Portland Place. On Dorset Street Lower, south of Eccles Street, some minor kerb realignments are proposed to facilitate a bus lane, cycle track and traffic lane in each direction. The painted central reserve will be removed to facilitate this. Four existing cellars are affected by the Proposed Scheme. The cellars will be acquired and infilled with concrete.

It is proposed to introduce new turning restrictions:

- Left turn ban from Dorset Street Lower outbound to Synott Place;
- Right turn ban from Dorset Street Lower inbound to Eccles Street, and
- Left turn ban from Dorset Street inbound to Hardwicke Place.

On North Frederick Street, the existing bans on left-turning traffic from Dorset Street Lower and straight through traffic from Blessington Street will be maintained. North Frederick Street is restricted to one southbound bus lane and one northbound traffic lane from the junction of Dorset Street with Gardiner Row.

South of Gardiner Row the existing southbound traffic lane and bus lane will be maintained. This section of the scheme ties into the existing street layout at Parnell Street. Two-way cycle facilities will be provided on the west side of Parnell Square East. The right turn slip lane from Parnell Square North will be closed to facilitate the two-way cycle track.

Outbound buses will use Parnell Street, Parnell Square West and Granby Row to access Dorset Street Upper. A bus lane will be provided along these roads to facilitate outbound buses.

The existing signalised junctions at Clonliffe Road; Whitworth Road; Belvedere Road, North Circular Road, Gardiner Street Upper, Eccles Street and North Frederick Street / Blessington Street are proposed to be upgraded to provide improved infrastructure for pedestrians and cyclists.

At-grade cycle tracks have been utilised in order to maintain the existing kerb lines as the route approaches the city centre. The cycle tracks will be at carriageway level and segregated from general traffic using slip formed kerbs. At-grade cycle tracks have been proposed at Drumcondra Road Lower, southbound and Dorset Street Lower, between Portland Place Junction and Eccles Street Junction.

Bus stops will be upgraded to island bus stops, for improved safety of pedestrians and cyclists in the boarding and alighting zone.

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 MetroLink

MetroLink is a proposed high-capacity, high-frequency rail line running from Swords to Charlemont, linking Dublin Airport, Irish Rail, DART and Luas services, creating fully integrated public transport in the Greater Dublin Area. MetroLink will run along the R132, and the Fosterstown stop will be located on the east side of the R132 to the south of Pinnock Hill junction shown in **Figure 3.1** and **Figure 3.2.**

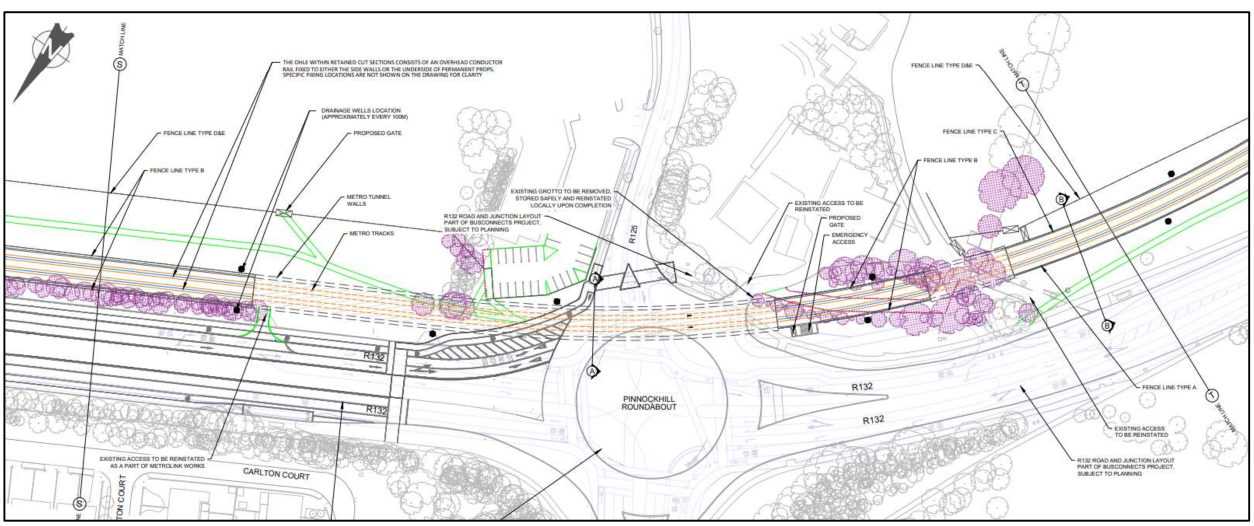

Figure 3.1: Metrolink/BusConnects Interface at Pinnock Hill

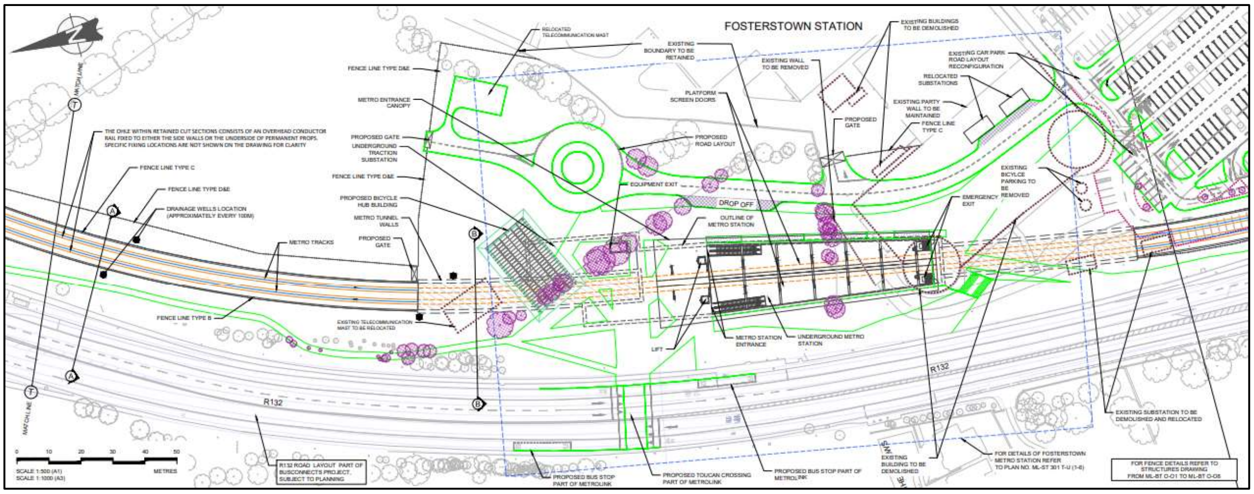

Figure 3.2: Metrolink/BusConnects South of Pinnock Hill

3.2.2 DART+ Programme

The DART+ West project which involves track upgrades and work to some stations and railway bridges will run from Connolly Station and a new Spencer Dock Station through Drumcondra over the existing rail bridge adjacent to Drumcondra train station and also under Drumcondra Road Lower at Binns Bridge. Currently available information can be found at: DART+ West Railway Order Application (dartplus.ie).

3.2.3 Fosterstown Local Area Plan

This Local Area Plan was adopted by the elected members of Fingal County Council on 13th September 2010 and subsequently extended in 2015 up to 31st December 2017.

This LAP sets out the development strategy for the proper planning and sustainable development of these residentially zoned lands, which are strategically located at the southern 'Gateway' to Swords, along the proposed MetroLink route and north of Dublin Airport, shown in **Figure 3.3** below. The lands are bounded by the R132 to the east side and there will be direct access from this area onto the R132.

The LAP recognises the requirement for the provision of the Fosterstown Link Road which will link Pinnock Hill roundabout with Forest Road. The proposed Pinnock Hill junction as part of the BusConnects proposals has been designed to integrate with the aspirations of the LAP.

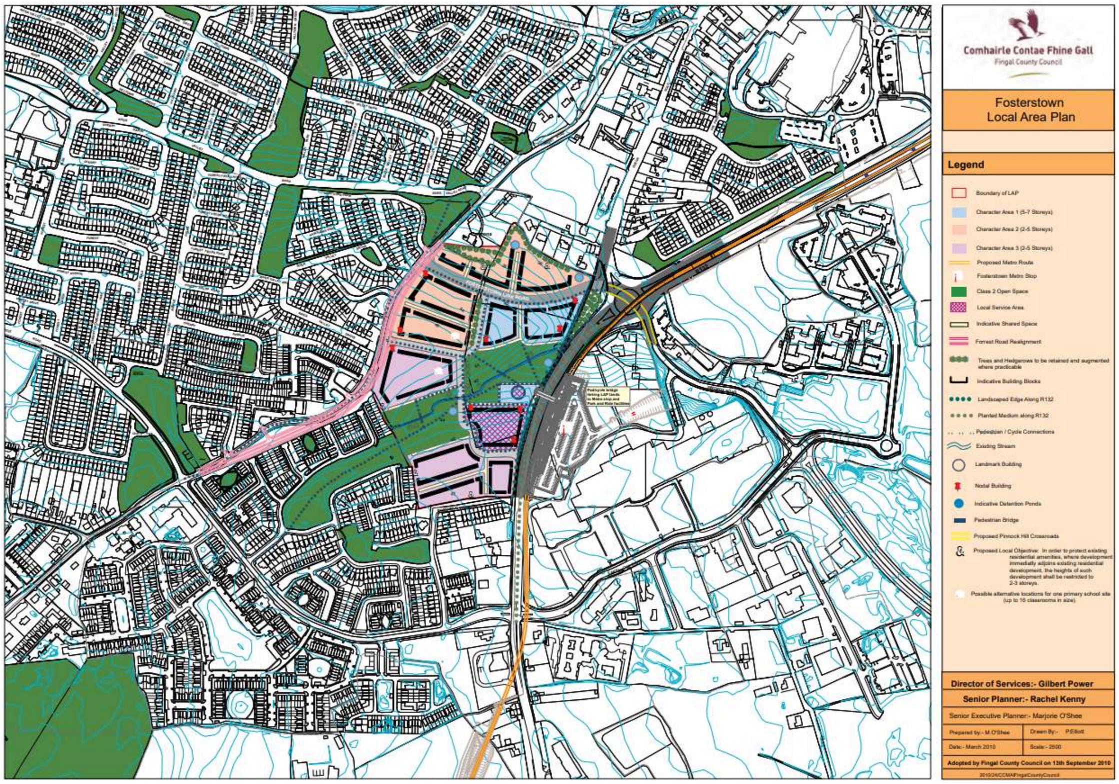

Figure 3.3: Fosterstown Local Area Plan

3.2.4 Omni Plaza Strategic Housing Development

The proposed site is located to the north west corner of the Omni Park Shopping Centre, Santry and at Santry Hall Industrial Estate, Swords Road, as shown in **Figure 3.4.** Planning permission for this Strategic Housing Development (SHD) (SHD0019/22) was lodged on 26 August 2022 and the last day for observations was 30 September 2022. The planning permission is for a Strategic Housing Development of 7 years in duration. The proposed development comprises the demolition of existing building and construction of a mixed use residential and commercial development ranging in height from 4 to 12 storeys over basement in four blocks, with internal residential amenity space, childcare facility, community building and two retail/café/restaurant units.

Figure 3.4: Location of the Proposed Omni Plaza SHD

3.2.5 Omni Living Strategic Housing Development

The proposed site is located to the north east of Omni Park Shopping Centre including a vacant warehouse on Swords Road. The site is bound by the Swords Road to the east and by a private access road to the north. Planning permission for this SHD (SHD0006/20) was lodged on 27 Match 2020 and granted on 3 September 2020. The development will consist of demolition of an existing structure on site, construction of a mixed-use development, generally ranging in height from 5 no. storeys to 12 no. storeys, incorporating apartments, commercial use, creche facility, aparthotel and public realm improvements.

Figure 3.5: Location of the proposed Omni Living SHD

3.2.6 Clúid Housing - Collins Avenue Junction

A planning application is being prepared by Clúid Housing for approximately 99 older person social housing units on the site of the Whitehall Church car park at the Swords Road/Collins Avenue junction. The proposed development is shown below in **Figure 3.6.** Access is anticipated to be via the existing access onto Collins Avenue.

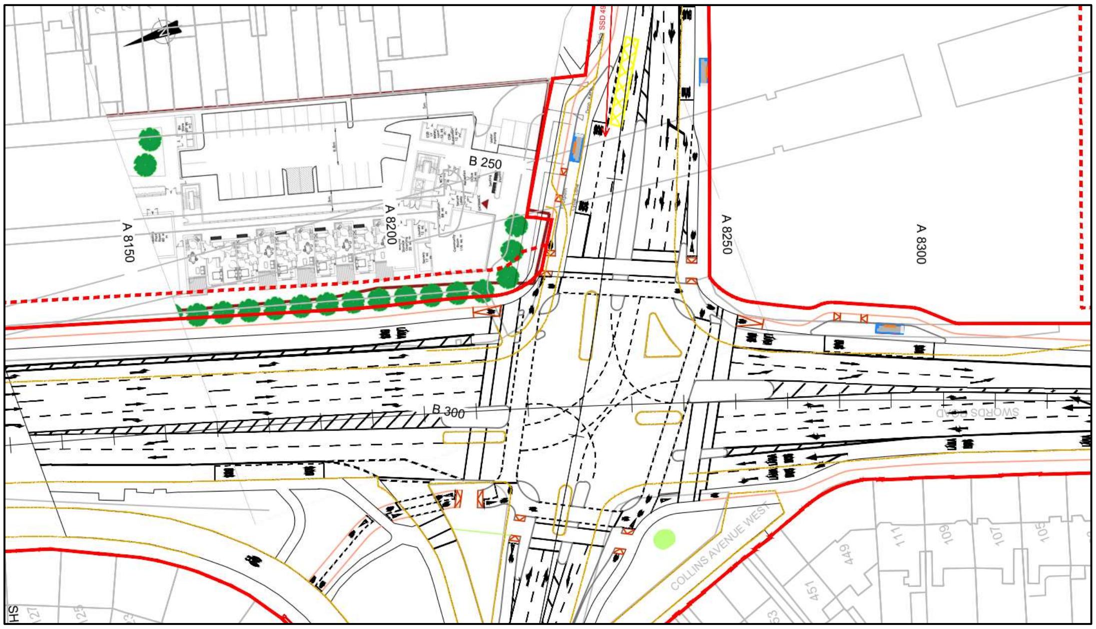

Figure 3.6: Clúid Housing – Collins Avenue Junction

3.2.7 PPP Social Housing Bundle 3 Collins Avenue, Whitehall, Dublin 9

A Part 8 notice for the construction of 83 residential dwellings at a site c.1.07 ha at Collins Avenue was published by Dublin City Council on the 10th May 2022. The consultation period for the proposal closed on the 21st June 2022. Planning has been granted for this site and procurement is at an early stage.

Figure 3.7: PPP Social Housing Bundle 3 Collins Avenue, Whitehall, Dublin 9

3.2.8 Hartfield Place PRS Development - Swords Road, Whitehall

This site is located south off Collins Avenue, west of Grace Park Road, north of Griffith Avenue and immediately adjacent to the eastern side of Swords Road, see **Figure 3.8** below. The site has a direct connection onto the R132 Swords Road. Full planning permission was granted for the site in 2010 (DCC Reg. Ref. 3269/10) which was subsequently appealed by a third party to An Bord Pleanála. An Extension of Duration for the permission was granted by DCC which requires the completion of the permitted works by 9th April 2022. Planning permission for an amendment to the permitted development was made during 2019 (DCC Reg. Ref. 3405/19) and was granted. A further application for an amendment to the permitted development was submitted in February 2021 and is currently awaiting a decision.

Figure 3.8: Hartfield Place PRS Development

3.2.9 Clonliffe Lands Masterplan Development

Planning permission has been granted by An Bord Pleanála for a development on lands off Clonliffe Road. This involves the development of 1000+ residential units on the remainder of the lands at the former Clonliffe Dublin Diocesan Seminary at Clonliffe College. The primary vehicular access point into the site will be from Clonliffe Road to the South.

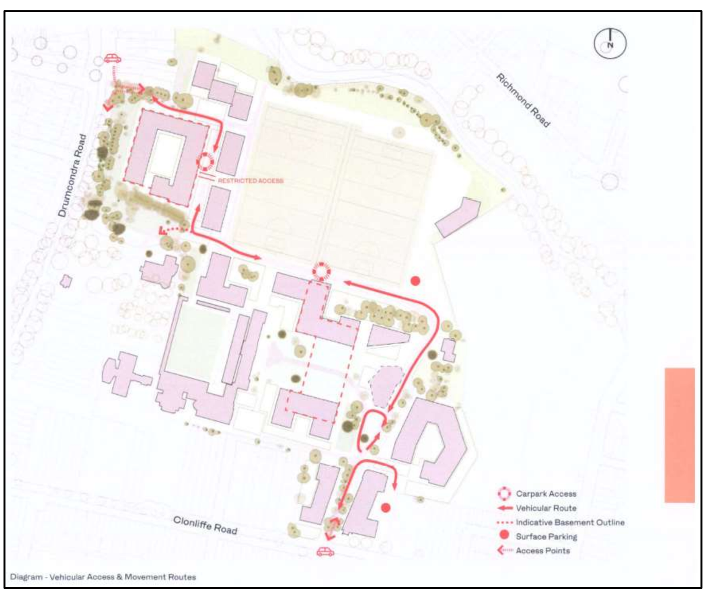

Figure 3.9: Clonliffe Lands Masterplan Development

The design has been developed with this in mind and, in so far as practicable, seeks to provide for improved existing or new interchange opportunities with other transport services. These are outlined below:

3.2.10 Griffith Avenue Protected Cycle Lane Scheme

The main aim of this scheme is to provide protected, safe and continuous cycling for all ages and abilities along this route. This is especially important with the numbers of schools in the area as well as the different DCU campus locations. The width of the carriageway on this section of Griffith Avenue is generous (12.3 m approximately) and will allow DCC to provide a 2 meter wide, high quality, protected cycle lane, on both sides of the carriageway while retaining generous traffic lanes in both directions and access to existing driveways. The construction of this scheme is now completed..

This scheme interfaces with the proposed Swords to City Centre scheme at the junction of Drumcondra Road Lower and Griffith Avenue, see **Figure 3.10** below.

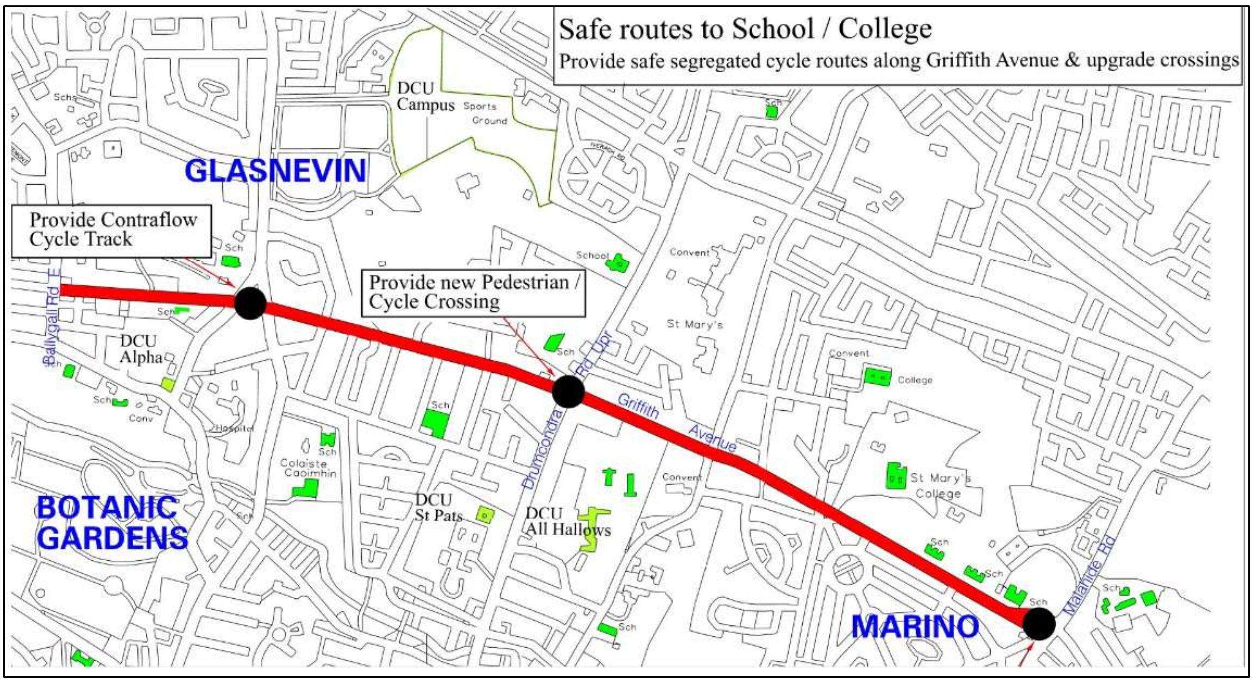

Figure 3.10 Griffith Avenue Protected Cycle Lane Scheme

3.2.11 Parnell Square Cultural Quarter

Parnell Square Cultural Quarter will be a landmark destination which will complete Dublin City's Civic Spine at its northern end, see **Figure 3.11.** Work has commenced surveying the properties to house the new City Library and other cultural facilities at Parnell Square North. It is intended that Dublin City Gallery The Hugh Lane will form part of the overall Parnell Square Cultural Quarter offering and its role and impact will be expanded by the development of the new facilities. The Parnell Square Cultural Quarter is an ambitious project encompassing places for learning, literature, music, innovation and enterprise, inter-culturalism and design.

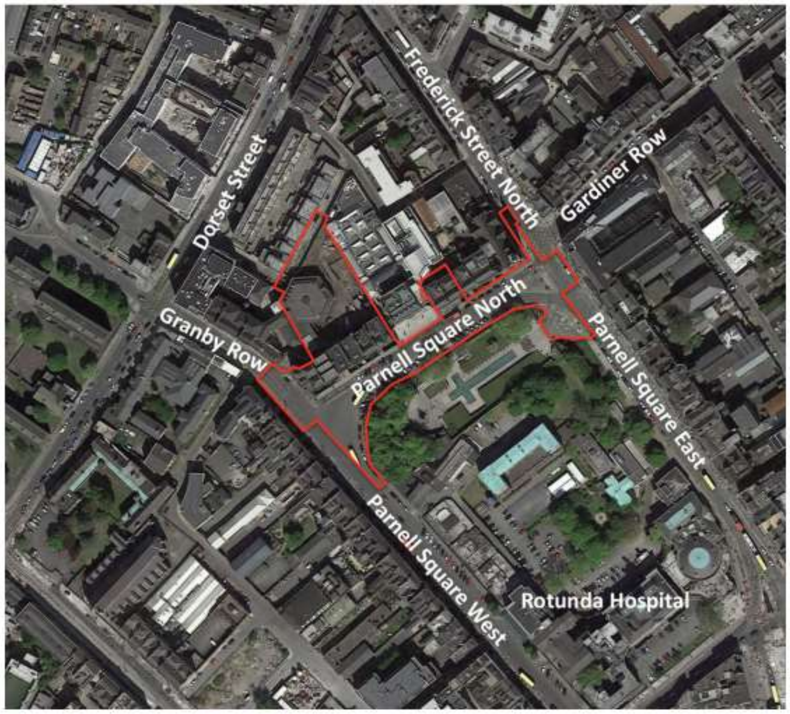

Figure 3.11: Site Location of the Proposed Parnell Square Cultural Quarter

3.2.12 Royal Canal Greenway – Phase 3

The Royal Canal Greenway Phase 3 will provide segregated cycling facilities along a 2.1km route that extends from North Strand Road (Newcomen Bridge) along the banks of the Royal Canal to Phibsborough Road (Cross Guns Bridge). The route is identified as a primary greenway route in the Greater Dublin Area Cycle Network Plan, published by the National Transport Authority in 2013. Construction commenced in Q1 of 2023 and is due for completion in Q2 of 2025.

Figure 3.12: Site Location of Royal Canal Greenway Phase 3

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) Publications (Standards and Technical), Building for Everyone: A Universal Design Approach (National Disability Authority) and the BusConnects Preliminary Design Guidance Booklet (BCPDGB).

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

- TII Publications (Standards and Technical);
- 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 DCC; 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)

[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)
		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)
		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)

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
		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)	20 km/h	• 10m radius (urban areas)	NCM 4.10.3
			30 km/h	• 20m	NCM 4.10.3
			40 km/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)
		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

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
		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	50 km/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		• 50 km/h	DMURS (Section 4.1.1 and Table 4.1)
	Visibility	Forward visibility stopping sight distance (SSD) (buses and Heavy Goods Vehicles (HGVs)).	50 km/h	• 49m	DMURS (Table 4.2 – 50km/h)
	Headroom	Headroom vertical clearance for different structures		• Overbridges – 5.3m(new construction), 5.03m (maintained headroom) • Footbridges and sign/signal gantries – 5.7m (new construction), 5.41m (maintained headroom)	DN-GEO-03036 (Table 5.1)

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
Traffic Lane	Design speed	Design speed for vehicles in general traffic lanes along the Proposed Scheme		• 50 km/h • 60 km/h	DMURS (Section 4.1.1 and Table 4.1)
	Traffic lane width	Minimum carriageway lane width	50 km/h	• 3m minimum width and lane widening as required by vehicle tracking assessment on tight bends	BCPDG (Section 5.1)
			60 km/h	• 3.25m minimum width	
	Visibility	Forward visibility SSD (cars and smaller vehicles).	50 km/h	• 45m	DMURS (Table 4.2 – 50 km/h)
			60 km/h	• 59m	DMURS (Table 4.2 – 60 km/h)
		Forward visibility SSD (buses and HGVs).	50 km/h	• 49m	DMURS (Table 4.2 – 50km/h)
			60 km/h	• 65m	DMURS (Table 4.2 – 60 km/h)
		Visibility to regulatory signage	Up to 50 km/h	• 60m recommended clear	TSM (Table 5.1)
			60 km/h	• 75m (90m where greater prominence is required by site conditions, or where greater emphasis is needed)	TSM (Table 5.1)
	Horizontal curvature	Minimum radius with adverse camber of 2.5%	50 km/h	• 104m	DMURS (Table 4.3)

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
			60 km/h	• 178m	DMURS (Table 4.3)
	Vertical curvature	Crest curve K value	50 km/h	• 4.7	DMURS (Table 4.3)
			60 km/h	• 8.2	DMURS (Table 4.3)
		Sag curve K value	50 km/h	• 6.4	DMURS (Table 4.3)
			60 km/h	• 9.2	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)
	Cross Fall	Cross-fall		• 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.
		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)

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
		Visibility to primary traffic signals	50 km/h	• 70m desirable minimum • 50m absolute minimum	TSM (Table 9.1)
			60 km/h	• 90m desirable minimum • 70m 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.	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)
				• 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)	
		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)

Cross Section Element	Design Parameter	Description	Design Speed (km/h)	Adopted Design Parameter(s)	Reference(s)
		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 width of traffic lanes on the Proposed Scheme are:

- 3.0m in areas with a posted speed limit ≤ 60km/h; and
- 3.25m 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. 2.0m 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**.

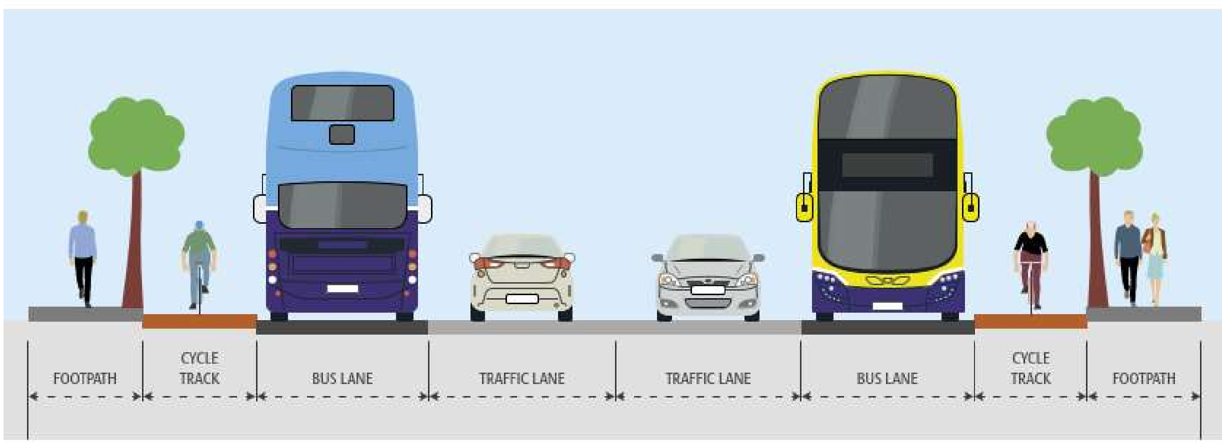

Figure 4.1: Typical CBC Cross Section

A detailed scheme breakdown of the proposed road cross section elements is provided in **Table 4.2**. These tables provide information on the existing facilities for pedestrians, cyclists, bus lanes and general traffic lanes between junctions along the route. A detailed description of the existing and proposed junction arrangements are 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 Nominal Cross-Section Widths

Location		Northbound/Outbound Carriageway				Southbound/Inbound Carriageway				Notes
Chainage Start	Chainage End	Nominal Footpath Width (m)	Nominal Cycle Track Width (m)	Nominal Bus Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Bus Lane Width (m)	Nominal Cycle Track Width (m)	Nominal Footpath Width (m)	
Pinnock Hill - Swords Road R132										
A0	A800	2	2	3	3	3	3	2	2	Desirable Minimum widths provided in accordance with CBC design strategy
A800	A2280	2	2	3.25*	3.25*	3.25*	3.25*	2	2	Desirable Minimum widths provided in accordance with CBC design strategy *Existing retained
A2280	A2850	2	3.25 Two-way cycle track	3.5*	3.5*	3.5*	3.5*	0	0	Desirable Minimum widths provided in accordance with CBC design strategy Two-way cycle track on northbound carriageway *Existing retained
Airport Roundabout - Swords Road R132										
A2850	A2935	2	3.25 Two-way cycle track	3.5*	3.5*	3.5*	3.5*	Existing Shared surface not required as part of the BusConnects infrastructure		Desirable Minimum widths provided in accordance with CBC design strategy Two-way cycle track on northbound carriageway *Existing retained
A2935	A2993	1.8	2.5 Two-way cycle track	3.5*	3.5*	3.5*	3.5*	Existing Shared surface not required as part of the BusConnects infrastructure		Two-way cycle track on northbound carriageway. The two-way cycle track width in front of the recently constructed office building (Corballis Hall) is reduced locally to avoid the building. *Existing retained

Location		Northbound/Outbound Carriageway				Southbound/Inbound Carriageway				Notes
Chainage Start	Chainage End	Nominal Footpath Width (m)	Nominal Cycle Track Width (m)	Nominal Bus Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Bus Lane Width (m)	Nominal Cycle Track Width (m)	Nominal Footpath Width (m)	
A2993	A3190	2	3.25 Two-way cycle track	3.5*	3.5*	3.5*	3.5*	Existing Shared surface not required as part of the BusConnects infrastructure		Two-way cycle track on northbound carriageway Desirable Minimum widths provided in accordance with CBC design strategy. *Existing retained
A3190	A3215	1.8	2.5 Two-way cycle track	3.5*	3.5*	3.5*	3.5*	Existing Shared surface not required as part of the BusConnects infrastructure		The cycle track widths reduce cyclist speeds for safety through the junction. *Existing retained
A3215	A3270	1.8	1.5	3.5*	3.5*	3.5*	3.5*	Existing Shared surface not required as part of the BusConnects infrastructure		Desirable Minimum widths provided in accordance with CBC design strategy *Existing retained
A3270	A4005	1.8	1.7	3.4*	3.4*	3.4*	3.4*	1.7	1.8	Existing shared path of 3.5m is changed to a cycle track/footpath by adding the white line to separate the cycle track. *Existing retained
A4005	A4035	1.8	1.7	3.4*	3.4*	3.4*	3.4*	1.7	1.8	Existing shared path of 3.5m is changed to a cycle track/footpath by adding the white line to separate the cycle track. *Existing retained
A4035	A4100	2	2	3.4*	3.4*	3.4*	3.4*	2	2	Desirable Minimum widths provided in accordance with CBC design strategy *Existing retained

Location		Northbound/Outbound Carriageway				Southbound/Inbound Carriageway				Notes
Chainage Start	Chainage End	Nominal Footpath Width (m)	Nominal Cycle Track Width (m)	Nominal Bus Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Bus Lane Width (m)	Nominal Cycle Track Width (m)	Nominal Footpath Width (m)	
Old Airport Road - Swords Road R132										
A4100	A4195	2	2	3	3	3	3	2	2	Desirable Minimum widths provided in accordance with CBC design strategy
A4195	A4202	2	2	3	3	3	3	1.5	2	The cycle track width at this section is reduced locally to avoid land take, which would impact the adjacent protected structure (Thatched Cottage and its curtilage).
A4202	A4230	1.85	2	3	3	3	3	1.5	2	The cycle track width at this section is reduced locally to avoid land take, which would impact the adjacent protected structure (Thatched Cottage and its curtilage).
A4230	A5700	2	2	3	3	3	3	2	2	Desirable Minimum widths provided in accordance with CBC design strategy
Northwood Avenue - Swords Road R132										
A5700	A5950	2	2	3.25*	3.25*	3.25*	N/A	2	2	Signal Controlled Bus Priority Inbound. Desirable Minimum widths provided in accordance with CBC design strategy *Existing retained
A5950	A6040	2	2	3	3	3	N/A	1.5	2	Signal Controlled Bus Priority Inbound. The cycle track width at this section is reduced to avoid land take which would impact the ground of Santry Demesne, the adjacent historical wall and pNHA.
A6040	A6094	2	1.5	N/A	3	3	3	1.5	2	Signal Controlled Bus Priority Outbound. The cycle track width at this section is reduced to avoid land take which would impact the ground of Santry Demesne, the adjacent historical wall and pNHA.

Location		Northbound/Outbound Carriageway				Southbound/Inbound Carriageway				Notes
Chainage Start	Chainage End	Nominal Footpath Width (m)	Nominal Cycle Track Width (m)	Nominal Bus Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Bus Lane Width (m)	Nominal Cycle Track Width (m)	Nominal Footpath Width (m)	
A6094	A6134	2	1.5	N/A	3	3	3	1.5	1.8	Signal Controlled Bus Priority Outbound. The cycle track and footpath widths at this section are reduced to avoid land take which would impact the ground of Santry Demesne, the adjacent historical wall and pNHA.
A6134	A6145	2	1.5	N/A	3	3	3	1.5	1.8	Signal Controlled Bus Priority Outbound. The cycle track and footpath widths at this section are reduced to avoid land take which would impact the ground of Santry Demesne, the adjacent historical wall and pNHA.
A6145	A6175	1.8	1.5	N/A	3	3	3	1.5	2	Signal Controlled Bus Priority Outbound. The cycle track and footpath widths at this section are reduced to avoid land take which would impact the ground of Santry Demesne, the adjacent historical wall and pNHA.
A6175	A6290	1.8	1.5	N/A	3	3	3	1.5	2	Signal Controlled Bus Priority Outbound. The cycle track and footpath widths at this section are reduced to avoid land take which would impact the ground of Santry Demesne, the adjacent historical wall and pNHA.
A6290	A6320	2	1.5	N/A	3	3	3	1.5	2	Signal Controlled Bus Priority Outbound. The cycle track width at this section is reduced to avoid land take which would impact the ground of Santry Demesne, the adjacent historical wall and pNHA.
A6320	A7000	2	2	3	3	3	3	2	2	Desirable Minimum widths provided in accordance with CBC design strategy

Location		Northbound/Outbound Carriageway				Southbound/Inbound Carriageway				Notes
Chainage Start	Chainage End	Nominal Footpath Width (m)	Nominal Cycle Track Width (m)	Nominal Bus Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Bus Lane Width (m)	Nominal Cycle Track Width (m)	Nominal Footpath Width (m)	
Lorcan Road - Swords Road R132										
A7000	A7135	2	N/A	3	3	3	3	N/A	2	A reduced cross section, with no cycle track provided. The cycle route is via a quiet street treatment of Lorcan Road, Lorcan Drive and Shanrath Road.
A7135	A7150	1.3	N/A	3	3	3	3	N/A	2	The footpath width at this section is reduced to avoid impact upon an existing service plinth at the service station.
A7150	A7650	2	N/A	3	3	3	3	N/A	2	A reduced cross section, with no cycle track provided. The cycle route is via a quiet street treatment of Lorcan Road, Lorcan Drive and Shanrath Road.
A7650	A7975	2	N/A	3	3	3	3	1.5	2	The north bound footpath and cycle route is via the quiet street treatment of the Swords Road.
A7975	A8050	2	N/A	3	3	3	3	1.5	2	Reduced cross section in front of the Church of the Holy Child. The north bound footpath and cycle route is via the quiet street treatment of the Swords Road.
A8050	A8616	2	2	3	3	3	3	2	2	Desirable Minimum widths provided in accordance with CBC design strategy
A8616	A8645	2	1.7	3	3	3	3	2	2	The cycle track width is reduced at this section to avoid land take, which would impact the row of high-quality trees planted along the boundary of the Plunket College. Extensive length of retaining wall would also be required if standard width cycle track is provided.

Location		Northbound/Outbound Carriageway				Southbound/Inbound Carriageway				Notes
Chainage Start	Chainage End	Nominal Footpath Width (m)	Nominal Cycle Track Width (m)	Nominal Bus Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Bus Lane Width (m)	Nominal Cycle Track Width (m)	Nominal Footpath Width (m)	
A8645	A8785	2	1.7	3	3	3	3	1.7	2	The cycle track width is reduced at this section to avoid impacting the ground of Highfield Hospital, with the need for retaining wall. The boundary wall of the GNI Above Ground Installation (AGI) will also be affected if standard cycle track width is provided.
A8785	A8830	2	1.7	3	3	3	3	2	2	The cycle track width is reduced at this section to avoid impacting the ground of Highfield Hospital, with the need for retaining wall. The boundary wall of the GNI Above Ground Installation (AGI) will also be affected if standard cycle track width is provided.
A8830	A8880	2	2	3	3	3	3	2	2	T Desirable Minimum widths provided in accordance with CBC design strategy
A8880	A8950	2	2	3	3	3	3	2.5 Two-way cycle track	2	The cycle track width reduces cyclist speeds for safety through the junction.
A8950	A9100	2	2	3	3	3	3	2	2	Desirable Minimum widths provided in accordance with CBC design strategy
Griffith Avenue - Swords Road N1										
A9100	A9254	2	2	3	3	3	3	2	2	Desirable Minimum widths provided in accordance with CBC design strategy
A9254	A9300	2	1.5	3	3	3	3	2	2	Existing kerb line to be retained where practicable. The cycle track width is reduced at this section to avoid a significant loss of mature trees along the Upper Drumcondra Road.

Location		Northbound/Outbound Carriageway				Southbound/Inbound Carriageway				Notes
Chainage Start	Chainage End	Nominal Footpath Width (m)	Nominal Cycle Track Width (m)	Nominal Bus Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Bus Lane Width (m)	Nominal Cycle Track Width (m)	Nominal Footpath Width (m)	
A9300	A9353	1.8	1.5	3	3	3	3	2	2	Existing kerb line to be retained where practicable. The cycle track and footpath widths are reduced at this section to avoid a significant loss of mature trees along the Upper Drumcondra Road.
A9353	A9450	2	1.5	3	3	3	3	2	2	Existing kerb line to be retained where practicable. The cycle track width is reduced at this section to avoid a significant loss of mature trees along the Upper Drumcondra Road.
Upper Drumcondra Road – Dorset Street Upper										
A9450	A9930	2	2	3	3	3	3	2	2	Desirable Minimum widths provided in accordance with CBC design strategy
A9930	A9990	2	2	3	3	3	3	1.5	2	Reduced cycle track width is provided due to space constraint across Frank Flood Bridge
A9990	A10030	2	2	3	3	3	3	1.7	2	Reduced cycle track width is provided due to space constraint
A10030	A10750	2	2	3	3	3	3	1.5	2	Reduced cycle track width is provided due to space constraint.
A10750	A10810	2	2	3	3	3	N/A	1.5	2	Signal Controlled Bus Priority at Binns Bridge due to space constraints. Reduced cycle track width is provided due to space constraint.
A10810	A11332	2	2	3	3	3	3	1.5	2	Reduced cycle track width is provided due to space constraint.
A11332	A11492	2	1.7	3	3	3	3	1.5	2	Reduced cycle track width is provided due to space constraint.

Location		Northbound/Outbound Carriageway				Southbound/Inbound Carriageway				Notes
Chainage Start	Chainage End	Nominal Footpath Width (m)	Nominal Cycle Track Width (m)	Nominal Bus Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Traffic Lane Width (m)	Nominal Bus Lane Width (m)	Nominal Cycle Track Width (m)	Nominal Footpath Width (m)	
A11492	A11500	2	1.7	3	3	3	3	1.5	2	Reduced cycle track width is provided due to space constraint.

4.3 Design Speed and Speed Limit

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 Department of Transport, Tourism and Sport (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.

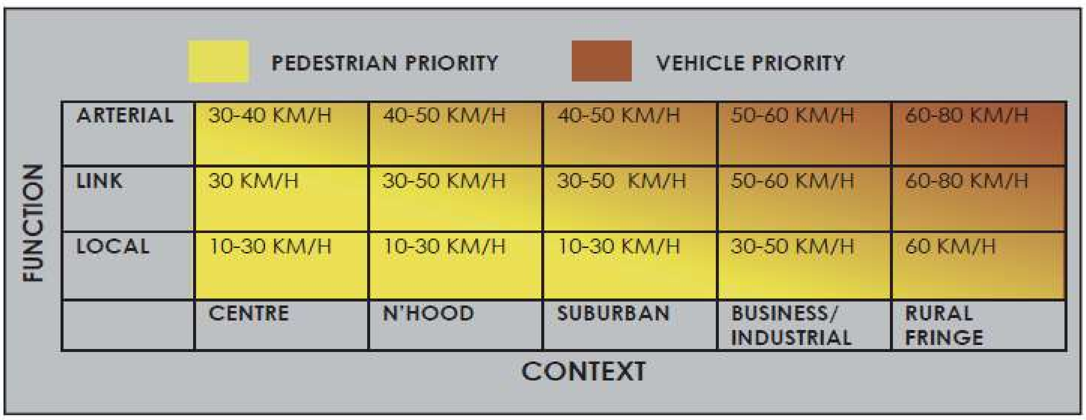

Figure 4.2: DMURS Design Speed Selection Matrix

The Proposed Scheme's design speeds and speed limits are detailed below in **Table 4.3.**

Table 4.3: Existing and Proposed Speed Limits and Design Speeds

Chainage reference	Road / Junction Name	DMURS Road Function	DMURS Place Context	Existing Speed Limit (km/h)	Proposed Design Speed (km/h)	Proposed Posted Speed Limit (km/h)
A100 to A5700	Pinnock Hill Roundabout to Northwood Avenue	Arterial	Business/Industrial	60	60	60

Chainage reference	Road / Junction Name	DMURS Road Function	DMURS Place Context	Existing Speed Limit (km/h)	Proposed Design Speed (km/h)	Proposed Posted Speed Limit (km/h)
A5700 to A10450	Northwood Avenue to St. Alphonsus Road	Arterial	Neighbourhood	50	50	50
A10450 to A11700	St. Alphonsus Road to Saint Mary's Place North/ Granby Row	Arterial	City Centre	50	50	50
C0 to C400	Fredrick Street North to Cavendish Row	Arterial	City Centre	30	30	30
D0 to D350	Granby Row to Parnell Square West	Arterial	City Centre	30	30	30

4.4 Alignment Modelling Strategy

The 3D highway design, including the horizontal and vertical alignments, 3D modelling corridors and the associated design features, have been developed using the Autodesk Civil 3D software. 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 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 over-ridding 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 to minimise rideability issues for vehicles crossing the crown line.

In the case of developing the vertical alignments along the route, a refinement process has been undertaken to minimise impacts to existing road network and develop the proposed carriageway levels as close to the 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 footway levels will require additional land-take 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 in levels between proposed and existing along the route, while at existing junctions 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, the 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 alignments 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 approximately

- Ch A2050 to A2450,
- Ch A4100 to A4450,
- Ch A5750 to A6300,
- Ch A7150 to A7600, and
- Ch A8300 to A8500.

These have been undertaken to facilitate provision of the typical CBC Cross Section.

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 Distances (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**. The desirable minimum forward visibility requirements were achieved across the entirety of the Proposed Scheme.

Table 4.4: DMURS 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

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 splays "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 TII DN-GEO-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 have been 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 is often determined by swept path analysis. While 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 safety 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

A summary of the vehicles used as part of the overall Swept Path Analysis are outlined below:

- **DB32 Private Car** – Analysis undertaken to ensure that length of driveways remains sufficient to accommodate a private car.
- **DB32 Refuse Vehicle** – Analysis undertaken to ensure refuse vehicles can make turns in/out of all side roads and entries.
- **Single Deck City Bus** – Analysis undertaken to ensure that buses can make all turns at junctions and as set out by bus lanes.
- **Rigid Truck** – Analysis undertaken to ensure rigid truck can make turns in/out of all major junctions.
- **FTA Design Articulated Vehicle (1998)** - Analysis undertaken to ensure FTA articulated trucks can make turns in/out of Pinnock Hill junction, Airside junction, Cloghran junction, Airport Roundabout, Green Long-term Parking junction, South Corballis Road junction, Old Airport Road junction, Turnapin Lane junction, and entrances to industrial estates.

There are no issues with Swept Path Analysis on the Proposed Scheme.

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’ 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 licences 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 are further discussed in **Chapter 13**.

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

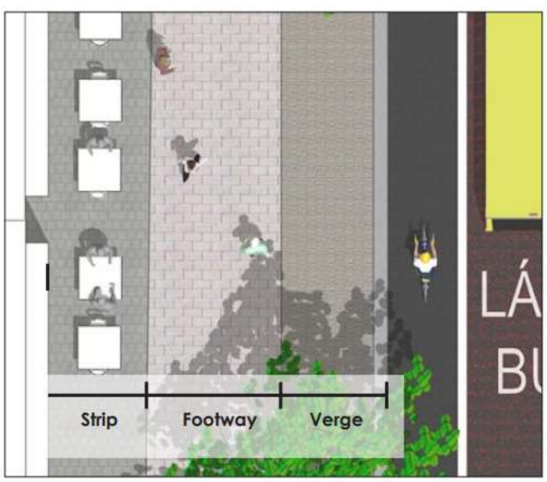

Figure 4.4: Key Components of the Footpath

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, desirable minimum lane widths have been adopted throughout.

Throughout the scheme, footway widths of 2.0m or wider have been proposed, with the exception of a limited number of stretches where widths of 1.5m or greater are proposed due to the presence of localised space constraints. The 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 4.5**. The footpath crossfall is recommended to be 2% - 3.3% as per TII DN-PAV-03026 *Footway Design*.

Table 4.5: DN-PAV-03026, Table 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 cross falls 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 within the constraints of the existing footpath extents.

4.9.3 Longitudinal Gradient

The adopted footway design longitudinal gradient parameters have been provided in **Table 4.1**. The footpath longitudinal gradient follows the gradient of the proposed carriageway. DN-PAV-03026, *Table 2.3* shown in **Table 4.5** recommends a longitudinal gradient of 1.25%-5%.

Similar to cycle tracks throughout the Proposed Scheme, longitudinal gradients of footpaths are likely to be constrained by the longitudinal gradient of the adjacent carriageway with little scope to vary the footpath 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 areas 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 to 4m in width have been incorporated throughout the design.

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. An Accessibility Audit of the existing environment was undertaken to help inform the preliminary design for 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**.

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 proposed footways has 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, whereby 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 being 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 footpath.

The principal source for guidance on the design of cycle facilities is the National Cycle Manual (NCM), published by the National Transport Authority.

The desirable minimum width for a single-direction, with-flow, raised-adjacent cycle track is 2.0m. 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 12km long from end to end. The General Arrangement drawings included within **Appendix B** show the improved extent of cycle provision, which is summarised below:

- 69% Existing cycle priority (outbound) (34% cycle track, 35% advisory cycle lane);
- 49% Existing cycle priority (citybound) (23% cycle track, 26% advisory cycle lane);
- 100% Proposed cycle priority (outbound) (89% cycle track, 11% quiet street); and
- 100% Proposed cycle priority (citybound) (89% cycle track, 11% quiet street).

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.

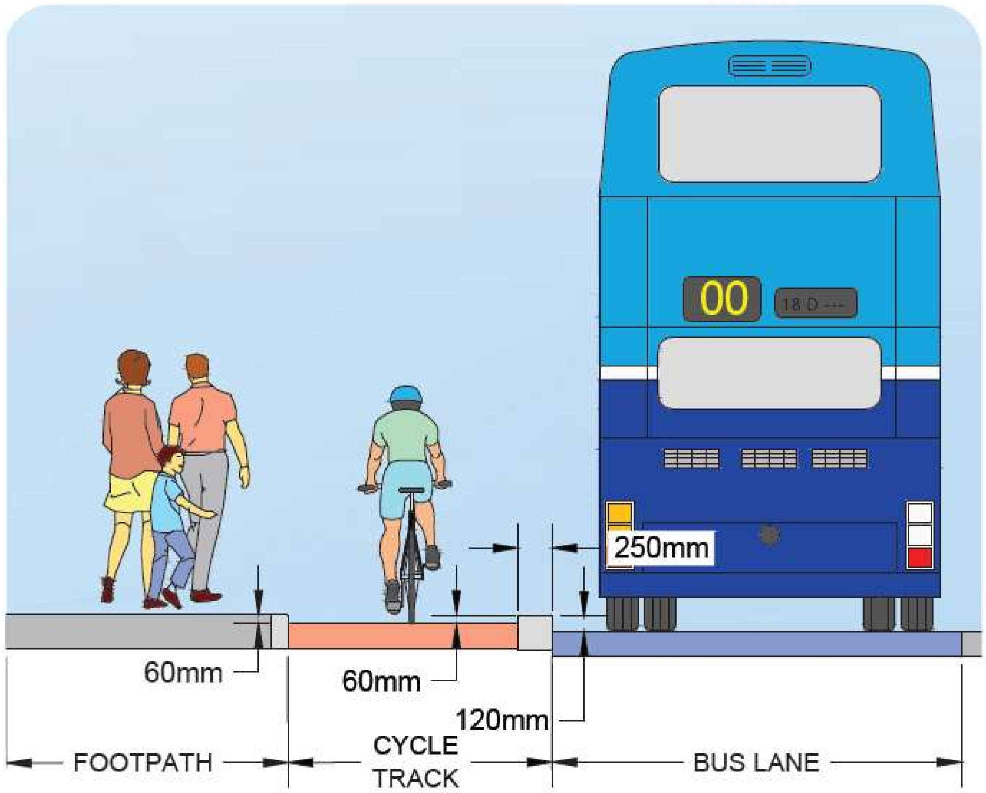

Figure 4.5: Fully Segregated Cycle Track

Fully segregated cycle tracks have been provided throughout the length of the scheme except for the sections between the Omni Shopping Centre and the Shantalla Road junction and between the Shantalla Road junction and Collins Avenue, where quiet street treatments are proposed.

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

- Drumcondra Road Upper – outbound at St Patrick's College;
- Drumcondra Road Lower – inbound from Clonliffe Road to Hardwicke Place;
- Dorset Street Lower – outbound from Eccles Street to Whitworth Road;
- Dorset Street Upper - outbound from Blessington Street to Eccles Street; and
- North Frederick Street and Parnell Square East.

4.11.2 Cycle Lanes

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 Tracks

Offline cycle tracks are fully offset from the road carriageway by a grass verge, providing a greater level of protection and comfort to cycle users. There are existing sections of offline cycle track between Griffith Avenue and Home Farm Road, and between Hollybank Road and Clonliffe Road. These sections of offline cycle track will be upgraded as part of the Proposed Scheme to improve the cycle track quality of service.

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 route. 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 minimal general traffic other than car users who live on the street , without the need to construct segregated cycle tracks or painted cycle lanes. The Quiet Street Treatment would involve appropriate advisory signage for both the general road users and cyclists.

A Quiet Street cycle route has been proposed from the Omni Park Shopping Centre/ Lorcan Road junction, through Lorcan Road concluding at the Larkhill Road/ Shantalla Road/ Shanrath Road junction. This Quiet Street cycle route avoids the pinch point at Santry Village.

Another Quiet Street cycle route commences at the Larkhill Road/ Shantalla Road/ Shanrath Road junction and concludes at the Collins Avenue Junction where the cyclist re-joins the mainline. This quiet street cycle route avoids the section of N1 with high volumes of traffic.

4.11.5 Treatment of Constrained Areas

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

All locations where widths are less than desirable minimum are recorded and presented in **Table 4.2**.

More significant localised narrowing is necessary in the locations below:

- Swords Road (R132), Ch A2935 to A2993;

- Swords Road (R132), Ch A4195 to A4230;
- Santry Demesne, Ch A5925 to A6325: Providing a standard width would require additional land take, impacting the ground of Santry Demesne, the adjacent historical wall and pNHA.
- Plunket College, Ch A8650 to A 8800: Providing a standard width would require additional land take, impacting the row of high-quality trees along the boundary of the Plunket College. Extensive length of retaining wall is also required if standard width cycle track is provided. Providing a standard width would require additional land take, impacting the ground of Highfield Hospital, with the need for retaining wall. The boundary wall of the GNI AGI will also be affected if standard cycle track width is provided.
- Upper Drumcondra Road Ch A9260 to A9350: Existing kerb line to be retained where practicable. Providing a standard width would result in significant loss of mature trees along the Upper Drumcondra Road.

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

Cycle stands will generally be provided, where practicable, at island bus stops and key additional locations as noted in the Landscape General arrangement Drawings in **Appendix B**.

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 (12km):

- 67% existing bus priority (outbound);
- 78% existing bus priority (citybound);
- 100% proposed bus priority (outbound); and
- 100% proposed bus priority (citybound).

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 fewer 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 12**.

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 and other authorised vehicle use 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 Bus 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 then be allowed through the lights. In considering signal-controlled bus priority it is necessary to look at the traffic implications both upstream and downstream of the area under consideration. For the signal-controlled bus 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 4.6**.

Table 4.6: Signal Controlled Bus Priority Locations

Location	Reason for Mitigation
Inbound between Northwood Avenue and the mid-block crossing near the Morton Stadium entrance	Providing a Southbound Bus Lane would require additional land take, impacting the ground of Santry Demesne, the adjacent historical wall. *Approximate Chainage A5700 to A6050, Southbound.*
Outbound between Coolock Lane Avenue and the mid-block crossing near the Morton Stadium entrance.	Providing a Northbound Bus Lane would require additional land take, impacting the ground of Santry Demesne, the adjacent historical wall or domestic entrances. *Approximate Chainage A6050 to A6350, Northbound*
Inbound between Whitworth Place and Portland Place	Providing a southbound Bus Lane would require widening of the Binns Bridge. *Approximate Chainage A10770 – A10800, Southbound*

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, cyclists and 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.

There is an existing arrangement on North Frederick Street which, although not demarcated as a bus lane, performs as a bus gate, and will be maintained.

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.

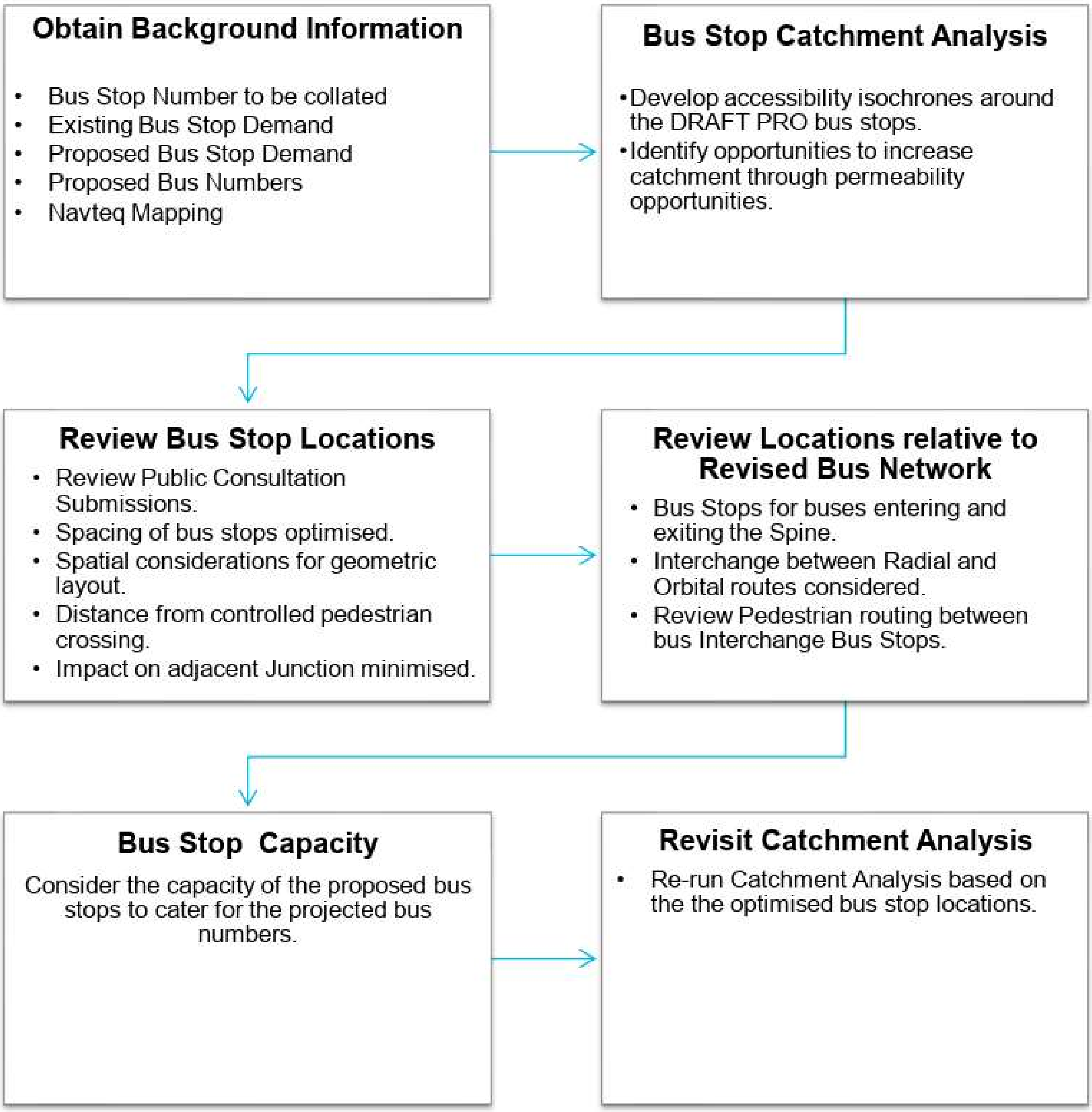

Figure 4.6: Bus Stop Location Assessment Process

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;
- Location minimises 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 4.7 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 also.

Table 4.7: Swords to City Centre Bus Stop Summary

Existing				Proposed			
No.	Bus Stop No.	Chainage	Distance between Stops (m)	No.	Bus Stop No	Chainage	Distance between Stops (m)
Inbound							
1	3694	A320	230	1	3694	A200	340
2	3695	A550	430	2	3695	A540	310
3	7115	N/A	N/A	3	7115	N/A	N/A
4	3696	A980	270	4	3696	A850	370
5	3697	A1250	450	5	3697	A1220	500
6	3698	A1700	180	6	3698	A1720	590
7	3699	A1880	1050	7	3699	A2310	620
8	3885	A2930	420	8	3885	A2930	420
9	1631	A3350	390	9	1631	A3350	390
10	5053	A3740	240	10	5053	A3740	240
11	1633	A3980	590	11	1633	A3980	580
12	1634	A4570	180	12	1634	A4560	720
13	1635	A4750	390			**Removed**	N/A
14	1636	A5140	510	13	1636	A5280	370
15	1637	A5650	300	14	1637	A5650	400
16	1638	A5950	730	15	1638	A6050	350
	-	-	0	16	**New**	A6400	380
17	1639	A6680	370	17	1639	A6780	270
18	1640	A7050	350	18	1640	A7050	350
19	231	A7400	360	19	231	A7400	360
20	1641	A7760	300	20	1641	A7760	300

Existing				Proposed			
No.	Bus Stop No.	Chainage	Distance between Stops (m)	No.	Bus Stop No	Chainage	Distance between Stops (m)
21	1642/10 4331	A8060	290	21	1642/10433 1	A8060	230
22	215	B150	N/A	22	7851	B150	N/A
23	237	B220	N/A	23	237	B220	N/A
24	213	A8350	260	24	213	A8290	320
25	214	A8610	260	25	214	A8610	260
26	4432	A8870	290	26	4432	A8870	290
27	119	A9160	250	27	119	A9160	250
28	44	A9410	160	28	44	A9410	160
29	7603	A9570	210	29	7603	A9570	210
30	45	A9780	320	30	45	A9780	320
31	46	A10100	390	31	46	A10100	350
32	47	A10490	210	32	47	A10450	180
33	48/ 100861	A10700	280	33	48/ 100861	A10630	340
34	49	A10980	300	34	49	A10970	290
35	51	A11280	140	35	51	A11260	500
36	52	A11420	340			**Removed**	N/A
37	261	C260	20	36	261	C260	20
38	262	C280	20	37	262	C280	20
39	263	C300	20	38	263	C300	20
40	264	C310	10	39	264	C310	10
41	265	C330	20	40	265	C330	20
Outbound							
1	5073	A40	560	1	5073	A40	450
2	3676 / 100161	A600	370	2	3676 / 100161	A490	260
3	3675	A970	260	4	3675	A750	350
4	3674	A1230	1020	5	3674	A1100	540
	-	-		6	**New**	A1640	610
5	3672	A2250	280	7	3672	A2250	860
8	3671	A2530	580			**Removed**	N/A
9	3670	A3110	340	8	3670	A3110	340
8	1630	A3450	710	9	1630	A3450	570
9	1629	A4160	365	10	1629	A4020	510
10	1628	A4525	645	11	1628	A4530	640
11	1627	A5170	490	12	1627	A5170	420
12	1626	A5660	390	13	1626	A5590	360
13	1625	A6050	570	14	1625	A5950	500

Existing				Proposed			
No.	Bus Stop No.	Chainage	Distance between Stops (m)	No.	Bus Stop No	Chainage	Distance between Stops (m)
	-	-		15	**New**	A6450	210
14	1624	A6620	480	16	1624	A6660	440
15	1623	A7100	210	17	1623	A7100	210
16	1622	A7310	260	18	1622	A7310	260
17	220	A7570	580	19	220	A7570	600
18	1620/ 100141	A8150	230	20	1620/ 100141	A8170	200
19	212	B420	N/A	21	212	B410	N/A
20	205	A8380	200	22	205	A8370	360
21	204	A8580	420	23	204	A8730	270
22	203 / 104351	A9000	310	24	203 / 104351	A9000	310
23	85	A9310	300	25	85	A9310	300
24	7602	A9610	160	26	7602	A9610	160
25	21	A9770	330	27	21	A9770	350
26	19	A10100	150	28	19	A10120	130
27	18	A10250	370	29	18	A10250	400
28	17/1001 21	A10620	340	30	17/100121	A10650	310
29	15	A10960	220	31	15	A10960	220
30	14	A11180	200	32	14	A11180	240
31	11	A11380		33	11	A11420	

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**.

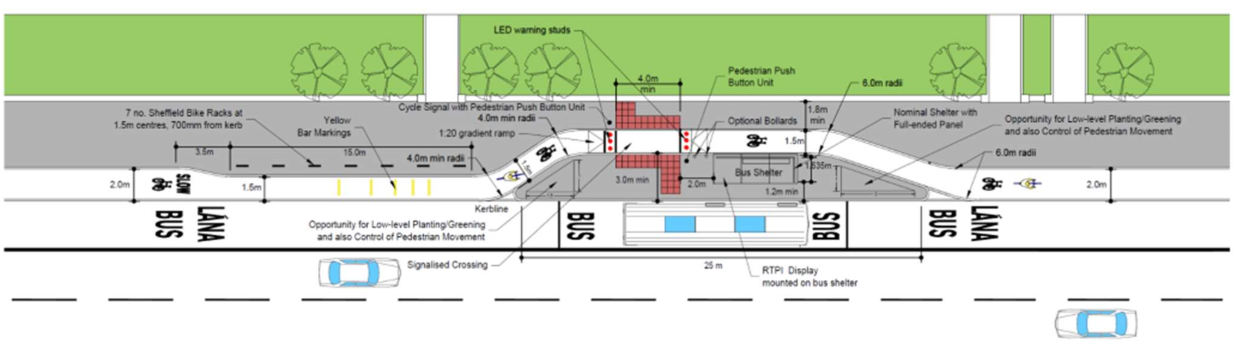

Figure 4.7: Example of an Island Bus Stop

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 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 is 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 will also be featured at the crossing points.

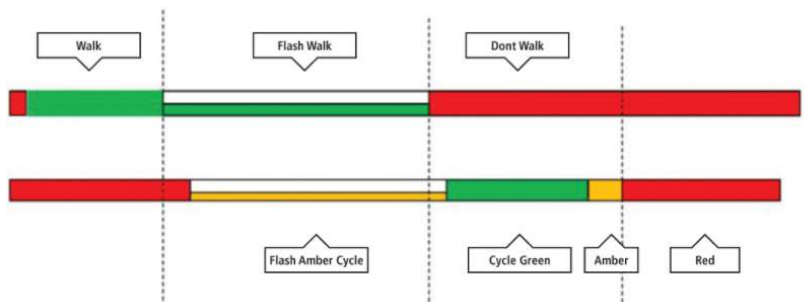

Figure 4.8: Example of a Nested Pelican Sequence

A 1:20 ramp is provided to raise the cycle track to the level of the footpath/island area onto a 4m wide crossing. Suitable tactile paving is also provided at the crossing point in addition to a series of LED warning studs at the crossing location 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 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 (Source: Google Streetview 2021)

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 BCPDG. **Table 4.8** below provides a summary of the proposed Island Bus Stop locations.

Table 4.8: List of Island Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter Type	Type
Inbound	Pinnock Hill	3694	A 200	Standard bus shelter	Island Bus Stop
Inbound	N1 Business Park	3696	A 850	New Standard bus shelter proposed	Island Bus Stop
Inbound	Equestrian Centre	3697	A 1220	New Standard bus shelter proposed	Island Bus Stop
Inbound	Kettles Lane	3698	A 1720	New Standard bus shelter proposed	Island Bus Stop
Inbound	Airport Parking	3885	A 2930	New Standard bus shelter proposed	Island Bus Stop
Inbound	ALSAA Sports Club	1631	A 3350	Standard bus shelter	Island Bus Stop
Inbound	Swords Road	5053/ 1632	A 3740	New Standard bus shelter proposed	Island Bus Stop
Inbound	Dardistown Cemetery	1633	A 3980	Standard bus shelter	Island Bus Stop
Inbound	Turnapin Lane	1636	A 5280	Standard bus shelter	Island Bus Stop
Inbound	Santry Close	1637	A 5650	Standard bus shelter	Island Bus Stop
Inbound	-	-	A 6400	New Standard bus shelter proposed	Island Bus Stop
Inbound	Schoolhouse Lane	1639	A 6780	Standard bus shelter	Island Bus Stop
Inbound	White Church	1642/ 104331	A 8060	Standard bus shelter	Island Bus Stop
Inbound	Iveragh Road	213	A 8290	Standard bus shelter	Island Bus Stop
Inbound	Highfield Hospital	214	A 8610	New Standard bus shelter proposed	Island Bus Stop
Inbound	Griffith Downs	4432	A 8870	Standard bus shelter	Island Bus Stop
Inbound	The Village	119	A 9160	Standard bus shelter	Island Bus Stop
Inbound	Skylon Hotel	44	A 9410	Standard bus shelter	Island Bus Stop

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter Type	Type
Inbound	Botanic Avenue	46	A 10100	Standard bus shelter	Island Bus Stop
Outbound	Pinnock Hill	5073	A 40	Standard bus shelter	Island Bus Stop
Outbound	N1 Business Park	3675	A 750	New Standard bus shelter proposed	Island Bus Stop
Outbound	Equestrian Centre	3674	A 1100	New Standard bus shelter proposed	Island Bus Stop
Outbound	-	-	A 1640	New Standard bus shelter proposed	Island Bus Stop
Outbound	Stockhole Lane	3672	A 2250	New Standard bus shelter proposed	Island Bus Stop
Outbound	Airport Parking	3670	A 3110	Standard bus shelter	Island Bus Stop
Outbound	ALSAA Sports Club	1630	A 3450	Standard bus shelter	Island Bus Stop
Outbound	Dardistown Cemetery	1629	A 4020	New Standard bus shelter proposed	Island Bus Stop
Outbound	Collinstown Park	1628	A 4530	New Slimline bus shelter proposed	Island Bus Stop
Outbound	Santry Retail Park	1627	A 5170	New Standard bus shelter proposed	Island Bus Stop
Outbound	Santry Close	1626	A 5590	Standard bus shelter	Island Bus Stop
Outbound	-	-	A 6450	New Standard bus shelter proposed	Island Bus Stop
Outbound	Schoolhouse Lane	1624	A 6660	Standard bus shelter	Island Bus Stop
Outbound	Iveragh Road	205	A 8370	Standard bus shelter	Island Bus Stop
Outbound	Highfield Hospital	204	A 8730	Standard bus shelter	Island Bus Stop
Outbound	Whitehall College/ Whitehall Garda St	203/ 104351	A 9000	Standard bus shelter	Island Bus Stop
Outbound	Wellpark Avenue	85	A 9310	Standard bus shelter	Island Bus Stop
Outbound	Botanic Avenue	19	A 10120	New Standard bus shelter proposed	Island Bus Stop

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 prevent 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 4.9** for the locations of bus stops of this type. An example of a Shared Landing Area Bus Stop is shown in **Figure 4.10.**

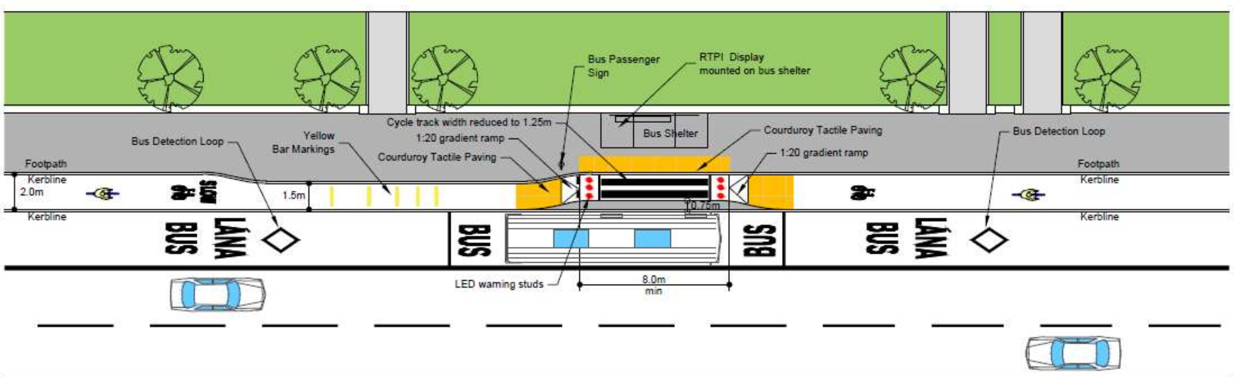

Figure 4.10: Example of a Shared Landing Area Bus Stop

Table 4.9: List of Shared Landing Area Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage		Bus Shelter Type	Type
Inbound	Collinstown Park	1634/ 1635	A	4570	New Standard bus shelter proposed	Shared
Inbound	Morton Stadium	1638	A	6050	Slimline bus shelter	Shared
Inbound	Ellenfield Park	1641	A	7760	New Slimline bus shelter proposed	Shared
Inbound	St Patrick's College	7603	A	9570	Standard bus shelter	Shared
Inbound	St. Patrick's College	7603/ 45	A	9740	Standard bus shelter	Shared
Inbound	Drumcondra Rail Station	47/ 48/ 100861	A	10580	New Standard bus shelter proposed	Shared
Inbound	Dorset Street Lower	49	A	10970	Standard bus shelter	Shared
Inbound	Temple Street	51/ 52	A	11260	Standard bus shelter	Shared
Inbound	Collins Avenue	215	B	200	Standard bus shelter	Shared

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter Type	Type
Outbound	Collinstown Park	1628	A 4525	New Slimline bus shelter proposed	Shared
Outbound	Morton Stadium	1625	A 5950	New Slimline bus shelter proposed	Shared
Outbound	St Patrick's College	7602	A 9610	Standard bus shelter	Shared
Outbound	DCU/ St. Patrick's College	21/ 7602	A 9780	Standard bus shelter	Shared
Outbound	Drumcondra Rail Station	17/ 100121	A 10650	Standard bus shelter	Shared
Outbound	Innisfallen Parade	15	A 10960	Standard bus shelter	Shared
Outbound	Dorset Street Lower	14	A 11180	Standard bus shelter	Shared
Outbound	Dorset Street Lower	11	A 11420	Standard bus shelter	Shared

4.13.4 Inline Bus Stops

Inline bus stops are used on the Proposed Scheme where there are no adjacent cycling facilities provided due to the presence of offline cycle facilities. Inline bus stops are provided at the following locations listed in **Table 4.10.**

Table 4.10: List of Inline Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Bus Stop Type
Inbound	Stockhole Lane	3699	A 2310	New Standard bus shelter proposed	Inline Bus Stop
Inbound	Omni Park SC	1640	A 7050	Standard bus shelter	Inline Bus Stop
Inbound	Shanvarna Road Est	231	A 7400	No shelter	Inline Bus Stop
Outbound	Omni Park SC	1623	A 7100	Standard bus shelter	Inline Bus Stop
Outbound	Shanowen Road	1622	A 7310	Slimline bus shelter	Inline Bus Stop
Outbound	Swords Road	220	A 7570	Slimline bus shelter	Inline Bus Stop

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Bus Stop Type
Outbound	Whitehall	1620/ 100141	A 8170	Standard bus shelter	Inline Bus Stop
Outbound	Parnell Square West	10	D 140	No shelter	Inline Bus Stop
Outbound	Parnell Square West	8	D 160	No shelter	Inline Bus Stop
Outbound	Parnell Square West	7	D 240	No shelter	Inline Bus Stop
Outbound	Parnell Square West	6	D 260	No shelter	Inline Bus Stop
Outbound	Granby Place	7615	D 260	No shelter	Inline Bus Stop
Outbound	Parnell Square West	4	D 270	No shelter	Inline Bus Stop
Outbound	Parnell Square West	3	D 320	No shelter	Inline Bus Stop
Outbound	Parnell Square West	2	D 340	No shelter	Inline Bus Stop

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 below.

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 (**Figure 4.13**) 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. **Figure 4.14**, **Figure 4.15** and **Figure 4.16** illustrate each of these scenarios.

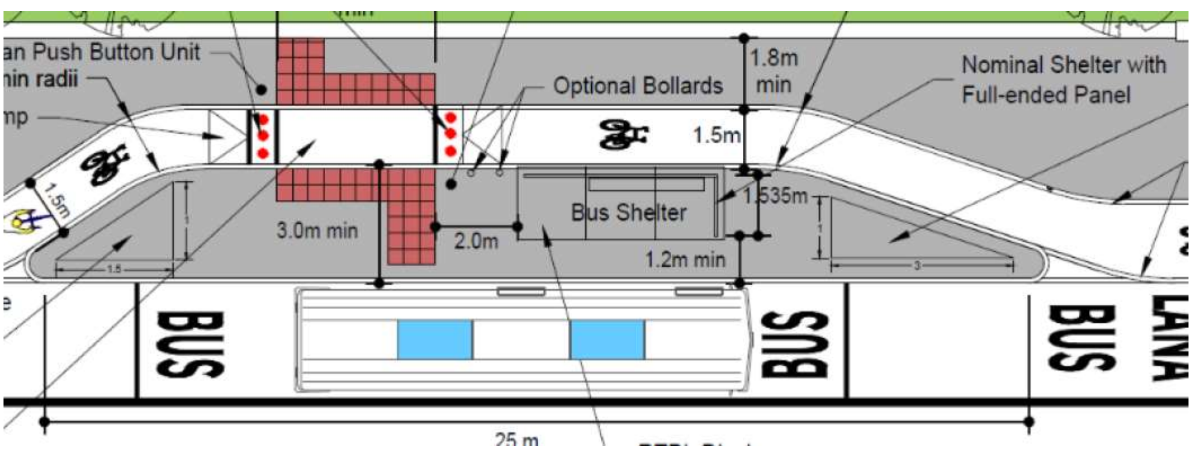

Figure 4.14: Preferred Shelter Location (On Island)

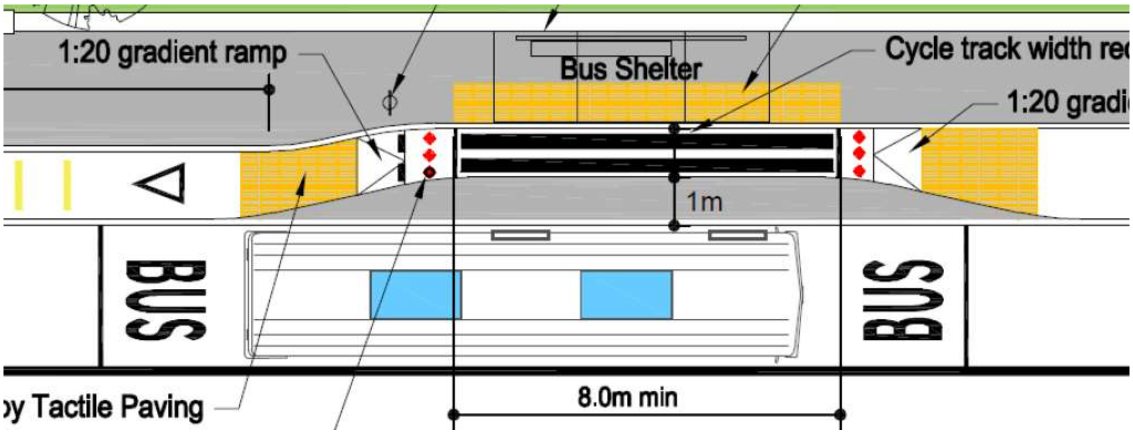

Figure 4.15: Alternative Shelter Location Back of Footpath (Narrow Island with Adequate Footpath Widths)

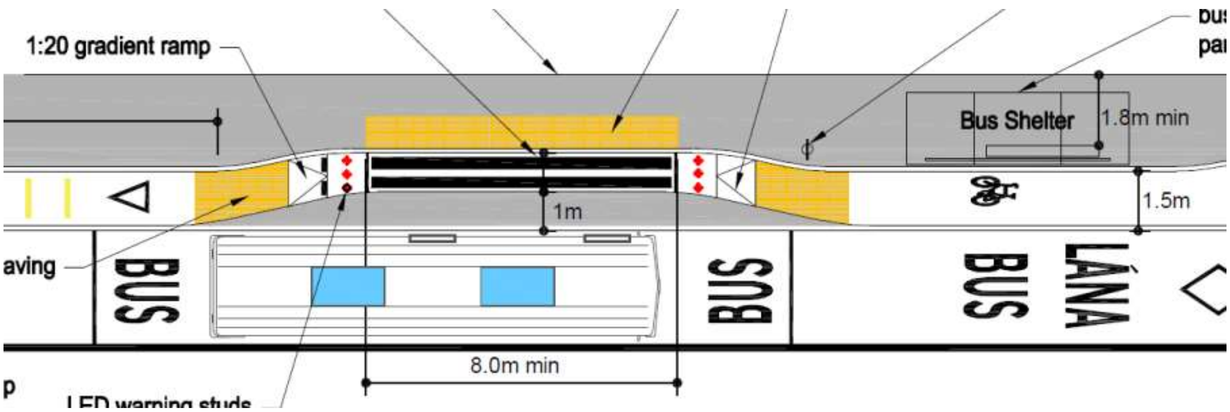

Figure 4.16: Alternative Shelter Location downstream of Island (Narrow Island with Narrow Footpath Widths at Landing Area)

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.

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 practicable 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 paid parking and 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 in **Appendix B** and further discussed in detail in Appendix G. The proposed changes in parking provision are summarised in **Table 4.11**, which provides a summary of the key residual parking/loading impacted areas along the Proposed Scheme.

Table 4.11: Summary of Parking Amendments

Locality	Parking type	Existing Parking Provision	Proposed Parking Provision	Change
Coachman's Inn, Swords Road / Old Stockhole Road	Informal parking	42	29	-13
	Adjacent parking	78	78	0
Paddy Shanahan Cars, Swords Road / Old Airport Road	Commercial vehicles parked for display (Car Sales)	46	32	-14
Swords Road / Schoolhouse Lane	Informal parking	20	17	-3
	Adjacent parking	22	13	-9
Swords Road / Shanowen Road	Informal parking	7	12*	+5
Comet Swords Road	Adjacent parking	47	46	-1
Swords Road / Iveragh Road	Informal parking	6	3	-3
	Adjacent parking	15	15	0

Locality	Parking type	Existing Parking Provision	Proposed Parking Provision	Change
Drumcondra Road Lower / Clonliffe Road to Whitworth Road	Designated paid parking	9	6	-3
	Designated loading bays	9	9	0
Frederick Street North	Designated paid parking	19	4	-15
	Disabled Permit Parking	2	1	-1

* Off street parking is proposed at residential properties between the shopping centre and Shanowen Road to offset the loss of on-street parking, the proposed off street parking arrangement is illustrated in **Figure 4.17.**

Figure 4.17: Proposed Off Street Parking Arrangement in Santry Village at Shanowen Road

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:

- Along the Swords Road (R132), the current proposal is to remove 13 informal parking spaces to the front of the Coachman's Inn. The majority of the impacted spaces are being used as parking for the Coachman's Inn. The impact is minor as The Coachman's Inn has parking provision for 78 parking spaces on its grounds.

- Along the Swords Road (R132), the current proposal is to remove 14 commercial parking spaces at Paddy Shanahan Cars.

- Along the Swords Road (R132) at Schoolhouse Mews a reduction of informal commercial on-street parking and adjacent parking at Magner's Pharmacy is mitigated with the relocation of three on-street designated spaces to the front of Magner's Pharmacy on the Swords Road and rationalisation of parking on Schoolhouse Lane. The removal of seven parking spaces at Trade Electric Group, Swords Road is considered the best method of providing for the objectives of the scheme.

- The impact on residential parking along the Swords Road at Shanowen Road is considered acceptable as residential properties adjacent to the parking spaces can be provide with dedicated alternative parking facilities by providing a driveway in their front gardens.

- At Santry Village, only one of 11 the adjacent commercial parking spaces at The Comet is to be removed. 36 other adjacent parking spaces are available in the vicinity of The Comet

- At Swords Road / Iveragh Road the removal of three commercial car park spaces along Swords Road is deemed as acceptable due to the availability of 15 other parking spaces on Iveragh Road.

- Along the Lower Drumcondra Road at Clonliffe Road, the number of Pay and Display parking spaces is reduced from nine to six spaces. The reduction in commercial parking spaces is to be diverted to the adjacent parking spaces at St. Anne's Road.

- At North Frederick Street a reduction of 16 Paid Parking spaces can be accommodated along the adjacent Hardwick Street, and there is further residential parking 100m to the north along Blessington Street and Wellington Street Lower. Planning permission has been granted to DCC to develop Parnell Square as a cultural quarter. As such any changes at this location due to the Bus Connects Scheme should be designed in line with the approved plans for Parnell Square. As per the Planning Application Report for Parnell Square Cultural Quarter, the subject site is located within a parking zone where car parking provision should be restricted owing to the proximity of these locations to public transport.

4.15 Turning Bans

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 4.12**.

Table 4.12: Summary of Turning Bans

Chainage	Minor Road	Major Road	Existing or Proposed	Turning Ban	Reason for Turning Ban
2275	Coachmans Inn Egress	Swords Road (R132)	Existing	No Right Turn	Island in Centre of Road
7580	Larkhill Road	Swords Road (R132)	Existing	No Right Turn	Larkhill Road is one way
7650	Old Swords Road	Shantalla Road	Existing	No Left Turn	Old Swords Road is one way

Chainage	Minor Road	Major Road	Existing or Proposed	Turning Ban	Reason for Turning Ban
7650	Old Swords Road	Larkhill Road	Existing	No Left Turn	Larkhill Road is one way
8025	Holy Child Roman Catholic Church	Swords Road (N1)	Existing	No Right Turn	Island in Centre of Road
9350	Home Farm Road	Upper Drumcondra Road	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
9360	Home Farm Road	Upper Drumcondra Road	Existing	No Left Turn	Existing Turn Ban used to regulate Traffic flow
9925	Millmount Avenue	Upper Drumcondra Road	Existing	No Left Turn	Existing Turn Ban used to regulate Traffic flow
9930	Richmond Road	Upper Drumcondra Road	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
10220	Carlingford Road	Drumcondra Road Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
10300	Dargle Road	Drumcondra Road Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
10420	St. Alphonsus Road	Drumcondra Road Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
10520	St. Alphonsus Avenue	Drumcondra Road Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
10530	St. Alphonsus Avenue	Drumcondra Road Lower	Existing	No Left Turn	One way street - Exit Only
10580	Grattan Parade	Drumcondra Road Lower	Existing	No Right Turn	Island in centre of road
10570	Fitzroy Avenue	Drumcondra Road Lower	Existing	No Right Turn	Island in centre of road
10750	Whitworth Road	Drumcondra Road Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow

Chainage	Minor Road	Major Road	Existing or Proposed	Turning Ban	Reason for Turning Ban
10770	Whitworth Place	Drumcondra Road Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
10900	Belvidere Road	Dorset Street Lower	Existing	No Left Turn	Existing Turn Ban used to regulate Traffic flow
10900	Innisfallin Parade	Dorset Street Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
10920	Belvidere Road	Dorset Street Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
10920	Innisfallin Parade	Dorset Street Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11000	North Circular Road	Dorset Street Lower	Existing	No Right or Left Turn	Existing Turn Ban used to regulate Traffic flow
11030	North Circular Road	Dorset Street Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11100	Gardiner Street Upper	Dorset Street Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11100	Synott Place	Dorset Street Lower	Proposed	No Left Turn	Remove conflict between cyclists and turning vehicles
11250	Eccles Street	Dorset Street Lower	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11300	Hardwicke Place	Dorset Street Lower	Proposed	No Left Turn	Remove conflict between cyclists and turning vehicles
11300	Eccles Street	Dorset Street	Proposed	No Right Turn	Straight ahead only
11330	Hardwicke Place	Dorset Street Upper	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11480	North Fredrick Street	Dorset Street Upper	Existing	No Left Turn except Public Service Vehicles, Motorcycles and Cyclists	Existing Turn Ban used to regulate Traffic flow
11480	Blessington Street	Dorset Street Upper	Existing	No Right Turn	One way street - Exit Only

Chainage	Minor Road	Major Road	Existing or Proposed	Turning Ban	Reason for Turning Ban
11520	North Fredrick Street	Dorset Street Upper	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11520	Blessington Street	Dorset Street Upper	Existing	No Left turn	One way street - Exit Only
11530	North Fredrick Street	Dorset Street Upper	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11720	Granby Row	Dorset Street Upper	Existing	No Left Turn	Existing Turn Ban used to regulate Traffic flow
11720	St Mary's Place	Dorset Street Upper	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11750	Granby Row	Dorset Street Upper	Existing	No Right Turn	Existing Turn Ban used to regulate Traffic flow
11750	Granby Row	Dorset Street Upper	Existing	No Left Turn	Existing Turn Ban used to regulate Traffic flow
C 380	Rutland Place	Parnell Street	Existing	No Right Turn	Straight ahead or left only
D 50	Granby Lane	Granby	Existing	No Right Turn	One Way Street
D 280	Granby Place	Parnell Square West	Existing	No Right Turn	One Way Street

4.16 Deviations from Standard

The Proposed Scheme has been designed in line with the principles and guidance outlined within the DMURS 2019. The scheme proposals have been developed in direct response to the aims and objectives of the Proposed Scheme as 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.
- 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 and place for 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 from these. A schedule of identified deviations relating to the road geometry, alongside those identified for other technical design elements, is included within **Appendix C.**

4.17 Road Safety and Road User Audit

DMURS recommends that a Quality Audit should be undertaken to demonstrate that appropriate consideration has been given to all of the relevant aspects of the design of any scheme which involves works on public roads. Furthermore, NGS Circular 3 of 2022, issued by the Department of Transport on the 7th June 2022 notes that Quality Audits are required for all works carried out on public roads which involve new infrastructure or reconfiguration of existing infrastructure.

NGS Circular 3 of 2022 outlines the following stages in the Audit process:

- Stage F: Route selection stage;
- Stage 1: Completion of preliminary design;
- Stage 2: Completion of detailed design,;
- Stage 3: Completion of construction; and
- Stage 4: Early operation.

In line with the above, a Stage 1 Quality Audit has been carried out on the Proposed Scheme. Refer to the Quality Audit Report in Appendix M1 The Quality Audit considers the following elements, and has been undertaken in general accordance with DMURS:

- Visual Quality Audit;
- Street Use Audit;
- Road Safety Audit;
- Access Audit;
- Walking Audit;
- Cycle Audit;
- Non-Motorised User Audit;
- Community Audit; and
- Place Check Audit.

In line with The TII Publication 'GE-STY-01024 Road Safety Audit' document, a Stage 1 RSA was undertaken as part of the Preliminary Design development. The RSA has been included in Appendix M2 complete with the proposed designers' responses.

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 Layout

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 BCPDGB. 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 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 car, 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 car, with the Proposed Scheme (i.e. the 'DM' scenario with the addition of the Proposed Scheme)

Both scenarios above comprised of 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 have 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 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 BCPDG;
- 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 practical;

- People Movement Calculator to inform junction staging and design development;
- LINSIG junction modelling to assess junction design performance and refinement;
- Micro-simulation 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 of 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 were kept as short as practicable. The cycle times at all signalised junctions in the DS scenarios for 2028 and 2043 are shown in the summary **Table 5.1**.

Table 5.1: Do-Something Cycle Times

No.	Junction	Proposed Do Something Cycle Time (sec)
1	Pinnockhill Jn (Swords (R132) Rd/ Dublin Rd)	120
2	Swords Road (R132)/Boroimhe Road (L2300)/Access to Airside	125
3	Kettle Lane Priority Junction	120
4	Dublin Road (R132)/Naul Road/Stockhole Lane	120
5	Dublin Airport Roundabout	90
6	Swords Road (R132)/Green Long-Term Car Park	120
7	Swords Road (R132)/Corballis Road	120
8	Swords Road (R132)/Old Airport Road	120
9	Swords Road (R132)/Quick Park at Dublin Airport	120
10	Swords Road (R132)/Turnapin Lane	120
11	Swords Road (R132)/Northwood Avenue	120

No.	Junction	Proposed Do Something Cycle Time (sec)
12	Swords Road (R132)/Coolock Lane	120
13	Swords Road (R132)/Santry Avenue	120
14	Swords Road (R132)/Magenta Crescent	120
15	Swords Road (R132)/Lorcan Rd/Omni Park Shopping Centre Access	120
16	Swords Road (R132)/Shanowen Road	120
17	Swords Road (R132)/Larkhill Road/Shanrath Road	120
18	Swords Road (R132)/Shantalla Rd	120
19	Swords Road (R132)/Collins Avenue	120
20	Swords Road (R132)/Iveragh Road	120
21	Swords Road (R132)/Seven Oaks Junction	120
22	Drumcondra Road Upper (R132)/Griffith Avenue	120
23	Drumcondra Road Upper (R132)/Home Farm Road	120
24	Drumcondra Road Upper (R132)/Richmond Road/Millmount Ave	120
25	Drumcondra Road Lower (R132)/Botanic Avenue	120
26	Drumcondra Road Lower (R132)/Clonliffe Road	120
27	Drumcondra Road Lower/Whitworth Place/Whitworth Road	120
28	Dorset Street Lower/Belvidere Road/Innisfallen Parade	120
29	Dorset Street Lower/North Circular Road	120
30	Dorset Street Lower/Gardiner Street Upper/Synnott Place	120
31	Dorset Street Lower/Eccles Street/Hardwicke Place	120
32	Dorset Street Lower/Frederick Street North/Blessington Street	120
33	Parnell Square north/Gardiner Row	120
34	St Mary's Pl North/Granby Row	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 removing 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 lanes 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. These instances have 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 BCPDG and referred to as Junction Types 1 to 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 the BCPDGB, comprises a dedicated bus lane on both inbound and outbound directions continued 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.

An example of a Junction Type 1 on the Proposed Scheme is shown in **Figure 5.1**.

Figure 5.1: Junction Type 1

The majority of the junction layouts for the Proposed Scheme follow Junction Type 1. However, some of the layouts on the Proposed Scheme, which use Junction Type 2 to 4 (**Figure 5.2 to Figure 5.4)**, or 'hybrid' junction layouts which comprise of a combination of Type 1 to 4, are disused in the next sections.

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-turning traffic is fewer than 150 PCUs per hour, then mainline cyclists could still proceed with left-turning traffic from the left-turning pocket on a flashing amber arrow.

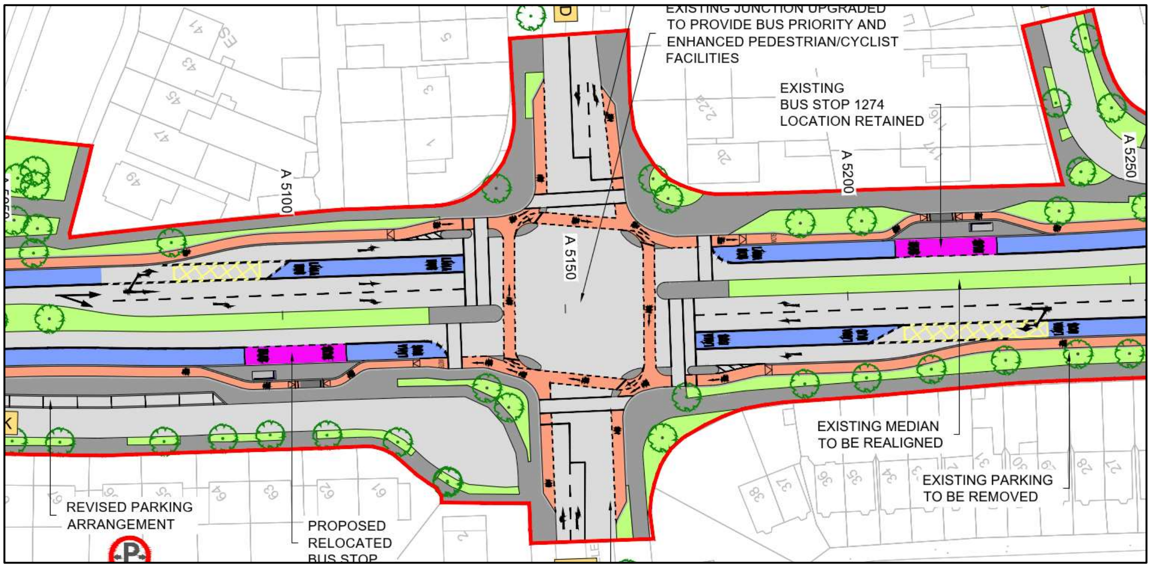

Figure 5.2: Junction Type 2

There are four hybrid layouts (i.e., combination of Types 1 and 2) on the Proposed Scheme.

5.3.3.3 Junction Type 3

Junction Type 3, as described in Section 7.4.3 of BCPDGB, illustrates a signalised junction 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 approximately 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.

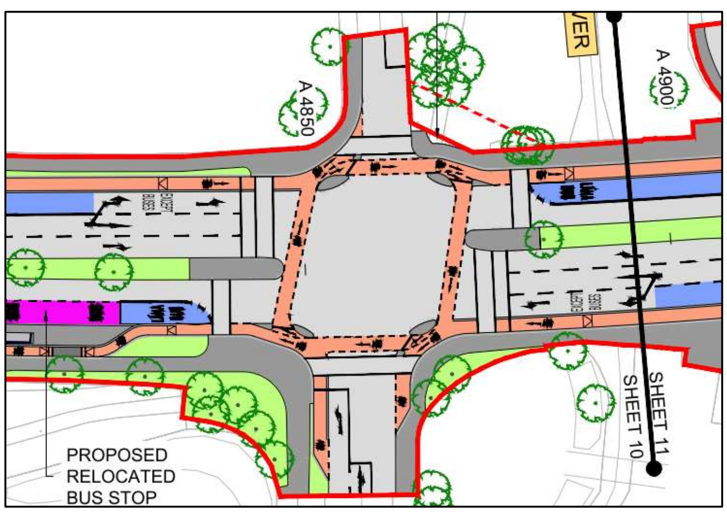

Figure 5.3: Junction Type 3

There is only one junction with a full Type 3 layout on the Proposed Scheme. However, there are three junctions with hybrid layouts (i.e., combinations of Types 1 and 3) on the Proposed Scheme.

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;
- 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 would be chosen for the following reasons:

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

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

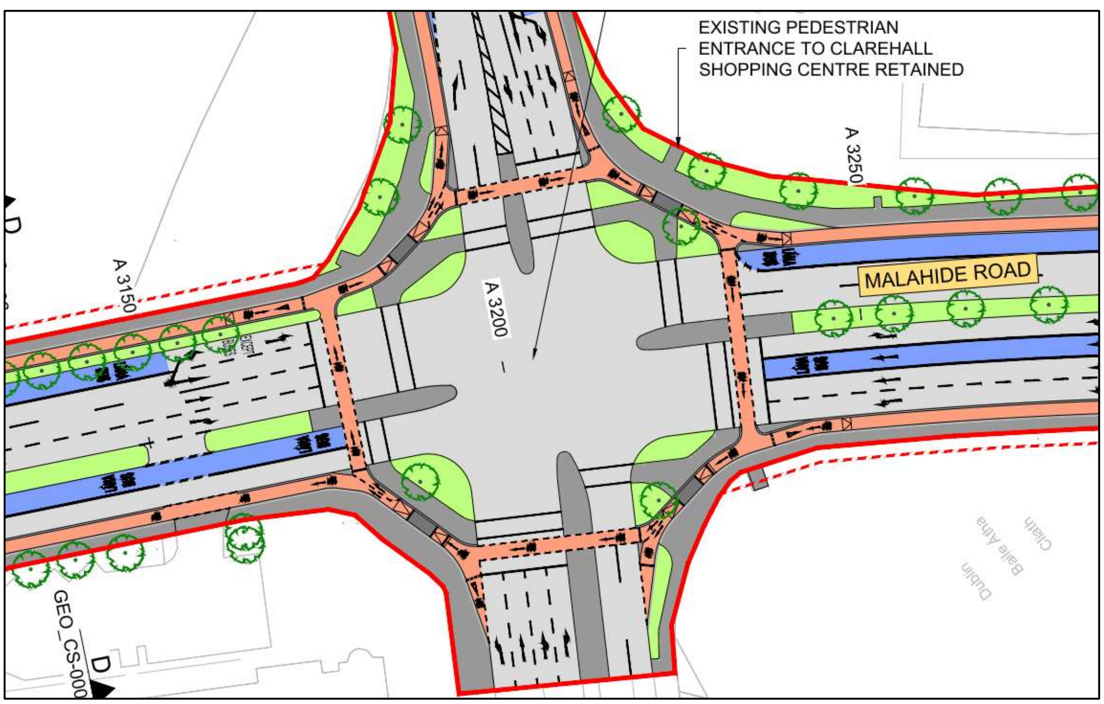

Figure 5.4: Junction Type 4

There are no Type 4 junctions on the Proposed Scheme.

5.3.4 Staging and Phasing

The optimum staging for each junction is 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 presents 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 five seconds early start has been proposed on the main arms of the majority of junctions, with three 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

No.	Junction Location	Description
1	Pinnockhill Jn (Swords (R132) Rd/ Dublin Rd)	New traffic signal crossroads replacing roundabout
2	Swords Road (R132)/Boroimhe Road (L2300)/Access to Airside	Modified and fully refurbished traffic signal crossroads.
3	Dublin Road (R132)/Naul Road/Stockhole Lane	New traffic signal crossroads replacing partial signalised roundabout
4	Dublin Airport Roundabout	Modified and fully refurbished traffic signal roundabout
5	Swords Road (R132)/Green Long-Term Car Park	Modified and fully refurbished traffic signal T-junction
6	Swords Road (R132)/Corballis Road	Modified and fully refurbished traffic signal crossroads
7	Swords Road (R132)/Old Airport Road	Modified and fully refurbished traffic signal crossroads
8	Swords Road (R132)/Turnapin Lane	Modified and fully refurbished traffic signal crossroads
9	Swords Road (R132)/Northwood Avenue	Modified and fully refurbished traffic signal T-junction

No.	Junction Location	Description
10	Swords Road (R132)/Coolock Lane	Modified and fully refurbished traffic signal crossroads
11	Swords Road (R132)/Santry Avenue	Modified and fully refurbished traffic signal T-junction
12	Swords Road (R132)/Lorcan Road/Omni Park Shopping Centre Access	Modified and fully refurbished traffic signal crossroads
13	Swords Road (R132)/Shanowen Road	Modified and fully refurbished traffic signal crossroads
14	Swords Road (R132)/Larkhill Road/Shanrath Road	Modified and fully refurbished traffic signal crossroads
15	Swords Road (R132)/Collins Avenue	Modified and fully refurbished traffic signal crossroads
16	Drumcondra Road Upper (R132)/Griffith Avenue	Modified and fully refurbished traffic signal crossroads
17	Drumcondra Road Upper (R132)/Richmond Road/Millmount Ave	Modified and fully refurbished traffic signal crossroads
18	Drumcondra Road Lower (R132)/Botanic Avenue	Modified and fully refurbished traffic signal crossroads
19	Drumcondra Road Lower (R132)/Clonliffe Road	Modified and fully refurbished traffic signal T-junction
20	Drumcondra Road Lower/Whitworth Place/Whitworth Road	Modified and fully refurbished traffic signal T-junction
21	Dorset Street Lower/Belvidere Road/Innisfallen Parade	Modified and fully refurbished traffic signal crossroads
22	Dorset Street Lower/North Circular Road	Modified and fully refurbished traffic signal crossroads
23	Dorset Street Lower/Gardiner Street Upper/Synnott Place	Modified and fully refurbished traffic signal crossroads
24	Dorset Street Lower/Eccles Street/Hardwicke Place	Modified and fully refurbished traffic signal crossroads
25	Dorset Street Lower/Frederick Street North/Blessington Street	Modified and fully refurbished traffic signal crossroads
26	Parnell Square north/Gardiner Row	Modified and fully refurbished traffic signal crossroads
27	St Mary's Pl North/Granby Row	Modified and fully refurbished traffic signal crossroads

Table 5.3: Overview of Moderate Junctions

No.	Junction Location	Description
1	Kettles Lane Priority Junction	New and fully refurbished traffic signal T-junction
2	Swords Road (R132)/Quick Park at Dublin Airport	Modified and fully refurbished traffic signal T-junction
3	Swords Road (R132)/Magenta Crescent	New traffic signal T-junction
4	Swords Road (R132)/Shantalla Rd	New traffic signal T-junction

No.	Junction Location	Description
5	Swords Road (R132)/Iveragh Road	New traffic signal T-junction
6	Swords Road (R132)/Seven Oaks Junction	Modified and fully refurbished traffic signal T-junction
7	Drumcondra Road Upper (R132)/Home Farm Road	Modified and fully refurbished traffic signal T-junction

5.3.5.1 Minor and Priority Junctions

There are 32 minor, mid-block signal and priority junctions (not including minor access points for properties) across the Proposed Scheme. These are shown on the General Arrangement Drawings contained within **Appendix B.**

5.3.5.2 Roundabouts

The airport roundabout is being retained 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, and whilst mitigating any resulting adverse traffic impacts.

The traffic modelling steps can be summarised as follows and are 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.

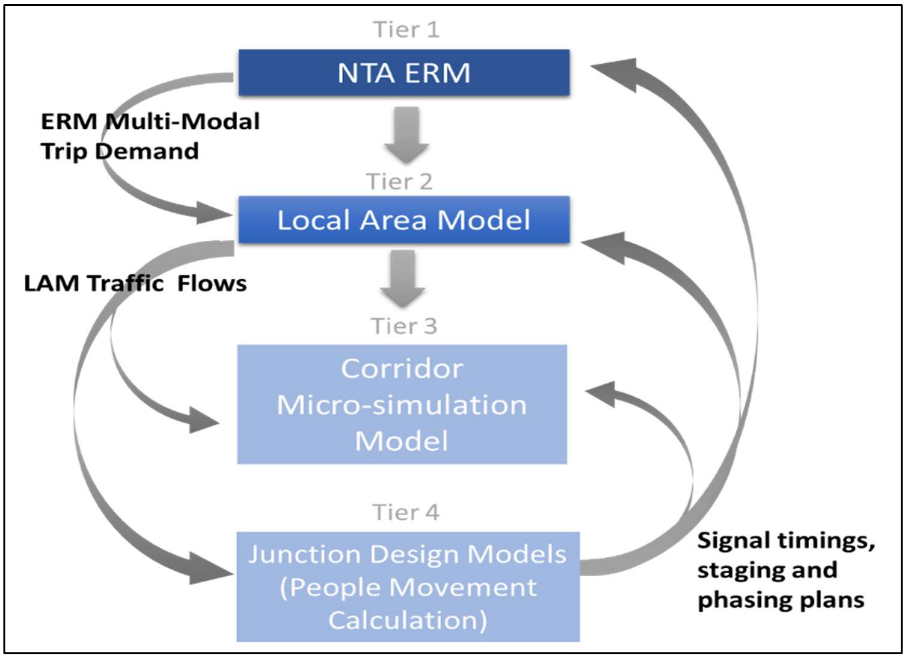

Figure 5.5: Proposed Scheme Traffic Modelling Hierarchy

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** left image illustrates an initial 2028 AM distribution plot, whilst **Figure 5.7** right image illustrates a final iterated distribution plot. The left image illustrates more significant traffic dispersion onto the surrounding road network, whilst the refined right image demonstrates a more optimised Proposed Scheme, where traffic dispersion has been significantly minimised without compromising the sustainable modes.

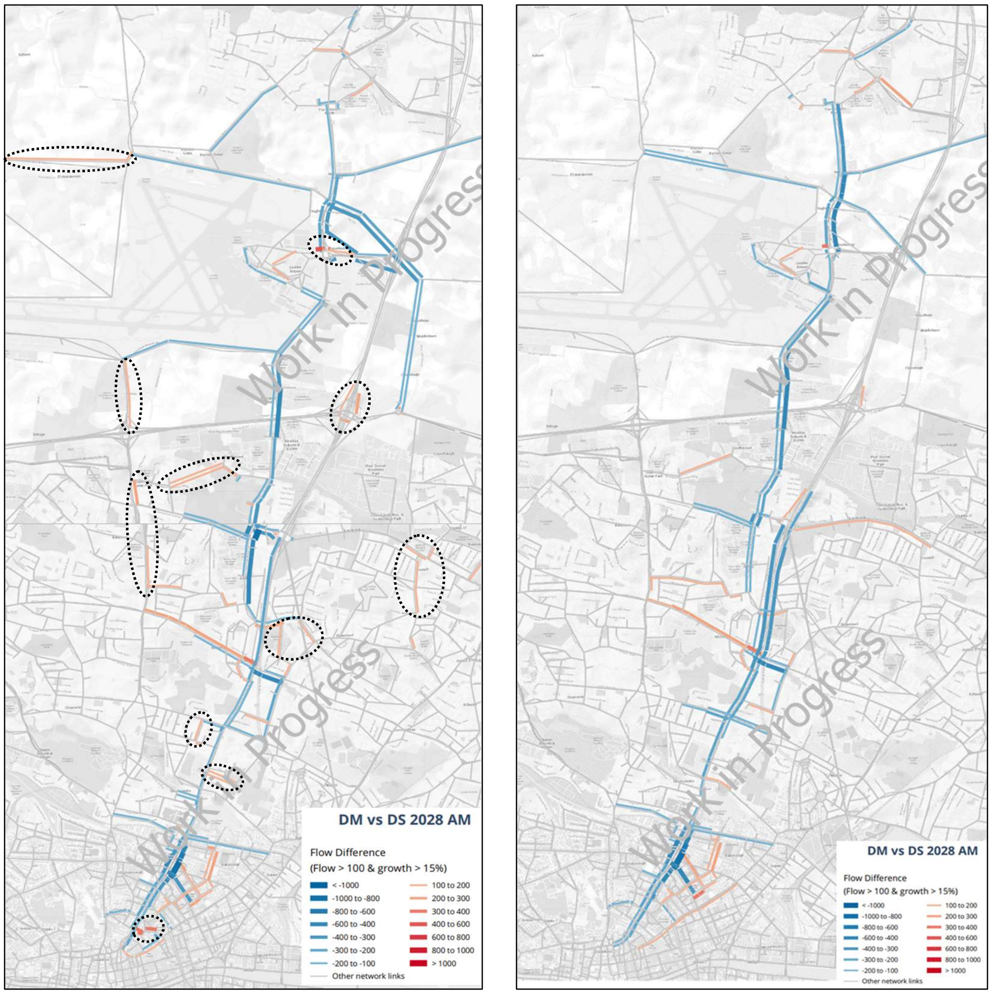

Figure 5.7: Flow Difference on Road links (Do-Minimum vs Do-Something), AM Peak Hour, 2028 Opening Year

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 main CBC 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 'National Cycle Policy Framework' (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 National Cycle Policy Framework. 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.

Table 5.4: Cyclist People Movement Quantification

No.	Junction Name	Cycle Quantification (Number of Cyclists)			
		2028 AM Peak Hour		2028 PM Peak Hour	
		Design Target	Total Modelled	Design Target	Total Modelled
1	Swords Road Bypass (R132) Dublin Road (R132) / Dublin Road (R836) / Pinnockhill (R125) Junction	713	320	693	399
2	Dublin Road (R132) / Swords Road (R132) / Boroimhe Road / Lakeshore Drive Junction	696	360	696	470
3	Swords Road (R132) / Kettle's Lane Junction	794	549	764	764
4	Dublin Road (R132) / Naul Road / Stockhole Lane Junction	1,104	590	1,074	605
5	Swords Road (R132) / Airport Motorway Link / Corballis Road North Junction	1,373	690	1,343	747
6	Swords Road (R132) / Green Long-Term Car Park Junction	693	693	693	693
7	Swords Road (R132) / Corballis Road South / Eastland's Road Junction	640	640	640	640
8	Swords Road (R132) / Collinstown Lane / Old Airport Road Junction	1,091	787	1051	991
9	Swords Road (R132) / Quickpark Car Park Access Junction	949	949	949	949
10	Swords Road (R132) / Turnapin Lane Junction	774	339	753	330
11	Swords Road (R132) / Northwood Avenue Junction	729	729	729	729
12	Swords Road (R132) / Coolock Lane (R104) Junction	906	659	906	616
13	Swords Road (R132) / Santry Avenue (R104) / Church Lane Junction	931	670	878	598
14	Swords Road (R132) / Magenta Crescent Junction	801	591	801	702
15	Swords Road (R132) / Lorcan Road / Omni Park Shopping Centre Access Junction	968	894	929	680
16	Swords Road (R132) / Shanowen Road Junction	No Protected Cycle Facilities			
17	Swords Road (R132) / Shantalla Road (R132) / Larkhill Road / Shanrath Road Junction	320	320	320	320
18	Swords Road (R132) / Shantalla Road (R132) Junction	603	603	603	603

No.	Junction Name	Cycle Quantification (Number of Cyclists)			
		2028 AM Peak Hour		2028 PM Peak Hour	
		Design Target	Total Modelled	Design Target	Total Modelled
19	Swords Road (R132) / Collins Avenue (R103) Junction	1,154	634	1,166	699
20	Swords Road (R132) / Iveragh Road Junction	1,289	485	1,297	438
21	Swords Road (R132) / Seven Oaks Junction	1,432	850	1,426	1,426
22	Drumcondra Road Upper (R132) / Griffith Avenue (R102) Junction	1,486	669	1483	610
23	Drumcondra Road Upper (R132) / Home Farm Road Junction	1,429	1429	1,429	714
24	Drumcondra Road Upper (R132 / Drumcondra Road Lower (R132) / Richmond Road / Millmount Avenue Junction	1,289	716	1,260	780
25	Drumcondra Road Lower (R132) / Botanic Avenue / Cian Park Junction	1,259	690	1,246	734
26	Drumcondra Road Lower (R132) / Clonliffe Road (R131) Junction	1,532	888	1,532	993
27	Drumcondra Road Lower (R132) / Dorset Street Lower (R132) / Whitworth Place / Whitworth Road Junction	1,704	1023	1,699	1121
28	Dorset Street Lower (R132) / Belvidere Road / Innisfallen Parade Junction	1,733	950	1,734	1,053
29	Dorset Street Lower (R132) /North Circular Road (R101) Junction	1,981	1,363	1,974	1,243
30	Dorset Street Lower (R132) / Gardiner Street Upper (R82) /Synnott Place Junction	1,734	861	1740	976
31	Dorset Street Lower (R132) / Dorset Street Upper (R132) / Eccles Street / Hardwicke Place Junction	1,681	854	1,661	979
32	Dorset Street Upper (R132) / North Frederick Street (R132) / Blessington Street (R135) Junction	1,655	1,087	1,638	1,000
33	North Frederick Street (R132) / Parnell Square East (R132) / Parnell Square North / Gardiner Row Junction	1,574	582	1,550	1,022
34	Dorset Street Upper (R132) Granby Row (R132) / St Mary's Place (R135) / Dorset Street Upper (R804) Junction	1,702	760	1,691	760

5.4.4.3 LinSig Results

Table 5.5 provides an overview of the junction analysis results.

Table 5.5: Signalised Junctions

No.	Junction Name	Signal Cycle Time (sec)		2028 Peak Hour (PRC in %)	
		Do Minimum	Do Something	AM Peak	PM Peak
1	Swords Road Bypass (R132) Dublin Road (R132) / Dublin Road (R836) / Pinnockhill (R125) Junction	N/A	120	-8.3	-18.5
2	Dublin Road (R132) / Swords Road (R132) / Boroimhe Road / Lakeshore Drive Junction	MOVA	125	-11.5	-16.2
3	Swords Road (R132) / Kettle's Lane Junction	N/A	120	2.1	21.1
4	Dublin Rd (R132) / Naul Road / Stockhole Lane Jn	MOVA	120	-16.0	-12.0
5	Swords Road (R132) / Airport Motorway Link / Corballis Road North Junction	80	90	-19.7	-10.1
6	Swords Rd (R132) / Green Long-Term Car Park Jn	100	120	69.3	270.3
7	Swords Road (R132) / Corballis Road South / Eastland's Road Junction	100	120	106.4	122.7
8	Swords Road (R132) / Collinstown Lane / Old Airport Road Junction	120	120	1.2	-7.4
9	Swords Rd (R132) / Quickpark Car Park Access Jn	MOVA	120	21.0	65.0
10	Swords Road (R132) / Turnapin Lane Junction	-	120	0.7	13.2
11	Swords Road (R132) / Northwood Avenue Junction	-	120	18.2	20.7
12	Swords Road (R132) / Coolock Lane (R104) Jn	140	120	1.1	-3.6
13	Swords Road (R132) / Santry Avenue (R104) / Church Lane Junction	140	120	1.7	-1.3
14	Swords Road (R132) / Magenta Crescent Junction	N/A	120	20.8	20.0
15	Swords Road (R132) / Lorcan Road / Omni Park Shopping Centre Access Junction	90	120	8.6	-21.9
16	Swords Road (R132) / Shanowen Road Junction	120	120	12.4	22.0
17	Swords Road (R132) / Shantalla Road (R132) / Larkhill Road / Shanrath Road Junction	120	120	31.6	28.5
18	Swords Road (R132) / Shantalla Road (R132) Junction	N/A	120	38.6	25.1
19	Swords Road (R132) / Collins Avenue (R103) Jn	120	120	1.1	-12.0
20	Swords Road (R132) / Iveragh Road Junction	120	120	37.9	12.2
21	Swords Road (R132) / Seven Oaks Junction	-	120	16.1	8.5
22	Drumcondra Road Upper (R132) / Griffith Avenue (R102) Junction	120	120	-5.6	-7.0
23	Drumcondra Rd Upper (R132) / Home Farm Rd Jn	120	120	38.4	17.8
24	Drumcondra Rd Upper (R132 / Drumcondra Rd Lower (R132) / Richmond Rd/ Millmount Avenue Jn	120	120	-60.0	-39.0
25	Drumcondra Road Lower (R132) / Botanic Avenue / Cian Park Junction	120	120	1.5	6.5

No.	Junction Name	Signal Cycle Time (sec)		2028 Peak Hour (PRC in %)	
		Do Minimum	Do Something	AM Peak	PM Peak
26	Drumcondra Rd Lower (R132) / Clonliffe Rd (R131) Jn	120	120	6.7	2.8
27	Drumcondra Road Lower (R132) / Dorset Street Lower (R132) / Whitworth Place / Whitworth Road Junction	136	120	-7.1	-15.6
28	Dorset Street Lower (R132) / Belvidere Road / Innisfallen Parade Junction	130	120	-1.9	-47.4
29	Dorset Street Lower (R132) /North Circular Road (R101) Junction	120	120	-3.4	-4.7
30	Dorset Street Lower (R132) / Gardiner Street Upper (R82) /Synnott Place Junction	120	120	-19.9	-6.1
31	Dorset Street Lower (R132) / Dorset Street Upper (R132) / Eccles Street / Hardwicke Place Junction	120	120	-17.6	-6.8
32	Dorset Street Upper (R132) / North Frederick Street (R132) / Blessington Street (R135) Junction	120	120	24.0	7.4
33	North Frederick St. (R132) / Parnell Square East (R132) / Parnell Square North / Gardiner Row Jn	90	120	-5.4	-6.7
34	Dorset St. Upper (R132) Granby Row (R132) / St Mary's Place (R135) / Dorset St Upper (R804) Jn	110	120	56.6	16.6

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 using data from the Geological Survey Ireland (GSI), GeoHive, Environmental Protection Agency and Flood Information websites.

- 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 and Hydrogeology of the Environmental Impact Assessment Report (EIAR) Volume 2 of 4 Main Report.

6.2 Summary of Ground Investigation Contract

The ground investigation (GI) works for the project are being undertaken in a phased manner. Only a preliminary ground investigation had been carried out at the time of writing. This was carried out between September and November 2020, 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 led to restricting the initial scope of the ground investigation to the Frank Flood Bridge (ChA9950-A10000) in Drumcondra and a proposed retaining wall at the Airport Business Park in Santry (ChA5200-A5800).

The Ground Investigation contractor, Causeway Geotechnical Ltd was appointed by the NTA. The ground investigation field works were carried out between September and November 2020. Groundwater monitoring is ongoing.

6.3 Ground Investigation

Three boreholes were proposed for the work, one cable percussion borehole at Airport Business Park and two cable percussion boreholes with rotary follow-on at each proposed abutment location at Frank Flood Bridge. The borehole at Airport Business Park was cancelled due to access constraints. The borehole at the north abutment of

Frank Flood Bridge was also abandoned as the location of utilities in the vicinity were not proven prior to mobilising to site. The initial phase of ground investigation also comprised two trial pits in Whitehall, at the former site of the Dublin Port Tunnel Shaft (ChA8250-A8550) and two slit trenches at the Frank Flood Bridge to investigate the depth and number of utilities in the vicinity of the bridge.

The investigation comprised:

- 1 no. Cable Percussion Borehole with rotary cored follow-on;
- 2 no. Trial Pits;
- 3 no. Slit Trench for utilities identification;
- Geotechnical and environmental sampling;
- Groundwater monitoring; and
- In-situ testing and laboratory testing of samples.

For further details of the works refer to Factual Report – Report No. 20-0399A Bus Connects Route 2 Swords to City Centre – Ground Investigation, Causeway Geotechnical Ltd, December 2020 (**Appendix E**).

Further phases of ground investigation generally conforming to the guidelines of Eurocode 7 will be required as the design develops.

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 and Hydrogeology, Environmental Impact Assessment Report (EIAR) Volume 2 of 4 Main Report.
- Factual Report – Report No. 20-0399A Bus Connects Route 2 Swords to City Centre – Ground Investigation, Causeway Geotechnical Ltd, December 2020 (Appendix E).

6.4.1 Quaternary Deposits

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

- Glacial till or gravels derived from limestones.
- Local deposits of alluvium are expected to cross the route between ChA200-A350, ChA1450-ChA1500, ChA5700-A5800 and Ch A9750-A10050.

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

6.4.2 Bedrock Geology

The route passes through 4 different bedrock formations along the route:

- Malahide formation of Limestone, between Ch A0 – Ch A1950.
- Waulsortian Limestones of ‘massive unbedded lime-mudstone’, between Ch A1950 – Ch A2450.
- Tober Colleen formation of ‘calcareous shale, Limestone conglomerate’, between Ch A2450 – Ch A4350; and

- Lucan formation, of 'dark limestone and shale' between Ch A4350 – CH A11764 and Ch C10 – Ch C450 and CH D0 – Ch D374.

6.5 Contaminated Land

The proposed works will be carried out within a predominantly urban environment, therefore there is a high probability of made ground associated with residential and industrial development being encountered across the scheme. Additionally, a historic quarry is recorded to the east of R132 Dublin Road and south of Stockhole Lane at Cloghran Roundabout.

Made ground was recorded at two locations during the ground investigation, the site of the Port Tunnel Shaft at the junction of Swords Road and Collins Avenue and at Frank Flood Bridge. Samples tested for contamination were determined to be non-hazardous, however, further testing is required.

6.6 Ground Summary and Material Properties

The ground conditions at the south abutment of the proposed structure at Frank Flood Bridge were investigated during the Bus Connects Route 2 Swords to City Centre – Ground Investigation. The borehole carried out indicated that the ground conditions at this location are largely consistent with what was anticipated following the desk study of firm to stiff fine grained Glacial Till overlying limestone bedrock. A greater thickness of made ground than anticipated was recorded in the borehole and slit trenches carried out at both north and south abutment locations.

For full details of the ground conditions and material properties of the structures investigated in the preliminary GI refer to Factual Report – Report No. 20-0399A Bus Connects Route 2 Swords to City Centre – Ground Investigation, Causeway Geotechnical Ltd, December 2020 (**Appendix E**).

6.7 Groundwater

A summary of the groundwater monitoring to date is presented in **Table 6.1** below. Details of the monitoring standpipe can be found in Factual Report – Report No. 20-0399A Bus Connects Route 2 Swords to City Centre – Ground Investigation, Causeway Geotechnical Ltd, December 2020 (**Appendix E**).

Table 6.1: Summary of Groundwater Monitoring.

Borehole ID	Standpipe Depth (m)	Depth to Groundwater (m)					
		19-Nov	19-Jan	12-Feb	23-Apr	02-Jun	22-Jun
R2-CPRC02	10.57	2.93	2.61	2.72	2.88	2.83	2.96

6.8 Preliminary Engineering Assessment

Construction of the Proposed Scheme will require a small number of relatively low-height retaining walls and minor structures as well as a bridge crossing over the Tolka River. Further details are provided in **Chapter 8.**

6.8.1 Foundations and Retaining Walls

The underlying geology of stiff Glacial Till or bedrock 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 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 may also have been done to level a hill side; or
- The ground has been previously disturbed to construct a deep sewer, fuel tank or other buried structure.

6.8.2 Frank Flood Bridge

The foundations for the river crossing adjacent to the existing Frank Flood bridge are anticipated to be a combination of end-bearing piles on the south abutment and a tension piles on the north abutment. The results of a preliminary assessment indicate that ground conditions recorded R2-CPRC02, comprising stiff to very stiff Glacial Till and bedrock of limestone, are anticipated to provide sufficient skin friction and bearing capacity for 600mm diameter piles.

Further investigation of the north bank is required to confirm the ground model in this location for the design of the tension pile.

6.8.3 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 on-going 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 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 re-use 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, and a detailed cost estimate of the proposed pavement works will be prepared).
- 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 design. Investigation into ground conditions will be required in areas where widening of the existing carriageway or construction off-line 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 off-line 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 may require new full depth construction.

For widening schemes, 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
- Fingal 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 budget and is reactive to public complaints. Road Condition Index (RCI) is determined from the 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 walked high-level visual 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 was stored in ArcGIS. 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 Right-of-Way (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 a typical general arrangement plan 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.

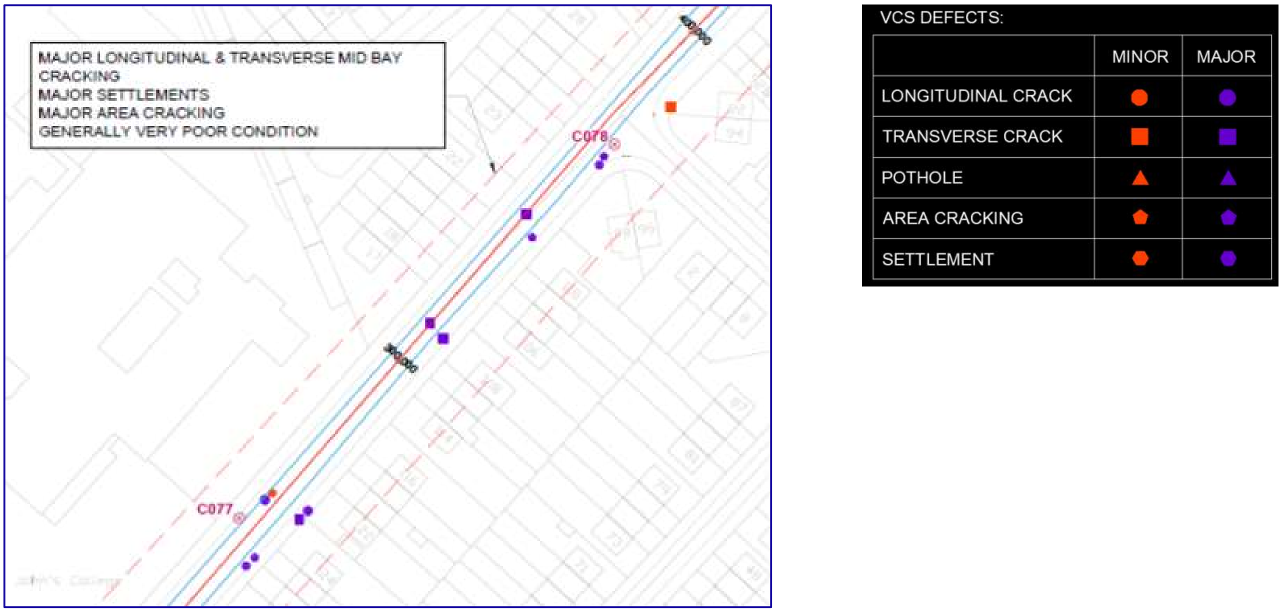

Figure 7.1: Example Ranking of Pavement Condition and the Type and Location of Defects Observed.

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 and information from drive-through videos. 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 **Table 7.2** 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	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 is considered 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 Baring 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 300 mm.

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 period. Two alternative options should be considered:

- Grouted Macadam surface course. 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 on-line and off-line 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

New Footway	Depth (mm)	Material Type	Specification Clause
Binder course	50	AC20 dense bin 70/100 des	SPW 0900 cl. 3.1.5
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 re-use 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 progressing in accordance with the various phases as outlined in Transport Infrastructure Ireland (TII) Publications.

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 TII 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.

Preliminary Design Reports were produced for Major Structures that require works as part for this scheme. This was undertaken in accordance with DN-STR-03001 Technical Approval of Road Structures on Motorways and Other National Roads (formerly NRA BD 2). The Preliminary Design Reports produced for this scheme are summarised in **Table 8.1.** The Preliminary Design Reports and associated drawings are contained in **Appendix J.**

Table 8.1: Summary of Structures Preliminary Design Reports

Structures	Reference	Appendix
Frank Flood Bridge Preliminary Design Report, Route 2: Swords to City Centre	BCIDB-JAC-STR_ZZ-0002_BR_00-RP-CB-0003	**Appendix J**
Retaining Walls Preliminary Design Report, Route 2: Swords to City Centre	BCIDB-JAC-STR_ZZ-0002_RW_00-RP-CB-0003	**Appendix J**

8.1.1 Consultation

Throughout the development of the options in the subsequent stages of the scheme the following authorities should be kept appraised of the aspects of the proposals that will impact them.

- Dublin City Council;
- Fingal County Council; and
- Transport Infrastructure Ireland.

8.2 Summary of Principal Structures

A number of Principal Structures exist along the length of the scheme. Their location and type is indicated in the **Table 8.2** below.

Table 8.2: Tabular Summary of Principal Structures

Identity	Irish OS Grid	ITM Grid	Chainage(m)	Description
Kilronan Bridge	317813E 244629N	717754E 744653N	1+465	Small stream intersects R132. Corrugated steel pipe culvert spanning 2.2m. No works proposed at this location.
Tolerbunny Bridge	317492E 242600N	717433E 742624N	3+030	Box culvert with splayed integral wingwalls. Carries R132 over Cuckoo stream. Internal span approximately 2m and Internal depth approximately 2m. No widening required at this location.
Turnapin Culvert	317138E 241575N	717079E 741599N	4+775	Box culvert carries the R132 over an unnamed stream. Internal span 1.5 m internal height 1m. No works required at this location.
Turnapin Bridge	317157E 241436N	717098E 741459N	4+900	Carries the M50 over the R132. Widening of highway corridor below structure. Regrading of block paver verges, however no impact to structural elements.
Santry Bridge	317046E 240699N	716987E 740722N	5+710	Carries R132 over the Santry River. Gabion wingwalls are visible at west end. Consists of 3 No. pipe culverts all less than 1m span. East end of structure consists of a masonry arch culvert. No proposed works at this location.
Frank Flood Bridge	316172E 236739N	716113E 736763N	9+950	3 span masonry bridge carries the N1 over the River Tolka. Construction of current structure circa 1813. Proposed strengthening and construction of parallel structure.
Drumcondra Rail Bridge	315981E 236143N	715921E 736167N	10+610	Single span steel warren truss carries the Dublin to Sligo rail line over the N1. Deck consists of steel troughing. No proposed works at this location.
Binn's Bridge	315898E 235976N	715839E 736000N	10+770	3 span masonry bridge. Carries the N1 over the Royal canal and the Dublin to Sligo rail line. No proposed works at this location.

8.2.1 Frank Flood Bridge

Frank Flood Bridge (formerly known as Drumcondra Bridge) is an existing structure that carries the Preferred Route Corridor over the Tolka River. The proposed corridor is wider than the existing arrangement and consequently a proposed independent parallel footbridge will be provided.

The existing bridge consists of a 3-span masonry arch with a total length of 19.48m and a width of 19.43m. The bridge was constructed in circa 1813 and is included in the Industrial Heritage Record. The new highways arrangement will result in the removal of the western footpath and the introduction of a northbound bus lane running adjacent to the western parapet. This will require strengthening of the spandrel wall to accommodate the increase in surcharge. Mitigation measures will also be introduced to reduce the risk of collision with the substandard western parapet.

The proposed bridge consists of a 50m, 2-span steel structure comprising central varying depth box girder with a tie down arrangement at the north of the structure. The span arrangement is governed by the flood plain on the south side of the river which needs to remain open for high flow situations. The north span will be 38m and south span will be 12m. Distance between the deck soffit and the ground varies. A minimum clearance of 1.5m is provided at the abutments.

Due to the inclusion of this structure on the Industrial Heritage Record, this structure is considered sensitive to changes in appearance. Therefore, the design of the structure is to minimise impact to the visual appearance to retain the cultural heritage at this site.

The superstructure will consist of a central varying depth box girder to be proportioned to minimise structural depth above deck level and provide unobstructed views of the existing bridge from Our Lady's Park. The girder will increase in depth over the support locations and 'disappear' below deck level at mid span locations. Transverse members will have sufficient stiffness to distribute load into the central girder such that edge girder size can be minimised. Allowance will be made to accommodate the large amount of services to be diverted below the deck. The substructure will consist of conventional bank seat abutments supported on piled foundations at the north and south ends of the structure. The central support will consist of a leaf pier supported by piled foundations set back an appropriate distance from the river wall. A tie down arrangement will be created to the north of the structure with a tension connection between the central box and an independent pile group. This will limit midspan deflections allowing for a more slender structure.

The bridge deck superstructure will be continuous. It will be supported on bearings at both abutments and the pier. Additionally, the superstructure will be connected to an independent pile group via mechanical pin connections. The cross section of the deck is governed by the need to accommodate a large number of utility diversions.

Based on available information, the general ground conditions consist of approximately 3m of made ground above a stratum of soft to firm boulder clay underlain by limestone. Bedrock level is expected to be encountered 10m to 20m below ground level. Foundations would be situated in the boulder clay and will consist of piled foundations.

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;
- Environmental barriers less than 2.0m in height

The scope of the scheme does not require the design of any of the above structures and therefore does not require Technical Approval.

8.4 Summary of Retaining Walls

There are a number of proposed retaining walls and embankment slopes along the length of the scheme. The location and type of structure is indicated in the **Table 8.3**. 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
R2-RW026	Precast RC	varies	1.25	max	1+620	1+650	30	N/A
R2-RW022	Precast RC	varies	2	max	1+940	1+990	50	1
R2-RW027	Graded Slope	varies	1.3	max	2+040	2+125	85	N/A
R2-RW008	In-situ RC	varies	0.75	max	4+380	4+420	40	N/A
R2-RW009	Precast RC	varies	1	max	4+500	4+550	50	N/A
R2-RW010	Precast RC	varies	2	max	5+550	5+620	70	1
R2-RW028	In-situ RC	varies	1	max	6+410	6+470	60	N/A
R2-RW014	In-situ RC	varies	1.2	max	6+730	6+765	35	N/A
R2-RW015	Precast RC	varies	1.4	max	6+770	6+800	30	N/A
R2-RW016	In-situ RC	varies	1.5	max	7+220	7+290	180	1
R2-RW017	In-situ RC	varies	1.5	max	7+255	7+280	25	1
R2-RW018	In-situ RC	varies	1.5	max	7+315	7+385	70	1
R2-RW019	Precast RC	varies	1	max	8+080	8+220	140	N/A
R2-RW020	Precast RC	varies	1.2	max	8+410	8+560	150	N/A
R2-RW029	Precast RC	varies	2	max	8+560	8+640	80	1
R2-RW021	Precast RC	varies	1.4	max	8+710	8+745	35	N/A

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 the Dublin BusConnects Core Bus Corridors is summarised in the BusConnects Core Bus Corridor Drainage Design Basis Document 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; and
- 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 Drainage Design Basis.

9.2 Existing Watercourses and Culverts

The Proposed Scheme crosses the following watercourses:

- Gaybrook River at Airside;
- River Sluice north of Dublin Airport;
- Cuckoo Stream at Dublin Airport;
- River Mayne south of Dublin Airport;
- Santry River at Ballymun; and
- River Tolka at Drumcondra.

All watercourses are maintained by existing culverts or bridge structures where they pass beneath the Proposed Scheme except for River Tolka. The crossing of the Tolka by the Proposed Scheme will be by both an existing road bridge and new footbridge located upstream.

Stage 1 and 2 Flood Risk Assessments have been completed on the full Preliminary Design and are summarised in **Section 9.6**. A Stage 3 Flood Risk Assessment has been completed for the proposed new crossing of the River Tolka, which is also summarised in **Section 9.6**.

9.3 Existing Drainage Description

The Proposed Scheme extends from Swords to a terminus in Dublin City Centre. The Proposed Scheme comprises widening and/or adjustment of the existing highway to accommodate segregated cycle and bus lanes, in addition to provision for pedestrians and other traffic.

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 points. 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 seven 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 within **Appendix B.** The catchments are summarised in **Table 9.1** below.

Table 9.1: Proposed Scheme Existing Drainage

Existing Catchment Reference	Chainage	Approx. Drainage Catchment Area (km^2)	Existing Network Type	Existing Outfalls
Catchment 1	A000 - 0910	3.69	Surface water (storm)	Network outfalls to the River Ward
Catchment 2	A0910 - 2300	4.03	Surface water (storm)	Network outfalls to the River Sluice
Catchment 3	A2300 - 4215	3.92	Surface water (storm)	Network outfalls to the Cuckoo Stream
Catchment 4	A4215 - 4800	2.18	Surface water (storm)	Network outfalls to the Mayne River
Catchment 5	A4800 - 7245	9.07	Surface water (storm)	Network outfalls to the Santry River
Catchment 6	A7245 - 10115	31.69	Surface water (storm)	Network outfalls to the River Tolka
Catchment 7	A10115 – 11769 D0000 – D0374 C0000 – C0450	Ringsend Wastewater Treatment Plant (WwTP) Catchment	Foul/combined	Foul/combined network drains to Ringsend WwTP with sewer overflows to the River Liffey

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 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 run-off from road pavement or any other paved areas is collected in a positive drainage system. Over-the-edge discharges are not permitted; and
- Narrow filter drains or fin drains are not expected for inner city roads that are typical of the Swords 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 to determine 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** containing a column entitled 'Net change' which takes account of the change of use from impermeable to permeable areas and vice versa.

Table 9.2: Proposed Scheme Summary of Increased Permeable and Impermeable Areas

Existing Catchment Reference	Chainage	Drainage Catchment Area (m2)	Change of use to impermeable areas (m2)	Change of use to permeable areas (m2)	Net Change (m2)	Percentage Change (%)
Catchment 1a	A0000 – A0300	18,748	4,556	1,591	2,965	15.82%
Catchment 1b	A0300 – A0650	8,617	723	1,318	-595	-6.91%
Catchment 1c (east)	A0650 – A1000	8,525	276	78	198	2.33%
Catchment 1c (west)		8,142	1,112	310	802	9.86%
Catchment 2a	A1000 – A1450	11,464	747	284	463	4.04%
Catchment 2b (east)	A1450 – A1650	2,859	645	0	645	22.57%

Existing Catchment Reference	Chainage	Drainage Catchment Area (m2)	Change of use to impermeable areas (m2)	Change of use to permeable areas (m2)	Net Change (m2)	Percentage Change (%)
Catchment 2b (west)		2,300	120	0	120	5.22%
Catchment 3a (east)	A1650 – A2150	14,954	2,167	0	2,167	14.50%
Catchment 3a (west)	A1650 – A2050	7,013	394	227	167	2.39%
Catchment 3b (west)	A2050 – A2150	2,519	911	214	697	27.67%
Catchment 4a (east)	A2250 – A2650	10,400	802	0	802	7.72%
Catchment 4a (west)		10,039	1,328	0	1,328	13.23%
Catchment 4b	A2650 – A2900	23,301	702	0	702	3.02%
Catchment 4c	A3050 – A3200	5,915	259	0	259	4.38%
Catchment 5a	A3200 – A3950	28,683	0	0	0	0.00%
Catchment 5b (east)	A3950 – A4100	6,814	168	65	233	3.42%
Catchment 5c (east)	A4100 – A4350	2,352	0	0	0	0.00%
Catchment 5c (west)	A4100 – A4200	1,763	98	0	98	5.56%
Catchment 5d (west)	A4300 – A4350	770	120	0	120	15.59%
Catchment 6	A4400 – A4700	7,344	479	0	479	6.53%
Catchment 7a	A4800 – A5250	7,661	343	0	343	4.48%

Existing Catchment Reference	Chainage	Drainage Catchment Area (m2)	Change of use to impermeable areas (m2)	Change of use to permeable areas (m2)	Net Change (m2)	Percentage Change (%)
Catchment 7b	A5000 – A5400	11,072	1,812	47	1,765	15.95%
Catchment 8	A5400 – A5750	10,448	598	41	557	5.34%
Catchment 9	A5700 – A6100	9,732	715	151	564	5.80%
Catchment 10	A6300 – A6500	18,592	611	5	606	3.26%
Catchment 11	A6500 – A6750	6,660	510	0	510	7.66%
Catchment 12	A6750 – A7000	7,895	1,069	66	1,003	12.71%
Catchment 13a	A7200 - A7400	4,366	193	0	193	4.43%
Catchment 13b	A7700 – A7950	9,217	707	0	707	7.68%
Catchment 14	A7950 – A8050	9,714	0	0	0	0.00%
Catchment 15a	A8050 – A8250	14,415	1,649	269	1,380	9.57%
Catchment 15b	A8250 – A8350	4,141	285	0	285	6.88%
Catchment 15c	A8350 - A8800	10,659	428	0	428	4.02%
Catchment 16a	A8800 – A9500	25,536	232	32	200	0.79%
Catchment 16b	A9500 – A10150	18,796	644	0	644	3.43%
Catchment 17a	A10150 – A10500	10,566	213	0	213	2.02%

Existing Catchment Reference	Chainage	Drainage Catchment Area (m2)	Change of use to impermeable areas (m2)	Change of use to permeable areas (m2)	Net Change (m2)	Percentage Change (%)
Catchment 17b	A10500 – A11764	38,776	0	0	0	0.00%
Catchment 18	C000 - C450	10,576	0	0	0	0.00%
Catchment 19	D000 - D374	7,068	0	0	0	0.00%

9.4.1 Method of Design

The 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.

Design Step	Details
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 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 area	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

Parameter and Feature	Design Standard
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 following drainage types are proposed for the catchments comprising newly paved and combined existing/newly paved areas:

- **Sealed Drainage** which collects, conveys and discharges runoff via a sealed pipe network. For the purposes of the Proposed Scheme, this type of drainage comprises 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 at downstream.
- **Underground stormwater attenuation tanks** collect and store excess surface water run-off 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 and Swales** are provided as road edge channels. These receive flows from the sealed pipe network and are designed to convey, attenuate and treat runoff prior to discharge.
- **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.
- **Attenuation Tanks/Oversized Pipes/Ponds (AT/OSP)** where there is insufficient attenuation volume provided by the proposed SuDS drainage measures. Hard attenuation measures such as concrete tanks and or oversize pipes can be provided to meet the required attenuation volume.

9.5.2 Summary of Surface Water Drainage

SuDS measures are included for each catchment where there is an increase in the impermeable drainage area to ensure no increase in run off and that provision is made for treatment.

For catchments where there is no change in the impermeable surface area and the kerb line is to be changed the existing sealed pipe network will be retained with new split entry gully connections provided as appropriate. As for any new drainage network, the 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. A split entry gully will be used to ensure the bus wheel track zone does not overlap with a normal road gully. For catchments where there is no change in the impermeable surface area and no change to the kerb line the current drainage will remain unchanged.

A summary of the proposed drainage measures for the Proposed Scheme are presented in **Table 9.5**.

Table 9.5: Summary of Proposed Drainage Measures

Drainage Measure	Chainage
Asset Owner/Location: Fingal County Council	
Sealed pipe network, underground attenuation	A0000 – A0500
Existing drainage retained	A0500 – A0750
Swale, sealed pipe network	A0750 – A0800
Sealed pipe network, dry detention basin	A1050 – A1500
Sealed pipe network, dry detention basin	A1500 – A1800
Swale, sealed pipe network	A1800 – A2050
Sealed pipe network	A2200 – A2700
Sealed pipe network, underground attenuation	A2700 – A3200
Existing drainage retained	A3200 – A3650
Filter drain	A3600 – A4200
Sealed pipe network, Oversized pipes	A4400 – A4800
Sealed pipe network, Oversized pipes	A4800 – A5250
Sealed pipe network, Oversized pipes	A4800 – A5400
Sealed pipe network, Oversized pipes	A5400 – A5700
Sealed pipe network, Oversized pipes	A5700 – A6000
Asset Owner/Location: Fingal County Council/Dublin City Council	
Sealed pipe network, Dry detention basin	A6300 – A6500
Sealed pipe network, Oversized pipes	A6500 – A6750
Sealed pipe network, Oversized pipes	A6750 – A6850
Asset Owner/Location: Dublin City Council	
Sealed pipe network, Oversized pipes	A7000 – A7600
Sealed pipe network, Oversized pipes	A7700 – A7850
Existing drainage retained	A7850 – A8100
Sealed pipe network, Dry detention basin	A8100 – A8350
Sealed pipe network, Oversized pipes	A8350 – A11764

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, cycle and running lanes in addition to a footway. Without mitigation, the increased impermeable area would lead to increased run off rates and faster time to peak flow in the existing drainage network.

As noted in **Table 9.2**, SuDS measures are to be provided to ensure **no increase** in existing run off rates from newly paved and combined existing/newly paved catchment areas. The SuDS measures are designed to cater for:

- Combined new/existing paved areas: the 1 in 30-year storm with a 20% allowance for future climate change; and
- Newly paved areas: the 1 in 100-year storm with a 20% allowance for future climate change.

The capacity of the proposed SuDS measures was based on the incoming flows and permitted discharge for each catchment. The permitted discharge rate was taken to be:

- Combined new/existing paved catchment areas: the existing 1 in 5-year flow unless available network/model information shows an alternative existing rate of discharge from existing paved areas;
- Existing paved catchment areas: the existing 1 in 5-year flow unless available network/model information shows an alternative existing rate of discharge; and
- Newly paved catchment areas: 2l/s/ha with minimum flow of 2l/s.

The permitted discharge from newly paved catchment areas (i.e., the existing greenfield rate) was calculated using the *Institute of Hydrology Report No. 124 Flood Estimation for Small Catchments Method.*

A range of storm durations were 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 run off volumes are greater. This hierarchy promotes the concept of a SuDS Management Train, where measures are proposed as a sequence of component 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. Source: produced by Jacobs from CIRIA SuDS Manual 2015

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 principal objectives of the road drainage system is to minimise the impact of the runoff from the roadways on the surrounding environment using individually or in combination: 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/carrier drains, 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 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 and/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

Drainage Design Catchment Reference	Existing Catchment Reference (Refer to Table 1)	Impermeable Surface Area (m2)		SuDS Measures Required	Permitted Discharge (l/s)	SuDS Measures Proposed	Catchment Outfall
		Existing	Proposed				
A0000 – A0500	Catchment 1c	28,972	2,367	Yes	As existing	119m^3 underground attenuation tank	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Sluice River.
A0500 – A0750	Catchment 1b	5,099	330	Yes	As existing		New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Sluice River.
A750-A800	Catchment 1a	1,787	470	Yes	2	56m3 Capacity Swale	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Sluice River.
	Catchment 1b	1,787	330	Yes	2	9m3 attenuation oversized pipes	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Sluice River.
A1050 – A1500	Catchment 2	7,795	1,070	Yes	2	85 m3 capacity attenuation pond	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Cuckoo Stream.

Drainage Design Catchment Reference	Existing Catchment Reference (Refer to Table 1)	Impermeable Surface Area (m2)		SuDS Measures Required	Permitted Discharge (l/s)	SuDS Measures Proposed	Catchment Outfall
		Existing	Proposed				
A1500-A1800	Catchment 3	7,795	4,250	Yes	2	20m3 capacity attenuation pond	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Cuckoo Stream.
A1800 – A2050	Catchment 3	9,821	4,250	Yes	2	200m^3 capacity swale	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the River Mayne.
A2200 – A2700	Catchment 4a	15,134	752	No	As existing	No new SuDS in this location, new drainage attenuated in S08	New drainage to discharge to the existing stormwater network. Existing stormwater network outfalls to the Santry River.
A2700 – A3200	Catchment 4b	31,355	430	Yes	2	468m^3 capacity underground attenuation	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Santry River.
A3200 – A3650	Catchment 4c	17,832	0	No	As existing	No new drainage in this location.	No new drainage in this location, outfalls as existing.
A3600 – A4200	Catchment 5	12,594	200	Yes	As existing	0.5m^3 Capacity Filter Drains	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Santry River.

Drainage Design Catchment Reference	Existing Catchment Reference (Refer to Table 1)	Impermeable Surface Area (m2)		SuDS Measures Required	Permitted Discharge (l/s)	SuDS Measures Proposed	Catchment Outfall
		Existing	Proposed				
A4400 – A4800	Catchment 6	7,123	338	Yes	As existing	9m^3 capacity attenuation provided by oversized pipes	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Tolka River.
A4800 – A5250	Catchment 7a	8,891	240	Yes	2	None. Tie the new drainage into the existing stormwater network. No space available for SuDS measures. Oversize pipes to be used to provide online attenuation volume 6m^3.	New drainage to discharge to the existing stormwater network. Existing stormwater network outfalls to the Tolka River.
A4800 – A5400	Catchment 7b	15,670	806	Yes	2	None. Tie the new drainage into the existing stormwater network. No space available for SuDS measures. Oversize pipes to be used to provide online attenuation volume 31m^3.	New drainage to discharge to the existing stormwater network. Existing stormwater network outfalls to the Tolka River.
A5400 – A5700	Catchment 8	6,632	470	No	As existing	None. Tie the new drainage into the existing stormwater network. No space available for SuDS measures. Oversize pipes to be used to provide online attenuation volume 15m^3	New drainage to discharge to the existing stormwater network. Existing stormwater network outfalls to the Tolka River.

Drainage Design Catchment Reference	Existing Catchment Reference (Refer to Table 1)	Impermeable Surface Area (m2)		SuDS Measures Required	Permitted Discharge (l/s)	SuDS Measures Proposed	Catchment Outfall
		Existing	Proposed				
A5700 – A6000	Catchment 9	5,509	860	Yes	2	None. Tie the new drainage into the existing stormwater network. No space available for SuDS measures. Oversize pipes to be used to provide online attenuation volume 37m^3	New drainage to discharge to the existing stormwater network via underground attenuation tank. Existing stormwater network outfalls to the Tolka River.
A6300 – A6500	Catchment 10a	4,285	315	Yes	2	34m^3 Capacity pond	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Tolka River.
A6500 – A6750	Catchment 10b	5,744	525	Yes	2	None. Tie the new drainage into the existing stormwater network. No space available for SuDS measures. Oversize pipes to be used to provide online attenuation volume 18m^3	New drainage to discharge to the existing stormwater network via SuDS measures. Existing stormwater network outfalls to the Tolka River.
A6750 – A6850	Catchment 10c	2,138	450	Yes	2	None. Tie the new drainage into the existing stormwater network. No space available for SuDS measures. Oversize pipes to be used to provide online attenuation volume 14m^3	New drainage to discharge to the existing stormwater network. Existing stormwater network outfalls to the Tolka River.
A7000 – A7600	Catchment 11	7348	0	No	As existing	No new drainage in this location	No new drainage in this location, outfalls as existing.

Drainage Design Catchment Reference	Existing Catchment Reference (Refer to Table 1)	Impermeable Surface Area (m2)		SuDS Measures Required	Permitted Discharge (l/s)	SuDS Measures Proposed	Catchment Outfall
		Existing	Proposed				
A7700 – A7850	Catchment 13	6124	450	Yes	2	None. Tie the new drainage into the existing stormwater network. No space available for SuDS measures. Oversize pipes to be used to provide online attenuation volume of $14m^3$.	New drainage to discharge to the existing foul/combined network. Existing network outfalls to the Ringsend WwTP
A7850 – A8100	Catchment 14	5,841	0	No	As existing	No new drainage in this location	No new drainage in this location, outfalls as existing.
A8050 – A8250	Catchment 15a	14,415	1,380	Yes	2	$60m^3$ of attenuation provided by oversized pipes	New drainage to discharge to the existing stormwater network. Existing network outfalls to the Ringsend WwTP.
A8250 – A8350	Catchment 15b	4,141	285	Yes	2	$10m^3$ of attenuation provided by oversized pipes	New drainage to discharge to the existing stormwater network. Existing network outfalls to the Ringsend WwTP.
A8350 – A8800	Catchment 15c	10,659	428	Yes	2	$10m^3$ of attenuation provided by oversized pipes	New drainage to discharge to the existing surface water network. Existing network outfalls to the Ringsend WwTP.
A8800 – A9500	Catchment 16a	25,536	200	Yes	2	$11m^3$ of attenuation provided by oversized pipes	New drainage to discharge to the existing surface water network. Existing network outfalls to the Ringsend WwTP.

Drainage Design Catchment Reference	Existing Catchment Reference (Refer to Table 1)	Impermeable Surface Area (m2)		SuDS Measures Required	Permitted Discharge (l/s)	SuDS Measures Proposed	Catchment Outfall
		Existing	Proposed				
A9500 – A10150	Catchment 16b	18,796	664	Yes	2	20m^3 provided by oversized pipes	New drainage to discharge to the existing surface water network. Existing network outfalls to the Ringsend WwTP.
A10150 – A10500	Catchment 17a	10,566	213	Yes	2	3m^3 attenuation provided by oversized pipes	New drainage to discharge to the existing surface water network via repositioned gullies. Existing network outfalls to the Ringsend WwTP.

9.6 Drainage at Structures

Table 9.8 lists the watercourses which are crossed by the Proposed Scheme. All watercourses are currently in culvert or there is an existing bridge structure where they pass beneath the existing highway.

Table 9.8: Watercourses Crossed by the Scheme

Watercourse	Chainage	Crossing Detail
Royal Canal	A10800	Bridge
River Tolka	A9950	Bridge
Santry River	A5700	Culvert
River Mayne	A4800	Culvert
Cuckoo Stream	A4300	Culvert
Sluice River	A1450	Culvert
Gaybrook Watercourse	A250	Culvert

Apart from the River Tolka no works are proposed to change the width of the highway at any of the crossings listed in **Table 9.8**. The existing culverts/bridges will therefore be retained without modification and there will no change in hydraulic capacity or any associated flood risk.

A new bridge crossing of the River Tolka is required as part of the Proposed Scheme. This will be constructed immediately upstream of an existing bridge (that is retained) and will have a larger hydraulic capacity than the downstream bridge structure. A hydraulic analysis of the proposed bridge was completed to show that it do not result in an increase in flood levels.

A Section 50 consent will be sought for the proposed bridge. Section 50 consent will not be required for any of the other culverts as no modifications are required for the Proposed Scheme.

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 full Proposed Scheme. A Stage 3 Flood Risk Assessment was completed for the proposed new bridge crossing of the River Tolka. The outcomes from the FRA are summarised in this section and **Table 9.9**.

Table 9.9: Flood Risk Summary

Flood Risk Source	Level of Risk	Notes
Artificial Drainage – Grand Canal	Low	The Royal Canal passes beneath the Proposed Scheme. Water levels along the canal are regulated by a series of lock gates and waste-weirs. There are insufficient flows in the canal to pose a flood risk to the Proposed Scheme.
Fluvial – River Tolka	High	A new bridge crossing is proposed for the River Tolka. A hydraulic analysis was completed for the proposed bridge to demonstrate that there was no increase in the risk of flooding.
Fluvial – Santry River	High	The Proposed Scheme is at risk from flooding from the Santry River in the 10% AEP, 1% AEP and 0.1% AEP floods. Assessment Summary: • The Proposed Scheme is located in Flood Zone A at the Santry River and requires a Justification Test • There is no change in flood risk to or arising from the works associated with Proposed Scheme from the Santry River
Fluvial – Mayne River	High	The Proposed Scheme is at risk from flooding from the Mayne River in the 1% AEP and 0.1% AEP floods. Assessment Summary: • The Proposed Scheme is located in Flood Zone A at the Mayne River and requires a Justification Test • There is no change in flood risk to or arising from the Proposed Scheme from the Mayne River
Fluvial – Cuckoo Stream	High	The Proposed Scheme is at risk from flooding from the Cuckoo Stream in the 1% AEP and 0.1% AEP floods. Assessment Summary: • The Proposed Scheme is located in Flood Zone A at the Cuckoo Stream and will need a Justification Test • There is no change in flood risk to or arising from the Proposed Scheme from the Cuckoo Stream
Fluvial – Sluice River	Low	The Sluice River passes beneath the Proposed Scheme in culvert. The Office of Public Works (OPW) CFRAM mapping shows that the scheme is not at risk from flooding up to and including the 0.1% AEP flood.
Fluvial/Pluvial – Gaybrook River (at Pinnock Hill Roundabout)	Low	Flooding along the N1 due to the overflowing of surface water pipes as a result of heavy rainfall. Flood water was diverted onto the Dublin/Belfast Road to prevent properties from flooding. No further information on alleviation schemes that took place following this event. Flood extents in this area are currently under review by the OPW.

Flood Risk Source	Level of Risk	Notes
Pluvial	High	A high risk of pluvial flooding is prevalent across Dublin due to the limited capacity of the existing surface water network. Notable areas of potential pluvial flooding identified along the Proposed Scheme include at Santry, Whitehall and Drumcondra.
Coastal – River Liffey	Low	CFRAM and Irish Coastal Protection Strategy Study (ICPSS) flood mapping show that the junction between Gardiner Street Lower and Beresford Place is potentially at risk of coastal flooding in a 0.1% Tidal AEP event. There are several flood defence schemes in place to mitigate against this risk. Quay walls on both sides of the River Liffey from East Wall Road Bridge to the Sean Heuston Bridge protect the majority of Dublin City Centre from coastal flooding. There are also ongoing works at South Campshires area from Butt Bridge to Cardiff Lane that will protect the area from an estimated 200-year flood event plus climate change. As part of the Dublin Coastal Flooding Protection Project, a review of the capacity of existing coastal flood defence schemes was carried out. The report, published in 2005, identified a number of locations in where the current level of flood defences was below that required for current and future predicted sea levels. The quay wall located at Custom House Quay was not present on this list, therefore it can be concluded that the wall should provide adequate protection against current and future coastal flood risks. Due to the high elevation of this location above flood levels and the flood alleviation measures, the risk of coastal flooding along the Proposed Scheme is considered to be low.

9.7.1.1 Fluvial Flood Risk Summary

The Flood Risk Assessment identified parts of the Proposed Scheme are at risk from fluvial flooding from the Mayne River, Santry River and Cuckoo Stream during the1%AEP Flood. With reference to the Flood Risk Management (FRM) Guidelines, these parts of the route will be identified as being located in Flood Zone A. As the Proposed Scheme comprises extension and adjustment to an existing highway, no works can be reasonably undertaken to reduce the existing risk of flooding.

A Justification test was completed for the Proposed Scheme to demonstrate compliance with the Justification test as set in the FRM Guidelines.

A summary of the flood risk assessment of the proposed new bridge crossing of the River Tolka is provided in **Section 9.7.2**.

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) Annual Exceedance

Probability (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

Section 8.2.1 describes the design for a new footbridge/cycle bridge that will be constructed immediately upstream of the existing Frank Flood Bridge crossing of the River Tolka. The proposed bridge comprises a 50m, 2-span steel structure comprising central varying depth box girder with a tie down arrangement at the north of the structure. The span arrangement has been designed to maintain the adjacent floodplain on the south side of the river which needs remain available for flood storage.

The proposed new bridge is located immediately upstream of the existing Frank Flood Bridge, and spans the Area Benefitting from Defence (ABD) provided by the River Tolka Flood Relief Scheme (FRS); refer to **Figure 9.1**. The ABD is stated as providing a 1% AEP Standard of Protection. No property flooding has been recorded at this location since the construction of the River Tolka FRS.

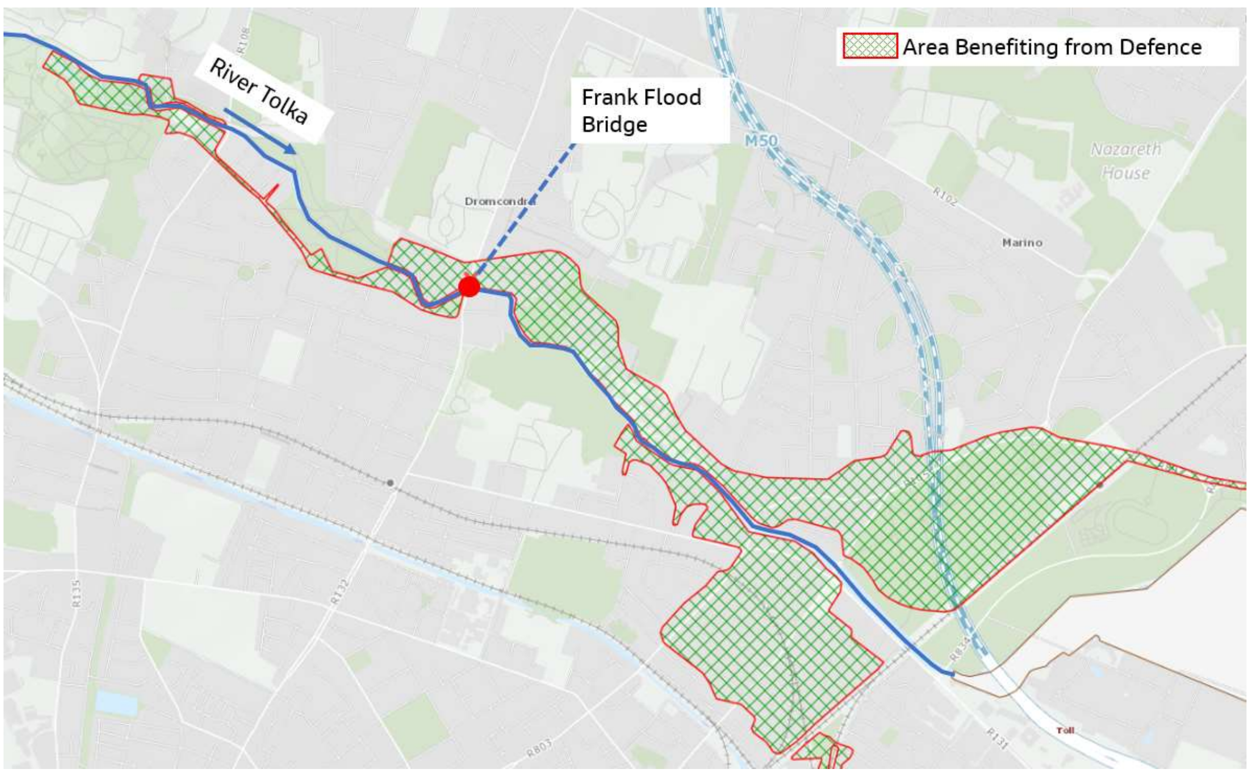

Figure 9.1: River Tolka FRS Area Benefitting from Defence (ABD); ***Source: www.floodinfo.ie***

A Stage 3 Flood Risk Assessment was completed for the proposed new bridge, which is summarised in **Section 9.7.2.1** below.

9.7.2.1 Hydraulic Analysis

9.7.2.1.1 Existing Situation

The existing Frank Flood Bridge was constructed around 1813 and comprises a three-span masonry bridge. The arches are approximately 4m wide and 6m high. The three arches have soffit levels of approximately 7.00m AOD, 7.33m AOD, and 7.01m AOD on the northern, middle, and southern arches respectively.

The Frank Flood Bridge is a significant restriction to flow along the River Tolka, with the effective flow area through the bridge approximately $60m^2$. During flood conditions, flows are backed-up by the bridge as the hydraulic capacity is limited by the three bridge arches.

Existing flood defences are located on the north and south bank of the River Tolka up stream of Frank Flood Bridge. The defences have a crest level of 7.77mOD and are stated to provide a 1% AEP standard of flood protection. The defences are designed to allow for backing-up of flows by the bridge during flood conditions.

9.7.2.1.2 Conceptual Analysis of the Proposed Works

The proposed works comprise construction of a two-opening bridge located 3m upstream of the existing Frank Flood crossing. The existing Frank Flood Bridge is retained and not modified.

The key hydraulic design features for the new bridge are as follows:

- The proposed minimum soffit level is 7.421m OD. The design of the bridge soffit has been limited by the requirement for the bridge to meet existing road/pavement levels on the north/south bank where it meets the R132. The proposed soffit levels still exceed the existing maximum soffit level of Frank Flood Bridge of 7.33mOD;
- The effective flow area through the bridge is approximately 120m2. This compares to an effective flow area through the existing Frank Flood Bridge of approximately 60m2l;
- The floodplain beneath the proposed bridge span on the south bank is to be lowered. This will provide additional floodplain storage and will increase the effective channel section flow area immediately upstream of Frank Flood Bridge by approximately 13m2; and
- The existing flood defence level of 7.77mOD on both banks of the river will be maintained by the new bridge.

Conceptually, the proposed bridge will not impact on flood levels and will have only a marginal impact on the existing hydraulic channel characteristics of the River Tolka. This is because the flow area and soffit levels of the existing Frank Flood Bridge are significantly less and below those proposed for the new bridge respectively. This will mean that in a flood, flows will continue to be backed-up by the existing Frank Flood Bridge when its existing soffit levels are reached before the new bridge could have any hydraulic effect.

Lowering of the floodplain beneath the new bridge on the south bank will also create additional floodplain storage upstream of the existing bridge. This will not impact flood levels however, as these will continue to be controlled by the hydraulic capacity and backwater effect of Frank Flood Bridge. The overall increase in floodplain storage provided by the floodplain lowering works is also small in the context of typical flood volumes on the River Tolka.

There will be no change in flood levels downstream of Frank Flood Bridge. This is because flows passing downstream will be continued to be controlled by the existing capacity of Frank Flood Bridge.

There will be no change in the standard of flood protection provided by the existing flood defences. This is because the height of the defences was determined based on the hydraulic capacity of the existing Frank Flood Bridge. As noted, flood levels will continue to be determined by the existing capacity of Frank Flood Bridge following completion of the new crossing.

9.7.2.1.3 Hydraulic Modelling of the Proposed Works

The OPW do not have a current model of the River Tolka. A truncated 1-D model of the River Tolka was therefore constructed using survey data provided by the OPW to test the hydraulic impact of the proposed new bridge. The model was 1.1km in length and comprised 600m of the River Tolka upstream of Frank Flood Bridge and 500m downstream of the bridge.

The model was run with fixed inflows between 80m^3/s and 140m^3/s[2] to test the hydraulic impact of the proposed new bridge. The results are summarised in **Table 9.10.**

Table 9.10: Frank Flood Bridge Hydraulic Modelling Results Summary

Peak River Tolka Flow (m^3/s)	Peak Water level Upstream of Proposed Bridge (mOD)		Difference (m)
	Existing Situation	With Proposed Scheme	
80	6.27	6.27	0.00
90	6.52	6.52	0.00
97	6.70	6.70	0.00
120	7.32	7.32	0.00
140	7.91	7.91	0.00

The model results confirm the outputs of the conceptual hydraulic analysis that the proposed new bridge has no impact on flood levels. This is to be expected as the hydraulic capacity of the proposed bridge is significantly larger that the hydraulic capacity of the existing bridge, that is located immediately downstream.

9.8 Section 50

There are modifications proposed at the River Tolka Frank Flood Bridge. A stage 3 FRA has been carried out and a Section 50 application to OPW will be required.

[2] The River Tolka Flooding Study Final Report prepared for Dublin City Council (2003) indicates that a flood with a 1% Annual Exceedance Probability (AEP), or a 1-in-100-year flood event, has a peak flow of 90m^3/s.

There are recorded estimates of gauged flows on the Tolka extending back to 1880. The largest gauged flow was 97m^3/s and occurred in 2002

10. Services and Utilities

10.1 Overview of Utilities 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 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;
- Fingal County Council; and
- Dublin City County Council.

10.1.2 Phase 1 Utility Survey

A targeted utility survey to PAS128A, including a GPR (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 a high concentration of utility diversions is proposed were also surveyed to ensure that adequate spacing is available 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 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 which was prepared for each utility company.

Consultation meetings were held with ESB, Gas Networks Ireland, Irish Water and Eir. The Proposed Scheme proposals were 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);
- GNI; and
- Telecommunication Services – Eir, Virgin Media, eNet and BT.

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

The services conflicts and the associated diversions 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 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 in **Appendix B**.

10.3 Summary of Recommended Diversions

10.3.1 ESB Networks

Jacobs 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. There is one location where high voltage cables have been identified that require relocation. There are several locations where low and medium voltage cables require relocation. These conflicts are listed in **Table 10.1** below and are illustrated on the drawing set BCIDB-JAC-UTL_UE-0002_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
R2-UE-MV-001A	ESB	A 0+150 - 0+200	MV Underground	Diversion of c. 50m of MV cables in footway R132 south and Swords Road north on Pinnock Hill Roundabout.
R2-UE-MV-002	ESB	A 0+190 - 0+320	MV Underground	Diversion of c. 130m of MV cables in verge/footway of R132 south of Pinnock Hill Roundabout
R2-UE-LV-001	ESB	A 0+700 - 0+850	LV Overhead	Diversion of c. 150m of LV overhead cables in footway of R132 Swords Road crossing Boroimhe Road at Airside Junction
R2-UE-LVUG-001	ESB	A 0+800	LV Underground	Network Investigation Required to determine full extent of LV diversion required at Airside Junction. C. 30m.
R2-UE-MV-004	ESB	A 0+800	MV Underground	Diversion of c. 75m of MV Underground cables in footway of Airside junction leading up to entrance of Airside Retail Park
R2-UE-MV-006	ESB	A 2+710	MV Underground	Diversion of c. 90m of MV Underground cables in footway and crossing carriageway located at Airport Roundabout
R2-UE-MV-009	ESB	A 4+280 - 4+310	MV Underground	Diversion of c. 30m of MV Underground cables in footway of R132 Swords Road at junction with Quick Park
R2-UE-LV-002	ESB	A 4+290 - 4+560	LV Overhead	Diversion of c. 360m of LV overhead cables in footway of R132 Swords Road and crossing road to Quick park
R2-UE-LVUG-004	ESB	A 4+875	LV Underground	Minipillar and associated cabling relocation required on Swords Road.
R2-UE-LVUG-005	ESB	A 4+950	LV Underground	Minipillar and associated cabling relocation required on Swords Road at the entrance to North Ring Business Park.
R2-UE-LV-003	ESB	A 5+180 - 5+240	LV Overhead	Diversion of c. 80m of LV overhead cables in footway of R132 Swords Road crossing junction between Swords Road and the entrance to Dublin Airport Business Park
R2-UE-LV-004A	ESB	A 5+880	LV Overhead	LV Pole and OH cables impacted by widening. Pole relocation required.

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UE-MV-017	ESB	A 5+920 - 6+020	MV Underground	Diversion of c. 110m of MV Underground cables in footway of R132 Swords Road
R2-UE-LV-005	ESB	A 6+500 - 7+010	LV Overhead to LV Underground	Diversion of c. 290m of LV overhead cables in footway of R132 Swords Road opposite Santry Hall Industrial Estate. Replacement cables to be put underground for this section.
R2-UE-LV-005A	ESB	A 6+500 - 7+010	LV Overhead	A continuation of R2-UE-LV-005. 250m of existing LV overhead lines and poles to be set back to new boundary.
R2-UE-LVUG-007	ESB	A 6+725 - A 6+750	LV Underground	c. 50m LV underground cable relocation and associated pole relocation.
R2-UE-LVUG-008	ESB	A 6+750 - A 6+800	LV Underground	c. 50m LV underground cable relocation to be undertaken in conjunction with R2-UE-LV-005
R2-UE-MV-022	ESB	A 6+680 - 6+740	MV Underground	Diversion of c. 85m of MV Underground cables in footway of R132 Swords Road opposite St Johns Court
R2-UE-MV-026	ESB	A 7+140 - 7+300	MV Underground	Diversion of c. 160m of MV underground cables in footway of R132 Swords Road between junctions with Omni Park Service Entrance and Shanowen Road
R2-UE-LV-006	ESB	A 7+180 - 7+280	LV Overhead	Diversion of c. 115m of LV overhead cables in footway of R132 Swords Road
R2-UE-LV-007	ESB	A 7+300 - 7+450	LV Overhead	Diversion of c. 190m of LV overhead cables in footway of R132 Swords Road opposite The Comet
R2-UE-LVUG-009	ESB	A 8+150 - A 8+220	LV Underground	c. 80m LV underground cable relocation due to widening into verge
R2-UE-LV-008	ESB	A 8+350 - 8+690	LV Overhead	Diversion of c. 340m of LV overhead cables in footway of R132 Swords Road
R2-UE-MV-028	ESB	A 8+340 - 8+550	MV Underground	Diversion of c. 215m of MV cables in verge/footway of R132 Swords Road
R2-UE-MV-029	ESB	A 8+820 - 8+950	MV Underground	Diversion of c. 140m of MV Underground cables in footway of R132 Swords Road

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UE-LVUG-011	ESB	A 9+930 - 10+060	LV Underground	c. 130m LV underground cable relocation due to widening into footway of Frank Flood bridge. LV to be diverted onto new structure.
R2-UE-HV-001	ESB	A 9+930 - 10+060	HV Underground	38Kv HV underground diversion required at Frank Flood Bridge. Existing cables impacted by proposed bridge structure. To be installed by river under bore. Diversion of c. 130m

10.3.2 Irish Water - Water and Foul Sewer

Jacobs 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. These diversions are listed in **Table 10.2** below and are illustrated on the drawing sets BCIDB-JAC-UTL_UW-0002_XX_00-DR-CU-9001 and BCIDB-JAC-UTL_UD-0002_XX_00-DR-CU-9001 included within **Appendix B.**

Table 10.2: Irish Water, Water Main Diversions

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UW-001	IW	A 0+150	150mm PVC Main	Diversion of c. 65m along footway of Dublin Road at Pinnock Hill Roundabout.
R2-UW-002A	IW	A 0+150 - 0+260	100mm PVC Main	Diversion of c. 125m in in verge between R132 south and Swords Road on Pinnock Hill Roundabout.
R2-UW-008	IW	A 1+970 - 2+130	225mm PVC Main	Diversion of c. 175m of 225mm PVC watermains in footway of Swords road crossing junction with Naul Road
R2-UW-027	IW	A 6+650 - 6+990	100mm Ductile Iron	Diversion of c. 340m of 100mm Ductile Iron mains in footway of Swords Road crossing junction with Magenta Crescent
R2-UW-030	IW	A 7+130 - 7+240	100mm CI Main	Diversion of c. 110m of 100mm CI water main under cycleway on Swords Road from Omni Park Service Entrance
R2-UW-031	IW	A 7+130 - 7+550	100mm CI Main	Diversion of c. 425m of 100mm CI water main under footway on Swords Road from Omni Park Service Entrance

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UW-033	IW	A 7+320 - 7+380	3' CI Main	Diversion of c. 65m of 3' CI water main under footway on Swords Road
R2-UW-P037	IW	B 0 - B 0 + 250	300mm Ductile Iron	Diversion of c. 260m of 300mm Ductile Iron mains in footway of Swords Road and Collins Avenue
R2-UW-043	IW	A 9+900 - 10+080	600mm Ductile Iron Trunk Main	Diversion of c.210m of 600mm Ductile Iron water main
R2-UW-044	IW	A 9+925 - 10+030	225mm CI	Diversion of c.110m of 225mm CI water main Frank Flood Bridge - Proposed parallel bridge structure and widening of Bus lane into footway at this location impacting this main. Will need to be replaced with a new main on new structure bridge deck as existing main doesn't have sufficient cover.

10.3.3 Eir

Jacobs has undertaken consultation with Eir regarding the impact of the Proposed Scheme on their assets. There are several locations along the route where conflicts occur with Eir infrastructure, 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-0002_XX_00-DR-CU-9001 included within **Appendix B.**

Table 10.3: Eir Diversions

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UX-EIR-004A	Eir	A 0+150 - 0+230	Eir Ducting	Diversion of c. 80m of Eir ducting in footway/verge of Swords Road north of Pinnock Hill Roundabout.
R2-UX-EIR-009	Eir	A 0+730 - 0+880	Eir Ducting	Diversion of c. 145m of Eir ducting in footway of Swords Road at junction with Boroimhe Road
R2-UX-EIR-011	Eir	A 0+810	Eir Ducting	Diversion of c. 26m of Eir ducting in footway of Airside and new chamber
R2-UX-EIR-013	Eir	A 1+650 - 2+030	Eir Ducting	Diversion of c. 392m of Eir ducting in footway of Swords Road prior to Cloghran Road Roundabout.

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UX-EIR-014	Eir	A 1+770 - 1+990	Eir Ducting	Diversion of c. 220m of Eir ducting in footway of Swords Road prior to Cloghran Roundabout
R2-UX-EIR-018	Eir	A 2+070 - 2+140	Eir Ducting	Diversion of c. 75m of Eir ducting in footway of Swords Road following Cloghran Roundabout
R2-UX-EIR-020	Eir	A 2+700 - 2+820	Eir Ducting	Diversion of c. 139m of Eir ducting in footway of Swords Road following Airport Roundabout
R2-UX-EIR-028	Eir	A 4+140 - 4+440	Eir Ducting	Diversion of c. 312m of Eir ducting in footway of Swords Road across Quick Park
R2-UX-EIR-046	Eir	A 5+300 - 5+400	Eir Ducting	Diversion of c. 100m of Eir ducting in footway of Swords Road opposite the Airways Industrial Estate
R2-UX-EIR-051	Eir	A 5+780 - 5+920	Eir Ducting	Diversion of c. 142m of Eir ducting in footway of Swords Road adjacent to Santry Demesne and rebuild of required chambers
R2-UX-EIR-054	Eir	A 5+780 - 6+050	Eir Ducting	Diversion of c. 280m of Eir ducting in footway of Swords Road after Santry Close and rebuild of required chambers
R2-UX-EIR-066	Eir	A 6+660 - 6+760	Eir Ducting	Diversion of c. 155m of Eir ducting in footway of Swords Road crossing junction with Magenta Crescent
R2-UX-EIR-078	Eir	A 7+150 - 7+610	Eir Ducting	Diversion of c. 470m of Eir ducting, chambers and poles in footway of R132 Swords Road
R2-UX-EIR-078A	Eir	A 7+300 - 7+500	Eir Ducting	Diversion of c. 210m of Eircom ducting, chambers and poles in footway, of R132 Swords Road.

10.3.4 Communications Providers

Jacobs has undertaken consultation with other communication providers including Virgin Media, BT, eNet regarding the impact of the Proposed Scheme on their assets. There are four locations along the scheme where conflicts with Virgin Media infrastructure has been identified and one location where conflict with BT and eNet infrastructure has been identified. These diversions are listed in **Table 10.4** below and are illustrated on the drawing set BCIDB-JAC-UTL_UX-0002_XX_00-DR-CU-9001 included within **Appendix B.**

Table 10.4: Communications Provider Diversions

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UX-BT-004	BT	A 1+650 - 1+920	BT ducting	Diversion of c. 280m of BT ducting in footway of Swords Road prior to Cloghran Road Roundabout.
R2-UX-VM-004	Virgin Media	A 1+810 - 2+010	VM ducting	Diversion of c. 216m of VM ducting in footway of Swords Road prior to Cloghran Road Roundabout.
R2-UX-VM-005	Virgin Media	A 2+030 - 2+180	VM ducting	Diversion of c. 105m of VM ducting in footway of Swords Road after Cloghran Road Roundabout.
R2-UX-VM-007	Virgin Media	A 2+710 - 2+830	VM ducting	Diversion of c. 128m of VM ducting in footway of Swords Road following Airport Roundabout
R2-UX-VM-007A	Virgin Media	B 0+000 - 0+280	VM ducting	Diversion of c. 242m of VM ducting in footway of Collins Avenue at junction with Swords Road and rebuild of required chambers
R2-UX-ENET-001	eNet	A 9+925 - 10+050	eNet ducting	Frank Flood Bridge Diversion of c. 140m of Eir ducting from existing western footway to new structure and associated chambers.

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-0002_XX_00-DR-CU-9001 included within **Appendix B.**

Table 10.5: GNI Diversion

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UG-MP-002A	GNI	A 0+150 - 0+300	MP Underground	Diversion of c. 140m of medium pressure gas main in footway between R132 south and Swords Road north on Pinnock Hill Roundabout.
R2-UG-MP-010	GNI	A 4+180 - 4+310	MP Underground	Diversion of c. 140m of medium pressure gas main in footway of R132 Swords road prior to Quick Park

Ref Number	Utility Provider	Chainage	Asset Impacted	Description of Works
R2-UG-LP-001	GNI	A 7+150 - 7+500	LP Underground	c. 335m low pressure 90PE main diversion due to widening into verge.
R2-UG-LP-002	GNI	A 8+500 - 8+800	LP Underground	c. 320m low pressure 250PE main diversion due to widening into verge.
R2-UG-LP-003	GNI	A 9+100 - 9+ 130	LP Underground	c. 45m low pressure 180PE main diversion due to widening into verge.
R2-UG-LP-004	GNI	A 9+925 - 10+030	LP Underground	Frank Flood Bridge - Proposed parallel bridge structure at this location potentially impacting 315mm low pressure gas main attached to side of existing bridge. C. 105m diversion required.
R2-UG-LP-005	GNI	A 9+925 - 10+030	LP Underground	Frank Flood Bridge - Proposed parallel bridge structure at this location potentially impacting 250mm low pressure gas main attached to side of existing bridge. C. 90m diversion required.

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 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 of the European Communities (Waste Directive) Regulations, 2011. 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 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 material requirements and could potentially realise up to 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	150 kg 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	100 kg/unit	Nominal assumed average weight per gate over scheme
Metal railings	Metal	15 kg/m	Nominal assumed average weight per railing over scheme
Fencing	Metal	40 kg/m	Nominal assumed average weight per railing over scheme
Traffic Signals	Metal	68 kg/ 4m pole 15kg per traffic signal head Assumed 2 heads per pole	*Source: Siemens Helios General Handbook Issue 18.* Nominal assumed average scenario per signal over scheme length
	Plastic	9 kg	
Traffic Signs	Metal	20kg/ 3m pole 0.75 m sign height 0.01 m pole thickness	Nominal assumed average scenario per traffic sign over scheme length

Item	Material	Assumed Nominal Weight	Notes
Lighting poles	Metal	100 kg per 8m pole	Nominal assumed average scenario over scheme length
ESB/EIR poles	Timber/wood	250 kg per 9m pole	Nominal assumed average scenario over scheme length
Bus stops	Plastic	365 kg per bus stop	JCDecaux and NTA (2017) *Reliance Bus Shelter information*
	Metal	2400 kg per bus stop	JCDecaux and NTA (2017) *Reliance Bus Shelter information*
	Glass	54 kg per bus stop	JCDecaux and NTA (2017) *Reliance Bus Shelter information*
Litter bins	Metal	60 kg per bin	Omos specification. Nominal assumed average scenario over scheme length
Safety barrier	Metal	20 kg/m	Nominal assumed average scenario over scheme length
Cabinets	Metal	85 kg	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	35 kg	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	27.9 kg per m width of road	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)

Item	Material	Assumed Nominal Weight	Notes
Cast Iron Bollard	Metal	50 kg	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	130 kg	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)
Bike Railings / handrails	Metal	16 kg	Dublin City Council (2016) *Construction Standards for Road and Street Works in Dublin City Council*
Gully grates	Metal	40 kg	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)

Item	Material	Assumed Nominal Weight	Notes
Chamber covers and frame	Metal	0.112 tonnes	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	0.04 tonnes	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/m3)	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
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

Material	Densities (tonnes/m3)	Notes
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)
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)

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
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 ½ 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.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/cycletrack)	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)

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
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)
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 DCC standard bus corridor detail with 200mm capping assumed.

Layer	Assumed Layer thickness (m)	Assumed material spec. (TII)
Footpath sub-layer excavation due to Full Depth Construction (FDC) widening (material under footpath)	0.1	Granular material- Class ½ Granular Subbase material
	0.75	Soil and stones- Class 2/4/U1 Cohesive subgrade material
Verge and sub-layer excavation due to FDC widening (material under verge)	0.3	Soil and stones- Class 5 Topsoil material
	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 ½ 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 164,000 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 general 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 planning's to be used in capping material and 803 sub-base 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 Proposed Scheme.

It is estimated that an order of magnitude of 1,730 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 reuse 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	24,000
Bituminous mixtures	12,000
Soil and stone	128,000
TOTAL	**164,000**

12. Traffic Signs, Road Markings, 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.**

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 have been assessed taking consideration of key destinations/centres; intersections/decision points; built and natural environment; other modes of traffic; visibility of signs and viewing angles; space available for signs; existing street furniture infrastructure; existing signs. In line with DMURS, the signage proposals have been 'kept to the minimum requirements of the Traffic Signs Manual (TSM) to avoid sign congestion within the Proposed Scheme corridor.

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 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 Marking

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.

12.3.3 Road Marking

A preliminary design of road markings has been undertaken in accordance with TSM Chapter 7 and the BCPDGB. For further details refer to the preliminary design drawings contained within **Appendix B**. The preliminary road marking design included the following items:

- Bus lanes;
- Cycle tracks;. The pavement will be marked according to best practice guidelines such as DMURS and the National Cycle Manual with particular attention given to junctions. Advance Stacking Locations (ASLs) have been designed where practicable to provide a safer passage for cyclists at signal-controlled junctions 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.

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 determined by BCID lighting design 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 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’
- TII Specification for Works, Series 1300 & 1400;
- TII Standard 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 Stops

The Proposed Scheme will include for the provision of lighting in covered areas, open areas and passenger waiting areas.

The location of the lighting columns will be dictated by light spread of fittings to give the necessary level of illumination (the columns at stops provide clearance for buses).

12.5 Traffic Signals

12.5.1 Above Ground Infrastructure

The Preliminary design shows the proposed locations of above ground infrastructure. This is included in the Junction Systems Design drawings in Appendix B.

12.5.1.1 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.

12.5.1.2 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.

12.5.1.3 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 positioned 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 will 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.

12.5.2 Under Ground Infrastructure

12.5.2.1 Ducts

Where practicable, existing chambers and ducting will be retained.,

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.

12.5.2.2 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.

12.5.2.3 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, 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.

12.5.3 Traffic Signal Priority

12.5.3.1 Overview

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 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 possible 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 using 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 Types 2 and 3. 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.

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.

12.6 Communication

Communications will be used to connect on-street devices with the traffic control rooms. 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.

12.7 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.**

12.7.1 Camera Positioning and Monitoring

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. Thus, 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. It is noted that the existing approximately 20m CCTV pole at the Tonlegee Junction will need to be moved or an alternative camera arrangement installed.

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.

12.7.2 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 minimize 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 prioritize the access for pedestrians and cyclists in the area and the aesthetics of the street urban landscape

12.7.3 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.

12.7.4 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.

Where it is not practicable to use existing network for a continuous fibre optic cable network the Proposed Scheme will require a new telecommunications ducting network consisting of two ducts with chambers at 180m centres along one side of the road with spurs to connect to cabinets and equipment. 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.

12.7.5 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.

12.8 Real Time Passenger Information

12.8.1 General

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 display on a dedicated mounting post, as illustrated below.

Figure 12.1: RTPI Display at Bus Stop

12.8.2 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.

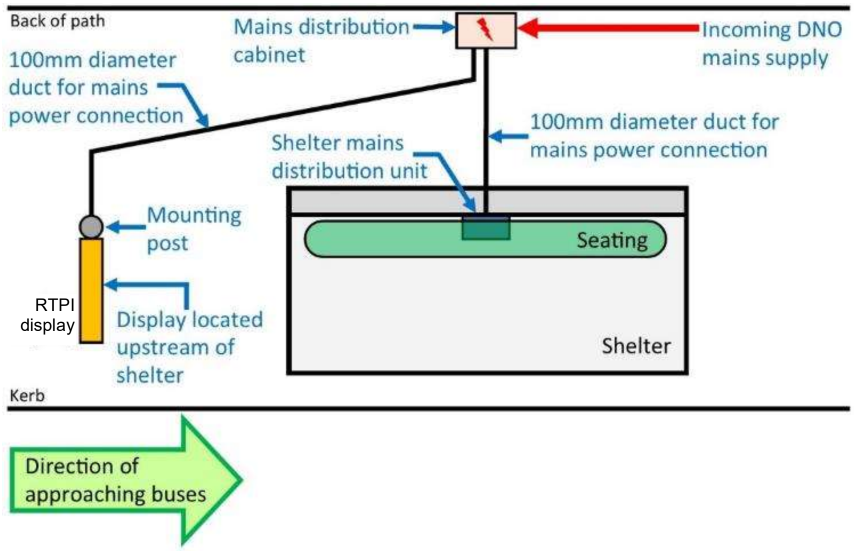

Figure 12.2: Typical Layout for Bus Stop with RTPI Display

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.

12.8.3 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**:.

12.8.4 Data Communications for RTPI Display

The majority of RTPI systems currently in operation now use the mobile phone (GPRS/3G/4G) 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.

12.9 Roadside Variable Message Signs

No roadside Variable Message Signs (VMS) exist along the route, and the original concept design and its development did not identify the requirement for any new VMS.

12.10 Maintenance

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

12.11 Safety and Security

12.11.1 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 possible 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.

12.11.2 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

12.12 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 following provisions:

- 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;
- Location of chambers away from pedestrian desire lines, and areas of tactile paving. This is to provide for a reduced impact on Traffic Management;
- Chambers to be placed at 180m centres on longitudinal duct runs, 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
- Location of 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 Compulsory Purchase Order (CPO) Deposit Maps. The total area that lies within the proposed road development boundary is approximately 50ha. including the existing roads and footpaths.

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 3.64ha of land will be required to be permanently acquired, of which approximately 1.12ha is currently in DCC ownership and 2.52ha is in FCC ownership, to construct the Proposed Scheme. There will also be an additional 4.18ha of temporary land required to allow for construction of boundary treatment and surface tie in work. This includes approximately 1.52ha currently in DCC ownership and 2.67ha in FCC ownership.

Reference should be made to the CPO Documents' prepared as part of the planning application for further details.

13.3 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
Lands at Dublin Road, Swords, Co. Dublin	Y	N
Ground at Airside Retail Park, Swords, Co. Dublin	Y	Y
Land to West of R132 Dublin Road, between Boroimhe Willows and Boroimhe Elms, Fosterstown North, Swords, Co. Dublin	Y	Y
Land to West of R132 Dublin Rd, to front of Boroimhe Elms, Fosterstown North, Swords, Co. Dublin	Y	Y
Land & Buildings to the south entrance to Boroimhe Estate, Hollytree House, Nevinstown, Swords, Co. Dublin	Y	Y
Land & Buildings to west of R132 Dublin Road, Texaco Service Station, Airside, Nevinstown, Swords, Co. Dublin	Y	Y
Land & Dwelling House to East of R132 Dublin Rd, Nevinstown Lane, Swords, Co. Dublin	Y	Y

Address	Permanent Land Take	Temporary Land Take
Gateway at Nevinstown Lodge, Nevinstown West, Swords, Co. Dublin, K67K6H6	N	Y
Gateway at Orchard 1, Nevinstown West, Swords, Co. Dublin, K67K8W6	N	Y
Ground at junction of Boroimhe Road and R132, Swords, Co. Dublin	Y	Y
Ground at junction of R132 Dublin Road and Nevinstown Lane, Swords, Co. Dublin, K67 F6W0	Y	Y
Lands to front of Boland Car Dismantlers, Newtown West, Swords, Co. Dublin	Y	Y
Lands at Nevinstown West, Swords, Co. Dublin	Y	N
Outside N1 Business Park and Glenmore House, Nevinstown, Swords, Co. Dublin	Y	Y
Verge off R132, Swords, Co. Dublin	N	Y
Verge adjacent to R132, Swords, Co. Dublin	N	Y
Ground adjacent to R132, Swords, Co. Dublin	Y	Y
Plot at Stockhole Lane, Cloghran, Co. Dublin	Y	N
Plot at Old Stockhole Lane, Cloghran, Co. Dublin	Y	Y
Lands adjacent to Roundabout, Dublin Road, Swords, Co. Dublin	Y	N
Ground at junction of Dublin Road and Pinnock Hill Roundabout, Miltonsfields, Swords, Co. Dublin	Y	N
Access road to Halpenny Golf, off R132, Swords, Co. Dublin	Y	Y
Grass verge along Swords Road, Santry, Dublin 9	Y	Y
Hard surface to rear of footpath, Swords Road, Santry, Dublin 9	Y	N
Green area adjacent to Coolock Lane, Santry, Dublin 9	Y	N
Verge adjoining Kilronan Equestrian Centre, Cloghran, Swords, Co. Dublin	Y	Y
Public ground adjacent to R132, Swords, Co. Dublin	N	Y
Outside Glenmore House, Nevinstown, Swords, Co. Dublin	Y	Y
Entrance to Kilronan Equestrian Centre, Cloghran, Swords, Co. Dublin	Y	Y
Verge adjacent to National Show Centre, Cloghran, Swords, Co. Dublin	Y	Y
Entrance to Kettle's Lane, Cloghran, Swords, Co. Dublin	Y	Y
Grass Verge to front of Metropoint Business Park, Nevinstown East, Swords, Co. Dublin	Y	Y
Land West of Junction of R132 Dublin Rd and Naul Rd, Cloghran, Co. Dublin	Y	Y
Land north-west of junction of R132 Dublin Rd. and Naul Road, Cloghran, Co. Dublin	Y	Y
Land north-east of junction of R132 Dublin Rd. and Stockhole Lane, Cloghran, Co. Dublin	Y	Y

Address	Permanent Land Take	Temporary Land Take
Land to North of Main Entrance to Dublin Airport, Cloghran, Co. Dublin	Y	Y
Land to South of Main Entrance to Dublin Airport and West of R 132 Swords Road, Cloghran, Co. Dublin	Y	Y
Grass area adjacent to R132, Dublin Road, Swords, Co. Dublin	Y	Y
Land to East of R132 Dublin Road, in front of Coachmans Inn, Cloghran, Co. Dublin	Y	Y
Land north west of junction of R132 Dublin Rd. and Naul Road, Cloghran, Co. Dublin	Y	Y
Swords Veterinary Hospital, Milton Fields, Pinnockhill, Swords, Co. Dublin, K67 YX67	Y	Y
Access to O'Scanaill Veterinary and Ceim Dearg, Miltonsfields, Swords, Co. Dublin	Y	Y
Grass verge at R132 Swords Road, Co. Dublin	Y	Y
Plot to west of R132, Airport lands and part of ground pertaining to new offices,	Y	Y
Grass verge adjacent to Dublin Airport Green Car Park, Swords Road, Co. Dublin	N	Y
Green area adjacent to ALSAA, Old Airport Road, Co. Dublin	N	Y
Grass Verge, Swords Road, Co. Dublin	N	Y
Airport car park and path, Swords Road, Co. Dublin	Y	N
Pavement to front of Kealy's of Cloghran, Swords Road, Co. Dublin	Y	Y
House on Swords Road, Corballis, verge/entrance outside	Y	Y
Plot to west of R132, Dublin	Y	N
San Antoine and Tig Mór, Swords Road, Corballis, verge/entrance outside	Y	Y
Cloghran Guest House, Swords Road, Corballis, Swords, Co. Dublin, K67EA03	Y	Y
Lowlands', 2, Swords Road, Corballis, Cloghran, Swords, Co. Dublin	Y	N
1 Swords Road, Corballis, Swords, Co. Dublin, K67H0F4	Y	N
Property at Airport, Swords Road, Co. Dublin	Y	Y
Lands adjacent to entrance to Dardistown Cemetery, Swords Road, Co. Dublin	Y	Y
Land at Entrance to Dardistown Cemetery, Dardistown, Co. Dublin	Y	Y
Land in front of Collinstown Cross Industrial Estate, Swords Road, Dardistown, Co. Dublin	Y	Y
Dardistown Cottage, Swords Road, Cloghran, Swords, Co. Dublin, K67 R8H3	Y	Y
Entrance to JJ Gillian site and grass area, Swords Road, Cloghran, Swords, Co. Dublin	Y	Y

Address	Permanent Land Take	Temporary Land Take
Paddy Shanahan Cars, Cloghran, Co. Dublin	Y	Y
Land at entrance to Car Park, Swords Road, Cloghran, Swords, Co. Dublin	Y	Y
Land at East Side of R132 Swords Road, Dardistown, Co. Dublin	Y	Y
Land at Derryloam, Swords Road, Swords, Co. Dublin, K67 YD42	Y	Y
Lands at Collinstown Cross, Swords Road, Cloghran, Co. Dublin	Y	Y
Plot to east of R132 Dublin Rd., Cloghran, Co. Dublin	Y	Y
Dublin Airport lands, Cloghran, Co. Dublin	N	Y
Open Space on East Side of R132 Swords Road, Co. Dublin	Y	N
Yard at Actavo (Santry Hire & Sales), Swords Road, Co. Dublin	Y	Y
North Ring Business Park, Swords Road, Dublin 9	Y	Y
East side of R132 Swords Road, Co. Dublin	Y	N
East side of R132 Swords Road, outside Altrad (Santry Hire & Sales), Co. Dublin	Y	Y
Lands at entrance to Harris Park, Swords Road, Dublin 9	Y	Y
Entrance to Kart City, Swords Road, Dublin 9	Y	Y
Entrance to Advance Business Park, Swords Road, Dublin 9	Y	Y
Entrance to North Ring Business Park, Swords Road, Santry, Dublin	Y	Y
Outside Nesta, Swords Road, Santry, Dublin	Y	Y
Unused ground at North Ring Business Park, Swords Road, Santry, Dublin 9	Y	Y
Industrial yard on west side of R132 Swords Road, Riverview Business Park, Co. Dublin	Y	Y
Land adjoining units (1 & 2?) on east side of R132 Swords Road, Airways Industrial Estate, Santry, Dublin 9	Y	Y
Woodford Business Park, Turnapin Lane, Santry, Co. Dublin	Y	Y
Grass verge adjacent to Woodford Business Park, Swords Road, Dublin 9	Y	Y
Entrance at Fury Road, Santry, Dublin 9	Y	Y
Grass verge, Airport Business Park, Santry, Dublin 9	Y	Y
Land adjoining Unit 3A on East Side of R132 Swords Road, Airways Industrial Estate, Santry, Dublin 9.	Y	Y
Land adjoining unit 3B on East Side of R132 Swords Road, Airways Industrial Estate, Santry, Dublin 9	Y	Y
Entrance to Furry Park Industrial Estate, Swords Road, Dublin 9	Y	Y
Airport Business Campus, Swords Road, Dublin 9	Y	Y
Portion of yard area outside Little Venice, Swords Road	Y	Y
Entrance to Furry Park Industrial Estate, Santry, Dublin 9	Y	Y
Fingal County Council land East of Swords Road, Santry, Dublin	Y	Y

Address	Permanent Land Take	Temporary Land Take
Morton Sports Stadium, Swords Road, Santry, Dublin 9	N	Y
Ground adjoining Little Venice Restaurant, Dublin 9	Y	N
Entrance to Northwood, Swords Road, Santry, Dublin 9	Y	N
Land to west side of R132 Swords Road, Santry Demesne, Swords Road, Santry, Dublin 9	Y	Y
Commercial Units at corner of Swords Road and Coolock Lane, Santry, Dublin 9	Y	Y
Carlton Hotel site to West of R132 Swords Road, Dardistown, Co. Dublin	Y	Y
Lands to front of Marymount, Swords Road, Swords Road, Co. Dublin, K67 T867	Y	N
Lands at Value Van Rental, Swords Road, Dardistown, Swords, Co. Dublin	Y	Y
Land on East Side of R132 Swords Road, Dardistown, Swords, Co. Dublin	Y	Y
Land and Vacant Buildings, East Side of R132, Swords Road, Dardistown, Swords, Co. Dublin	Y	Y
Royal College of Surgeons Sports Ground, Swords Road, Swords, Co. Dublin	Y	Y
Land and Vacant Dwelling on West Side of R132 Swords Road, Swords, Co. Dublin	Y	Y
Collinstown Lodge, Swords Road, Swords, Co. Dublin, K67 H9W0	Y	Y
Land to Front of Whitehall Colmcille GAA Club Cloghran Grounds, Swords Road, Turnapin Great, Co. Dublin	Y	Y
Skoda Car Garage, Annesley Williams, Swords Road, Swords, Co. Dublin	Y	Y
Glen Dimplex, Swords Road, Swords, Co. Dublin	Y	Y
Entrance road to Collinstown Business Park, Swords Road, Dublin 9	N	Y
East side of R132 Swords Road, Dardistown, Swords, Co. Dublin	Y	Y
Grass area along Swords Road, Santry, Dublin 9	Y	Y
AIB, Swords Road, Dublin 9, D09 DH56	Y	Y
1 Magenta Crescent, Dublin 9, D09 CH28	Y	Y
Entrance to Magenta Crescent, Santry, Dublin 9	Y	Y
Land to east side of R132 Swords Road, Santry Villas, Swords Road, Santry, Dublin 9	Y	Y
Pavement at Pedestrian entrance to Holy Child Church car park, Whitehall, Dublin 9	Y	Y
Green area and Swords Road, Co. Dublin	Y	N
Grass verge at Whitehall Junction, Whitehall, Dublin 9	Y	N
Green area at Collins Avenue, Whitehall, Dublin 9	Y	N
Pavement adjacent to Whitehall Football Club, Whitehall, Dublin 9	Y	Y

Address	Permanent Land Take	Temporary Land Take
Green area at Seven Oaks, Whitehall, Dublin 9	Y	N
Park to West Side of Drumcondra Road Lower at Junction with Botanic Avenue, Drumcondra, Dublin 9	Y	Y
Green area along Drumcondra Road Lower, Dublin 9	Y	Y
Magenta Hall, Santry, Dublin 9	Y	Y
Site with vacant buildings on West Side of Swords Road, Santry, Co. Dublin, D09 C623	Y	Y
Access Road to Santry Hall Industrial Estate, Swords Road, Santry, Dublin 9	Y	Y
Green space at Santry Hall Industrial Estate, Santry, Dublin 9	Y	Y
Maxol, 309 Swords Road, Dublin 9, D09H7F9	Y	Y
305 Swords Road, Santry, Co. Dublin	Y	Y
Cnocán An Rince, 303 Swords Road, Dublin 9, D09 X5W6	Y	Y
Laneway surrounding numbers 277 to 301 Swords Road, Santry, Co. Dublin	Y	Y
301 Swords Road, Dublin 9, D09EP84	Y	Y
299 Swords Road, Dublin 9, D09 C586	Y	Y
297 Swords Road, Dublin 9, D09 HD63	Y	Y
295 Swords Road, Dublin 9, D09 TW14	Y	Y
293 Swords Road, Dublin 9, D09 KW18	Y	Y
291 Swords Road, Dublin 9, D09K589	Y	Y
Saint Frances, 289 Swords Road, Dublin 9, D09YP59	Y	Y
Glenvale, 287 Swords Road, Dublin 9, D09T207	Y	Y
285 Swords Road, Dublin 9, D09 E0A2	Y	Y
283 Swords Road, Dublin 9, D09 YN81	Y	Y
281 Swords Road, Dublin 9, D09R5C6	Y	Y
279 Swords Road, Dublin 9, D09 W102	Y	Y
277 Swords Road, Dublin 9, D09FN32	Y	Y
269 Swords Road, Dublin 9, D09 P466	Y	Y
267 Swords Road, Dublin 9, D09 TD74	Y	Y
265 Swords Road, Dublin 9, D09 HF40	Y	Y
263 Swords Road, Dublin 9, D09 W920	Y	Y
261 Swords Road, Dublin 9, D09 F838	Y	Y
259 Swords Road, Dublin 9, D09 F226	Y	Y
Carrenree, 257 Swords Road, Dublin 9, D09 K854	Y	Y
304 Swords Road, Dublin 9, D09 A2C3	Y	Y

Address	Permanent Land Take	Temporary Land Take
Laneway between 302 & 304, Swords Road, Santry, Co. Dublin	Y	Y
302 Swords Road, Dublin 9, D09Y042	Y	Y
300 Swords Road, Dublin 9, D09 TH61	Y	Y
298 Swords Road, Dublin 9, D09H267	Y	Y
296 Swords Road, Dublin 9, D09 CK30	Y	Y
282 Swords Road, Dublin 9, D09 DY26	Y	Y
280 Swords Road, Dublin 9, D09PX95	Y	Y
278 Swords Road, Dublin 9, D09H671	Y	Y
276 Swords Road, Dublin 9, D09RK82	Y	Y
270 Swords Road, Dublin 9, D09 VX28	Y	Y
268 Swords Road, Dublin 9, D09AP98	Y	Y
266 Swords Road, Dublin 9, D09 WP99	Y	Y
264 Swords Road, Dublin 9, D09 AX09	Y	Y
262 Swords Road, Dublin 9, D09 RV04	Y	Y
260 Swords Road, Dublin 9, D09T183	Y	Y
258 & 258a Swords Road, Dublin 9	Y	Y
Laneway adjacent to 256, Swords Road, Santry, Co. Dublin	Y	Y
256 Swords Road, Dublin 9, D09 RX73	Y	Y
Hair Nail & Beauty Salon, 254 Swords Road, Dublin 9, D09F761	Y	Y
252 Swords Road, Dublin 9, D09T1F8	Y	Y
250 Swords Road, Dublin 9, D09E735	Y	Y
Planted area at service entrance to OMNI, Swords Road, Santry, Dublin 9	Y	Y
Airvista Office Park, Santry, Co. Dublin	Y	Y
Trade Electric Group / Barber Shop, Swords Road, Santry, Dublin 9	Y	Y
Pavement to front of former Swiss Cottage, Swords Road, Santry, Dublin 9	Y	N
37 & 39 Swords Road, Dublin 9, D09K3H6	Y	N
37A Swords Road, Santry, Dublin 9	Y	N
Ashley House, 2A Swords Road, Santry, Dublin 9	Y	N
Tanning Salon.ie, Swords Road, Dublin 9, D09HN66	Y	N
Magner's Pharmacy, Old Swiss Cottage, Swords Road, Dublin 9, D09P6C8	Y	N
Old Swiss Cottage, School House Lane, Santry, Dublin 9	Y	N
Green Verge at South Eastern Junction of Swords Road and Coolock Lane, Dublin 9	Y	Y
Green Verge at South Western Junction of Swords Road and Santry Avenue, Dublin 9	Y	Y

Address	Permanent Land Take	Temporary Land Take
Entrance to Santry Place Apartments, Santry, Dublin 9	N	Y
Grass verge adjacent to Santry Place, Swords Road, Santry, Dublin 9	Y	Y
Portion of Storage Yard at Chadwicks, Swords Road/Santry Avenue, Dublin 9	N	Y
Whitehall Church Car Park, Collins Avenue, Whitehall, Dublin 9	Y	Y
Site at junction of Collins Avenue and R132 Swords Road, Whitehall, Dublin 9	Y	Y
Development site at junction of Collins Avenue and R132 Swords Road, Whitehall, Dublin 9	Y	Y
Clonturk Community College, Swords Road, Dublin 9, D09 W5K6	N	Y
Highfield Health Care, Swords Road, Dublin 9, D09H343	Y	Y
Green area at Bonnington Hotel, Whitehall, Dublin 9	Y	Y
255 Swords Road, Dublin 9, D09RK31	Y	Y
Aras Mhuire, 253 Swords Road, Dublin 9, D09 CD83	Y	Y
251 Swords Road, Dublin 9, D09 YX68	Y	Y
249 Swords Road, Dublin 9, D09 YV78	Y	Y
Plot to front of Comet Pub, Swords Road, Santry, Dublin 9	Y	Y
Laneway to side of 241 Swords Road, Dublin 9	Y	Y
248 Swords Road, Dublin 9, D09 K8W7	Y	Y
246 Swords Road, Dublin 9, D09 Y2X3	Y	Y
244 Swords Road, Dublin 9, D09 FW99	Y	Y
Green area adjacent to Shanrath Road, Whitehall, Dublin 9	Y	Y
Road embankment at Drumcondra Bridge/Frank Flood Bridge, Drumcondra, Dublin 9	Y	Y
River Tolka, Drumcondra, Dublin 9	Y	Y
20 Drumcondra Road Upper, Dublin 9, D09E443	Y	Y
18 Drumcondra Road Upper, Dublin 9, D09XF86	Y	Y
Thunders, 16 Drumcondra Road Upper, Dublin 9, D09XY32	Y	Y
14 Drumcondra Road Upper, Dublin 9, D09K6C1	Y	Y
Sherry Fitzgerald, 12 Drumcondra Road Upper, Dublin 9, D09KR04	Y	Y
10 Drumcondra Road Upper, Dublin 9, D09H3C5	Y	Y
8 Drumcondra Road Upper, Dublin 9, D09HY29	Y	Y
6 Drumcondra Road Upper, Dublin 9, D09H6K8	Y	Y
Landing outside 4 Drumcondra Road Upper, Dublin 9	Y	Y
Landing outside 2 Drumcondra Road Upper, Dublin 9	Y	Y

Address	Permanent Land Take	Temporary Land Take
Tesco Metro, 22 Drumcondra Road Upper , Dublin 9, D09R286	Y	Y
24 Drumcondra Road Upper, Dublin 9 D09RY10	Y	Y
186 Drumcondra Road Upper, Dublin 9, D09 W6T4	Y	Y
188 Drumcondra Road Upper, Dublin 9, D09 N271	Y	Y
237 Griffith Avenue, Dublin 9, D09 X3T6	Y	Y
67 Dorset Street Upper, Dublin 1, D01XE10	Y	N
66 Dorset Street Upper, Dublin 1, D01R2R7	Y	N
65 Dorset Street Upper, Dublin 1, D01X7R6	Y	N
63 Dorset Street Upper, Dublin 1, D01K5Y4	Y	N
62 Dorset Street Upper, Dublin 1, D01K4P1	Y	N
61 Dorset Street Upper, Dublin 1, D01HP65	Y	N
54 Dorset Street Upper, Dublin 1, D01Y9E2	Y	N
50 Dorset Street Upper, Dublin 1, D01HD92	Y	N
Roadway & Pavement under rail bridge, Drumcondra Road Lower, Dublin 9	N	Y
Roadway & Pavement above rail line, Binns Bridge, Dorset Street Lower, Dublin 1	N	Y

13.4 Demolition, if any

The main structures to be demolished or removed along the Proposed Scheme are:

- Collinstown Cross-Part Demolition of Commercial Premises; and
- Two Semi-Detached Cottages at the Royal College of Surgeons Sports Ground.

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.

13.5 Summary of Accommodation Works and Boundary Treatment

The locations for proposed new boundary treatments along the Proposed Scheme have been provided 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 –There are no significant retaining walls within this scheme; 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.

Where cellars are affected by the Proposed Scheme they will be acquired and infilled with concrete. The Proposed Scheme will impact four4 cellars along Dorset Street Upper (Nos. 62, 63, 65 and 66). At these cellars an opening will be created in the existing footpath, the cellar will be surveyed, any existing access doorway will be blocked up with a sold concrete block wall. Any utilities or pipework within the cellar will be relocated or protected before the cellar is infilled with formed concrete. The existing concrete slab at footpath level will be removed and replaced with a new footpath with surface finishes to match the surrounding footpath.

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

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:

Fingal Development Plan 2023 – 2029

The Fingal Development Plan 2023 – 2029 is the county level planning framework applicable to the northern end of the Proposed Scheme from Pinnock Hill to the R132 Swords Road/R104 Santry Avenue Junction.

- Chapter 4 of the plan, *Community Infrastructure and Open Space*, sets out objectives in relation to Open Space (Section 4.5.2) and includes Objective CIOSO52, which seeks to protect, preserve and ensure the effective management of trees and groups of trees.

- Chapter 6, *Connectivity and Movement*, includes Objectives CMP18 to CMO31, which support sustainable mobility objectives relating to major rail and bus projects such as MetroLink, BusConnects and DART+ and LUAS Expansion under the National Development Plan 2021–2030. Objective CMO28 supports the national transport agencies in creating bus connectivity between Dublin 15, including the Blanchardstown Centre and Dublin Airport/Swords. Objective CMO30 aims to support opportunities provided by any public transport infrastructure works to improve and provide new cycling and walking links, including crossings of motorways and major roads which currently represent major permeability barriers to active travel especially in South Fingal.

- Chapter 9, *Green Infrastructure and Natural Heritage*, addresses biodiversity, parks, open space and recreation, surface water, heritage, and landscape. Special Amenity Areas, High Amenity Areas, Highly Sensitive Areas, County Geological Sites and beaches are specifically noted under landscape, and specific objectives for Green Infrastructure are set out under Objectives GINHP1 to GINHO26.

- Objective GINHP10 seeks a net gain in green infrastructure through the protection and enhancement of existing assets, through the provision of new green infrastructure as an integral part of the planning process. Objective GINHO22 states an intention to resist development that would fragment or prejudice the County's strategic green infrastructure network. Objective GINHO30 states that all infrastructure projects are to have a net biodiversity gain and this principle shall be incorporated from the start of the Proposed Scheme.

- Section 9.6 of the plan, *Natural Heritage*, addresses: Trees and Hedgerows; Landscape Character Assessment; Views and Prospects; Special Amenity Areas; and High Amenity Zoning. Section 9.6.9, *Protection of Trees and Hedgerows*, sets out objectives in relation to protection of trees and hedgerows including Tree Protection Orders and Tree Protection Objectives. Policy GINHP21 aims to protect existing woodlands, trees and hedgerows which are of amenity value and contribute to landscape character. The route of the Proposed Scheme is located in the low sensitivity 'Low Lying Character Type', a large landscape character area covering all of central south Fingal, including Dublin Airport. The area contains pockets of important valued areas requiring particular attention such as important archaeological monuments and demesnes and Santry Demesne proposed Natural Heritage Area (pNHA). Objective GINHO60 seeks to protect views and prospects that contribute to the character of the landscape, particularly those identified in the Fingal Development Plan (see Sheet 8 Swords), from inappropriate development. There are no Special Amenity or High Amenity Areas along the route of the Proposed Scheme.

Dublin City Development Plan 2022-2028

The Dublin City Development Plan 2022-2028 is the county level planning framework applicable to the section of the Proposed Scheme south of the Santry Avenue.

- Chapter 9 Sustainable Environmental Infrastructure and Flood Risk includes Policy SI22 to use SuDS in all new developments where appropriate, as set out in the Greater Dublin Regional Code of Practice for Drainage Works.
- Chapter 10 Green Infrastructure and recreation includes Objective GI08 to support the implementation of the Dublin City Biodiversity Action Plan 2021- 2025 and reflects the Strategic Objectives of Ireland's National Biodiversity Plan (Actions for Biodiversity 2017-2021).
- Chapter 10 Green Infrastructure also includes the Dublin City Tree Strategy 2016-2020 incorporating a set of policies for the long-term promotion and management of public trees in Dublin and Objective GI40 to identify opportunities for new tree planting.

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 2021-2025

Covers all areas of the City including roadsides and footpaths and reflects the Strategic Objectives of Ireland's National Biodiversity Plan (Actions for Biodiversity 2017-2021)

- 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 FCC 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 document BusConnects Dublin - Urban Realm Concept Designs, https://busconnects.ie/wp-content/uploads/2021/01/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 was taken to assist with drainage along the route. SuDS principles are 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

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

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.

14.5.1 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 re-laid 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.

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 180 trees lost and 8,380m^2 of woodland area removed, refer to **Table 14.1** below. This loss has been partially addressed through mitigation and replanting efforts as outlined in the planting strategy (**Section 14.6.3**) below. However, with 91 new individual trees planted and 1160m^2 of new woodland area it still results in a net loss within the constraints of 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
804	624	180	91	715 (-11%)
Approximate decrease in trees within the development area of approximately 11% 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)
90480	82100	8380	1160	83260(-8%)
Approximate decrease in woodland planting within the development area of approximately 8% 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 tree planting consistent with the recommendations of the Dublin City Tree Strategy.
- 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. Additional information on suitable plant species is also provided in Section 14.6.5.

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** below).

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. City centre locations have narrower medians with formal arrangements of tree and shrubs. In these scenarios species selection and correct tree pit design is crucial to ensure this component of green infrastructure thrives.

Figure 14.2: Example of Central Median Planting within the City

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 14.16:**).

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 scheme from verges adjacent to industrial units, retail frontages, schools, 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**).

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 **Figure 14.18**:).


Figure 14.5: Example of Trees Planted within a Public Realm Space

14.6.5 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 detail design stage.

Table 14.2 Proposed Tree Species

Species - Scientific name	Common names in English - Irish	Size
Acer campestre	Field maple	8-10,12-14, MS
Acer platanoides	Norway maple	14-16
Acer pseudoplatanus	Sycamore	12-14
Aesculus x carnea	Red horsechestnut	12-14
Alnus glutinosa	Common Alder	14-16
Betula nigra	River birch	12-14
Betula pendula	Silver birch / Beith gheal	12-14, MS
Carpinus betulus 'Fastigiata'	Hornbeam	12-14
Castanea satvia	Sweet chestnut	14-16
Fagus sylvatica	Beech	14-16
Liquidambar styraciflua	Sweetgum	14-16

Species - Scientific name	Common names in English - Irish	Size
Pinus sylvestis	Scotts pine	20-25, 200-250cm, 300-350mcm
Platanus x hispanica	London plane	14-16
Populus nigra	Black poplar	12-14
Prunus avium 'Plena'		14-16
Prunus serrula	Tibetan cherry	MS
Pyrus calleryana 'Chanticleer'	Ornamental pear	14-16
Liquidambar styraciflua 'Levis'	Sweet gum	14-16
Quercus petraea	Sessile oak	14-16, 20-25
Quercus robur	English oak	14-16
Sorbus aucuparia	Mountain ash	12-14
Tilia cordata 'Green Spire'	Small leaved lime	14-16
Zelkova errata 'Green Vase'	Japanese Zelkova	14-16

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 Pinnock Hill Junction to Boroimhe Road

Existing Character: The start of the Proposed Scheme is a wide, vehicle - dominated roundabout with poor pedestrian crossings, existing grass verges and woodland planting at the edges. It marks a threshold into the Swords Village Centre with a 'welcome' sign at the southern approach and an existing sculpture at the northern arm towards the entrance to Swords. The rest of the section is characterised as a wide arterial road within a rural character with an interface with the Airside Retail Park. There are future interface considerations with the proposed Fosterstown MetroLink Station.

Design Proposals: The existing roundabout is proposed to be redesigned as a fully signalised junction with pedestrian and cycle facilities. This design creates more space for landscaped areas at the edges, especially towards the Swords entrance and facilitates a gateway area to be created with the relocated sculpture to be placed on a plinth and a new and enhanced 'Welcome to Swords' sign. These landscaped areas would feature block planting of varied heights and seasonal planting or wildflower meadows. Clumps of trees reflecting woodland planting are proposed where highway visibility splays and utilities allow. The footways and cycle ways are in asphalt with concrete kerbs to match existing.

The eastern arm of the R132, which is designed by external parties, is proposed to have a grass verge median or planting to enhance the area.

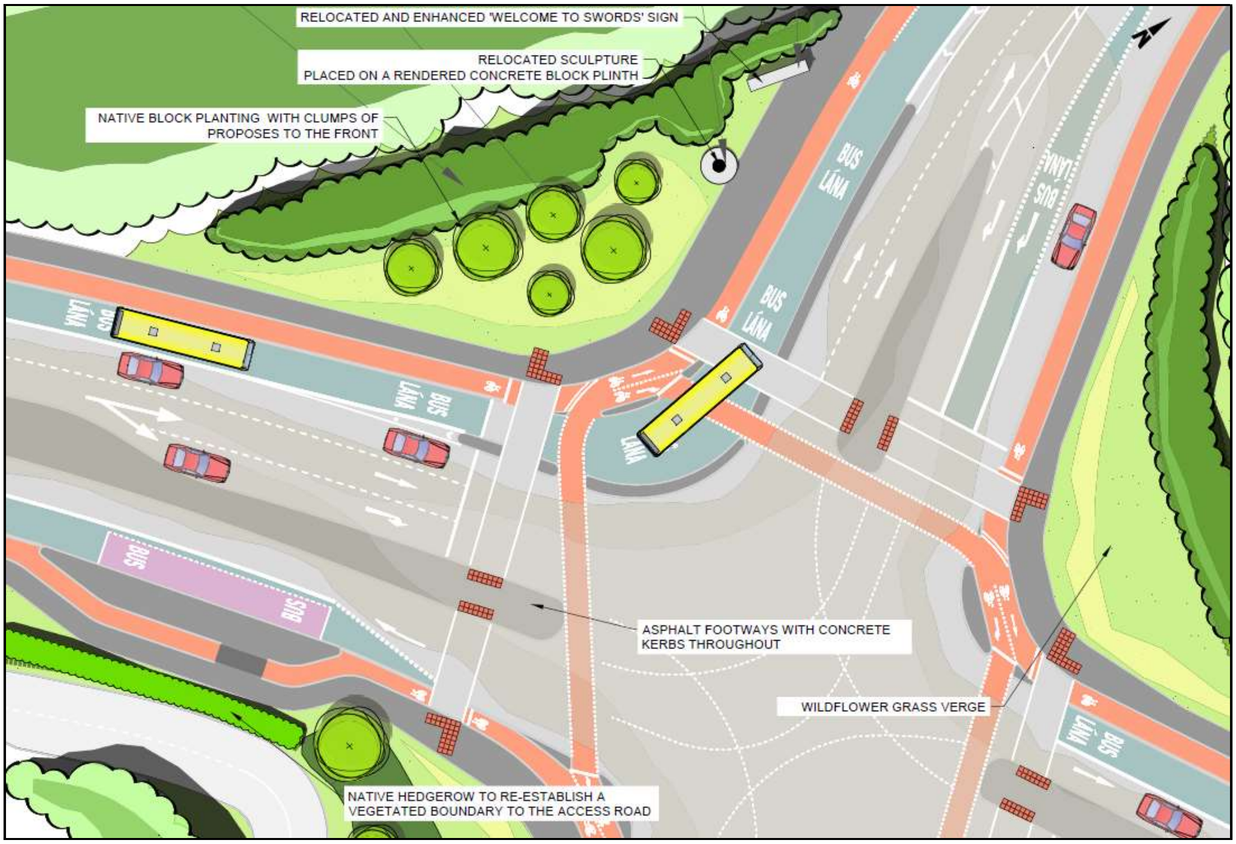

Figure 14.6: Pinnock Hill Junction Design

14.7.2 Boroimhe Road to Cloghran Roundabout

Existing Character: Arterial road with rural character and interface with several big-box retail uses, including Airside Retail Park north of Boroimhe Road junction with a substantial built form set back from route and the Kilronan Equestrian Centre.

Design Proposals: Replacement of ornamental planting, proposed tree planting and reinstatement of grass verge proposed for boundary with Airside Retail Park that is impacted by kerb realignments.

Boundary walls impacted at Airside junction proposed to be reinstated to match existing rendered walls. A low boundary wall and reinstated grass verge proposed at the Texaco boundary. Replacement ornamental planting proposed at the entrance of Glenmore House and replacement boundary fence and hedge proposed along the western boundary impacted by kerb realignment. Proposed priority crossing in concrete blocks proposed at the entrance to Kilronan House. Restoration of verges as needed along the Metro Point boundary.

Footways impacted by kerb realignments in this section finished in asphalt with concrete kerbs to match existing.

14.7.3 Cloghran Roundabout to Airport Roundabout

Existing Character: An arterial road with residential, mixed use and retail park interfaces. Key locations include National Show Centre, Coachman's Inn and Halpenny Golf Driving Range.

Design Proposals: Cloghran Roundabout is proposed to be redesigned as a junction. Existing young trees planted along the boundary of the National Show Centre will be lifted stored and re-planted to be back of the new re-aligned footway. Behind this, a large SUDs feature is proposed together with species rich grass to enhance biodiversity. On the western side of the junction management of the planting edge is required together with strips of new native planting and hedgerows tom to reinstate vegetated boundaries. Grass verges will be reinstated.

A local intervention is proposed at the Coachman's Inn including reinstating the boundary wall with a low stone wall and concrete paving blocks at the entrance to the car park.

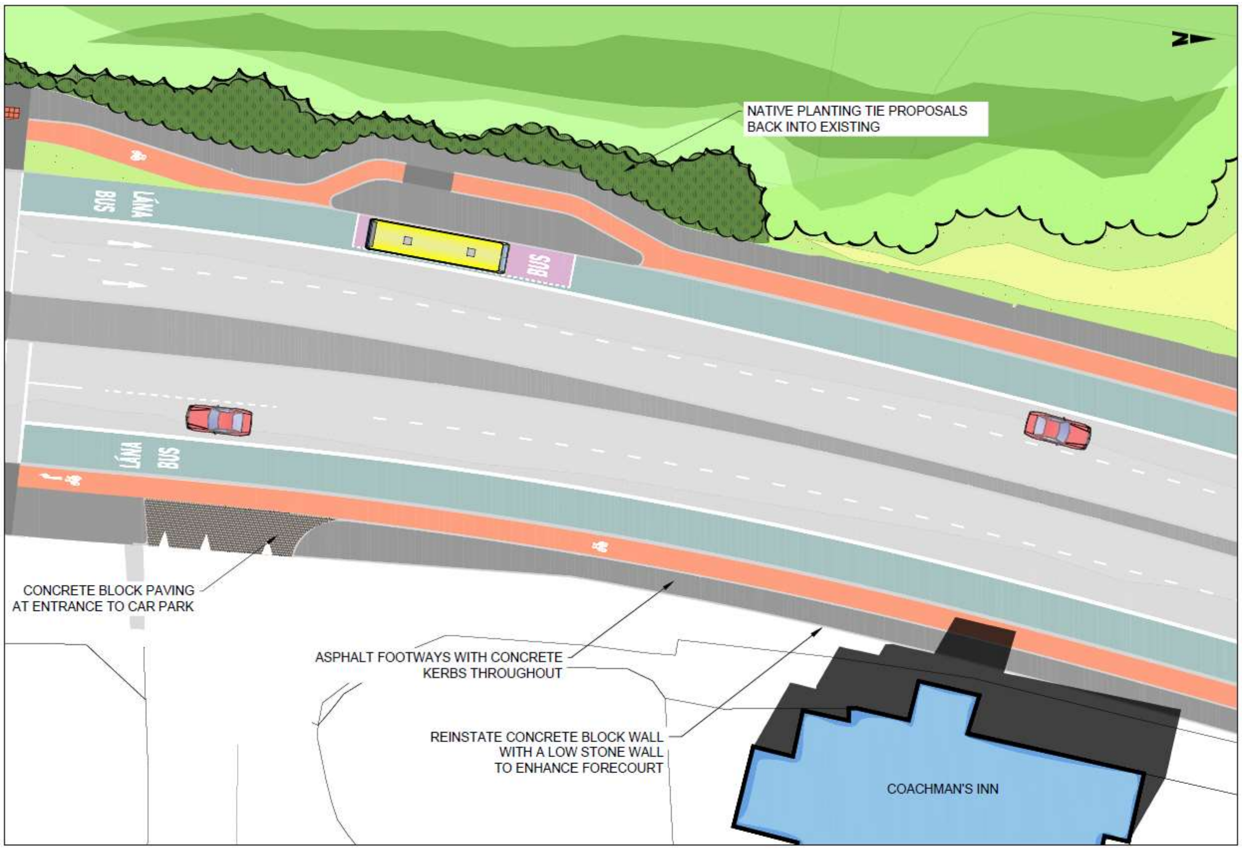

Figure 14.7: Coachman's Inn Area Design

Footways impacted by kerb realignments in this section are finished in asphalt with concrete kerbs to match the existing.

14.7.4 Airport Roundabout to Old Airport Road

Existing Character: This section features a wide arterial road with the roundabout being a key access point into Dublin Airport. The wide Airport Roundabout features a central sculpture, grass verges and edge tree planting with adjacent airport related car parking areas, the ALSAA Sports Centre and Swords Rugby Club.

Design Proposals: Minor changes to road alignment are proposed at the Airport Roundabout. Reinstatement of larger areas of grass verge will be treated with species rich grass. Where kerb realignment is necessary, the footway materials and kerb types shall match the existing materials. Edge planting management, crown lifting, and replacement tree planting is proposed on the western side of the roundabout approaches. Asphalt and concrete kerbs are proposed for footways and on traffic islands which are changed by the realignment.

Proposed footways materials in the rest of this section are also finished in asphalt with concrete kerbs. Driveways and access points are to be reinstated with materials to match existing.

14.7.5 Old Airport Road to Santry River

Existing Character: The wide arterial road transitions into a narrower road section beyond the Old Airport Road junction where Collinstown Cross Industrial Estate has a potential redevelopment plan. The character changes from airport related functions to an outer suburban road with a mix of residential, airport related hotels, commercial and retail park uses. Some traditional thatched roof houses that are listed are located south of Old Airport Road. The character of the road changes again from retail park and mixed use to predominantly residential at the Santry River area.

Design Proposals: The south western area of Old Airport junction has been identified for a proposed local landscape planting feature. The landscape area consists of new native planting and feature trees set within seasonal or wildflower meadow planting. The existing trees are proposed to be retained and managed.

The boundary of Collinstown Cross Industrial Estate is proposed to be reinstated in discussion with the landowners and their plans for the redevelopment of the site.

Figure 14.8: Old Airport Junction / Collinstown Cross Design

Just south of the junction, a building with a thatched roof has some heritage significance. It is proposed to adjust the boundary wall by setting it back slightly to suit the realigned footway. The wall reinstatement is to be rendered walls, with railings and garden restoration to match the existing. South-east of the Quick Park entrance road, the boundaries are to be replaced 'like for like' consisting of a low concrete wall, hedge and trees.

The entrance to the Carlton Hotel is proposed as a priority crossing in concrete setts along with reinstated ornamental planting and flagpole relocation as needed in discussion with the landowners. The footway along the boundary is proposed to be surfaced in poured concrete and concrete kerbs in discussion with landowners. The boundary wall with railing will be reinstated in a style to match the existing.

The boundary opposite the GreatGas Express which has an existing low mound, is proposed to have a new fence with a hedge behind it in discussion with the landowner.

The proposals include rebuilding the gates and wall to the Royal College of Surgeons Sports Ground to match existing in discussion with the landowners.

Along the Whitehall Colmcille GAA Club boundary, the unattractive steel railing is proposed to be replaced with a low stone wall and railings in discussion with landowners to enhance the street scene.

Along the boundary with Annesley Williams, a low wall with a rendered finish is proposed in order to enhance the street scene. A new pedestrian priority crossing of reduced width is proposed at the entrance finished in concrete setts.

At the Santry Business Park boundary the proposal is to replace the existing palisade fence with a low stone wall and paladin railings above, in discussion with landowners, in order to achieve a consistent appearance of boundary treatment along the road and enhance the street scene. Grass verge restoration is required to areas affected by the scheme.

South east of the Turnapin Lane junction, a new hedge is proposed to be set back to replace the existing hedge forming the boundary with the industrial estate.

Footways in this section are proposed to be finished in poured concrete with concrete kerbs to match existing.

As the route approaches the Santry River interface, a no-dig construction method is to be adopted to protect the existing trees along the east side just north of the river.

The area immediately north of Santry River has been identified as a location for a local enhancement. The entrance to Santry Riverside Walk will be enhanced by existing vegetation being partly cleared to open views to the river. New concrete paving and a seating area will create a gateway and link to the walk. The footpaths outside Little Venice is proposed to be enhanced with concrete paving slabs and concrete kerbs with concrete setts at the driveway, as well as a low stone wall along the forecourt. Replacement wall, hedge and garden reinstatement planting as required along the boundary south of the river.

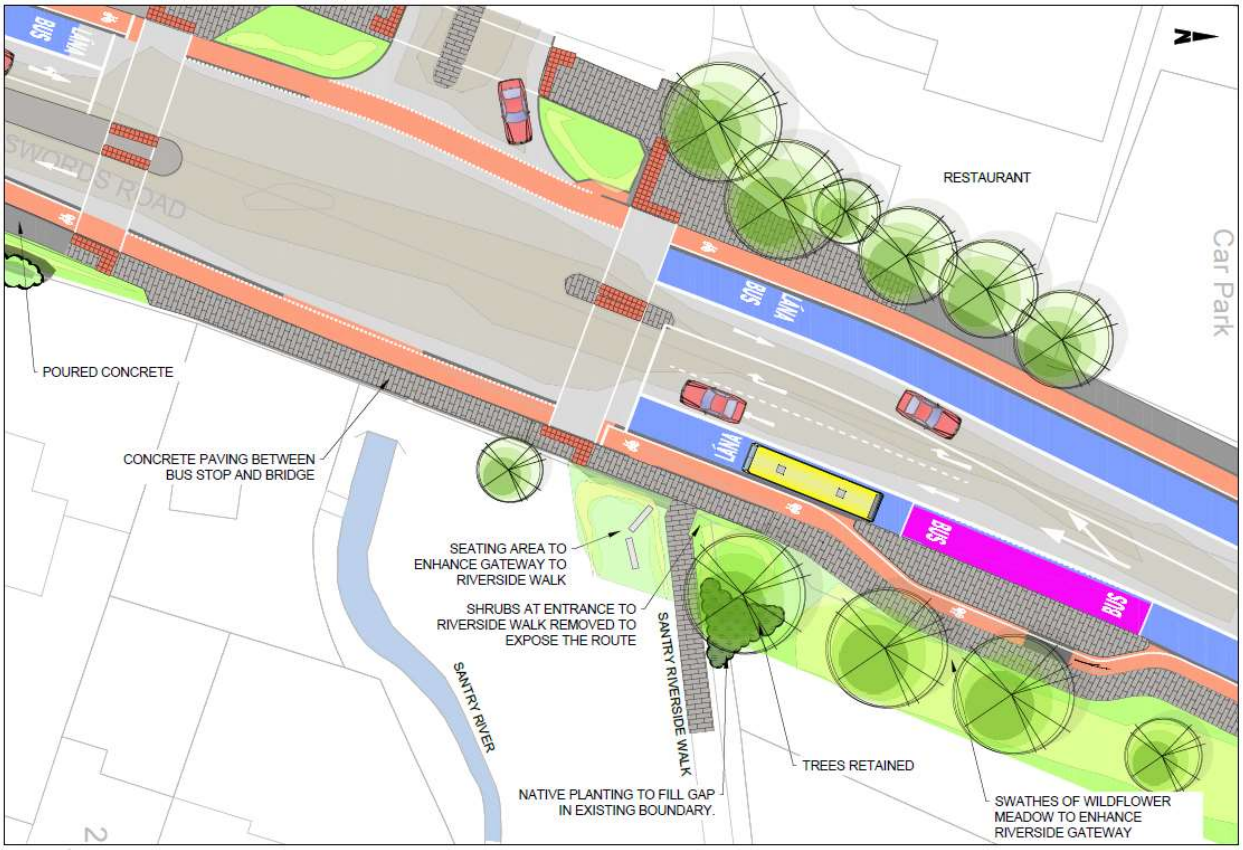

Figure 14.9: Area North of Santry River Design

14.7.6 Santry River to Coolock Lane

Existing Character: The character of the route changes south of Santry River from a wide outer suburban connector road to a narrower outer suburban residential road character. 2-storey residential properties and Santry Park form the edge to this section of the road corridor. Santry Demesne, Santry Park/Morton Stadium and the boundary wall are key features along this part of the route. Parts of the wall itself have some historical significance. Coolock Lane junction includes an entrance into Santry Park.

Design Proposals: The design proposes concrete paving slabs with concrete kerbs from the Santry River threshold to Shanrath Road - Larkhill Road junction. The entrance to Santry Park is proposed to be enhanced with granite setts and all the islands enhanced with concrete setts to improve overall image of the area. The existing trees in the park are retained with proposed new tree planting to be discussed with Local Authorities and stakeholders. The wall along the park south of the junction to be reinstated to match existing. A low stone wall and railings along the south-eastern side of the junction is to be reinstated to suit the realignment and materials are to match the existing.

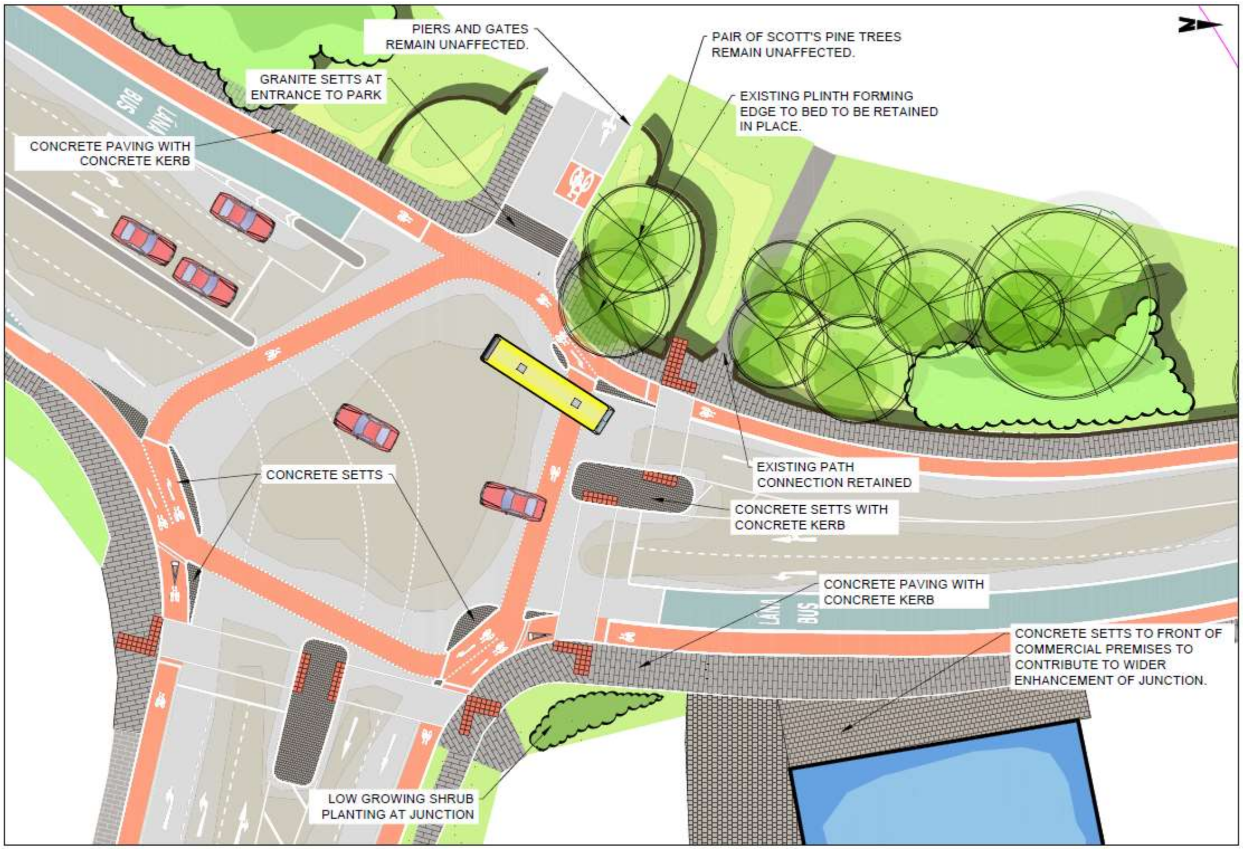

Figure 14.10: Coolock Lane and Entrance to Santry Park Design

14.7.7 Coolock Lane to Dublin Omni Park

Existing Character: This section is a connector road with a suburban character interfacing with retail, Village Centre and some residential properties. The Santry Village Centre interface is a key local centre. The Swiss Cottage site has a planned redevelopment.

Design Proposals: The public realm of the shopping parade opposite Heiton Buckley is proposed to be enhanced with concrete paving and concrete kerbs to improve the street scene.

The Swiss Cottage interface boundary is to be designed in discussion with landowner in line with new development at future design stages.

South of Swiss Cottage redevelopment site, the boundary proposal is for a low wall with railings along the eastern edge and a rendered wall with railing along the western edge, reinstated to match the existing style.

Along the Magenta Hall residential area, along both the western and eastern edges, the design proposes to replace multiple fence types with a unified design to provide a more consistent style to the street in this area. Along the residential edge it is proposed to reposition the newly planted trees and replace the ornamental or seasonal planting as required. The proposed fence design is to consider views from the residential area in order to screen the road. The current fence along Santry Hall Industrial Estate is proposed to be replaced with a fence that complements the residential fence style in order to provide a unified street scene.

The park entrance at the north-eastern corner of Lorcan Road is to be reinstated using concrete slab paving and concrete kerbs. The existing asphalt ramp within the park is to be extended and realigned. New stepped feature planting is incorporated to highlight this park corner along with new park trees as replacements for local tree losses and seasonal planting in a wave form to replace effected planting. The 'Magenta Hall' sign is re-positioned, and an advisory sign is to be located for the Quiet Street route along Lorcan Road.

Figure 14.11: North Eastern Corner of Lorcan Road Design

Footways are to be resurfaced with concrete paving slabs and concrete kerbs to enhance the street scene along this residential and mixed-use area.

14.7.8 Dublin Omni Park to Shanrath Road

Existing Character: A suburban connector road with a relatively narrow carriageway moving south. Dublin Omni Park is a local destination. South of Omni Park, 2-storey residential properties line both sides of the road, with many of the properties having elevated front gardens with steps up to the front door. There is a more consistent character of boundary styles along the eastern edge compared to the western edge.

Design Proposals: The design proposes to enhance the footways with concrete paving slabs and concrete kerbs with new driveway cross overs to be detailed in concrete setts to enhance the overall street scene. Where boundaries are affected, front gardens are to be restored as needed in consultation with landowners. Some properties are to incorporate new parking provision within front gardens.

The proposals seek to unify the design of all effected residential boundaries with two types of boundary designs, one which is a free-standing wall and one which is a retaining wall with railings above:

- Free-standing - This type of wall treatment replaces existing walls that has a singular wall component with coping detail on top. The proposed design includes a concrete block wall rendered in cream or off-white to match existing walls. The wall is detailed with a recess at the bottom to address the changes in the footway levels and to create a consistent straight base while the pre-cast coping complements the main wall and unifies the boundaries along the street.

- Retaining - This type of wall replaces existing walls that act as retaining structures to front gardens and includes a concrete block base for the retaining structure rendered in cream or off-white. New railings to match existing railing style. The wall is detailed with a recess at the bottom to address the changes in the footway levels and create a consistent straight base. Pillars with pre-cast coping complements the main wall and unifies the boundaries along the street.

Figure 14.12: Sketch View of New Property Boundaries Along Swords Road

The area in front of The Comet is proposed to have surface treatment enhancements. This includes a wider pedestrian footway in concrete paving and the vehicular forecourt in concrete setts. The pedestrian footway along the western retail area near The Comet is also proposed to be enhanced with concrete paving and the parking area in concrete setts along with a replacement low rendered wall off-white or cream to match the residential walls. The Centra forecourt proposes to be de-cluttered and reorganised. The footways along these retail areas to be resurfaced in concrete paving slabs and concrete kerbs to match the rest of the residential footways to the northern part of this section.

Figure 14.13: Sketch View Looking Towards The Comet

The eastern corner of the Shanrath Road-Larkhill Road junction has been identified as a cycle route with cycle lanes through the green space. The proposed design includes crown lifting of existing trees, feature concrete paving in the widened footway with seating and lighting along cycle lanes.

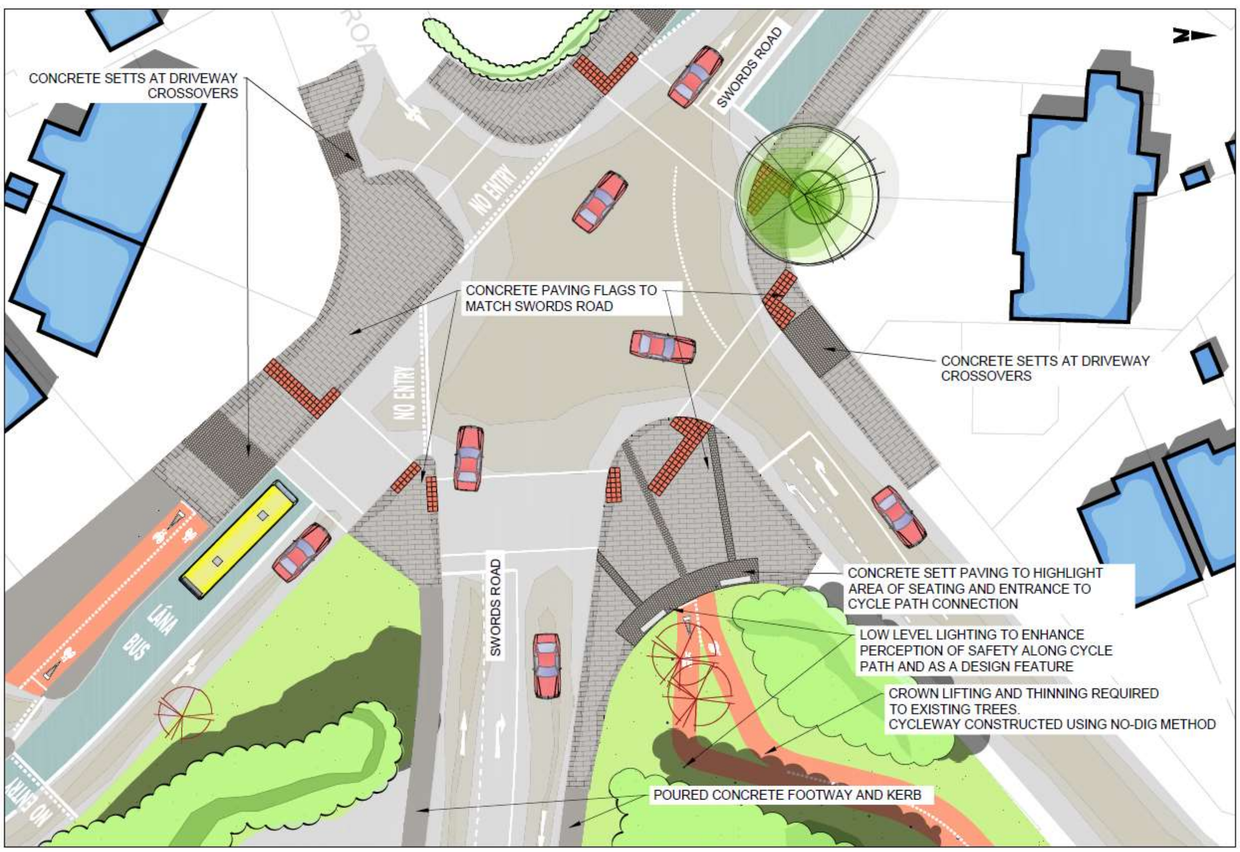

Figure 14.14: Eastern Corner of the Shanrath Road-Larkhill Road Junction Design

14.7.9 Collins Avenue to Griffith Avenue

Existing Character: A connector road with suburban character consisting of residential, mixed use and open space edges. Street clutter is evident on footways.

Design Proposals: The pedestrian and cycle crossings at the Collins Avenue junction are proposed to be improved. The local green space with trees and shrubs on the west side of the junction is to be retained and protected during the works where new footway connections and cycle paths pass through.

The shopping parade near Iveragh Road has been identified as a local enhancement to improve the setting and appearance of the local shops. Concrete paving slabs and concrete kerbs are proposed for footways and concrete setts for the parking areas. The bus stop area is enhanced with a widened area for pedestrians and shop fronts. Pedestrian crossings are improved as part of the re-aligned junction along with a continuous cycle track to both sides.

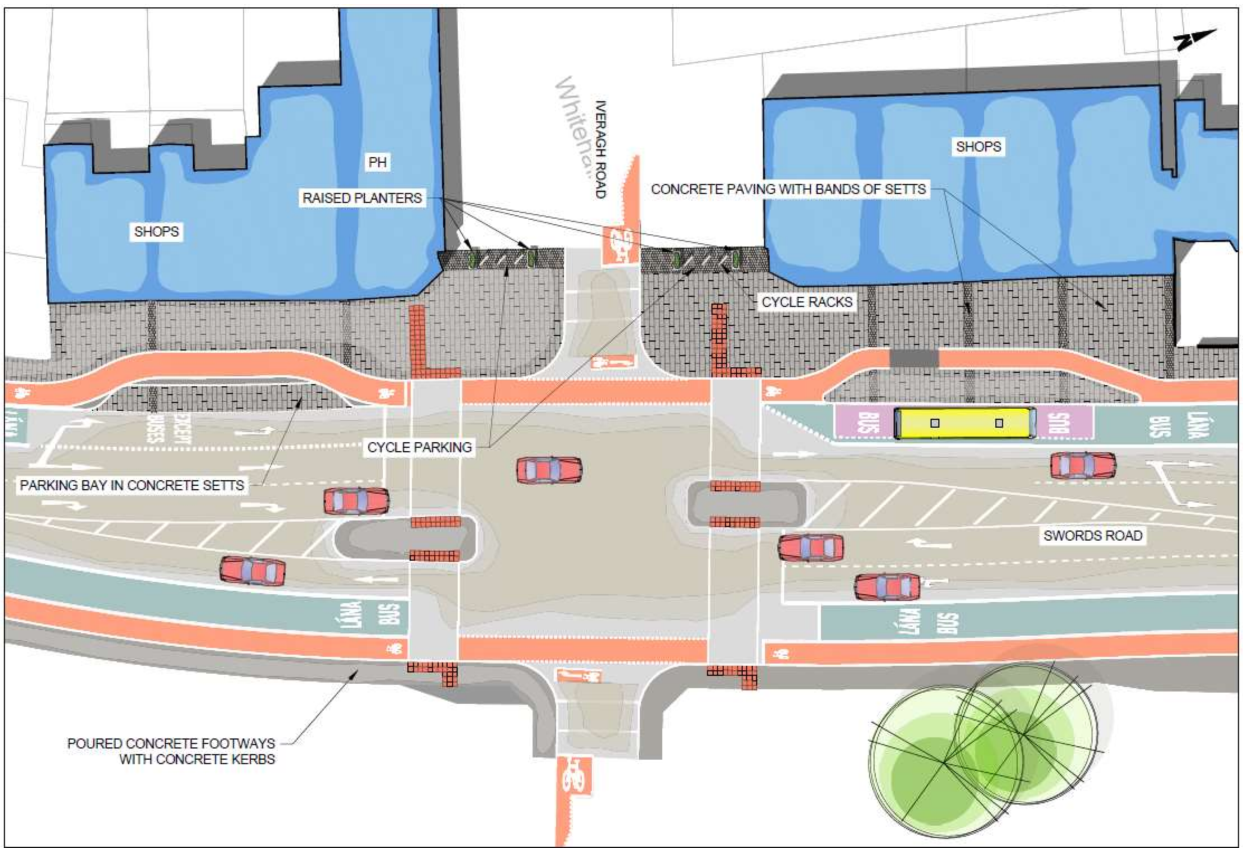

Figure 14.15: The Shopping Parade Near Iveragh Road Design

The boundary wall along Whitehall Colmcille GAA club main pitch is proposed to be reinstated as a rendered block work wall to improve the appearance of the existing boundary. The potential to include low walls with railings to open up views is to be discussed with landowners in future design stages.

Along the Plunket College boundary, a new bus stop requires a small amount of land take with a new hedge and retaining wall reinstated to match the existing. Priority crossings across side roads are proposed to promote pedestrian priority. Gardens and planting are re-instated along effected boundaries with no-dig construction methods to be utilised near existing trees to avoid impacts to roots. Pedestrian and cycle crossings are to be enhanced across the Griffith Avenue junction.

Footways impacted by kerb realignments in this section are proposed to be resurfaced with poured concrete and concrete kerbs to match the existing.

14.7.10 Griffith Avenue to Richmond Road

Existing Character: A suburban residential character with generally 2-storey houses in the northern part of the section. A tree lined boulevard character exists along Drumcondra Road Upper. The DCU area is a village centre which is frequented by residents and DCU students. The retail parade in the DCU area has narrow footways and The Cat and Cage pub is a local landmark. South of the pub and beyond is a small section of residential use along with another local retail shopping parade closer to the Frank Flood Bridge. The retail areas and on the bridge feature commemorative flower baskets on poles and planters. Street clutter and poor pedestrian facilities are present along this section.

Design Proposals: Along Drumcondra Road Upper, the design proposes to make footway surfaces consistent in appearance using poured concrete and concrete kerbs with repairs to match existing as needed. Reinstatement of grass verges and enlarging existing tree surrounds is proposed to support future tree health. No-dig construction methods are to be utilised where works could otherwise impact on existing tree roots.

The DCU area is proposed as a local area of enhancement with the proposed design including high-quality grey concrete slabs interspaced with darker grey linear bands of paving that continue along the DCU boundary to the west for visual continuity. Granite kerbs are proposed along this area utilising existing granite kerbs where practicable. A general declutter and unified street furniture use is proposed for this area. Parking bays are proposed to be finished in concrete setts to visually integrate with pedestrian areas, or as inset parking bays at footway level to provide wider footways when not in use. The private forecourts have the potential to be repaved in concrete block paving in consultation with landowners. Edge kerbs are proposed to mark the boundary of private forecourts. The commemorative flower post features are to be retained or relocated in consultation with Local Authorities.

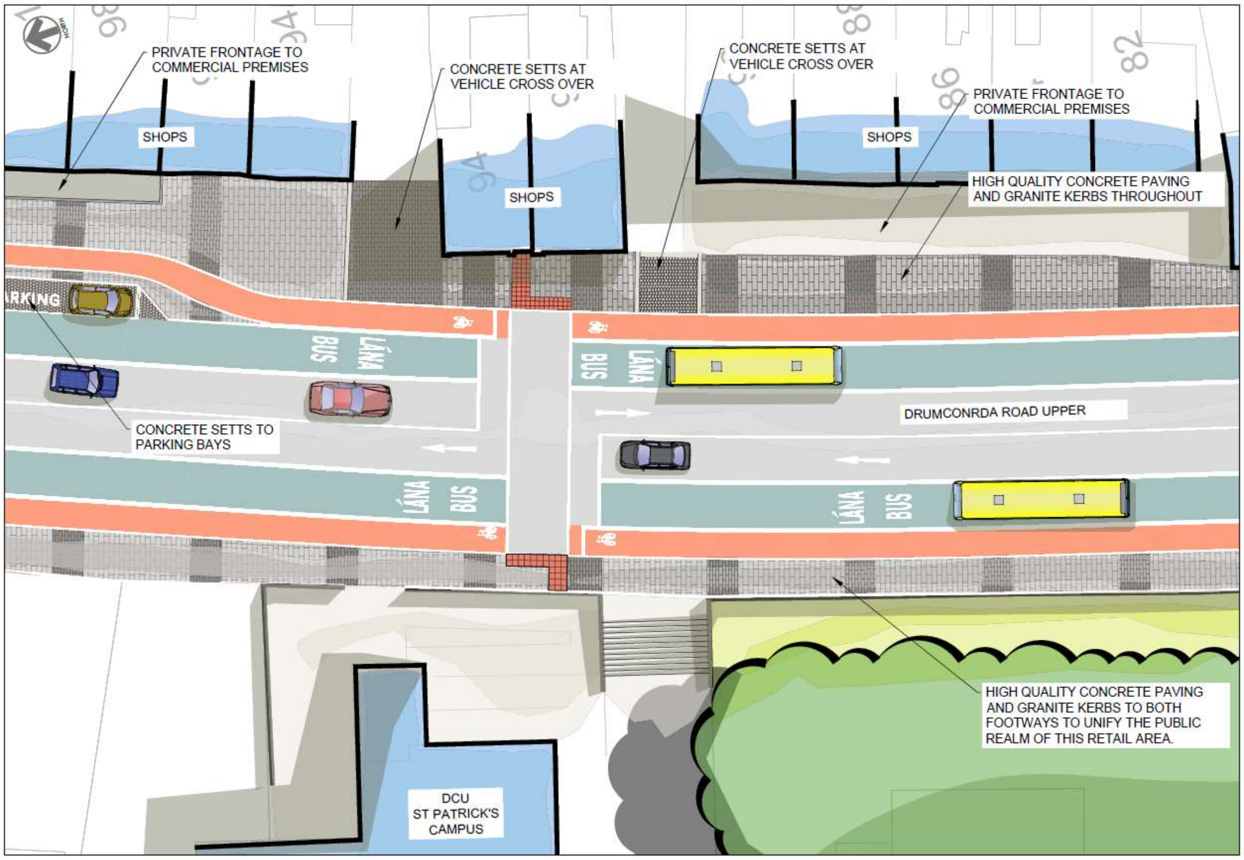

Figure 14.16: DCU Area Design

The footway in front of the Cat and Cage pub is to be finished in concrete paving slabs and granite kerbs. The banding feature starts at the edge of the pub. The pedestrian crossing at the side street is finished in concrete setts to enhance pedestrian priority. The residential area footways are to feature concrete paving slabs and granite kerbs of the same type as the retail area but without the banding feature.

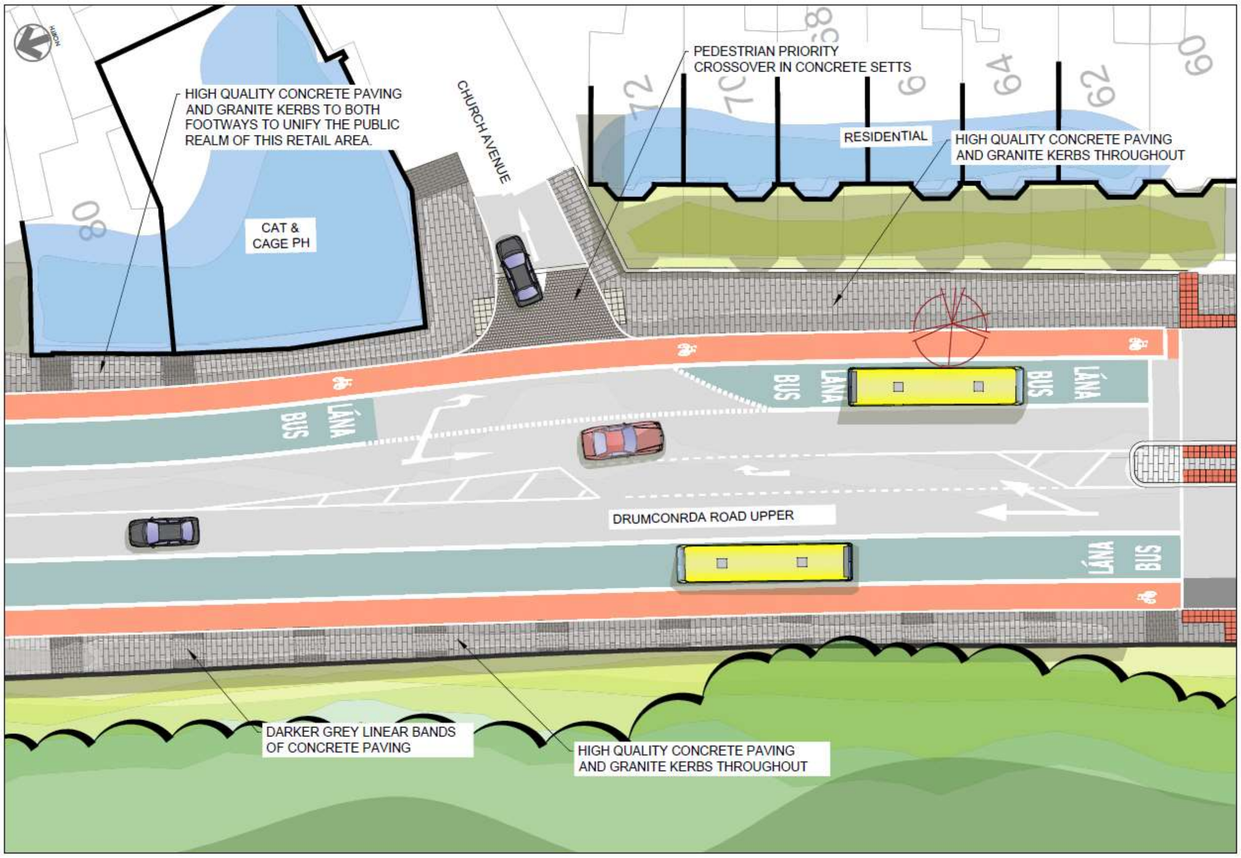

Figure 14.17: Footways in the Vicinity of the Cat and Cage Pub Design

The Drumcondra Road Upper shopping parade is also identified as a local enhancement opportunity to improve the image of the public realm. The design proposed is to reflect the same design style and materials as the DCU area in order to make the two retail areas visually unified. The design includes footway enhancements with high-quality grey concrete slabs interspaced with darker grey linear paving units as feature bands. Granite kerbs are proposed along this area reusing exiting granite kerbs where practicable. The refreshed paving and banding are proposed in the private forecourt areas up to the edge of the shops but will need to be agreed with landowners. Parking bays are proposed to be finished in concrete setts to visually integrate with adjacent pedestrian areas or as inset parking bays at footway level to provide wider footways when not in use. The commemorative flower pole features are to be retained or relocated within the darker banding feature paving in consultation with Local Authorities.

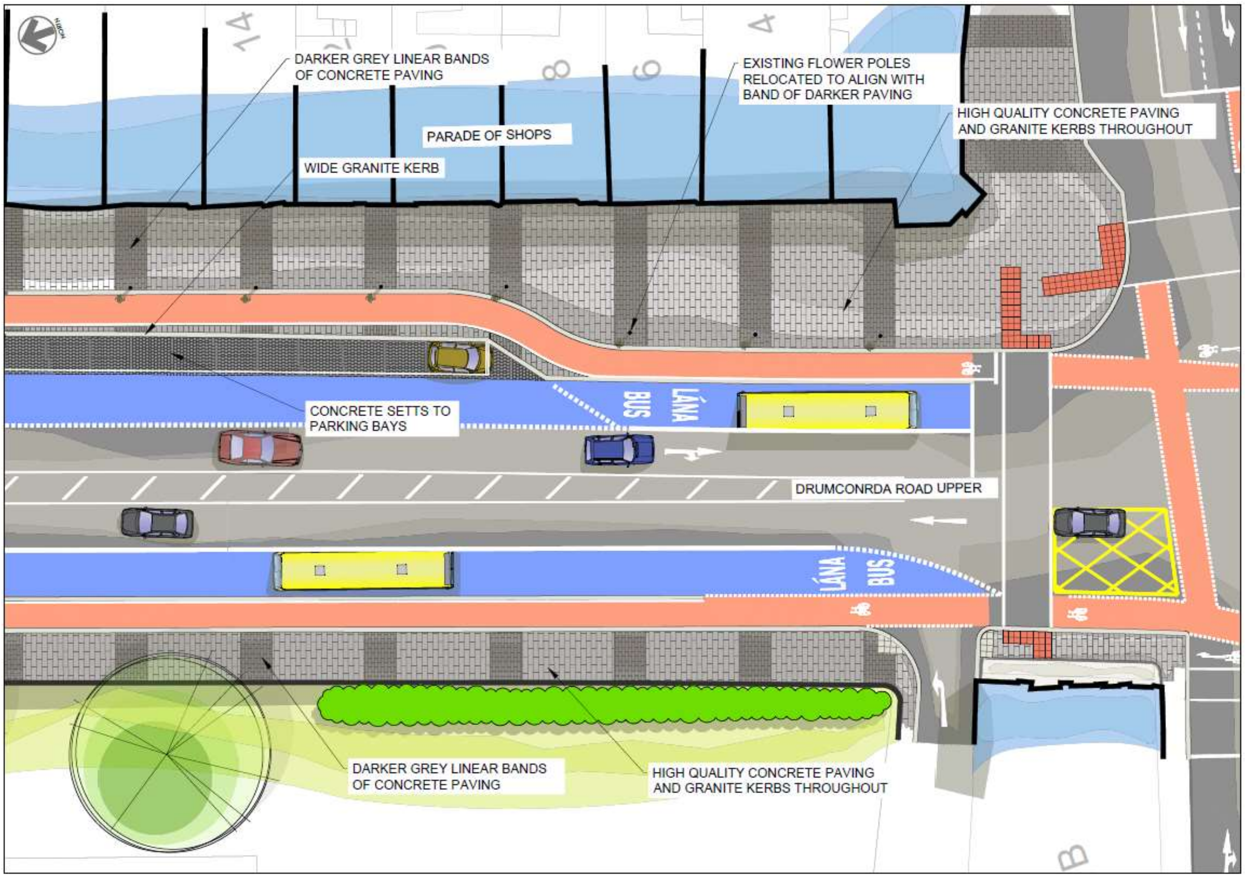

Figure 14.18: Drumcondra Road Upper Shopping Parade Design

14.7.11 Richmond Road to Drumcondra Station

Existing Character: A mix of retail, residential and mixed-use areas. This section begins at the Drumcondra Road Upper shopping parade with the Frank Flood Bridge and Our Lady's Park west of the bridge as local features. The park is a local green space with existing trees, seating, paths and a statue. A tree lined boulevard character exists along Drumcondra Road Lower. Drumcondra Station and the Railway Bridge mark a threshold between the tree lined residential area and the city centre.

Design Proposals: A new pedestrian and cycle bridge is proposed along the western edge of Frank Flood Bridge leading into Our Lady's Park.

The proposed bridge would require the removal of two Poplar trees within Our Lady's Park which are a different variety to one another and six Silver Birch trees adjacent to Millmount Terrace. Six new smaller-sized trees have been proposed surrounding the square paved area in Our Lady's Park, subject to underground utilities. Three new small canopy trees are proposed at the west end of the bridge adjacent to Millmount Terrace.

The existing square area of paving surrounding the statue on the south side of the river will be replaced and enhanced with a combination of stone and concrete paving together with new seating as a local area enhancement. The path close to the river will be re-aligned and re-surfaced to meet with the new paved square. Additional planting is to be provided on the eastern side of the path to prevent access to the narrow embankments leading to the river side beneath the structure.

The bridge structure and its parapets have been designed to be slender and visually 'light' to enable views of the existing road bridge to be retained. A two-tone colour scheme has been adopted which will create distinction between the central girder and the edge member preventing it appearing monolithic. The parapet top rail, posts and edge member are proposed to be painted light grey. The central girder is to be coloured oxide red which reflects the dark red brick colour in some of the buildings in proximity to the bridge. The proposed mesh panel of the parapet is to be stainless steel. The soffit of the bridge shall be painted black to create a shadow effect further improving the slender appearance of the edge member.

The bridge deck is proposed to be an anti-slip surface consisting of aggregate bonded together with an epoxy resin. This surface continues to the junction with Millmount Terrace to provide a consistent application of the same material. The cycle way section will be coloured 'Tuscan Terracotta' resin or similar in order that it appears as a tone that complements the standard cycle ways. The footway section will be coloured in a grey resin in order that it complements the new paved footways in the area.

The space between the bridge soffit and ground is to feature pebbles set in mortar to discourage anti-social behaviour.

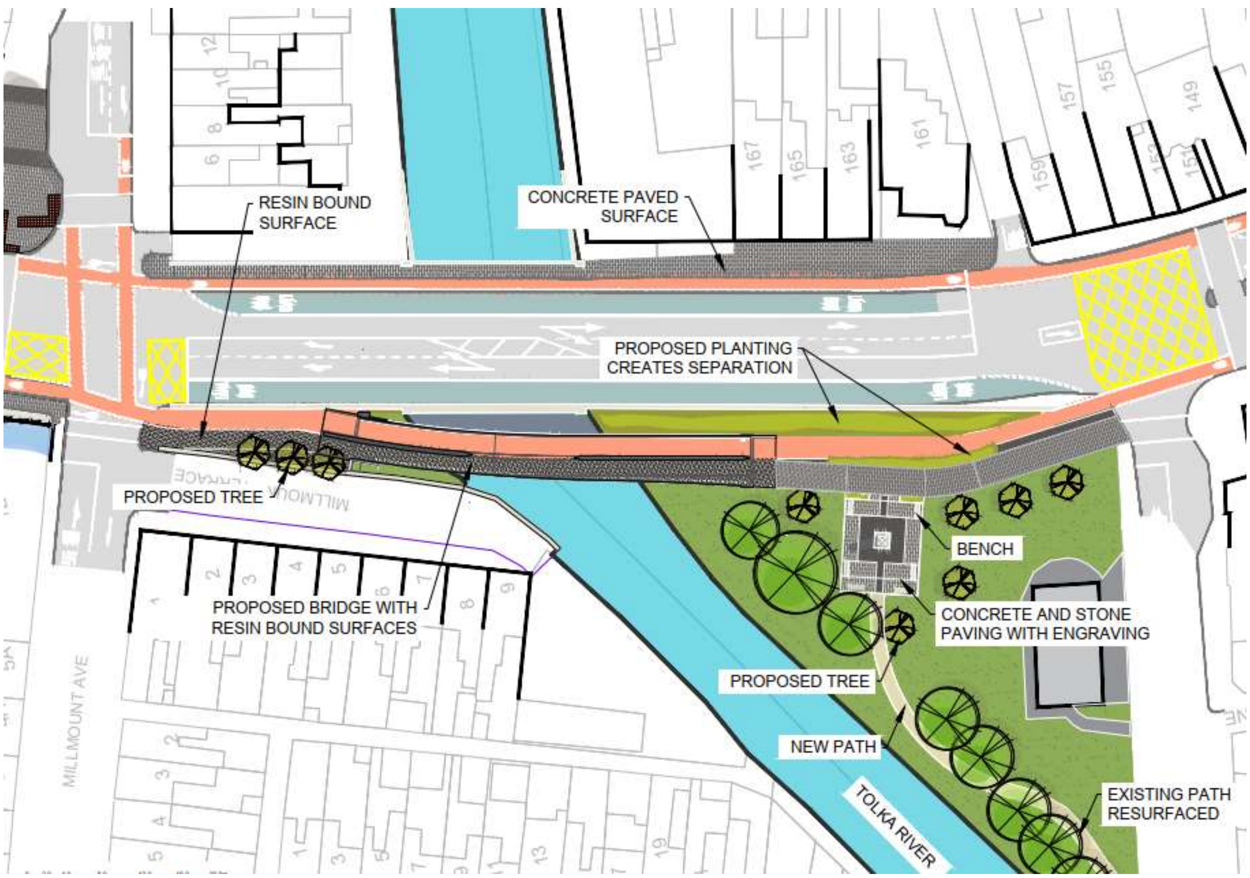

Figure 14.19: Frank Flood Bridge Design

The remaining footways along this section south of Botanic Avenue are proposed to be resurfaced in asphalt and concrete kerbs to match the existing. The footways along the residential area in Drumcondra Road Lower are to be repaired and resurfaced as needed.

Maintenance works are proposed for the existing brick structure at the northern end of Drumcondra Road Lower to remove the graffiti which will in turn enhance the street scene and perception of safety in the area.

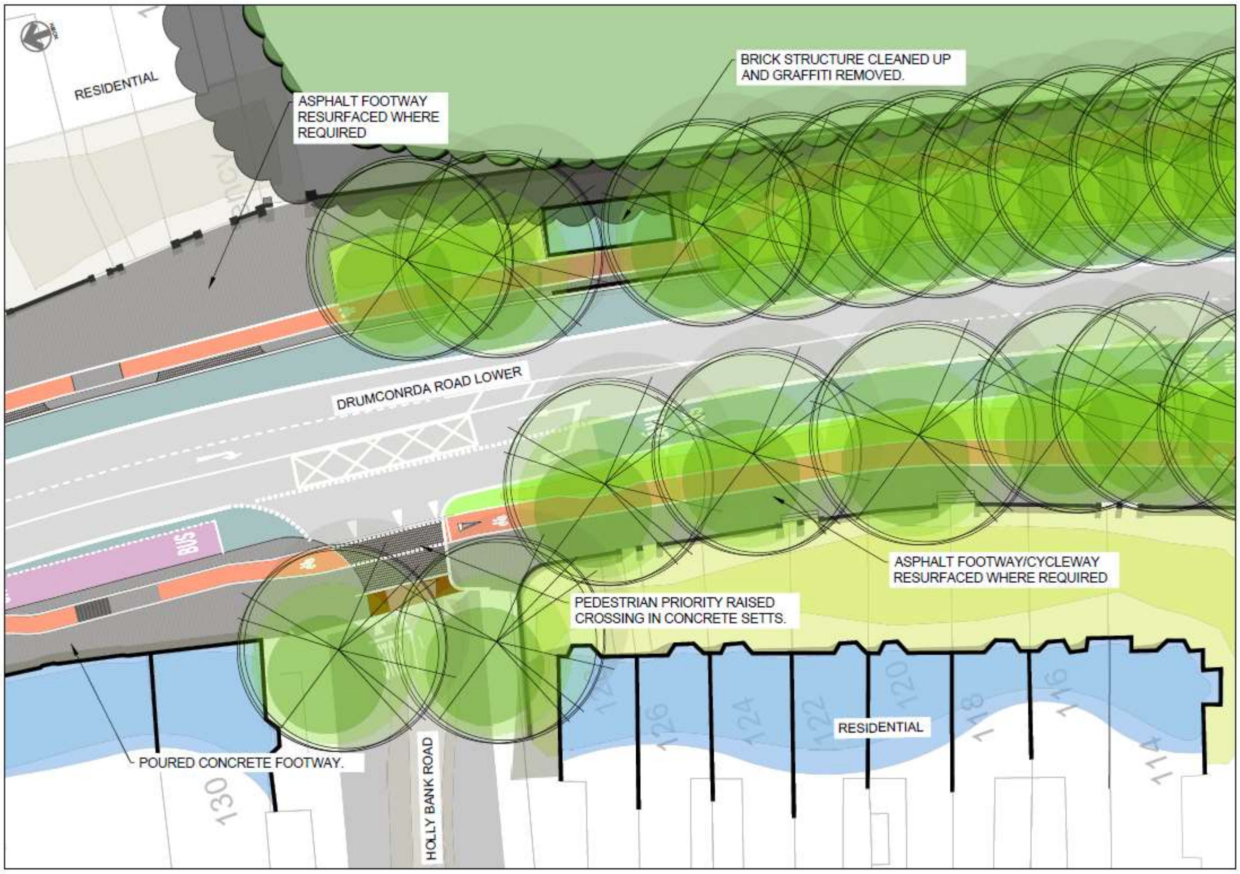

Figure 14.20: Northern End of Drumcondra Road Lower Design

Although not required to deliver the scheme, there is the potential to include a local area enhancement to the paved area outside the café in the residential area west of Drumcondra Road Lower. The concept proposal includes high quality grey concrete paving and granite kerbs.

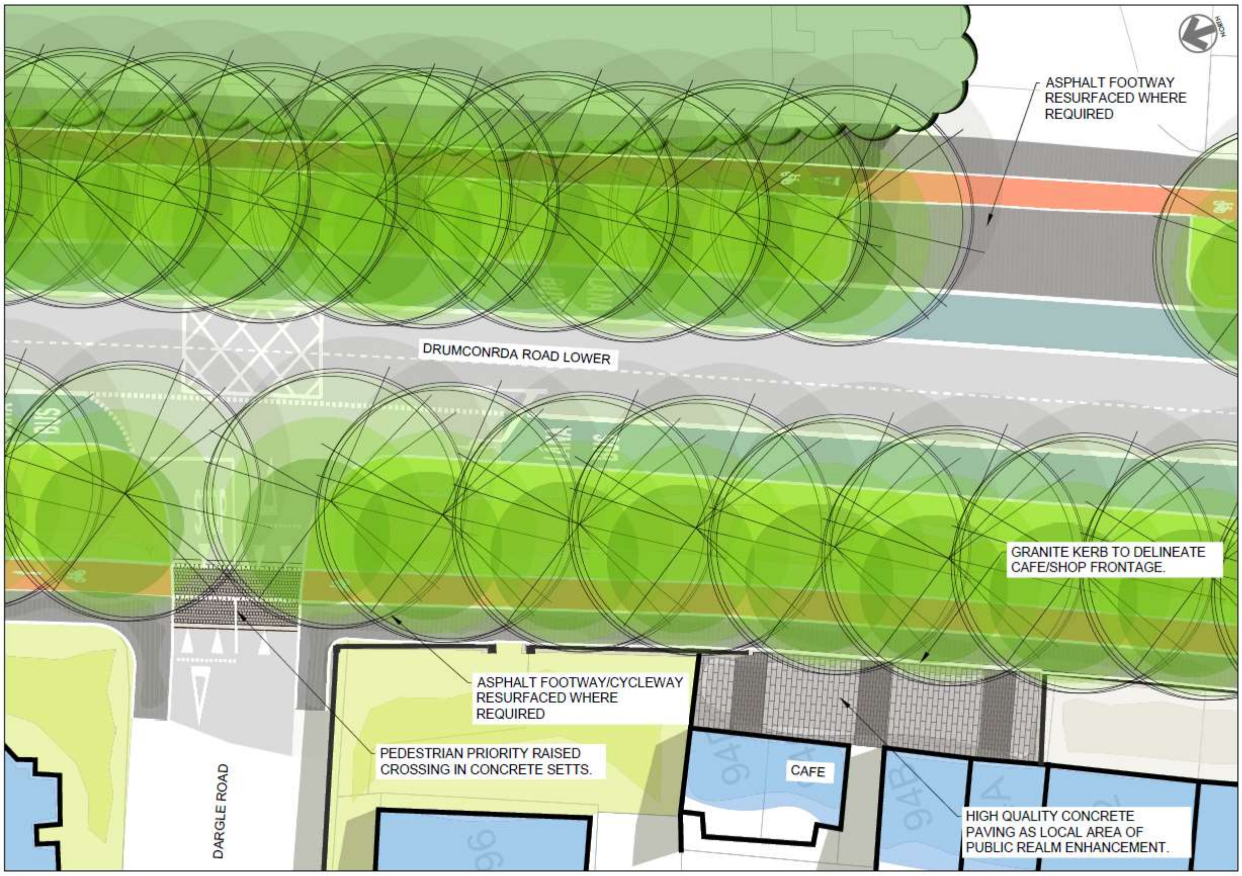

Figure 14.21: Café and Footways in the Residential Area West of Drumcondra Road Lower Design

The public realm in the Drumcondra Rail Station and Bridge area is to be improved by de-cluttering the footways. Any realignment to footways due to proposed works would be reinstated with materials to match the existing materials. The retention and reuse of paving and quality kerb materials is proposed where practicable.

14.7.12 Drumcondra Station to Parnell Square including Dorset Street Upper and Frederick Street North

Existing Character: A city street character as the route enters the city centre area. It is an area of retail and mixed-use along Dorset Street Lower and Upper with the existing public realm scheme featuring enhanced paving and a median with trees. Mostly built-up city scale building edges with a variety of uses. Key landmarks in the section include Parnell Square. The environment is one of high pedestrian and vehicle movements.

Design Proposals: Any footways effected by kerb realignments are proposed to be resurfaced in materials to match the existing footways using high quality granite paving and kerbs as required with the retention and reuse of paving and kerb materials proposed in this section.

The redesigned median at the northern part of the section is proposed to be finished in materials to match the existing scheme. Existing tree species and tree pits will be reviewed as a result of recent failures. Replanting of these tree avenues with a more appropriate resilient species is proposed and will be detailed in consultation with the authority. Pruning for maintenance is also proposed to other existing street trees.

Good quality concrete paving and granite kerbs are proposed for North Frederik Street and Granby Row. Retention and reuse of existing granite kerbs are proposed where practicable.

Parnell Square, north of Garden of Remembrance is identified as an urban realm enhancement area and is to be improved under a separate Dublin City Council scheme.

15. Scheme Benefits/ How are we 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 67% and 78% 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 A1, A2, A3, A4, D4 and X84, 19, 22, 24, 82, 197 bus routes, as well as multiple orbital routes including N2, N4, N6, N8.

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 34% and 23% of the route both 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.