Appendix H
Bus Stop Review Report

Ringsend to City Centre Core Bus Corridor Scheme

Bus Stop Review

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1. INTRODUCTION

This report presents a summary of the Bus Stop Review process conducted for the Ringsend to City Centre Core Bus Corridor (CBC) Scheme, hereinafter referred to as "The Scheme". The scheme is between the Talbot Memorial Bridge and Tom Clarke Bridge on both sides of the river Liffey.

The purpose of the Bus Stop Review process was to review the locations of the existing Dublin Bus Stops and to determine whether a stop should be removed, relocated, or remain in the existing location. This exercise was carried out in order to optimise the performance of the bus service along this route by reducing journey time of the bus service, to increase the walking catchment of the bus stops, and to ensure key trip attractors located along the route is sufficiently covered within the catchment of the bus stops.

In a number of locations, existing and proposed bus stops were therefore rationalised based on the best practice principles related to bus stop placement. The outcome of this study was to develop a more efficient route that would attract more passengers by creating a wider population catchment and offer a shorter journey time to destinations.

2. METHODOLOGY

2.1 Overview

The methodology used in this review is set out in the 'Bus Stop Review Methodology Report' produced by AECOM (Appendix D). This methodology includes various considerations to be made when assessing a stop location, and the background reasoning for those considerations.

Figure x below presents a flowchart which outlines the methodology proposed.

Each of the study components as outlined below are discussed in further detail in the remainder if this report and applied to the Ringsend to City Centre Scheme.

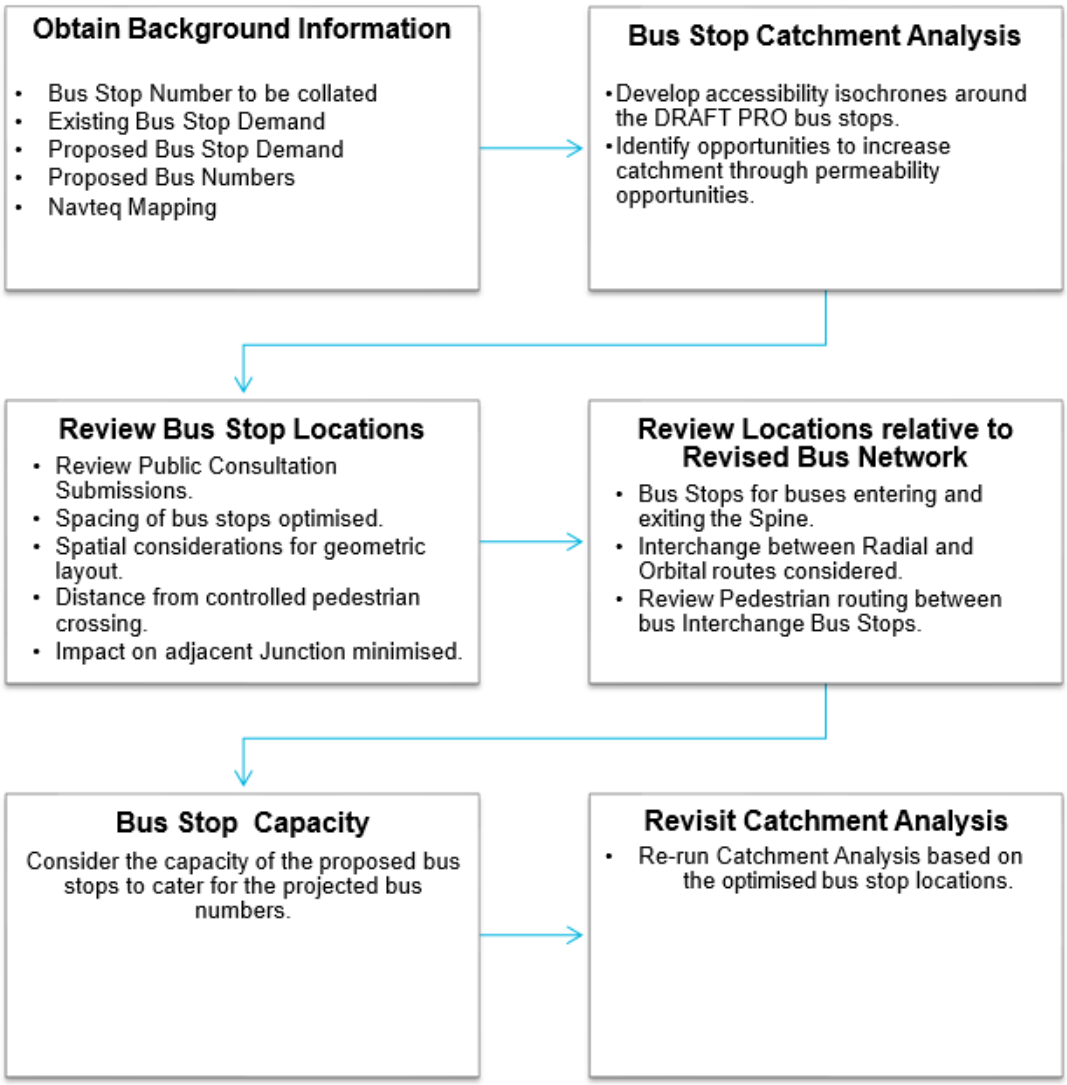


Figure 2.1 Bus Stop Review Flow Chart

3. BACKGROUND INFORMATION

To assess the bus stop locations, the following background information was gathered.

Table 1: Background information and sources

Information	Source
Stop numbers along route, inbound and outbound	Dublin Bus Automatic Vehicle Location (AVL) Data
Stop names	Dublin Bus AVL Data
Current Stop Location Coordinates	Google Maps
Existing distance between stops	Google Maps
Stop location as per PRO (relative to existing location)	PRO Design Drawings
PRO distance between stops	PRO Design Drawings & Google Maps
Peak boarding and alighting volumes & Times	NTA
Future Buses per Hour	SYSTRA
Existing Distance to junction/pedestrian crossing	Google Maps
PRO distance to junction/pedestrian crossing	PRO Design Drawings & Google Maps
Potential for interchanges with Orbital Routes	BusConnects Revised Network Layout

4. EXISTING BUS STOP CATCHMENT ANALYSIS

A catchment analysis was carried out in GIS using Navteq mapping as the network dataset, along with the coordinates of the existing bus stop locations. The current catchment on both the inbound and the outbound bus stops at their existing locations are shown in 5-minute and 10-minute walking intervals.

4.1 Ringsend to City Centre

Figure 2 and Figure 3 below show the catchments for the existing bus stop locations for the inbound and outbound directions in the Ringsend to City Centre section of the scheme.

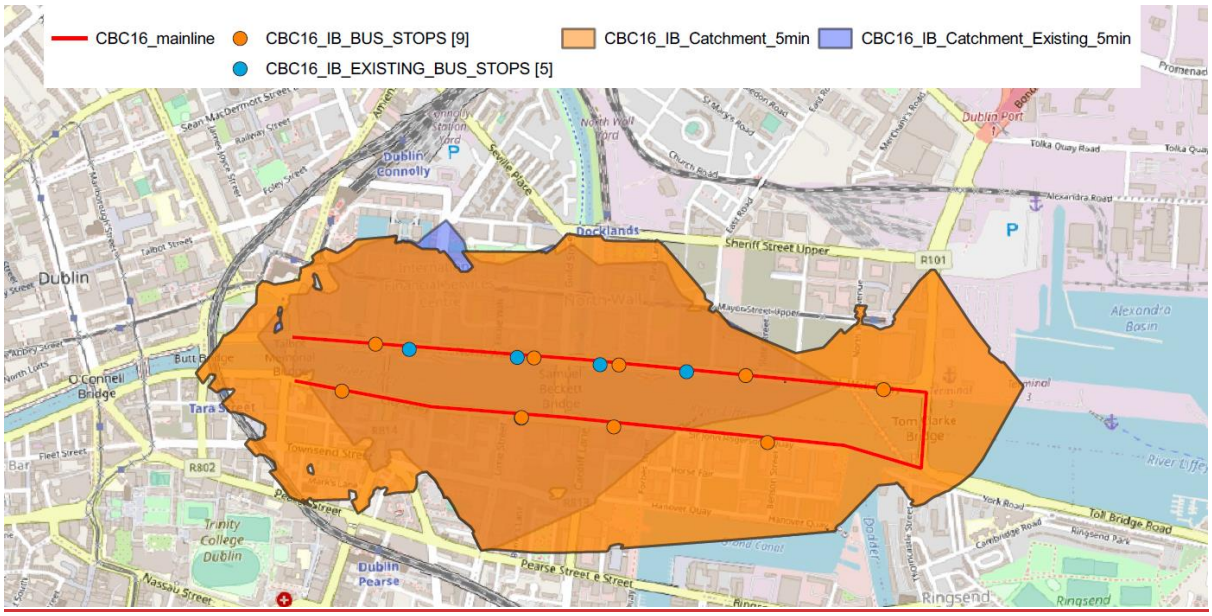


Figure 4.1 Existing Ringsend to City Centre Inbound Bus Stop Catchments

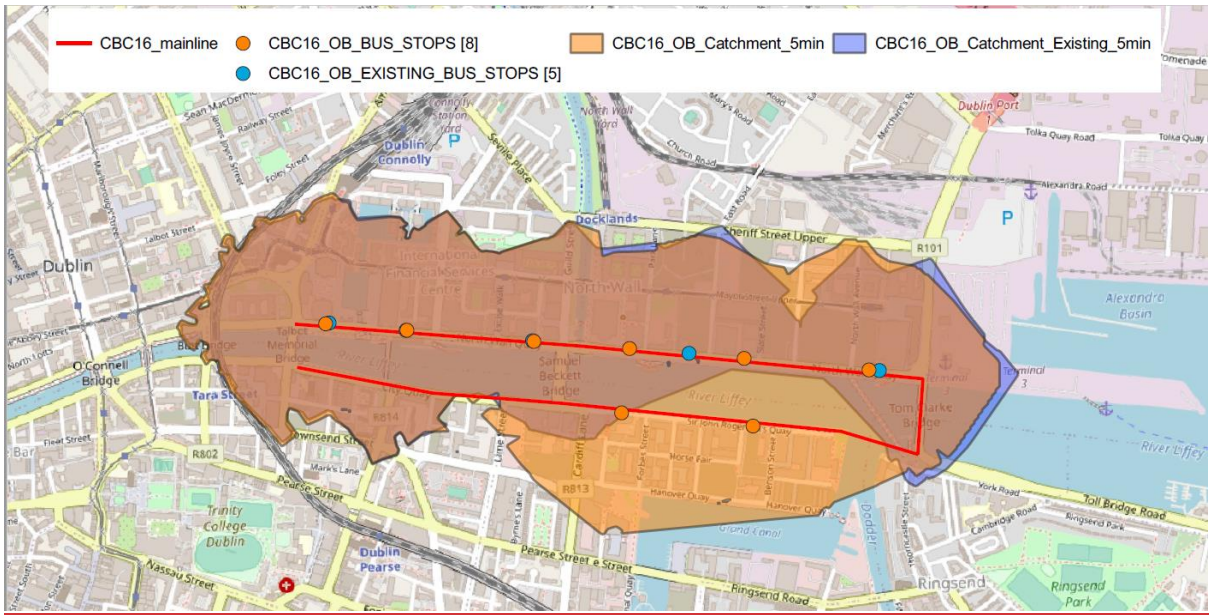


Figure 4.2 Existing Ringsend to City Centre outbound Bus Stop Catchments

5. REVIEW BUS STOP LOCATIONS

The locations of the bus stops were reviewed in accordance with the 'Bus Stop Review Methodology Report' produced by AECOM.

Appendix A includes a table of the bus stop review which was used when considering the possible relocation of each stop.

The main principles considered as part of the review are as follows:

- Aim to achieve a bus stop spacing of 400m in suburban locations, and 250m in urban centres
- Locate bus stop to nearest junction/pedestrian crossing
- Locate bus stop downstream of junction rather than upstream
- Consider space requirements to provide bus stop including shelter, waiting area, cycle lane and footpath provision and information displays
- Review existing and proposed boarding & alighting volumes to determine the size of the bus stop; and
- Potential interchange orbital bus services proposed as part of BusConnects with revised network.

The above principles were considered in conjunction with the use of Google Maps to determine the location of the bus stop.

The following considerations below were also used to help determine the location of the bus stops.

Maintain existing location: existing bus stops that meet the following considerations will be maintained in its existing location; Bus stop spaced at acceptable intervals, located optimally in relation to distance to junctions or pedestrian crossings, frequently used, and serving key land uses sufficiently.

Relocation of Bus Stop: if it was found that access to a bus stop could be improved by relocating it to a better proximity in relation to local features, the decision was made to relocate it if feasible.

Removal of Bus Stops: in some cases, it was found that a bus stop were too close to the next or previous stop. In this case it was decided to join bus stops at a new location to obtain better spacing by removing one of the stops.

6. REVISITED CATCHMENT

Following the review of the bus stop locations, the catchment analysis was carried out again in order to understand the impact of the changes on the bus network. The results of the catchment analysis with the proposed bus stop locations for the Ringsend to City Centre route is presented below. The Figures below compare the catchments for 5minute and 10-minute walking distance for the existing and proposed bus stop locations.

6.1 Ringsend to City Centre

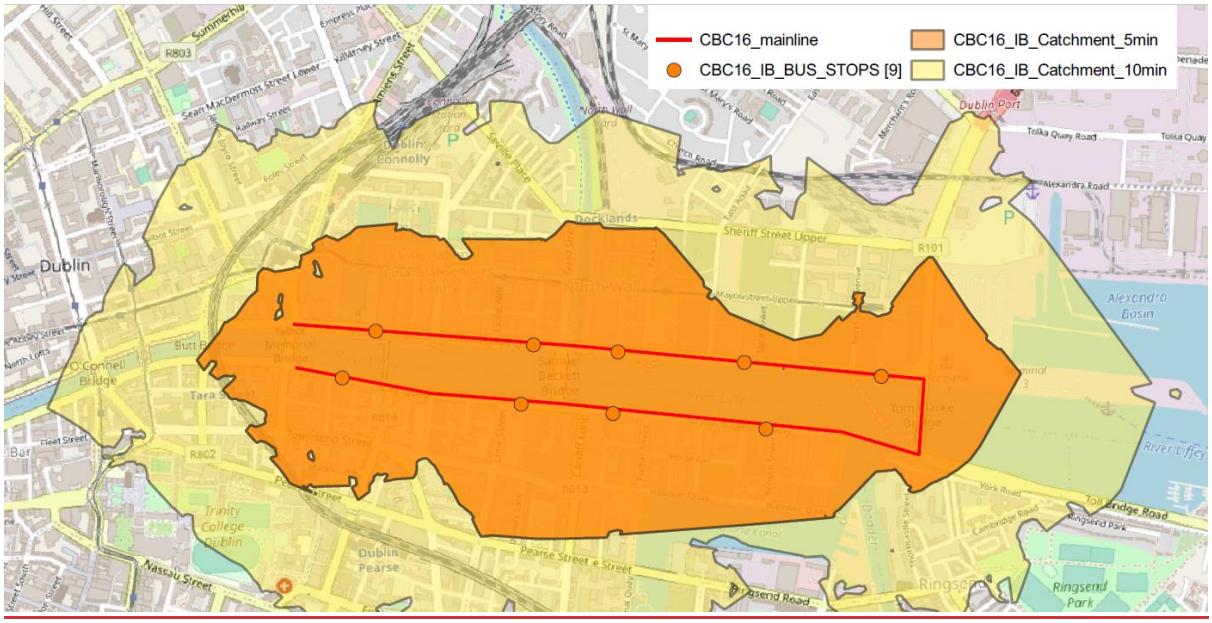


Figure 6.1 Proposed inbound bus stop catchment – 5 & 10 minutes

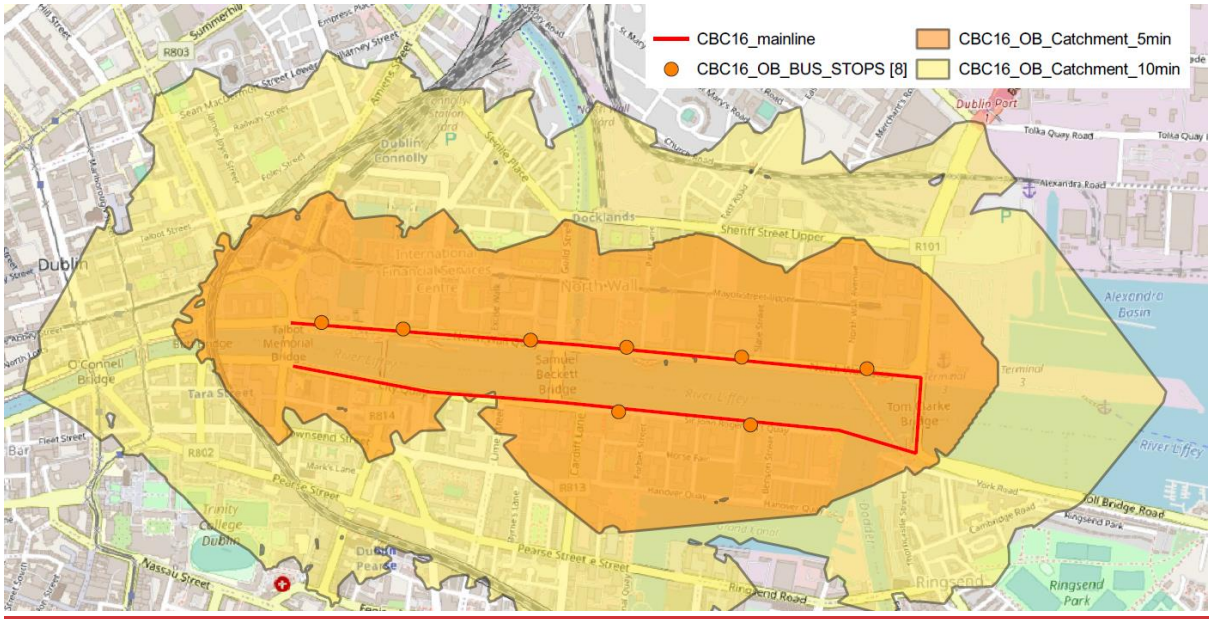


Figure 6.2 Proposed outbound bus stop catchment – 5 & 10 minutes

7. SCHEME SUMMARY

Table 7.1 and 7.2 below outline a summary of the outcome of the bus stop review process.

Table 7.1 Inbound Bus Stop Summary

Number of Existing Stops	4
Number of Stops Moved	3
Number of Stops Removed	1
Number of Stops Added	8

Table 7.2 Outbound Bus Stop Summary

Number of Existing Stops	6
Number of Stops Moved	2
Number of Stops Removed	1
Number of Stops Added	4

On the inbound direction there are four (4) existing bus stops. Three (3) bus stops will be moved, one (1) bus stop is to be removed from the route while eight (8) new stops will be added. The total proposed number of bus stops for the inbound direction is eleven (11).

On the outbound direction there are six (6) existing bus stops. Two (2) bus stops will be moved, one (1) bus stop is to be removed, while four (4) new bus stops will be added. The total proposed number of bus stops for the outbound direction is 9.

8. CONCLUSION

A bus stop review was carried out for the Ringsend to City Centre CBC Scheme. The purpose of the exercise was to understand and rationalise the locations of bus stops to reduce the total journey time within the Scheme and to improve the catchment of the bus stops.

The study entailed reviewing key features of the inbound and outbound bus stops, namely location, proximity to junctions, pedestrian crossings, distance between bus stops and major land use attractions next to the route, existing and projected passenger numbers and local considerations such as existing shelters, waiting areas, footpaths and cycle routes and the space to provide these where there currently is none.

As part of the exercise, catchment analyses have been carried out to demonstrate the impact of the proposed scheme. The results show that the catchment footprints along the routes have increased to some extent this is largely due to improved spacing of the stops, negating some overlap and filling gaps where bus availability was limited. The stops are positioned closer to intersections allowing the catchment to spread farther along the orbital roads.

It is recommended to relocate 3 stops in the inbound direction and 2 in the outbound direction. It is also recommended to remove 1 stop in the inbound and 1 stop in the outbound direction. In addition, it is also recommended to add 8 new stops in the inbound direction and 4 in the outbound direction.

It is expected that overall journey time along these routes will reduce as a result of these changes. In addition, the proposed bus infrastructure along City Quay and Sir John Rogerson’s Quay will allow for future bus service along this section.

APPENDIX A
BUS STOP REVIEW TABLE

Ringsend Inbound							
Existing				Proposed			
North Quays							
No.	Bus Stop No.	Chainage	Distance from Next Stop (m)	No.	Bus Stop No.	Chainage	Distance from Next Stop (m)
1	New			1	New (Coach)	A-100	360
2	New			2	New (Coach)	A-460	365
3	~~7611~~	A-610	220	3	~~7611~~	Removed	
4	7398	A-830	230	4	7398	A-780	220
5	New			5	New (Coach)	A-825	375
6	7397	A-1060	250	6	7397	A-1000	400
7	New			7	New (Coach)	A-1200	Last Coach Stop
8	6252	A-1310	End of Route	8	6252	A-1400	End of Route
	Average Distance:		233		Average Distance:		344
South Quays							
1	New			1	New	B-11240	395
2	New			2	New	B-10845	235
3	New			3	New	B-10610	460
4	New			4	New	B-10150	End of Route
					Average Distance:		363

Ringsend Outbound							
Existing				Proposed			
North Quays							
No.	Bus Stop No.	Chainage	Distance from Next Stop (m)	No.	Bus Stop No.	Chainage	Distance from Next Stop (m)
1	2498	A-1540	210	1	2498	A-1540	210
2	2499	A-1330	290	2	2499	A-1330	330
3	New			3	New (Coach)	A-1230	770
4	~~7216~~	A-1040	40	4	~~7216~~		
5	2500	A-1000	390	5	2500	A-1000	245
6	2501	A-610	470	6	2501	A-755	End of Route
7	New			7	New (Coach)	A-460	350
8	7623	A-140	End of Route	8	(Changed to Coach)	A-110	End of Coach
	Average Distance:		280		Average Distance:		381
South Quays							
1	New			1	New	B-10870	345
2	New			2	New	B-11215	End of Route
	Average Distance:				Average Distance:		345

		Ringsend Existing									
		Existing Information							Interaction with Junction and Ped Crossing		
New or Existing Bus Stop	Inbound/Outbound	Bus Stop Name	Bus Stop No.	Chainage	Distance from next stop (m)	Number of Passengers Boarding (Peak Hr)	Number of Passengers Alighting (Peak Hr)	Total (Boarding + Alighting)	Before/After the junction (in the direction of travel)	Bus Stop Distance from the nearest junction (m)	Distance to Pedestrian Crossing (m)
North Quays											
New	Inbound	New	New								
New	Inbound	New	New								
Existing	Inbound	North Wall Quay (Airlink Express)	~~7611~~	A-610	220	No Data	No Data	No Data	After	55	50
Existing	Inbound	Convention Centre	7398	A-830	230	1	7	8	Before	90	80
New	Inbound	New	New								
Existing	Inbound	Guild Street	7397	A-1060	250	3	16	19	After	75	65
New	Inbound	New	New								
Existing	Inbound	Docklands, North Wall Quay	6252	A-1310	End of Route	2	39	41	After	60	55
South Quays											
New	Inbound										
New	Inbound										
New	Inbound										
New	Inbound										

		Ringsend Inbound Bus Stop Review Outcome				
Inbound/Outbound	**Bus Stop Name**	**Bus Stop Treatment**	**No. Bus Bays**	**Bus Shelter**	**Type of Bus Stop Island or Shared Bus Stop Landing**	**Design Rational**
North Quays						
Inbound	New	New	Single	Coach Stop - No Proposed Shelter	Island Bus Stop	New inbound coach stop proposed across the 3 Arena
Inbound	New	New	Single	Coach Stop - No Proposed Shelter	Island Bus Stop	New inbound coach stop proposed across The Central Bank of Ireland
Inbound	North Wall Quay (Airlink Express)	Removed	Single			Removed to improve spacing between stops
Inbound	Convention Centre	Relocated	Single	New Proposed Bus Shelter	Island Bus Stop	Moved 50m to the east
Inbound	New	New	Single	Coach Stop - No Proposed Shelter	Island Bus Stop	New inbound coach stop proposed across The Convention Centre
Inbound	Guild Street	Relocated	Single	New Proposed Bus Shelter	Island Bus Stop	Moved 60m to the east closer to Guild Street junction
Inbound	New	New	Single	Coach Stop - No Proposed Shelter	Island Bus Stop	New inbound coach stop across the Citi Group building
Inbound	Docklands, North Wall Quay	Relocated	Single	New Proposed Bus Shelter	Island Bus Stop	Moved 90m to the west for better bus stop landing space
South Quays						
Inbound	New	New	Single		In-line Bus Stop	New Inbound stop
Inbound	New	New	Single	New Proposed Bus Shelter	In-line Bus Stop	New Inbound stop
Inbound	New	New	Single		In-line Bus Stop	New Inbound stop
Inbound	New	New	Single		In-line Bus Stop	New Inbound stop

			Ringsend Proposed Inbound Bus Stops						
			Distance		Interaction with Junctions and Ped Crossing				
Inbound/Outbound	Bus Stop Name	New or Existing Bus Stop	New Distance (Between Stops)	Chainage	Before/After the junction (in the direction of travel)	Bus Stop Distance from nearest junction (m)	Distance to Pedestrian Crossing (m)	Trip attractor	Lay-by or on street Bus Stop
North Quays									
Inbound	New	New	360	A-100	Before	70	60	3 Arena	On-Street
Inbound	New	New	365	A-460	Before	80	45		On-Street
Inbound	North Wall Quay (Airlink Express)	Existing		Removed					
Inbound	Convention Centre	Existing	220	A-780	After	65	55		On-Street
Inbound	New	New	375	A-825	Before	95	85	The Convention Centre	Lay-by
Inbound	Guild Street	Existing	400	A-1000	After	70	60		On-Street
Inbound	New	New	Last Coach Stop	A-1200	before	50	45		Lay-by
Inbound	Docklands, North Wall Quay	Existing	End of Route	A-1400	After	150	30		On-Street
South Quays									
Inbound	New	New	395	B-11240	Before	160	150		On-Street
Inbound	New	New	235	B-10845	Before	70	60		On-Street
Inbound	New	New	460	B-10610	After	120	80		On-Street
Inbound	New	New	End of Route	B-10150	Before	140	125		On-Street

		Ringsend Existing									
		Existing Information							Interaction with Junction and Ped Crossing		
New or Existing Bus Stop	Inbound/Outbound	Bus Stop Name	Bus Stop No.	Chainage	Distance from next stop (m)	Number of Passengers Boarding (Peak Hr)	Number of Passengers Alighting (Peak Hr)	Total (Boarding + Alighting)	Before/After the junction (in the direction of travel)	Bus Stop Distance from the nearest junction (m)	Distance to Pedestrian Crossing (m)
North Quays											
Existing	Outbound	Custom House Quay	2498	A-1540	210	19	2	21	After	80	70
Existing	Outbound	Docklands, CHQ	2499	A-1330	290	11	2	13	Before	70	60
New	Outbound		New			-	-	-			
Existing	Outbound	North Wall Quay	7216	A-1040	40	-	-	-	Before	110	100
Existing	Outbound	Beckett Bridge	2500	A-1000	390	14	1	15	Before	70	60
Existing	Outbound	New Wapping Street	2501	A-610	470	10	1	11	Before	55	45
New	Outbound		New			-	-	-			
Existing	Outbound	East Wall Road, 3 Arena	7623	A-140	End of Route	8	1	9	After	40	30
South Quays											
New	Outbound		New								
New	Outbound		New								

		Ringsend Outbound Bus Stop Review Outcome				
Inbound/Outbound	**Bus Stop Name**	**Bus Stop Treatment**	**No. Bus Bays**	**Bus Shelter**	**Type of Bus Stop Island or Shared Bus Stop Landing**	**Design Rational**
North Quays						
Outbound	Custom House Quay	Retain	Single	New Proposed Bus Shelter	In line bus stop	No Issue with existing location
Outbound	Docklands, CHQ	Retain	Single		In line bus stop	No Issue with existing location
Outbound	New	New	Single		In line bus stop	New Coach stop
Outbound	North Wall Quay	Removed	Single			
Outbound	Beckett Bridge	Retain	Single	New Proposed Bus Shelter	In line bus stop	No Issue with existing location
Outbound	New Wapping Street	Relocated	Single	New Proposed Bus Shelter	In line bus stop	Moved 145m to the west to improve spacing
Outbound	New	New	Single	New Proposed Bus Shelter	In line bus stop	New Coach stop
Outbound	East Wall Road, 3 Arena	Relocated	Single		In line bus stop	Moved 30m to the west to improve spacing
South Quays						
Outbound	New	New	Single	New Proposed Bus Shelter	Island Bus Sop	New outbound bus stop
Outbound	New	New	Single	New Proposed Bus Shelter	Island Bus Sop	New outbound bus stop

			Ringsend Proposed Inbound Bus Stops						
			Distance		Interaction with Junctions and Ped Crossing				
Inbound/Outbound	Bus Stop Name	New or Existing Bus Stop	New Distance (Between Stops)	Chainage	Before/After the junction (in the direction of travel)	Bus Stop Distance from nearest junction (m)	Distance to Pedestrian Crossing (m)	Trip attractor	Lay-by or On street Bus Stop
North Quays									
Outbound	Custom House Quay	Existing	210	A-1540	After	70	60	IFSC House	On-Street
Outbound	Docklands, CHQ	Existing	330	A-1330	Before	75	40		On-Street
Outbound	New	New	770	A-1230	After	25	10		Lay-by
Outbound	North Wall Quay	Removed							
Outbound	Beckett Bridge	Existing	245	A-1000	Before	75	60		On-Street
Outbound	New Wapping Street	Existing	End of Route	A-755	Before	45	30		On-Street
Outbound	New	New	350	A-460	After	85	40		On-Street
Outbound	East Wall Road, 3 Arena	Existing	End of Coach	A-110	After	45	30	3 Arena	On-Street
South Quays									
Outbound	New	New	345	B-10870	Before	65	50		On-Street
Outbound	New	New	End of Route	B-11215	After	130	120		On-Street

APPENDIX B
BUS STOP LOCATIONS MAP

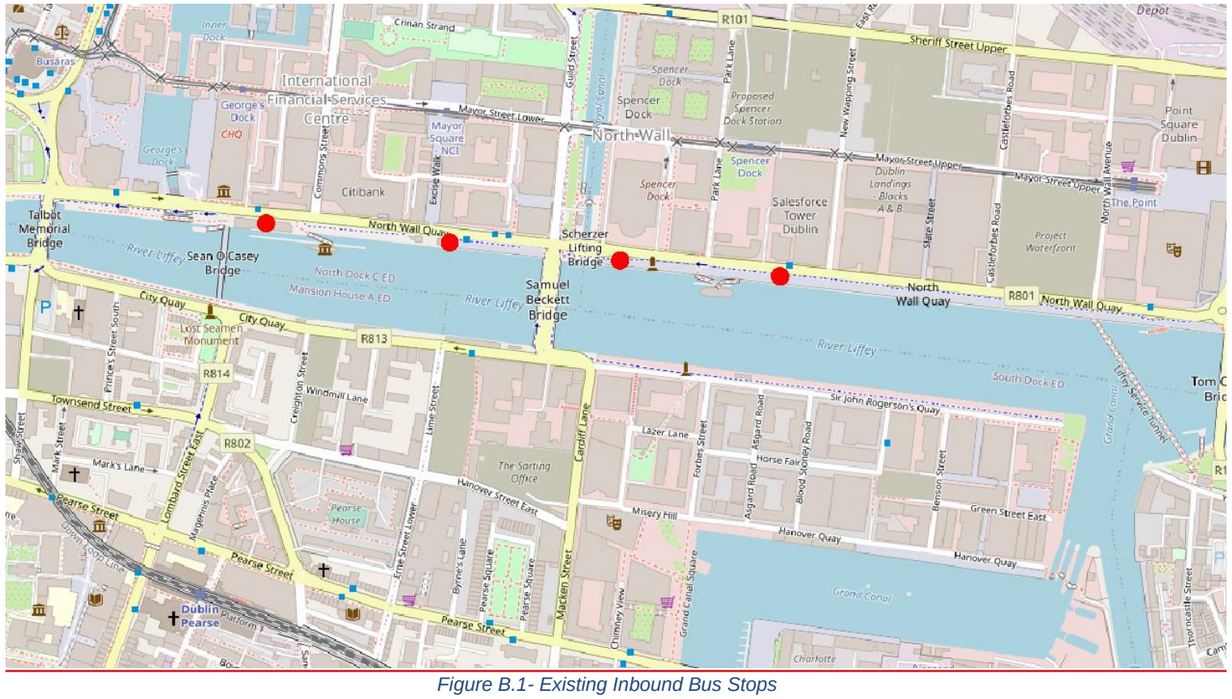


Figure B.1- Existing Inbound Bus Stops

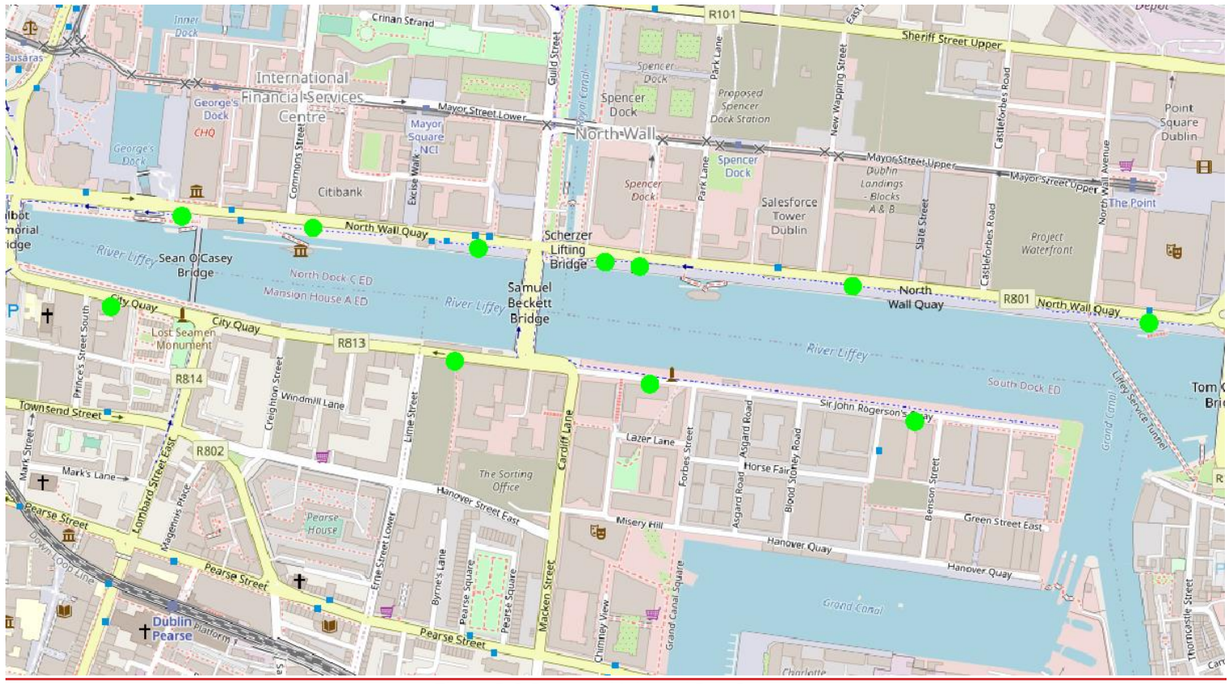


Figure B.2-Proposed Inbound Bus Stops

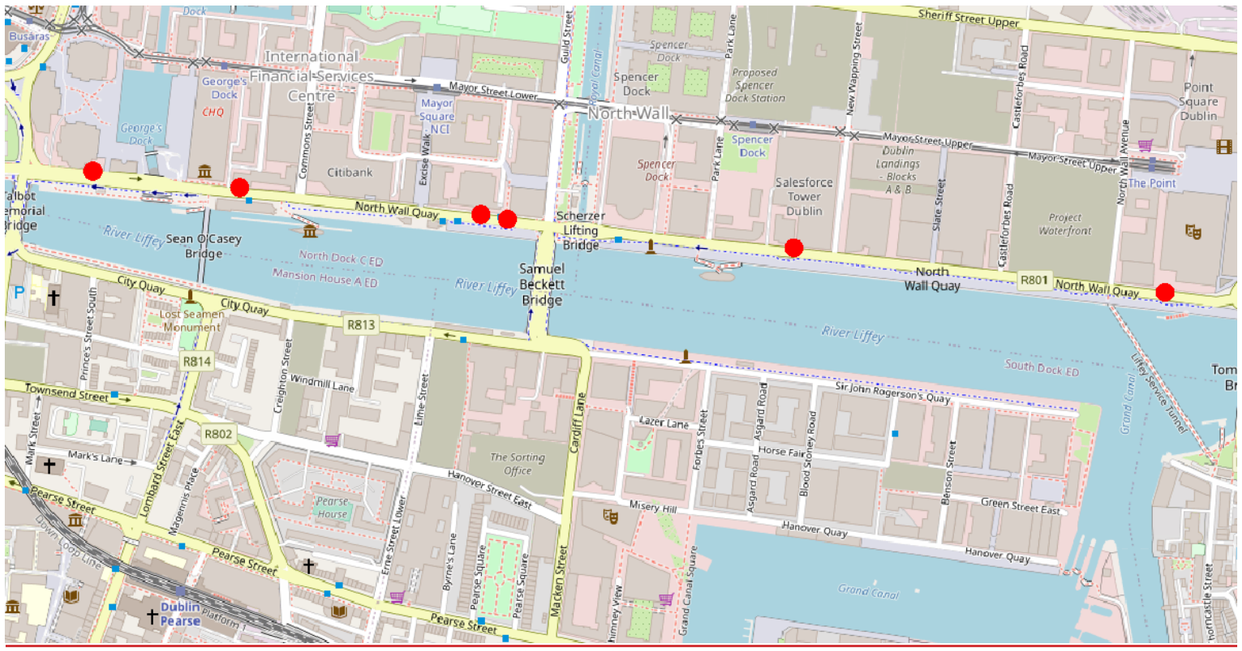


Figure B.3-Existing Outbound Bus Stops

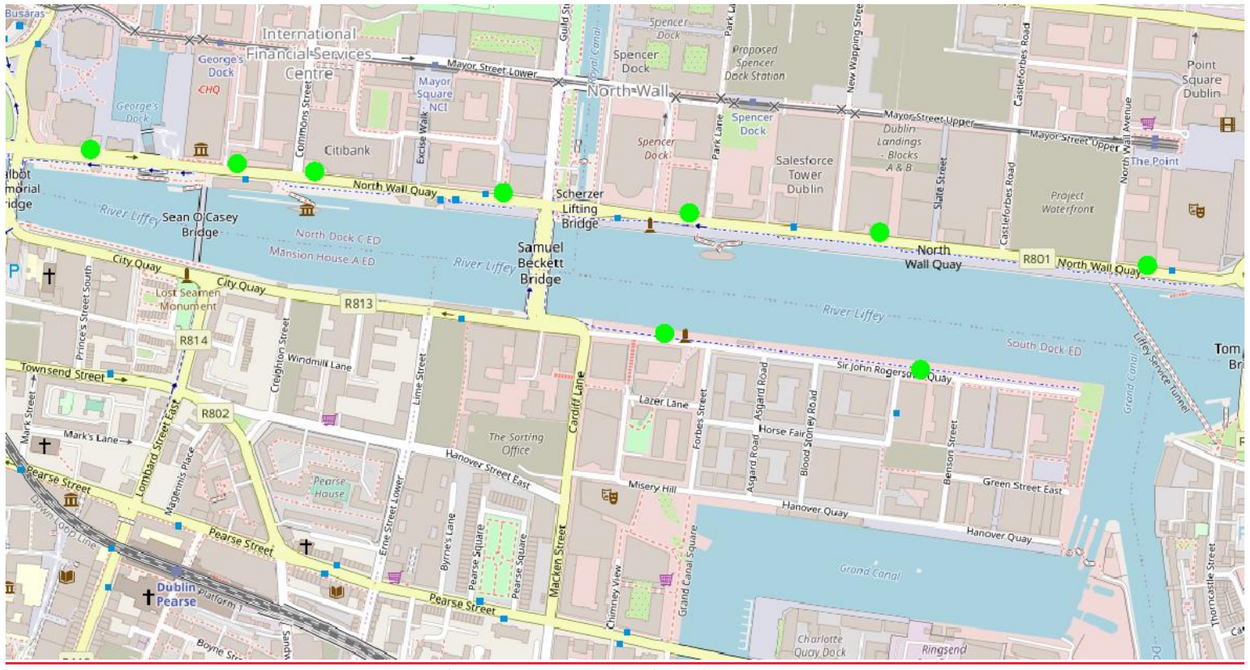


Figure B.4-Proposed Outbound Bus Stops

APPENDIX C
OVERLAP MAP

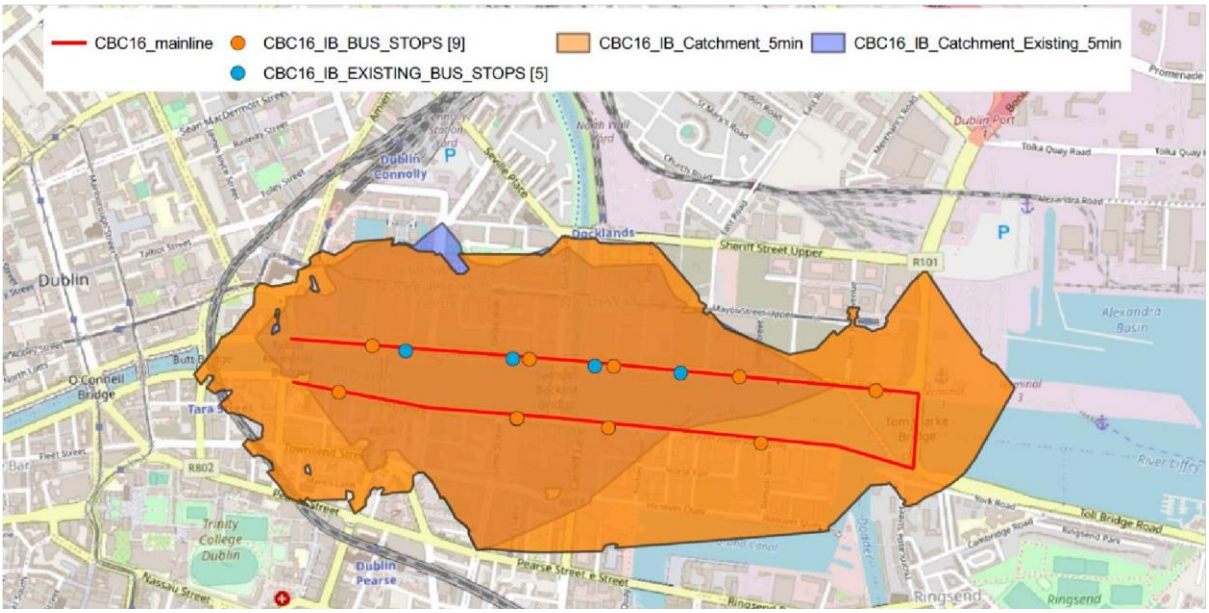


Figure 1- 5 Minute Walking Catchment Comparative, Inbound

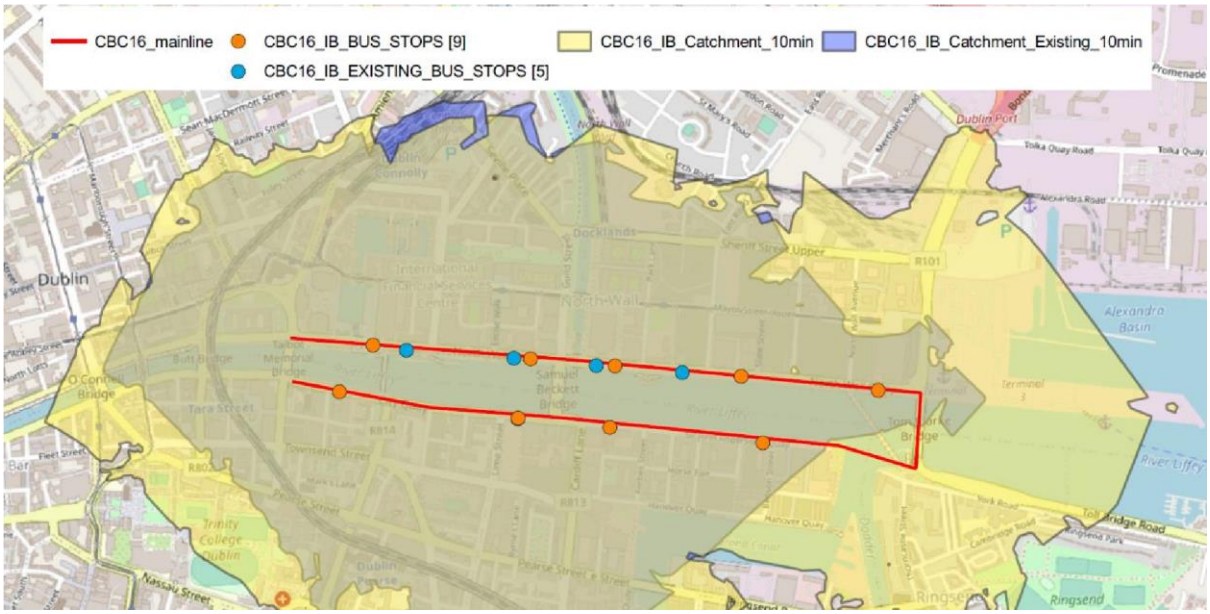


Figure 2- 10 Minute Walking Catchment Comparative, Inbound

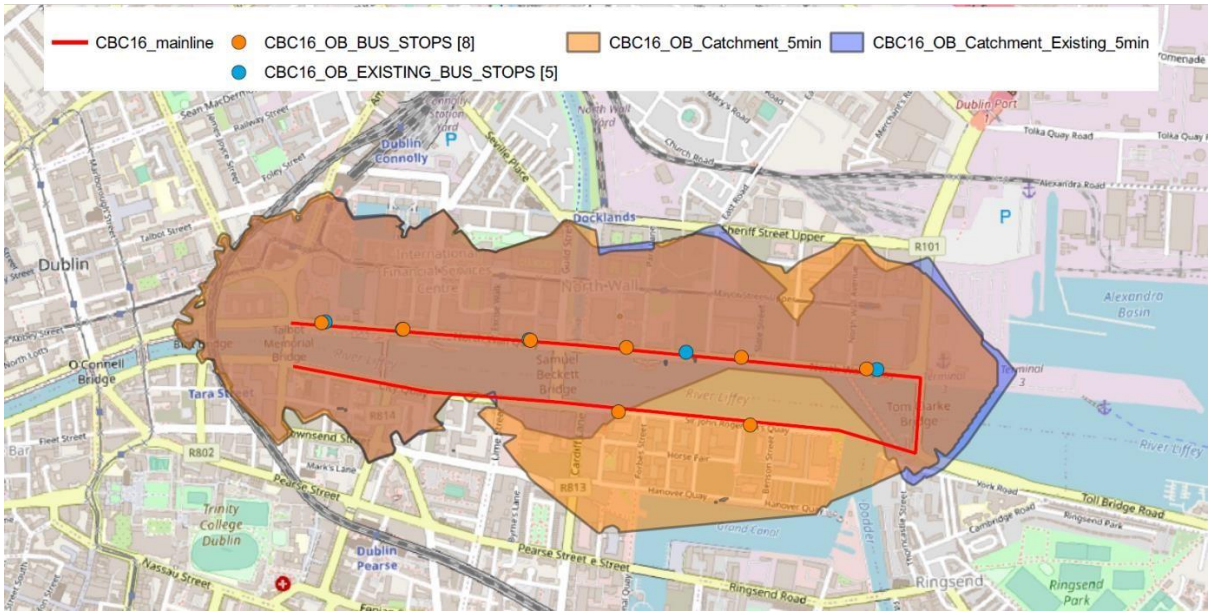


Figure 3- 5 Minute Walking Catchment Comparative, Outbound

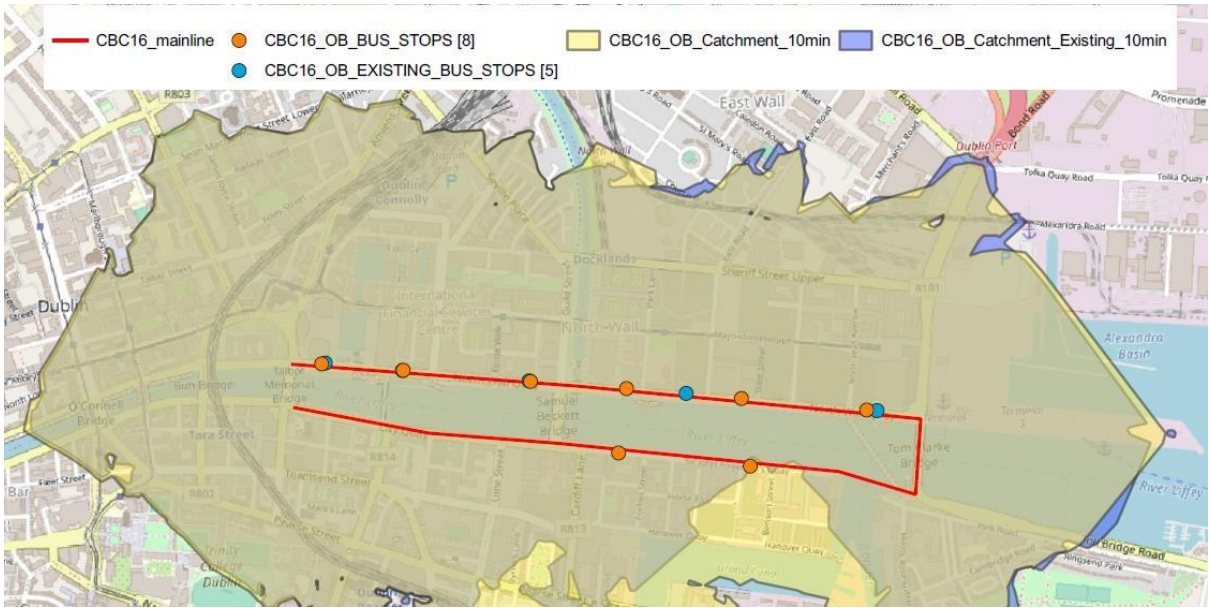


Figure 4- 10 Minute Walking Catchment Comparative, Outbound

APPENDIX D
BUS STOP REVIEW METHODOLOGY

Bus Stop Review Methodology (REV 3)

Project name	Date	Prepared by
Bus Connects Core Bus Corridor	21 June 2020	Joe Seymour - AECOM

1.0 Introduction

The location and design of bus stops will be critical to the success of the operation of BusConnects Dublin. Bus stop catchment areas and safety will need to be maximised, the size of the stop needs to be sufficient to meet the expected passenger and bus demand, and the bus stop itself must not become a bottle neck to the operation of the corridor. This methodology outlines how each corridor shall be assessed so as the location and operation of bus stops can be optimised.

This Note does not relate to the physical layout of the bus stops which is addressed in Chapter 11 of the Preliminary Design Guidance Booklet, although spatial considerations are discussed in section 5.4. Standard details for bus stop layouts are to be included in the next draft of the Design Guidance Booklet.

It is important to note that existing bus stops located along the Core Bus Corridors will have been subject to considerable thought by Bus Operators, An Garda Siochana, and the Local Authority. For this reason, it is imperative that each location is closely examined before it is considered for relocation or removal.

For avoidance of doubt this manual assumes the standard bus is a twin axle double decker bus (10 to 11m in length) with a front and middle doors. Other vehicles, such as 3-axle double decker, are in use by Dublin Bus and should be considered when undertaking the Geometric Design.

Figure 1.2 Standard Bus being used on the CBC's.

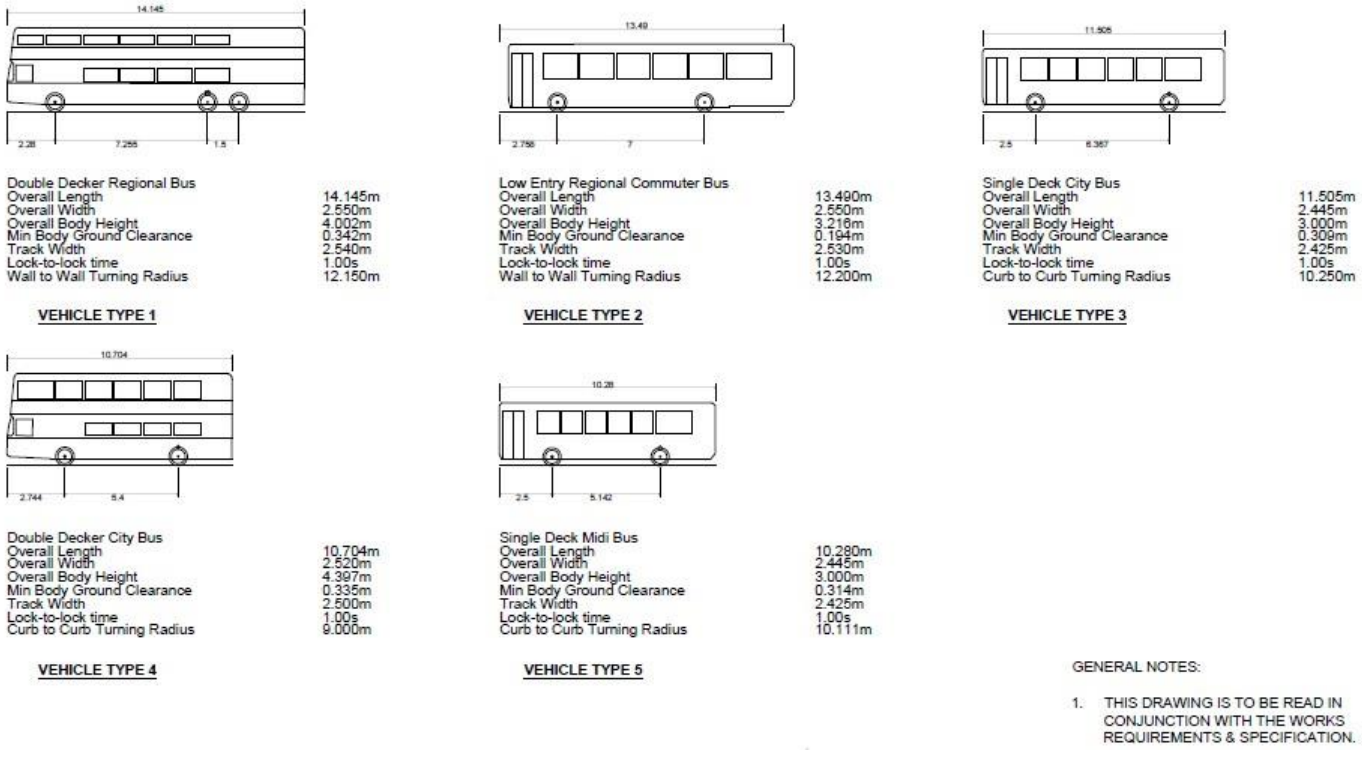


Figure 1.3 Standard Transport for Ireland Bus Specifications.

Considerations for Bus Stop Locations

The basic criteria for consideration when locating a bus stop:

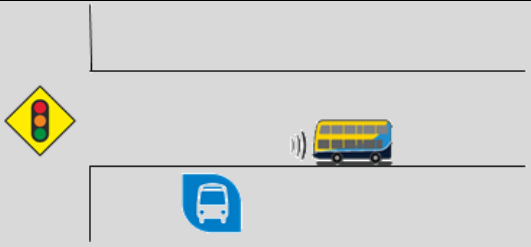
- Driver and waiting passengers are clearly visible to each other;
- Located close to key local facilities;
- Located close to main junctions without affecting road safety or junction operation;
- Located to minimise walking distance between interchange stops;
- Where there is space for a bus shelter;
- Located in pairs, 'Tail to tail' on opposite sides of the road;
- Close to (and on exit side of) pedestrian crossings;
- Away from sites likely to be obstructed; and
- Adequate footway width.

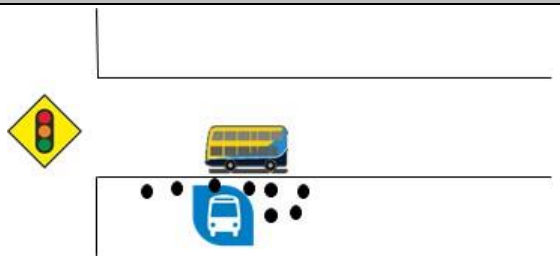
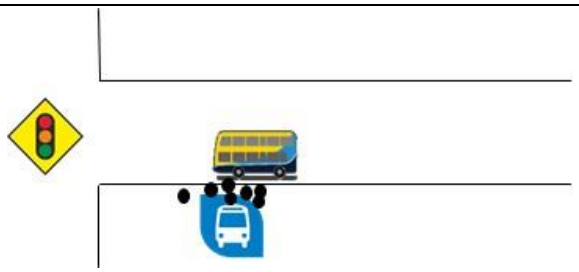
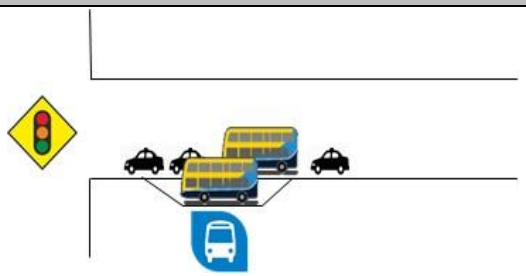
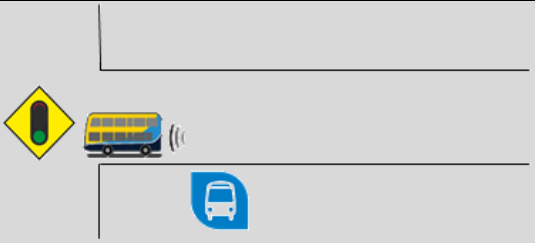
Principals of Bus Stop on high capacity Bus Systems.

The Core Bus Network Report (2015) noted that the distances between bus stops influences the efficiency of the bus network. In general, the lower the distances between stops along a corridor, the higher the delay that is incurred for buses. This delay is caused through acceleration and deceleration and delays associated with pulling in and out of bus stops with some estimates suggesting that stopping at bus stops makes up in excess of 20% of the journey times along the QBC corridors. International literature on bus stop spacing recommends a distance of 300 to 500m (NTA Report on Core Bus Network Infrastructure Network, February 2015) between stops in suburban areas is optimum, whereas in Dublin many routes have bus stops located at far lower spacing. The Core Bus Network Report concluded that increasing spacing between bus stops was part of the solution to reduce delays along the corridors.

The following indicates where delay materialises when accessing bus stops.

Table 1.1 Sources of Bus Delay associated with Bus Stops (TCQoSM, TRB)

1 Deceleration Time spent slowing to serve the stop.	

2 Bus stop failure Waiting for other buses to clear the stop	
3 Boarding lost time Waiting for passengers to reach the bus	
4 Passenger service time (dwell time) Opening the doors, boarding and alighting passengers, and closing the doors	
5 Traffic signal (traffic control) delay Waiting for the signal to turn green, or other traffic control delay	
6 Re-entry delay Waiting for a gap in traffic	
7 Acceleration Time spent getting back up to speed	

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

The acceleration and deceleration will be similar at all stops and clearly the overall impact is dependent on the number of bus stops along a route; this will be dealt with by examining the number of bus stops along a corridor.

Bus Stop failure is linked to the amount of time buses are stopped and the frequency of buses along the route and has a significant impact on the overall corridor capacity and efficiency, particularly where non stopping buses are present (Express or Regional Buses). A situation where a bus arrives at a bus stop to find all loading areas full:

- The bus must wait until space becomes available;
- Slows down the bus and creates schedule reliability issues; and
- Delay can also increase further as bus bunching occurs and bus dwell and traffic control delay times will increase.

The proximity of a bus stop to signalised junctions has an impact on bus speeds with far-side stops having the least negative impact on speed and capacity, and also favored as passengers cross the road behind the bus which increases safety.

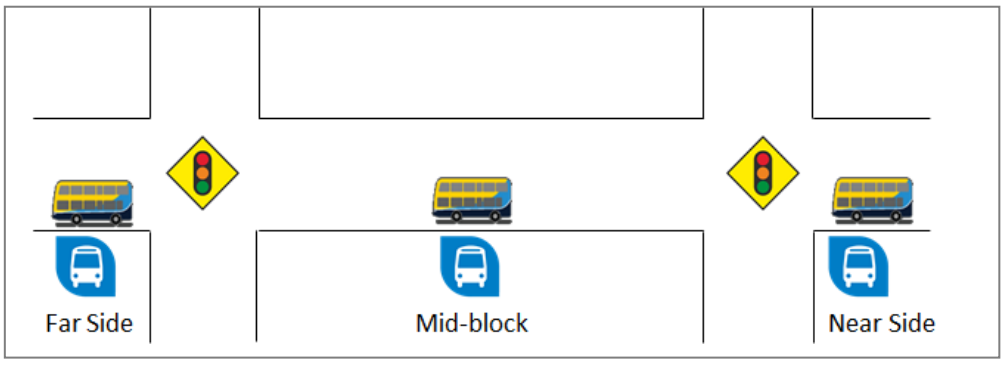


Figure 1.4 Typical Location of Bus Stops.

Ability to overtake slower buses is an important parameter where the route is made up of both express (rarely stopping) and slower (stopping at all stops) buses. For example, on the N11 QBC lay-bys (or passing lanes) were introduced after the original QBC was built to increase the capacity and allow express buses to pass the slower vehicles. On some of the BusConnects schemes this will need to be considered particularly on those routes that include regional and intercity services.

Figure 1.5 Stillorgan QBC with high bus flows and no bus laybys resulted in bus bunching/ platooning; bus lay-by's provided at key locations to allow express buses to pass slower buses. (Source: Google Maps)

Figure 1.6 A typical bus lay-by adjacent to a bus lane; note concrete surface for additional durability.

Consideration should also be given to locations where coaches stop along the Corridors, particularly those serving the airport which could require longer dwell time to allow passengers to load/unload their luggage. In these cases, a layby separate to the CBC Bus Stop maybe desirable (Figure 1.7).

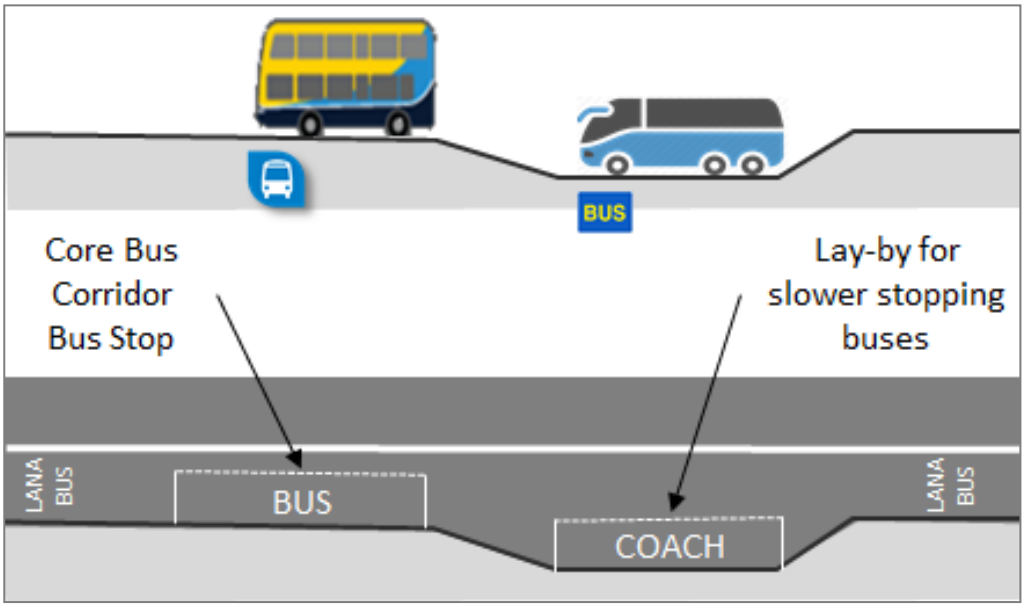


Figure 1.7 Double Bus Stop (in-line for BusConnects routes) concept for locations with buses requiring different dwell times.

Figure 1.8 Multiple bus operators may be using bus stops along the Corridors.

In general, most bus stops along corridors will be in-line (bus stops within the bus lane), as a result re-entry delays will not impact the operation of buses. However, on busier corridors where lay-bys are used re-entry may delay buses. ED's need to consider the flow of buses and taxis passing lay-by's, and where there is increased risk of delay additional measures may be required to generate

gaps in traffic (far-side) or the installation of a yellow box to allow buses to renter the traffic queue (near-side).

Pedestrian accessibility

Another important aspect of bus stop positioning is proximity to pedestrian crossings. Failure to provide high quality pedestrian facilities on the pedestrian desire line may lead to a higher accident risk associated with a bus stop. Therefore, designers need to consider how passengers are going to cross the road to get access to the stop, in general this will require bus stops to be located close to safe crossing points.

2.0 Methodology

This section outlines the process for examining each BusConnects Corridor and assessing and reporting on the bus stops along each route. The flow chart summarises the process and this is followed by a more detailed description of the tasks to be undertaken.

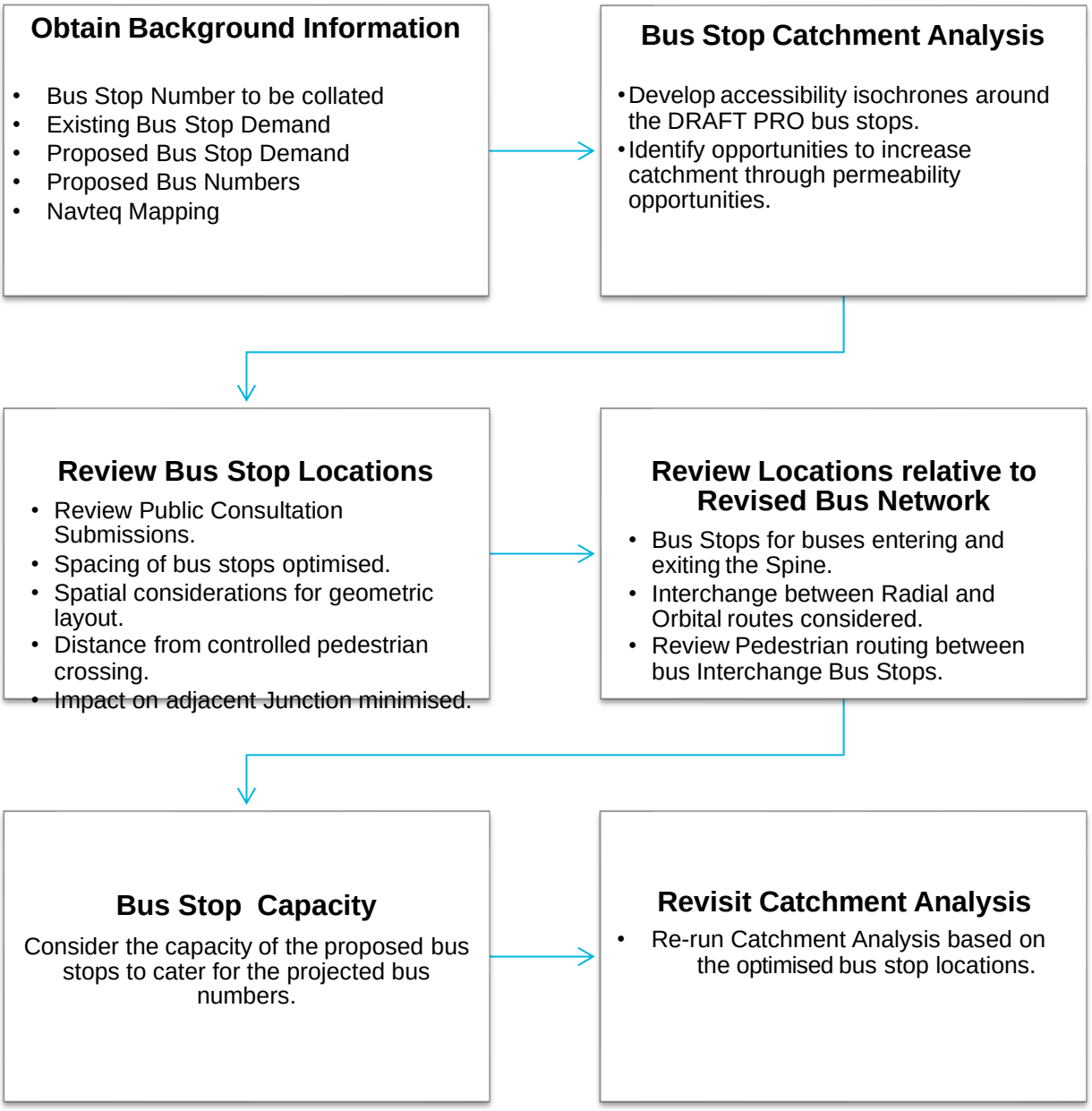


Figure 2.1 Flow Chart for proposed Bus Stop Review.

3.0 Background Information

In order to undertake the review of the bus stops along each corridor background information must be gathered. The following section outlines this information and how to obtain it.

Table 3.1 Information to be gathered to undertake the Bus Stop Review

Item	Description	Location/Contact
Bus Stop Number	Bus Stop Numbers can be obtained from a number of online sources. 	https://www.transportforireland.ie/plan-a-journey/
Existing Bus Stop Demand	Estimated boarding and alighting figures are available from NTA Business Intelligence Unit. Using Leap Card Data and Machine Learning the NTA has recently developed a tool for estimating where passengers are alighting buses along each route. The format that this will be available in is currently under development. This information can include details on use of Free Travel Pass which may help in identifying locations which are a higher priority for the elderly and those with accessibility issues.	**NTA Business Intelligence Unit**
Proposed Bus Stop Demand	Obtain future passenger demand for each corridor, this will come from the ERM. This will not be linked to specific bus stops, but zonal. The bus stop demand will then be linked to bus stops by using the existing bus stop data and factoring up existing boarding and alighting figures.	TIAR Consultant
Proposed Bus Numbers	The number of buses on each corridor is available from the BusConnects Network Redesign Team. This information has already been issued to each ED. It is the ED's responsibility to confirm that these figures are correct at this time.	Confirm that the numbers provided are the revised network data.
Navteq Mapping	The GIS Mapping is required to understand permeability in the area surrounding bus stops. NTA has this information and will provide it to each ED. Note that this base data will need to be reviewed thoroughly as from experience there will be many permeability routes that are missing.	NTA to issue mapping to all teams.

4.0 Bus Stop Catchment Analysis

Bus stop passenger catchment areas are critically important to the success of a high-quality bus corridor. The catchment at each bus stop needs to be maximised so as each stopping movement collects sufficient passengers to justify the loss in journey speed; a bus stopping at each bus stop to pick up one passenger will result in a very slow journey time, the ideal scenario is to stop less often and collect more passengers at each stop. Clearly too few bus stops could also be detrimental to the success of the scheme. To assess if bus stops are optimally spaced to maximise the passenger catchment area it is recommended that a catchment analysis using the NTA Navteq data(or similar process) is undertaken.

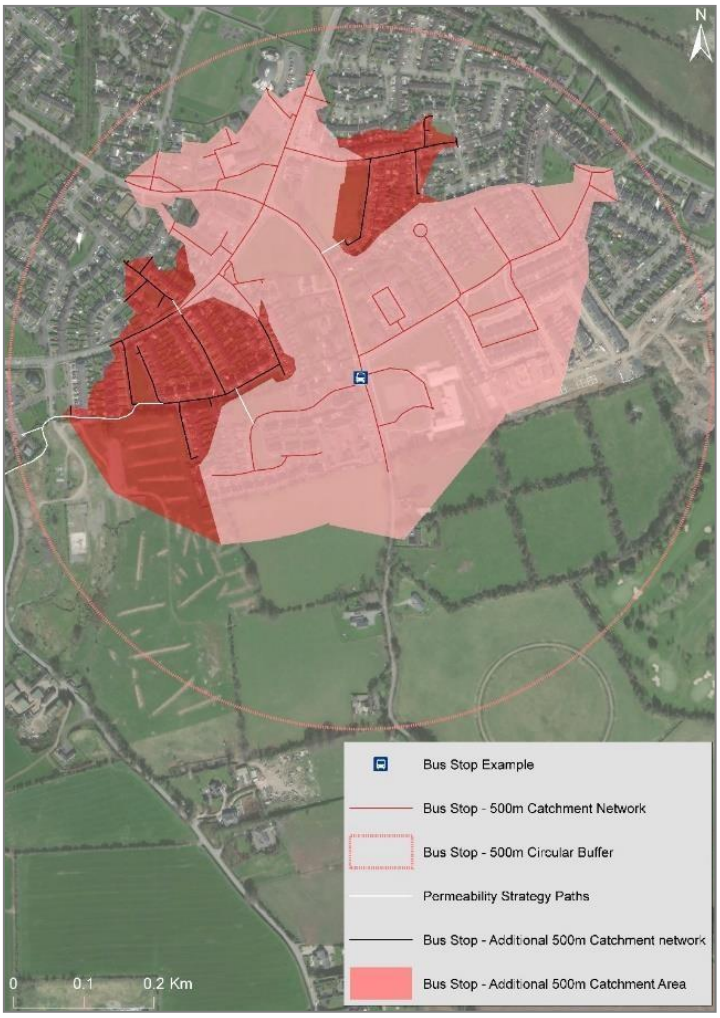


Figure 4.1 Passenger catchment analysis for a bus stop indicating the existing and possible catchment areas assuming permeability improvements can be undertaken.

Figure 4.1 indicates the area that is within a standard walking distance of a bus stop (400m for BusConnects CBC's) based on the actual walking distance rather than "as crow flies" analysis which can be misleading particularly where there are long sections of blank, inaccessible, wall along

corridors. The number of people living within this area can be obtained from GeoDirectory data. In addition, permeability solutions can be identified and the impact of making these changes can be quickly assessed in terms of increased catchment area. The process of undertaking this analysis is outlined below:

Task 1: Enhancing the Navteq network using OpenStreetMap to add footpaths, greenways, cut throughs which are accessible to most people, paths over greens or parks, etc., this is required as the network supplied by the NTA is a primarily a driving network not a pedestrian network.

To do this you will add walk links extracted from OpenStreetMap's data clearly coding these into the Navteq supplied by the NTA. Google Streetview should be used as a check to ensure any link added to the Navteq exist on the ground and are accessible to all. Informal walk links should not be added at this stage.

Figure 4.2 Example of permeability link missing from Navteq mapping on Tallaght/Clondalkin Cor Bus Corridor.

Task 2: Once the Navteq has been enhanced to the required level to capture all major pedestrian movement within bus stop catchment areas, catchment analysis shall be run for the proposed and existing bus stops. Using the Network Analyst Extension in ArcGIS generating 400m and 800m walking bands to reflect 5 and 10-minute walking catchments of bus stops.

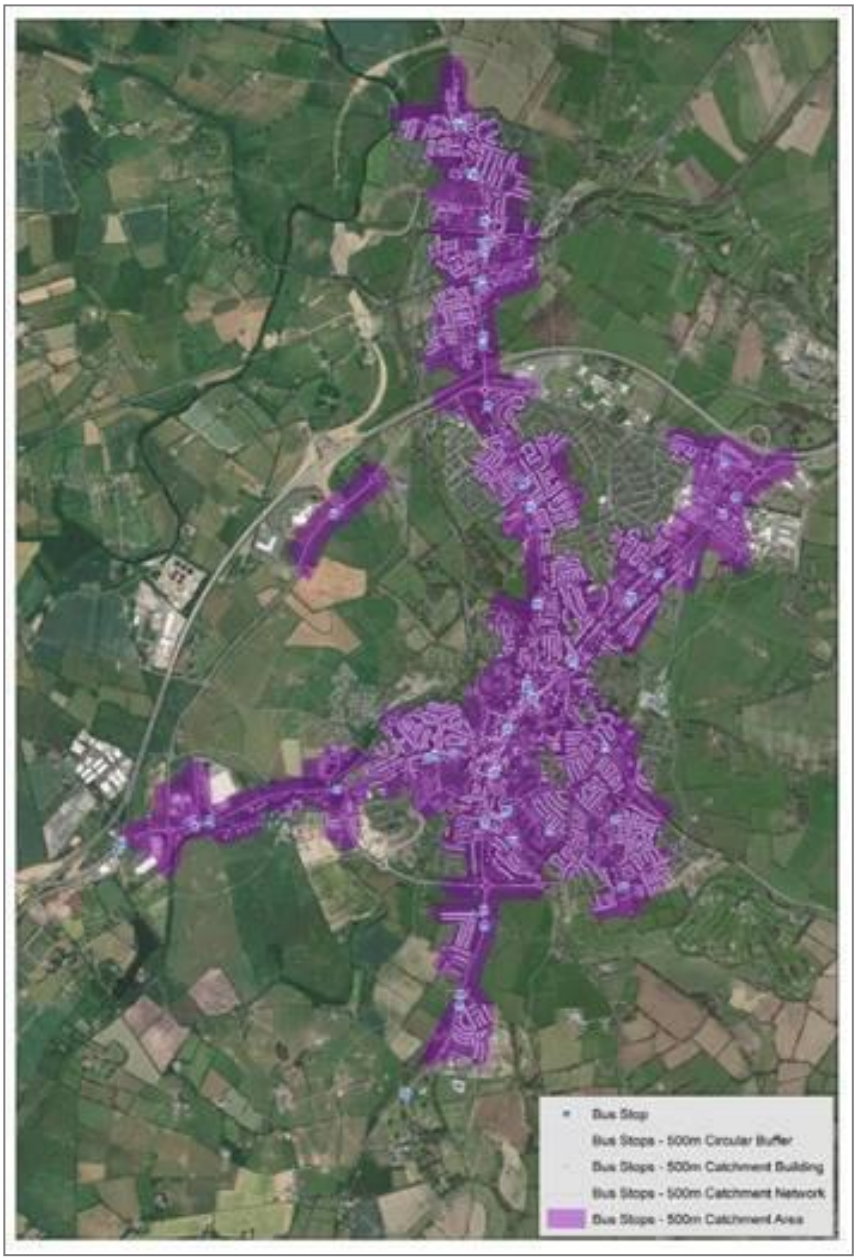


Figure 4.3 Example of catchment analysis run for all bus stops in Naas

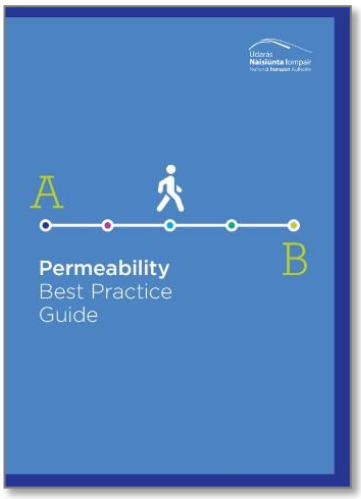
Task 3: Production of catchment tables identifying number of households using Geo Directory or population estimate using census 2016 and Geo Directory to apportion sections of Census Small Area within 400m and 800m catchments of each bus stop. Catchments will be non-overlapping to avoid double counting between stops along the same alignment.

Task 4: Maps will be generated for each stop along each of the alignment, or stops can be grouped together to reflect particular study areas. Maps can be generated in any particular format to match the theme of previous reports (EPR Reports).

Task 5: Quality Assurance and Checking of catchments is critical as missing, or additional, links will be easily identified by the public and could discredit the analysis if there are errors.

Having developed a detailed understanding of the catchment areas consideration should then be given to how the catchments can be widened through identification of permeability opportunities along the corridors. Permeability describes the extent to which an urban area permits the movement of people by walking or cycling. Such an approach is known as “filtered permeability”. Barriers to filtered permeability can include:

- Boundary walls around estates and within residential areas that prevent movement along natural desire lines, being usually the shortest and most direct route connecting two points;
- Cul-de-sacs which prohibit through movement;
- Poorly designed linkages that are difficult or unattractive to use; and
- Connections which require much longer travel distances than direct linkages.



The NTA Permeability Best Practise Guide should be followed for the identification and assessment of these opportunities. Careful consideration should be given to whether or not these proposals should form part of the Bus Connects scheme or if they should be identified to the Local Authority for actioning. Only those linkages that are directly linked to the corridor should be considered as part of this application.

An example from the Clongriffin to City Centre CBC can be seen in Figure 4.4 where a very large housing estate which is located immediately adjacent to the proposed bus corridor has a continuous boundary wall that runs for over 800m preventing easy access to the bus routes and requiring a walk of almost 1km to access the bus routes. Opening a pedestrian access on the boundary wall could create a much shorter route to the buses and substantially increase the bus passenger catchment area.

Figure 4.4 Permeability option on the Malahide Road (Source: Google Maps).

Figure 4.5 Boundary wall along Malahide Road (Corridor 1) where local residents have opened up individual doors to access the existing QBC route.

5.0 Review Bus Stop Locations

5.1 Public Consultation Feedback.

An important aspect of the bus stop review is to review feedback received from the general public in relation to the position of an existing, or proposed, bus stop along the corridor. This may identify a specific issue that the reviewer should be aware of before beginning the review. For example, the relocation of a bus stop away from a destination for people with mobility impairments may not have been identified during the preliminary design process and should now be considered. It is also important to review these comments against commitments that may have been given during the "one to one" meetings held during the initial, and subsequent, consultation stages.

Please note that some bus stops were relocated after the EPR public consultation as a result of public consultation comments, if a bus stop is being considered for relocation please also check whether it had been relocated previously by checking the EPR drawings and discussing with the NTA IPO.

5.2 Usage of Bus Stops.

In order to help the reviewer, understand the passenger movements at a bus stop it is recommended that the existing Boarding and Alighting Data is reviewed at this early stage and is used as an approxi for future passenger movements. This will provide an indication of the numbers using a bus stop in an area and would indicate the number of pedestrians movements having to be catered for. It will also indicate those bus stop locations that are relatively lightly used and could be considered for amalgamation with a nearby bus stop, relocation to a more convenient location, or removal completely.

5.3 Spacing of Bus Stops.

The spacing of bus stops has a significant impact on the average speed of a bus corridor, clearly the more times a bus stops the slower the overall journey time will be. A bus incurs a minimum of 15 seconds delay with each stop on an urban street just to decelerate, open and close the bus doors, and accelerate back to speed (25 seconds on a busway). Table 5.1 uses information extracted from the Transit Capacity and Quality of Service Manual (TRB) and indicates the estimated average speed on an 80kph busway. This clearly indicates that bus stop spacing, and dwell time have a large impact on average speed on bus corridors.

Table 5.1 Average Bus Speed (km/h) in Bus Priority Corridors, 80km/h running speed.

Average Stop Spacing (km)	Average Dwell Time (s)				
	0	15	30	45	60
0.8	50	37	32	27	24
1.6	61	51	45	40	37
2.4	68	58	53	48	45

For BusConnects it is proposed that bus stops should be spaced approximately **400m** apart on typical suburban sections of the route, dropping to approximately **250m** in urban centres (CIHT Buses in Urban Developments, January 2018). This spacing should be seen as a recommended spacing rather than an absolute minimum spacing.

The ability to increase stop spacing depends in part on the quality of the pedestrian connectivity in the area and also the availability of safe crossing points in the vicinity of the proposed bus stop. It may also depend on the characteristics of the passengers using the stop, e.g. persons with limited mobility may find it difficult to walk to the next stop. It is therefore recommended that for locations that may generate high number of elderly or mobility impaired bus passengers (health facilities, local businesses) consideration should be given to locating the bus stop within **100m** of the location if spatial considerations permit.

5.4 Spatial considerations for geometric layout.

The provision of high-quality bus stop infrastructure that is customer orientated is considered an essential part of the BusConnects offering, including:

- Being fully accessible for all bus passengers;
- Having a bus shelter for waiting passengers;
- Having both timetable and real time passenger information (RTPI) available to passengers;
- Having sufficient footpath space to allow the free movement of pedestrians passed the bus stop;
- Continuous cycle lane past the bus stop; and
- Provision of Cycle Parking at, or close to, the bus stop.

All of which requires significant space along the already congested radial routes that the Core Bus Corridors run along. Therefore, an important aspect of locating bus stops is identifying locations that have sufficient space to accommodate all, or most, of these elements.

The BusConnects Design Guide suggests that an Island Bus Stop (Figure 5.1) is the preferred bus stop option to be used as standard on the CBC project where space constraints allow. The **minimum footpath width within which an island bus stop can be implemented is 5.4m** (1.8m footpath + 1.2m cycle track + 2.4m island with shelter). This option assumes a shelter with half bay end panels. Should full panels (as seen on Figure 5.2) be required the width requirement will increase to approximately 6.3m. [Standard Detail in Development (21/6/20) which may change these dimensions, Rev 4 will include updated information].

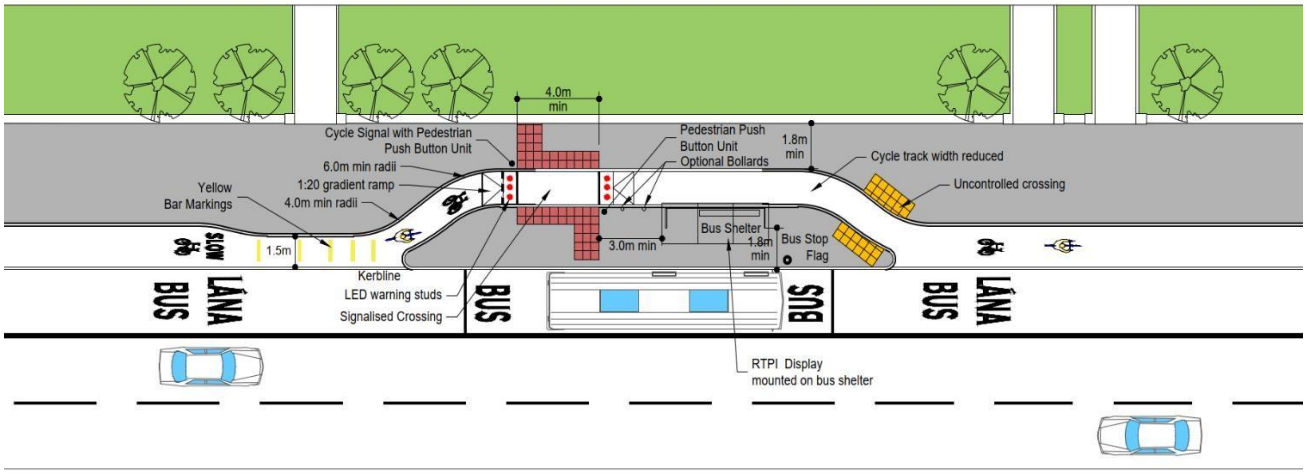


Figure 5.1 Typical Island Bus Stop Arrangement (Bus Connects Design Guideline).

Figure 5.2 Standard 3 Bay Reliance Mark Shelter with full width advertising panel.

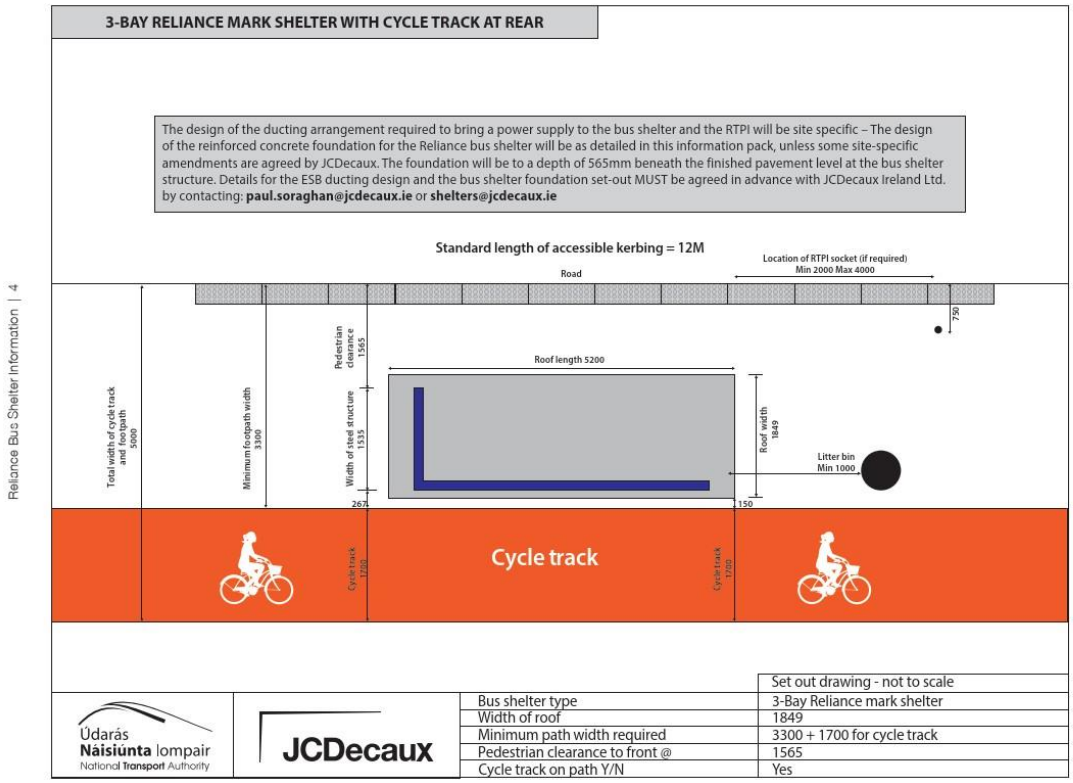


Figure 5.3 Standard layout for a 3 Bay Reliance Mark Shelter with full width advertising panel and cycle lane to the rear (note cycle lane width is to be determined by designers).

For locations where space is constrained an option consisting of a shared bus stop landing zone can be considered. This option is indicated in Figure 5.4 and should only be considered on a case-by-case basis to ensure suitability with particular attention paid to the volume of cyclists and volumes of boarding and alighting passengers. **Using the narrowest non-standard bus shelter this would require a minimum width of approximately 4.0m** (1.9m footpath with shelter + 1.2m cycle track + 0.75m island).

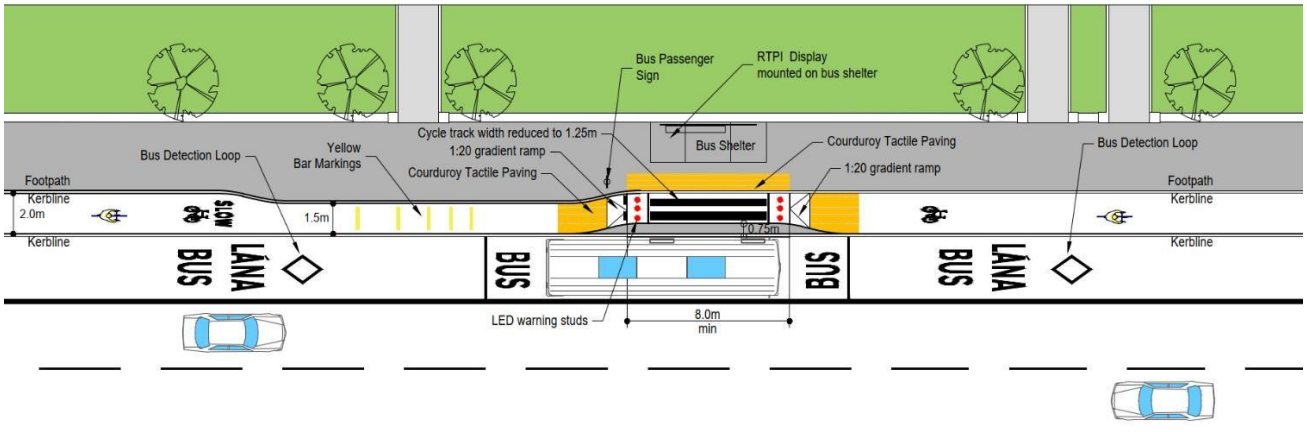


Figure 5.4 Shared Bus Stop Landing Zone Arrangement (Bus Connects Design Guideline).

Figure 5.5 Cantilever narrow roof Bus Shelter

It is important that ED's do not immediately choose the minimum sized shelter as this will impact on the weather protection provided to bus passengers and potentially advertising revenue share received by the NTA. Where there are a substantial number of bus stops using the nonstandard bus shelter it is recommended that the NTA IPO are consulted prior to finalising the proposals.

Providing cycle parking at bus stops has the potential to increase the catchment area of a bus corridor by providing a safe place for cyclists to secure their bike for the duration of their trip. ED's should look to provide cycle parking at all bus stops along the BusConnects Corridors where space permits. The **minimum provision is 3 Sheffield Stands** (accommodating 6 bicycles) in the vicinity of a bus stop. Where larger numbers of cyclists can be expected consideration should be given to providing a larger covered area of approximately 10 Sheffield Stands (accommodating 20 bicycles).

Figure 5.6 Sheffield Bicycle Stands provided at a Bus Stop on the N11.

Figure 5.7 Covered Sheffield Bicycle Stands provided at a Bus Stop on the N11.

5.4 Distance from controlled pedestrian crossing.

Pedestrians by their nature often take the quickest route to their destination rather than the safest route, particularly if they feel the safety risk is low. This results in bus passengers leaving buses stepping out in front of, or behind, buses and crossing the road in a hazardous manner. The placement of bus stops near safe pedestrian crossing points is therefore a critical aspect of bus stop design. Providing a bus stop where there is no, or an indirect, pedestrian crossing will lead to “jaywalking” and pedestrians making higher risk movements.

There are many examples of bus stop located immediately outside a pedestrian opening into a housing estate which makes it easy for passengers to access the bus stop in the morning, however on the return journey the passenger can often be isolated on the other side of the road with no safe crossing point available. While this may be satisfactory on some roads, it may not be on others, and how is a person with a mobility impairment to cross a busy radial route? **All bus stops along the CBC’s should be located within a short distance of a controlled crossing point.**

The optimum location to locate a bus stop is adjacent to junctions which have signalised pedestrian crossings provided on all desire lines. Much research has been undertaken in relation to the optimum location for a bus stop adjacent to a junction, either before (near-side) or after a junction (far-side), while there are advantages and disadvantages of both, all guidance recommends that locating the bus stop on the **far-side of a junction is the optimum solution**. While this may be theoptimum location in terms of the operation of a corridor a near-side bus stop may still be appropriatewhen spatial constraints, routing, or distance from junction are considered.

Figure 5.8 indicates various locations for bus stops at junctions with particular consideration for interchange between Spine and Orbital Core Bus Corridors. This indicates that all options which require passengers to interchange will require passengers to cross at least one arm of a junction (on average over both legs of their journey), emphasizing the importance of locating bus stops at junctions and providing controlled crossings on all desire lines between interchanging bus stops.

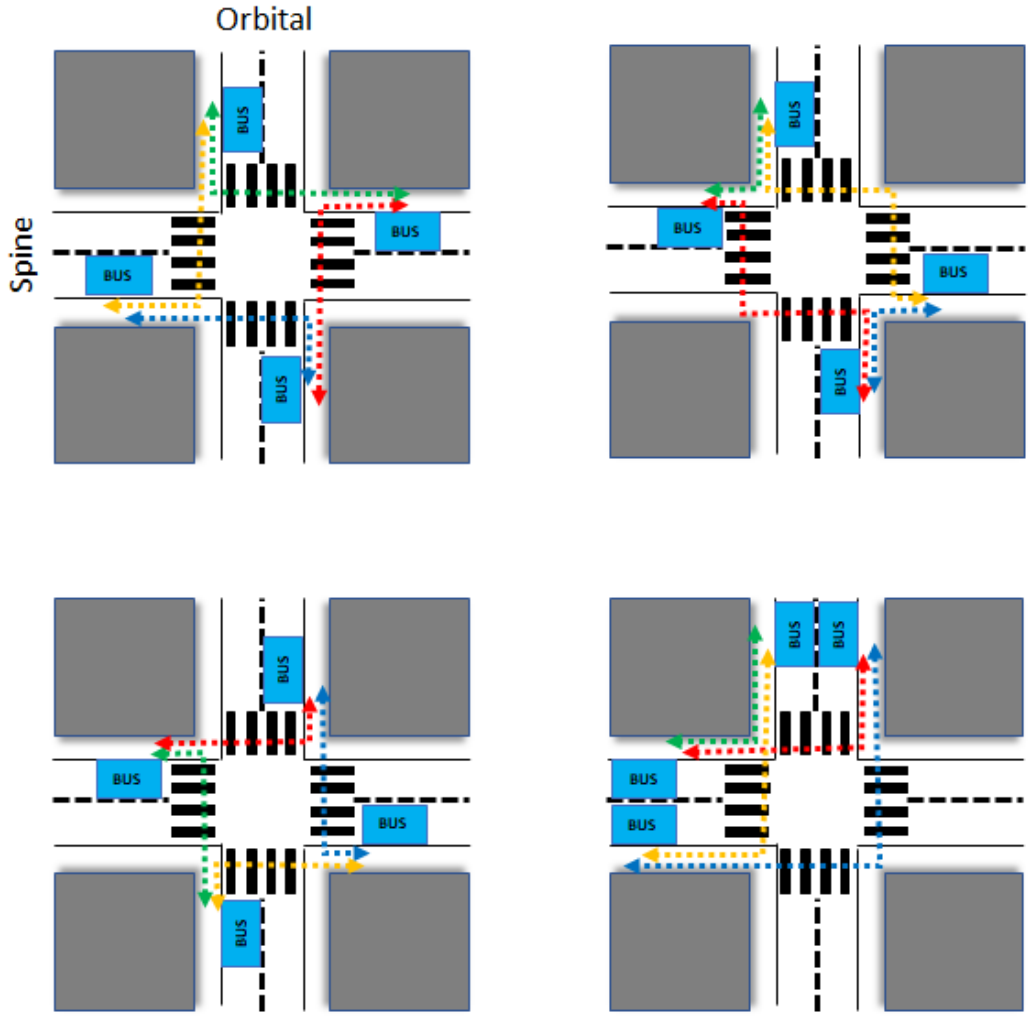


Figure 5.8 Bus stop locations and passenger interchange routes between them.

The DfT document Inclusive Mobility (2005) suggests recommended distance limits without rest for various Mobility Impaired Groups that ranges from 50 to 150m, which limits the distance between interchanging bus stops significantly. It is therefore recommended that the distance between the key interchange bus stops is limited to approximately **100m walking distance** where possible to enable all impaired groups to be able to interchange, consideration must be given to providing a rest spots at approximately 50m between the bus stops to cater for those that will not make this distance without a rest.

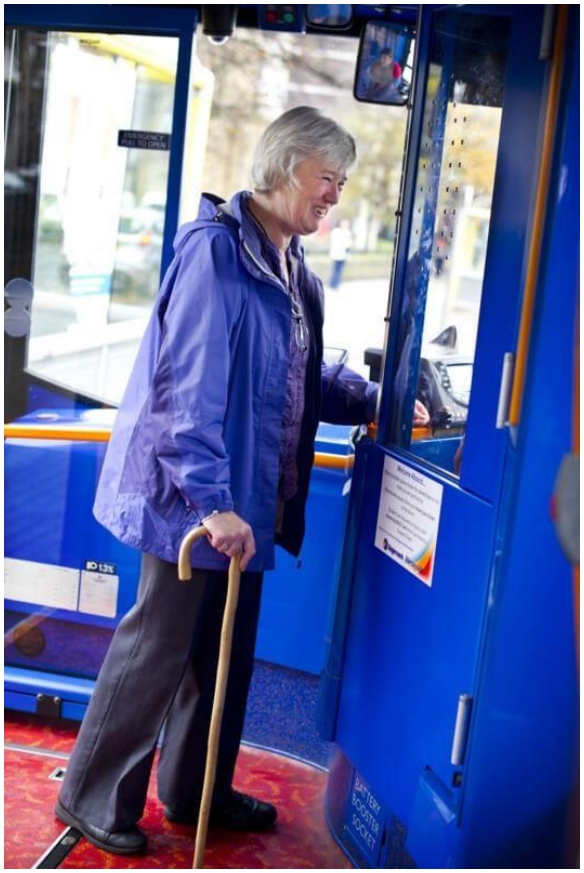


Figure 5.9 Pedestrians using sticks have a limited range of 50m before needing a rest.

For mid-block (between junctions) bus stops it is important that consideration is given to the location of a safe crossing point. It is recommended that a signalised crossing is located in close proximity to these stops to allow all passengers to cross the road safely. It is also recommended that bus stops are positioned upstream of this crossing to avoid buses blocking visibility to the crossing and that passengers walk to the back of the bus where they are more visible to oncoming traffic.

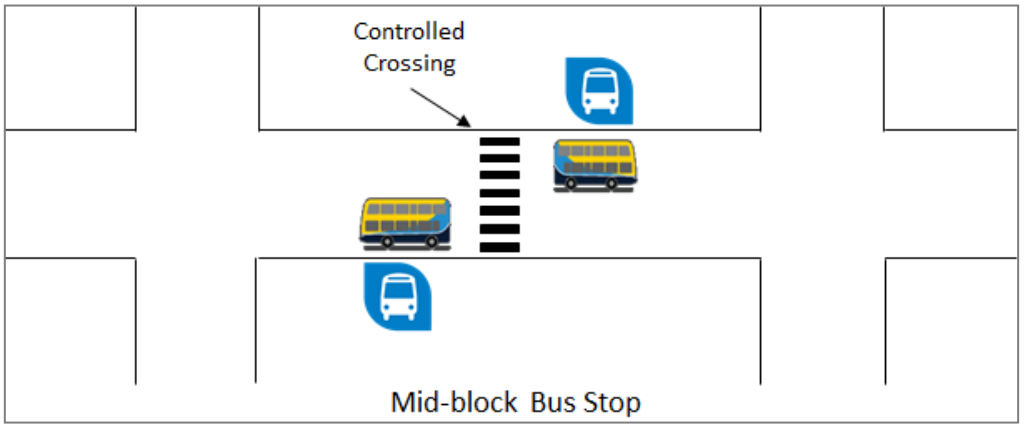


Figure 5.10 Mid-block bus stop optimum layout.

5.5 Impact on Adjacent Junction.

Locating bus stops close to junctions is optimum for pedestrian connectivity and safety, however it clearly can impact on the capacity of a junction and may result in increased congestion. Designers will need to review the location of the bus stops in order to minimise the impact on the operation and capacity of the junctions; things to consider include:

- Distance from the far-side bus stop to the junction. Buses will be running at headways of approximately 2 minutes at peaks on some corridors, while every effort will be made to avoid bunching it is likely that buses will end up meeting each other as they wait for a green signal. As a result, it is important that sufficient space for a bus to wait behind a stopped bus is provided at all junctions. Importantly this offset should start beyond the pedestrian crossing point in order to avoid blocking the crossing. Table 2.2 provides guidance on offset distance from key features.
- For near-side bus stops it is important that the location is reviewed in the context of visibility to the traffic signals for general traffic (bus, or the bus stop infrastructure, impacting on visibility to primary traffic signals) and also interaction with left turning traffic. Reference DMRB DN-GEO-03044 and DTTaS Traffic Signs Manual Chapter 9.
- Where a bus is joining a Spine from a side road it is important that the bus stops are fully accessible by the turning vehicle and sufficient space is provided to allow the bus to pull in flush with the bus stop so as the gap between the kerb and the bus is minimised (both doors). It is also important to ensure that the manoeuvring bus does not require the bus to sweep over the kerb line.

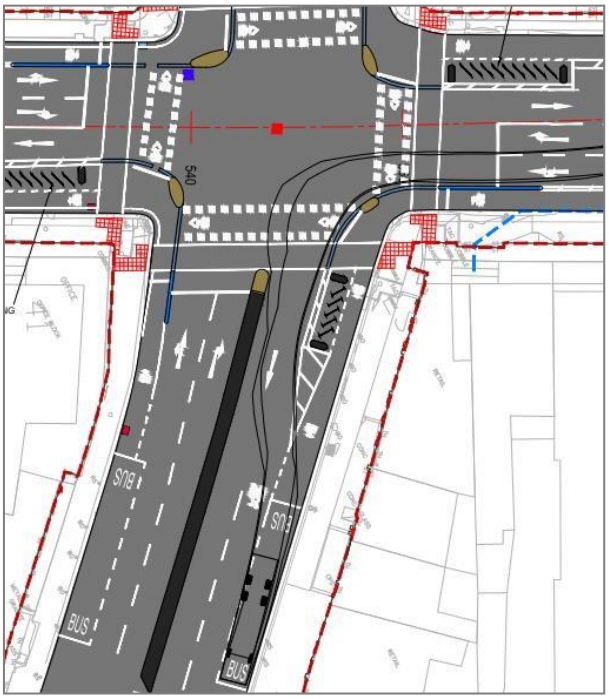


Figure 5.11 Tracking of a turning bus entering a bus stop.

Figure 5.12 Having buses flush with the bus stop is important to allow the ramp to lower correctly, but also to speed up the boarding and alighting of all passengers as gaps slow this down.

Table 5.2 Indicative Distances of Features from Bus Stops

(DRAFT NTA Bus Stop Design Guidance)

Feature	**Distance (m) to bus stop sign**
Prior to isolated pedestrian crossing signals or Zebra	18m
After pedestrian crossing signals or Zebra	10m + bus length*
Prior to signalised junction	20-30m
After signalised junction	20m + bus length*
Prior to or after a side road	20m
After a side road	10m + bus length*
Prior to a roundabout (no diverge)	20-30m
After a roundabout (no merge)	20m + bus length*

***the bus length should be the longest bus using the stop**

6.0 Review Locations relative to Revised Bus Network

The revised BusConnects Network is based on the Connective Network Principle which will rely on some interchange between routes to reduce journey times across the City. This Interchange will primarily occur in the City Centre where the spines overlap rather than along the Spines. However, some interchange will occur between the High Frequency Spines and the Frequent Orbital routes and also between the routes before Branches peel off the spine. Seamless interchange between these bus routes will be critical for the successful operation of this system.

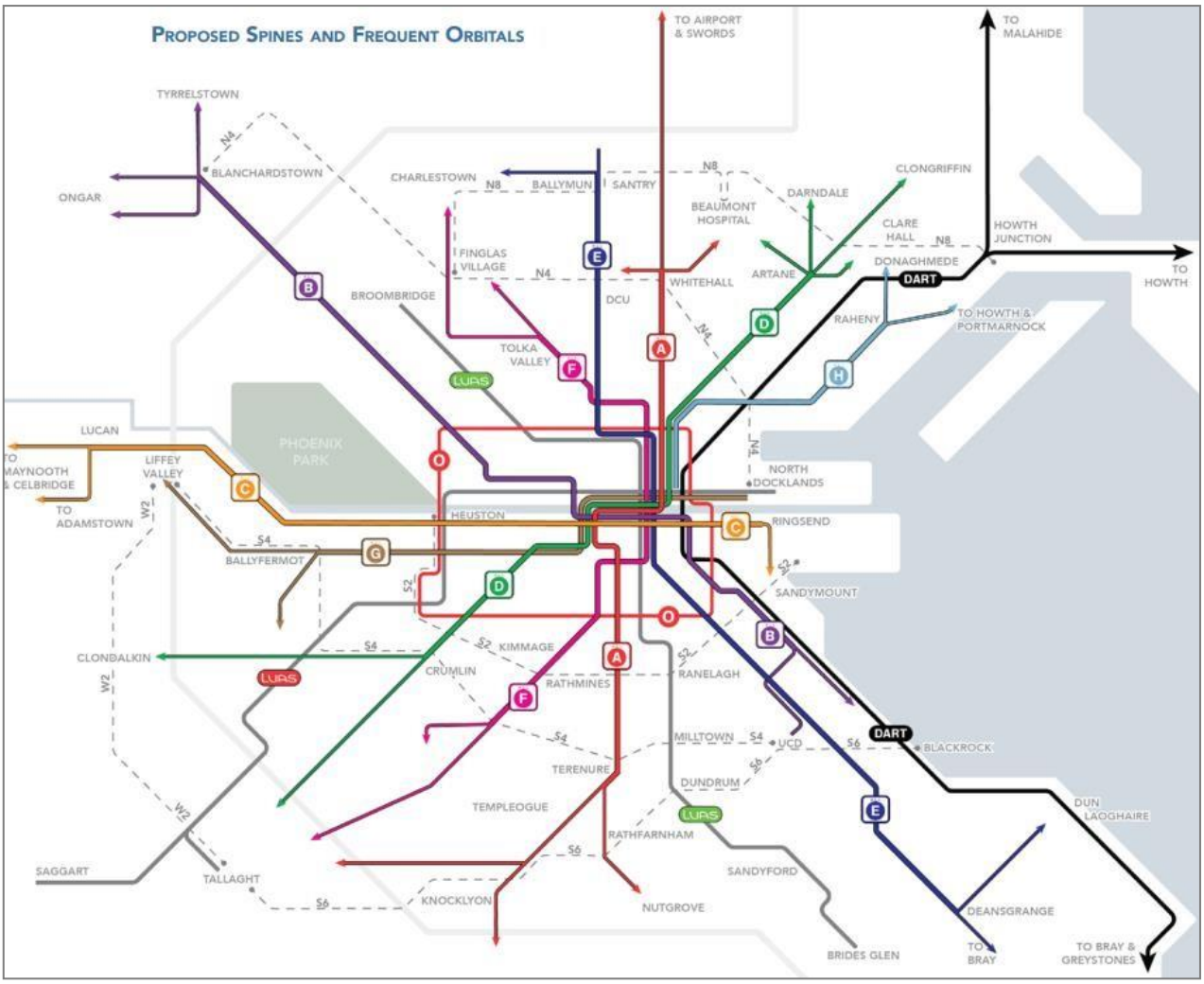


Figure 6.1 Simplified diagram of spines and frequent orbitals in the proposed network

The latest maps need to be obtained by each ED from the NTA IPO. In addition, the ED's can make use of the NTA's Remix system, which is an on-line route and stop information system for the proposed bus network.

6.1 Buses entering and exiting the Spine.

For buses entering and exiting the Spine, consideration should be given to how passengers may switch from one branch to another branch route. While this can happen anywhere along the Spine it will most regularly occur at the last stop before the branch route peels off the Spine. An existing example of this can be seen at Foxrock Church where two high frequency routes (46A/145) deviate at this point. At the last stop before the 46A deviates to Kill Avenue significant numbers switch from one route to the other.

Figure 6.2 Foxrock Church Bus Stop on the N11 QBC

For the Core Bus Corridors consideration should be given to the size and location of the stops before branch routes leave the main Spine. The optimum location of stops at this location will allow all routes to overlap prior to the junction thus removing the necessity for passengers to walk to anotherbus stop.

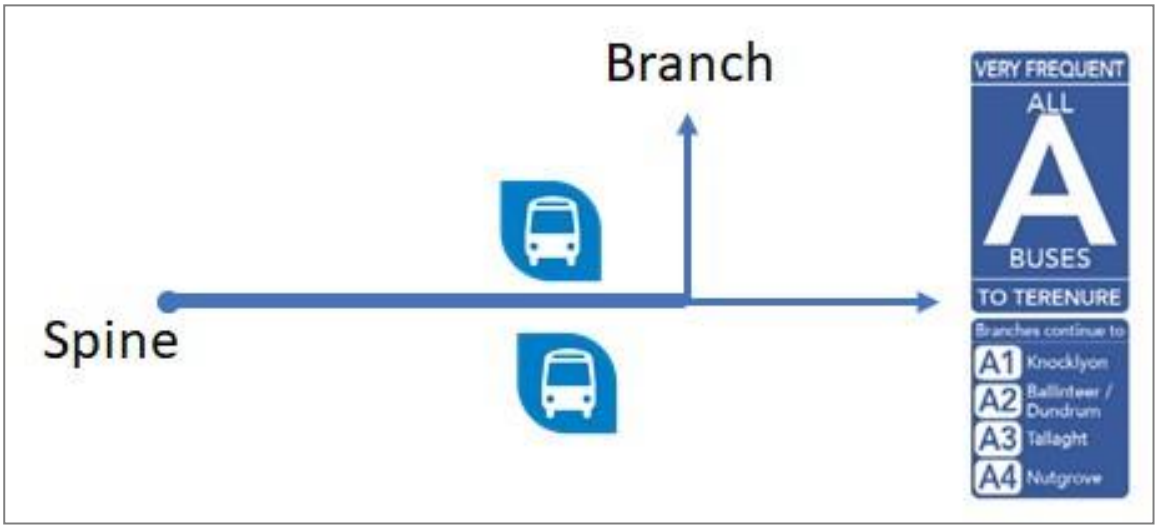


Figure 6.3 Location of Bus Stops Immediately before Branch Route Peels Off Spine

6.2 Interchange between Radial and Orbital routes.

The movement of passengers from one corridor to another is critically important to make Dublin more accessible by public transport. Making this interchange as easy as possible is thus critical to the successful delivery of the BusConnects Programme. Figure 3.4 indicates two typical scenarios that will arise on this project; the crossing movement (D/N4) and the overlapping movement (D/N2).

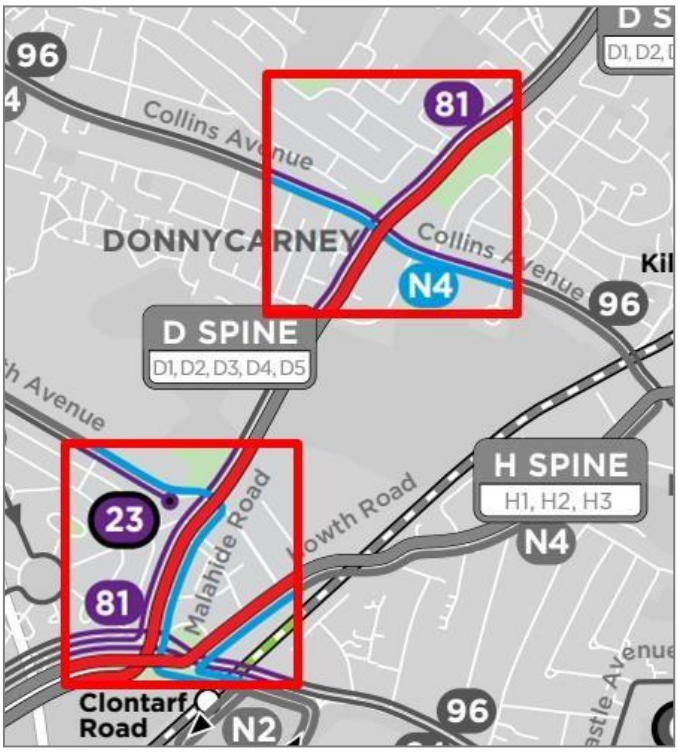


Figure 6.4 Two Different Scenarios for Interchange between orbital and radial corridors.

The optimum solution, but the less likely one, is the overlapping of routes which will allow passengers to leave one route and access another one via the same bus stop (or the opposite pair) making it a very easy interchange. For this option it is important that the designer considers the location of bus stops in a similar manner to the previous section on peeling off of branch lines.

For the more common crossing of routes the location of the bus stops needs to be carefully considered to minimise the distance passengers have to walk and to ensure there is a safe crossing location to facilitate this movements. This was outlined in section 5.4. **For locations where interchange is expected it is recommended that the desirable maximum distance between the interchanging bus stops is 100m,** with rest stops provided at 50m for those with impairments that restrict the maximum walking distance to below 100m.

7.0 Bus Stop Capacity

The capacity of bus stops is a complex and dependent on many variables which may constantly vary throughout a typical peak hour. For this reason it is proposed to undertake a high level assessment of bus stop capacity at this time and a more detailed assessment at a later stage when the Microsimulation Models are available for each corridor which can include the interaction between junctions and bus stops (potential bunching of buses), taxi numbers on the corridor, and the number of express or stopping coaches. Information on the calculation of capacities is available in the TRB, Transit Capacity and Quality of Service Manual, 3rd Edition and for complex locations it is recommended that the designer review applicable sections of this document to gain an understanding of the critical parameters.

7.1 Number of Bus Bays

The TFL Bus Stop Design Guidance states that bus stop capacity is a function of bus length, service frequency, the number of serving routes and their average dwell time. The BusConnects Dublin Corridors will generally carry between 15 to 20 buses per hour at peak times, which equates to a bus every 3 minutes. Assuming a maximum dwell time of 1 minute it could be assumed that one bus stop will be sufficient in most cases. However, the spine corridors will have multiple branches joining at different points with buses running at different frequencies resulting in buses not running at a constant headway. Figure 7.1 below indicates a bus arrival scenario from the TFL Bus Stop Design Guideline which shows how buses may arrive at a stop. This shows the estimated volume of buses at a single bus stop, depending on the frequency of the respective services. For example, Scenario C shows that although there is a frequency of 26 buses per hour, the stop, would theoretically operate well below capacity, however the arrival pattern of buses means that at times more than one bus will be on the stop. For this reason, it would be recommended that this bus stopshould have sufficient space to board and alight two buses at once.

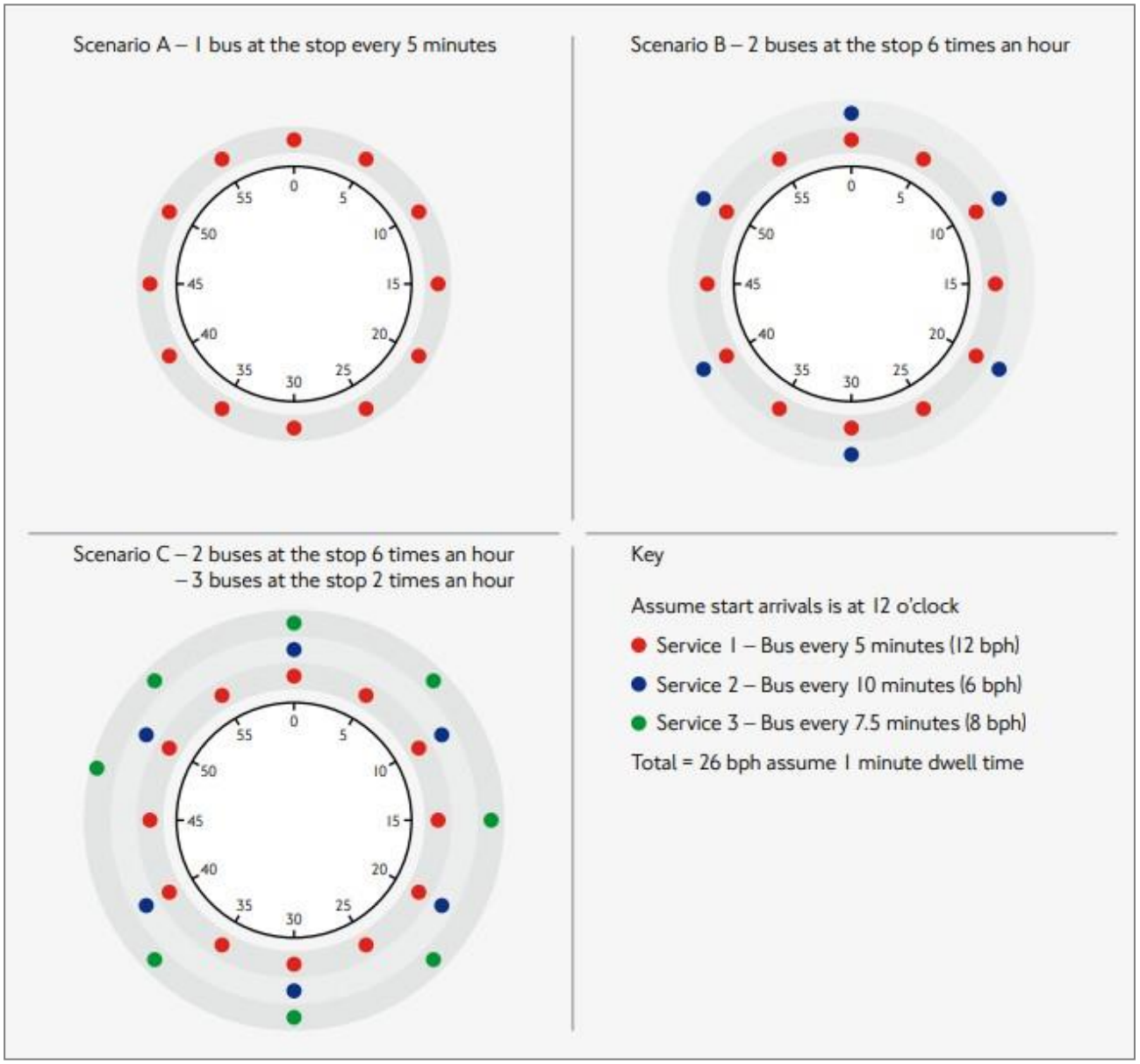


Figure 7.1 Bus Arrival Pattern at a Bus Stop (Source: TFL Bus Stop Design Guidance)

Detail on the buses using each corridor can be obtained from the NTA Remix site (obtain access from NTA IPO), or the frequency information from the BusConnects website. This can be used to make an estimate of the number of bays required at a bus stop by generating scenarios for the stops based on the headways for each route similar to Figure 7.1 above. These assessments will be superseded on completion of the micro-simulation analysis of each route, for this reason it is proposed to undertake this initial assessment based on the assumption that 2 bus bays will likely be required where there are between 25 and 30 buses on the route. This would require a longer bus cage that will accommodate two buses stopped simultaneously, approximately 24m in length (end to end bus), with Kassel Kerbs provided over its length to assist passengers, particularly those with a mobility impairment, to board and alight with ease from both buses.

Number of Bays at a Bus Stop	Where a Corridor is carrying approximately **25 to 30 buses** or more per hour, consideration be given to lengthened the bus stop cage and kerbing to provide space for 2 buses stopping simultaneously. Independent arrival and departure is not required.

Figure 7.2 Where space permits double bus bay should be provided where more than one bus is expected to arrive at a bus stop simultaneously (source: Google)

7.2 Passing Lanes

For corridors with large number of buses, particularly express buses that are not stopping at bus stops it may be necessary to provide a passing lane, or to indent the bus stop in a lay-by, to allow these faster moving buses to overtake the slower ones. This is likely to be particularly important on high capacity corridors where Regional Buses are accessing the City Centre. The TIAR Consultant has undertaken an initial assessment of this and have concluded that where the **hourly bus numbers exceed 40 the addition of a bus stop layby** will help maintain bus capacity and reliability along the corridor. The specific number for each corridor will be obtained from detailed microsimulation analysis at a later date.

Requirements for passing Lanes	Where a section of corridor is carrying approximately **40 to 50 buses** or more an hour**,** consideration should be given to providing passing lanes at bus stops.

Figure 7.3 In-line bus stops on a heavily used bus corridor can lead to express, or non-stopping buses, being delayed or making overtaking manoeuvres. (source: Dublin Bus Stuff).

8.0 Revisit Catchment Analysis

On completion of the review of bus stops along each corridor the catchment analysis for each corridor should be undertaken. The process was detailed in Section 4.0. The analysis should be undertaken and presented on a corridor basis with both Residential and Employment/Education population within 5 and 10 minutes presented.

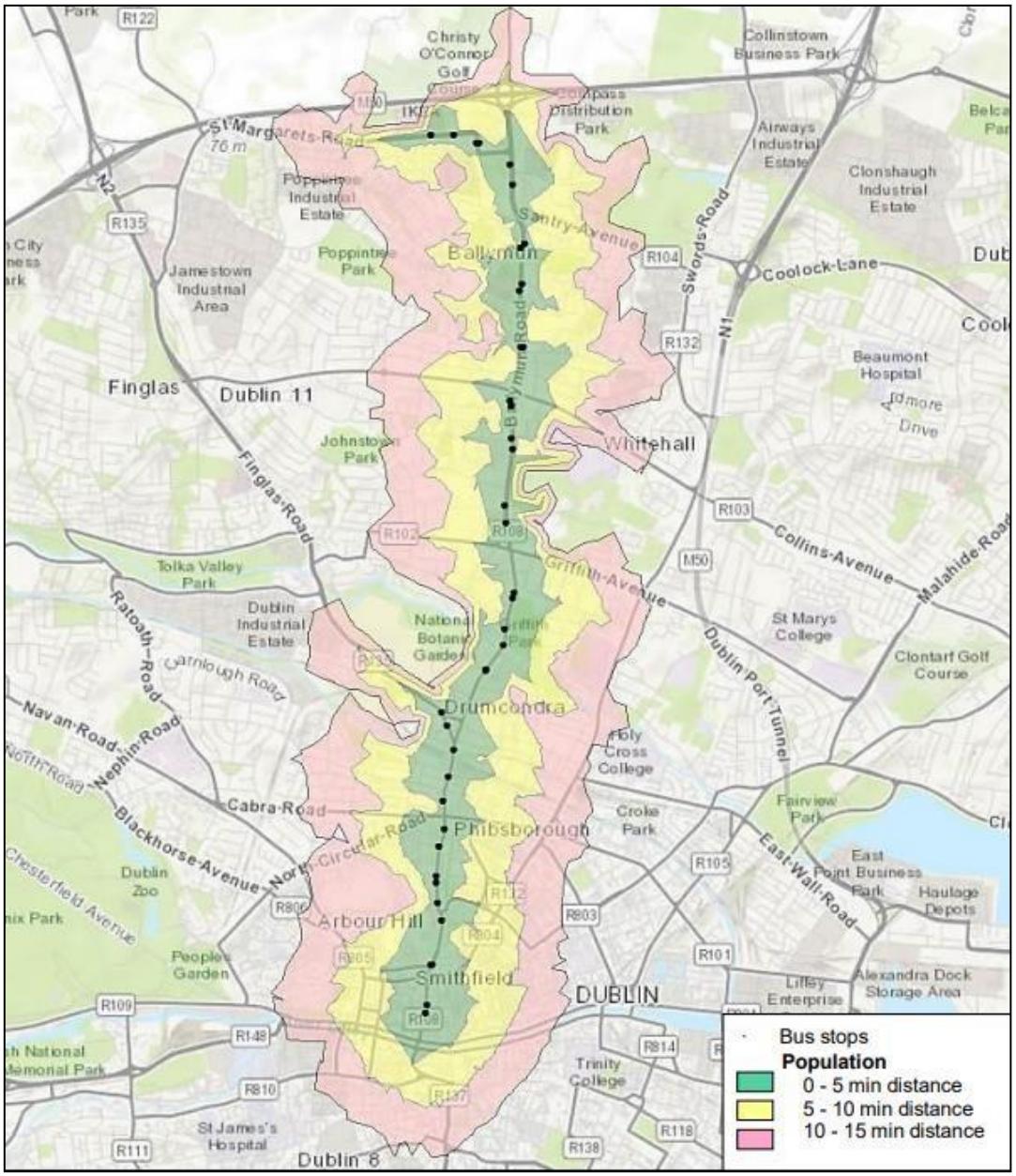


Figure 8.1 Typical map of bus corridor catchment areas

8.1 Presentation of Review

For consistency it is recommended that this review is undertaken, and presented, on the PRO drawings. High-level comments can be listed against each stop with distance between stops also noted (Document 1).

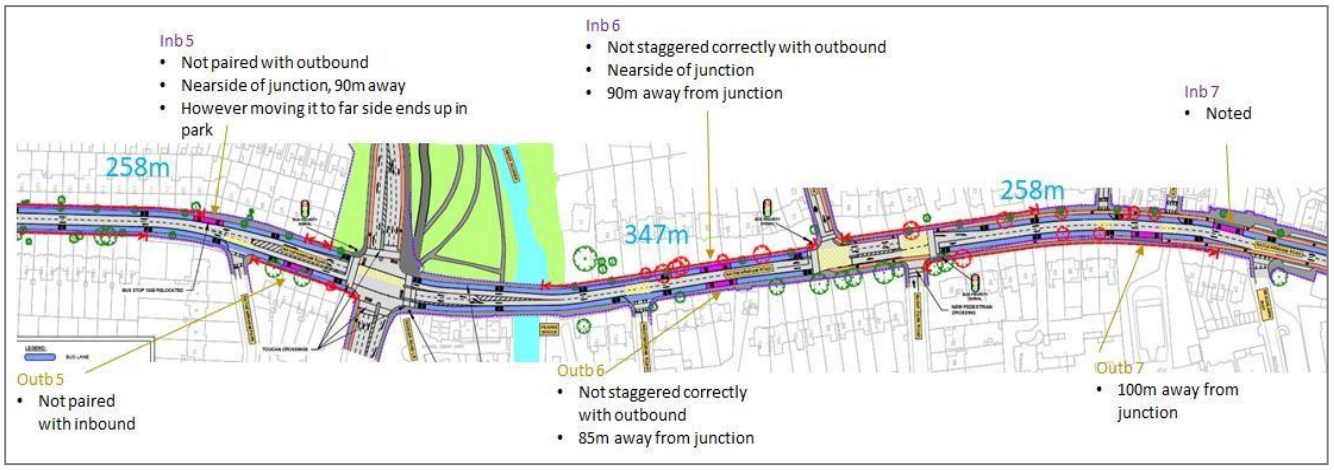


Figure 8.2 Example Review of Bus Stop Locations (Source: ARUP, Rathfarnham CBC).

This document should then be followed by a recommended bus stop strategy (Document 2) for each corridor indicating where bus stop are to be located and that all variables have been considered for each stop. This should be in a similar drawing to the review drawing in Figure 8.2, but focused on those stops that have been altered from the original PRO drawings. A summary table for each corridor should be placed on the front drawing of the recommendations summarising the existing and proposed bus stop strategy:

Corridor Name			
Number of Existing Bus Stops		**Length (KM)**	
	Existing	**Proposed**	**Comment**
Average Spacing of Bus Stops (m)			
All stops located adjacent to a controlled crossing?	Y/N	Y/N	
Have all accessibility / spatial requirements and consultation suggestion been accommodated?	-	Y/N	

Document 2 shall include a report providing specific details of each bus stop along a corridor and detailing the results of the catchment analysis for the optimised bus stops.

Revision History

Revision	Revision date	Details	Authorised	Name	Position
DRAFT 1	25 May 2020	Issued for Comment	JSY	Joe Seymour	Director
DRAFT 2	26 May 2020	Issued for Comment	JSY	Joe Seymour	Director
DRAFT 3	21 June 2020	Issued to ED's	JSY	Joe Seymour	Director