DART+ Coastal North

Public Consultation No.2

Annex 3.7: Option Selection Works around Howth Branch Level Crossings

NTA Údarás Náisiúnta Iompair National Transport Authority

Rialtas na hÉireann Government of Ireland | Tionscadal Éireann Project Ireland 2040

Iarnród Éireann Irish Rail

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ABBREVIATIONS

Abbreviation	Definition
AADT	Annual Average Daily Traffic. The total two-way traffic volume passing a point or segment of a road for one full calendar year, divided by the number of days in a year (365).
CCTV	Closed-circuit television
DART	Dublin Area Rapid Transport
EMU	Electric multiple units
IÉ	Iarnród Éireann
MCA	Multi-Criteria Analysis
MMQ	Mean maximum queue
OSI	Ordnance Survey Ireland
PCU	Passenger Car Units
TPH	Trains per hour
TPHPD	Trains per hour per direction
TSS	Train service specification
WTT	Working timetable

1. INTRODUCTION

The purpose of this report is to provide the technical input to the Preferred Option Report. This report details the assessment undertaken for impacts to the existing level crossings on the Howth Branch due to alterations to service frequency. This report builds on the work covered in the Technical Optioneering report presented in Public Consultation 1.

The report contains:

- An explanation of the impacts of the Train Service Specification on services on the Howth Branch line;
- The inputs, methodology and results for barrier opening times from a train operations perspective;
- Assessment of impacts of changed barrier opening times on vehicles;
- Assessment of impacts of changed barrier opening times on pedestrians and cyclists;
- Conclusion of the overall impact of changes to services on the Howth Branch.

1.1 Packages of work

The scope of work for DART+ Coastal North covers a wide range of interventions on the Northern Line needed in order to meet the Train Service Specification (TSS) requirements. To appropriately assess options against each other, the scope of work has been split into separate work packages, as described in the Preferred Option Report. Where appropriate, the works have then been further split down into 'sections' which define the system which has been subject to the optioneering and design process.

1.2 References

This report should be read in conjunction with the following related optioneering reports:

Table 1-1: List of key documents associated with this report

Annex	Title	Description
N/A	DART+ Coastal North Preferred Option Report	This is the main report which summarises the preferred options for the different packages on the DART+ Coastal North project.
N/A	DART+ Coastal North Preferred Option Report – Executive Summary	This report summarises the main Preferred Option Report.
1	Schematic Drawings	Schematic drawings of each preferred option, to support the Preferred Option Report.
2.1	Policy Context	This presents a detailed review of the European, National, Regional and Local policy context for the DART+ Programme and the DART+ Coastal North project.
2.2	Useful Links	Useful links to documents/websites relating to the DART+ Coastal North project.
3.1	Constraints Report	This report reviews the DART+ Coastal North constraints.

2. EXISTING SITUATION

2.1 Train operations

IÉ currently operates trains on the Howth Branch as an extension of DART services from Bray or Greystones, integrated with trains going to Malahide. Howth and Malahide-bound services split at Howth Junction & Donaghmede Station, where Howth Branch trains operate a stopping service at Sutton, Bayside, and Howth. Services average around 3 trains per hour (TPH) per direction - though on occasion IÉ schedules up to 4 TPH per direction during peak periods. Due to the interlined nature of Howth services, they are vulnerable to the import of delays from other parts of the network.

2.2 Level crossings

The Howth Branch has four level crossings:

Baldoyle Road Level Crossing (XQ001) – hereby referred to as Kilbarrack to match signal diagrams provided by IÉ, numbered 917 on signal diagrams (11 000 AADT);

- Sutton Level Crossing (XQ002) – numbered 916 on signal diagrams (12 700 AADT);
- Cosh Level Crossing (XQ003) – number 915 on signal diagrams (650 AADT);
- Claremont Level Crossing (XQ004) – numbered 913 on signal diagrams (160 AADT).

Kilbarrack Crossing (917) carries R809/Baldoyle Road over the Howth Branch, which is a critical corridor for road traffic. Sutton Crossing (916) is adjacent to Sutton Station and carries the heavily used R106/Station Road, a principal means of access for the Howth peninsula. Cosh Crossing (915) carries Lauder's Lane over the railway line, connecting one side of the Sutton Golf Club to the other. Claremont Crossing (913) allows for access to a small residential development on a private road and provides exclusive access to the area for motor vehicles. An informal path leads off to the west - connecting to Claremont Road and an overbridge over the railway to Howth Road - but is unusable other than for foot and cycle traffic. An overview of their locations on the Howth Branch is provided in Figure 2-1. Aerial views of the individual crossings are provided in the subsequent figures.

Figure 2-1 Overview of level crossing locations on the Howth Branch (Source: OSI aerial imagery)

Figure 2-2 Baldoyle Road Level Crossing (XQ001, 917) (Kilbarrack) plan view (Source: OSI aerial mapping)

Figure 2-3: Sutton Level Crossing (XQ002, 916) plan view (Source: OSI aerial mapping)

Figure 2-4 Cosh Level Crossing (XQ003, 915) plan view (Source: OSI aerial mapping)

Figure 2-5 Claremont Level Crossing (XQ004, 913) plan view (Source: OSI aerial mapping)

During normal operations the level crossings operate as part of the signalling system and are automatically lowered when a train passes a trigger point (referred to as a 'strike in point').

The level crossing boom gates are raised shortly after a train clears sensors adjacent to the level crossing. If a train in the opposing direction is scheduled to pass the level crossing shortly after a train clears it, the level crossing will stay closed until that train passes and clears the crossing as well.

All crossings are equipped with full four-quadrant boom gates, completely cutting off access to the railway when closed. All crossings are remotely observed with CCTV to ensure that the crossing is clear of traffic when the boom gates are closed. Spotlights are co-mounted with the cameras to allow all day operation.

3. RAIL SYSTEM OPTIMISATION

3.1 Train Service Specification

As part of the DART+ Coastal North project, IÉ intends to increase the number of services on the Howth Branch while also improving reliability by separating operations from the rest of the DART network. This forms part of the Train Service Specification (TSS), which is the 'desired' number of train services to have on each branch of the DART network (i.e., trains per hour per direction [TPHPD]). This report adopts version TSS 1C.

Whilst final operational decisions will be made subject to demand requirements and assessment, TSS 1C assumes Howth Branch trains will operate as a shuttle service between Howth and Howth Junction & Donaghmede stations (some through trains off-peak may be timetabled). Services in TSS 1C are assumed to change from being 3-4TPH per direction and dictated by scheduling needs in other parts of the network to being a regular service of 6 full-length trains per hour per direction, (i.e., trains departing every 10 minutes).

The changes represent a substantial increase in capacity, both in frequency and size of individual services. Additionally, as a shuttle service, Howth Branch trains will be almost fully insulated from delays on other parts of the DART and IÉ network.

Changes to the service and operating condition of the line creates the need to assess any impact on the barrier opening times and its associated effects on vehicles, pedestrians, and cyclists.

The proposed services as part of DART+ Coastal North are shown in Figure 3-1. Of note is the regularity and shuttle nature of the Howth Branch services which forms the basis of the assessment as described in this report.

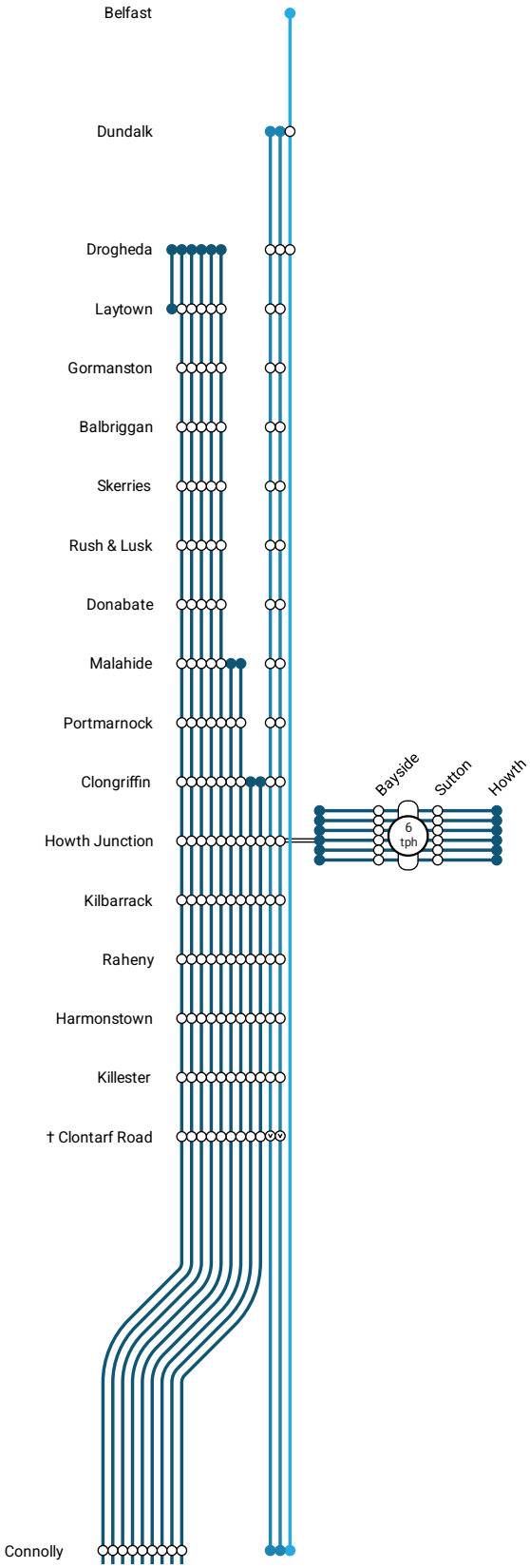

Figure 3-1 DART+ Coastal Services

3.2 Modelling Parameters

Following discussions with IÉ about the signal operations and an analysis of level crossing closure time based on control centre data collected between January 12-14, and May 1-9, 2022, it emerged that there are currently significant variations in the duration of the level crossing closure times. These are mostly due to the following three reasons:

- The timetable structure;
- Operational variance caused by train delays and different driver behaviours;
- Human interference in the signalling system by the signaller.

To create a common baseline for comparison, Arup developed four Howth Branch timetable variants in the RailSys software. The modelled closure times are based on the average value between the 5th and 95th percentile of all observed closure times and are centred around the time when the trains pass each level crossing. The level crossing closure data was calculated based on control centre data received from IÉ. An illustration of the calculation method can be seen in Figure 3-2 below.

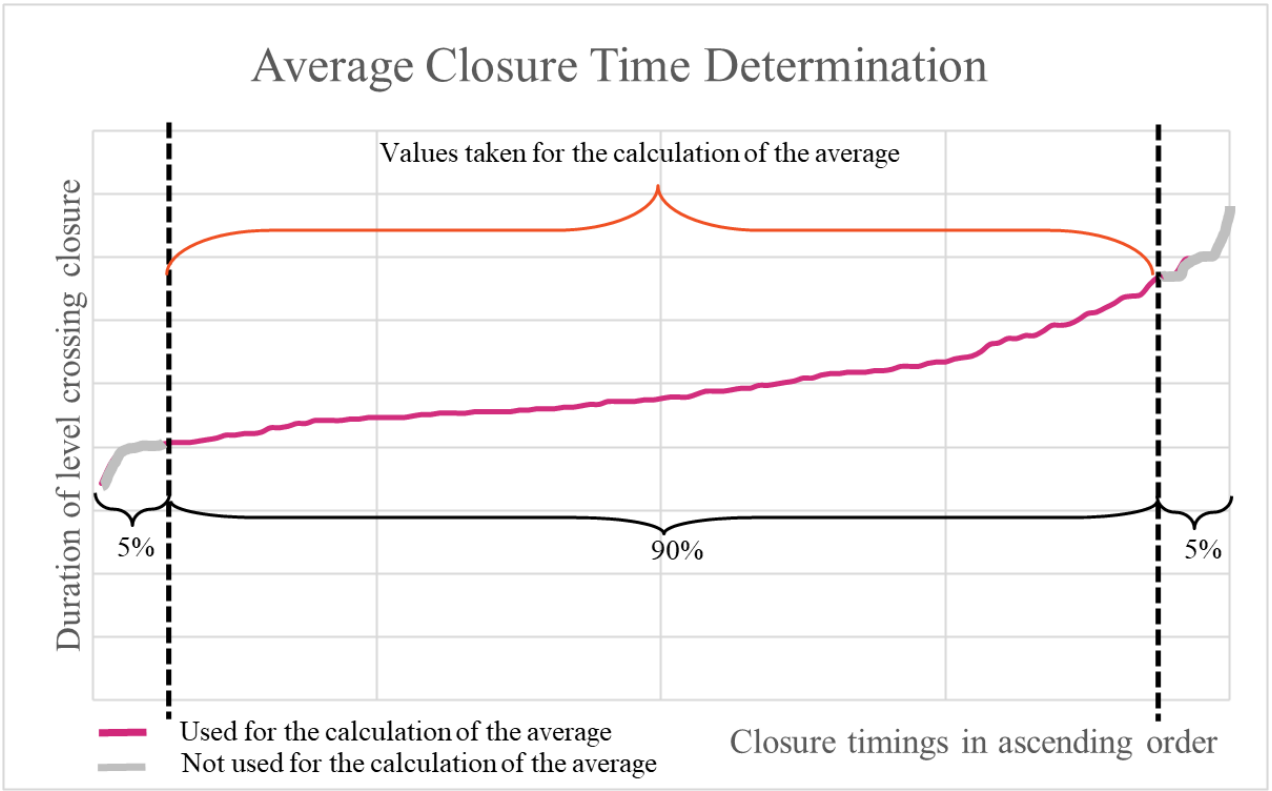

Figure 3-2 Example for the calculation of the average closure time

Arup, in agreement with IÉ, chose to exclusively model level crossing operations in their normally operated method, not including modelling non-standard scenarios such as non-stop trains or during perturbed operations. As such, trains in the current timetable are assumed to be DART EMU (Electric Multiple Unit) trainsets, and trains in the future scenario timetables are assumed to be XTRAPOLIS rolling stock as per agreement with IÉ.

A total journey time of 9 minutes has been assumed in both directions between Howth and Howth Junction & Donaghmede Stations, including a stop with 30 seconds dwell time at Bayside and Sutton Stations for all services. The journey time between Howth and Howth Junction & Donaghmede Stations remains as it is currently at 9 minutes.

The journey time between Howth Junction & Donaghmede and Howth Stations, however, is reduced from the existing duration of 11 minutes to 9 minutes. This is due to the proposed shuttle services being separated from the main line services, meaning delay cannot be passed on from the main line and does not have to be accounted for to the same extent as is currently the case in the service regulation. Currently services travelling away from Dublin allow for approximately an extra 2 minutes over the journey between Howth Junction & Donaghmede Station to Howth Station as an allowance to make up lost time as a result of delays on the busier areas of the network. This is removed in TSS1C as the shuttle service removes the risk of the delays.

The modelling assumes that all level crossings are automatic and require safe closure before the signals can be set for the approaching train. Between barrier closures, the road will need to be open for a minimum of 20 seconds, otherwise the barriers will remain down, and the crossing closed. The crossing is assumed to begin to open once the train passes a clearance point - assumed to be 10m off of the level crossing, and the barriers are assumed to take 8 seconds to open.

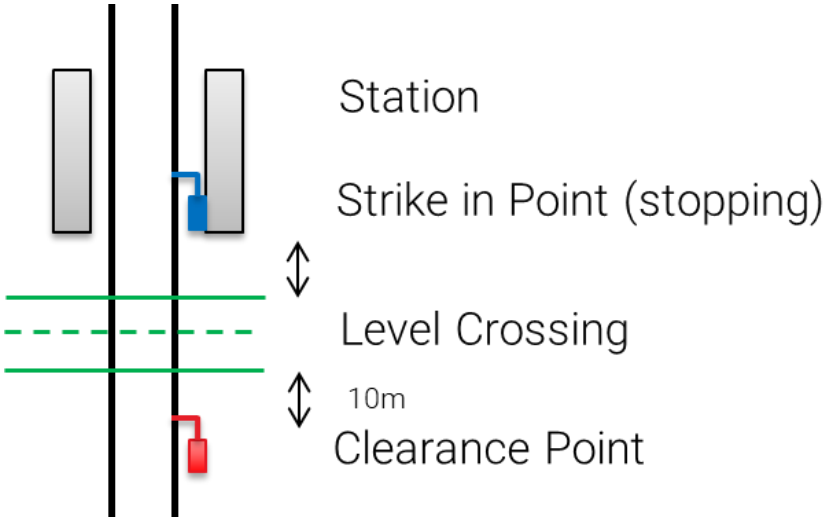

Figure 3-3 Example schematic for strike in and clearance points

Modelling has been undertaken with the following three objectives:

- To calibrate and validate the closure behaviour of the existing 3TPH Working Timetable, to use as a baseline assumption for future scenarios;
- To examine the impact of an increase in train frequency for 4, 5 and 6 TPH;
- To examine the sensitivity of level crossing closure times dependent on the timetable structure and/or performance of the 6 TPH TSS1C timetable.

Modelling covers the following 13 service variations per direction:

- 3 TPH (Reflects Working Timetable – i.e. the Baseline Scenario) – through services;
- 4 TPH (regular intervals) – shuttle services;
- 5 TPH (regular intervals) – shuttle services;
- 6 TPH (regular intervals, reflects TSS 1C) – shuttle services (Base Scenario);
- 6 TPH with 1-minute offset– shuttle services;
- 6TPH with 2-minute offset– shuttle services;
- 6TPH with 3-minute offset– shuttle services;
- 6TPH with 4-minute offset– shuttle services;
- 6TPH with 5-minute offset– shuttle services;
- 6TPH with 6-minute offset– shuttle services;
- 6TPH with 7-minute offset– shuttle services;
- 6TPH with 8-minute offset– shuttle services;
- 6TPH with 9-minute offset– shuttle services.

All offset scenarios are based on the 6 TPH TSS1C, with all down direction trains offset by a period of time. Offsets are continued up to + 9min, with a +10min offset being the point at which a regular 6 TPH per direction service will bring the timetable back to the original 0 min offset.

Since TSS1C is not necessarily the exact train timing to which trains will operate following implementation of the DART+ Programme, and as train services can be subject to delays, this serves as a sensitivity check to evaluate how differently the level crossings will behave if services are more synchronized or less synchronized.

3.3 Barrier Results

Arup modelled the level crossing closure times for the entire Howth Branch for 13 different service variations. Summary results from the existing case - which is the current 3 TPH working timetable where services operate as through-services - and the 6TPH TSS1C timetable (Base Scenario) - where services operate as shuttle services - are listed below in Table 3-1. Note that the results represent an average likelihood and not the rare occasion of a major incident or other irregular events.

TSS1C is the main service scenario, assuming trains will leave regularly every 10 minutes, with services departing from Howth Junction & Donaghmede Station and services departing Howth Station separated by ten minutes.

The level crossing closures are highly sensitive to the exact meeting point of trains in any given scenario; having trains cross simultaneously is the best case, as it allows two trains to pass for one closure. By contrast, the worst scenario would be two trains separated by 20 seconds or less, meaning that the level crossing will be held down for the maximum amount of time.

To test the effect of differing meeting points - stemming from different service patterns - scenarios offsetting the departure time of down trains by 1 to 10 minutes were run. Since the level crossing closure times depend on the relative meeting point between down and up services, it is only necessary to offset trains in one direction. Offsets were continued up to + 9 minutes, after which a +10-minute offset for a regular 6 TPH per direction service will bring the timetable back to its starting point.

The results in Table 3-2 shows the variation in opening times for the scenarios above. The variation is predominantly caused by the changing in train meeting points relative to the crossing locations.

This table also demonstrates that the Base Scenario is optimising level crossing opening durations around Sutton Level Crossing. In all modelled scenarios there will only be one set of trains per direction passing each other at the same time, and therefore the closure times can only be optimised for one crossing - in most cases at the detriment of the others.

Table 3-1 Level Crossing Open Time Results – Average open time and total open time in any given hour for 6 TPH (Base Scenario)

	Claremont (913)	Cosh (915)	Sutton (916)	Kilbarrack (917) (Baldoyle Road)
Proposed TSS1c (shuttle service) Base Scenario	- 12 Openings -Average opening duration: 2m:22s -Sum of average opening times per hour: 28m:26s	-6 Openings -Average opening duration: 4m:59s -Sum of average opening times per hour: 29m:56s	-6 Openings -Average opening duration: 7m:49s -Sum of average opening times per hour: 46m:54s	- 6 Openings -Average opening duration: 5m:10s -Sum of average opening times per hour: 31m:01s
Existing 3 TPH per direction (WTT) (through service)	-6 Openings -Average opening duration: 7m:17s -Sum of average opening times per hour: 42m:36s	-3 Openings -Average opening duration: 16m:17s -Sum of average opening times per hour: 46m:12s	-3 Openings -Average opening duration: 16m:37s -Sum of average opening times per hour: 48m:39s	-5 Openings -Average opening duration: 08m:48s -Sum of average opening times per hour: 44m:24s

Table 3-2 Level Crossing Open Time Results – Range of open time and closure times in any given hour for 6 TPH for varying train timing scenarios

	3 TPH WTT (Existing)	Base Scenario	Scenarios offsetting the departure time of down trains by 1 to 9 minutes								
Level Crossing		00:00	00:00+1 min	00:00+2 mins	00:00+3 mins	00:00+4 mins	00:00+5 mins	00:00+6 mins	00:00+7 mins	00:00+8 mins	00:00+9 mins
Claremont Level Crossing											
Open (%)	73%	47%	48%	56%	66%	71%	62%	52%	47%	47%	47%
Average opening times (mm:ss)	07:17	02:22	03:11	05:35	06:35	07:09	06:09	05:09	02:22	02:22	02:22
Average closure times (mm:ss)	02:38	02:38	03:29	04:25	03:25	02:51	03:51	04:51	02:38	02:38	02:38
Number of closure times	6	12	9	6	6	6	6	6	12	12	12
Cosh Level Crossing											
Open (%)	81%	50%	50%	50%	50%	50%	50%	60%	70%	70%	60%
Average opening times (mm:ss)	16:17	04:59	02:22	02:27	02:33	02:38	05:00	06:00	07:00	06:59	05:59
Average closure times (mm:ss)	3:44	05:01	02:30	02:30	02:30	02:30	05:00	04:00	03:00	03:01	04:01
Number of closure times	3	6	12	12	12	12	6	6	6	6	6
Sutton Level Crossing											
Open (%)	81%	78%	59%	49%	47%	47%	47%	47%	48%	58%	68%
Average opening times (mm:ss)	16:37	07:49	05:56	04:56	02:14	02:19	02:25	02:22	04:49	05:49	06:49
Average closure times (mm:ss)	03:43	02:11	04:04	05:04	02:38	02:38	02:38	02:38	05:11	04:11	03:11
Number of closure times	3	6	6	6	12	12	12	12	6	6	6
Kilbarrack Level Crossing											
Open (%)	74%	52%	62%	79%	69%	59%	49%	50%	50%	50%	50%
Average opening times (mm:ss)	08:48	05:10	06:10	07:52	06:52	05:52	04:52	02:24	02:31	02:31	02:31
Average closure times (mm:ss)	02:54	04:50	03:50	02:08	03:08	04:08	05:08	02:29	02:29	02:29	02:29
Number of closure times per hour	5	6	6	6	6	6	6	12	12	12	12

To test the impact of an increase in train frequency to 4 and 5 TPHPD, estimates for the average sum of minutes of open time have been calculated for each respective frequency on a clockface pattern. The values presented below are subject to change with a change of departure time. The model results for these can be observed in the table below. These have only been modelled to test the sensitivity of increasing train frequencies. No transport assessment has therefore been undertaken for these options. It should be noted that in each respective timetable, trains in each direction start on the hour in these instances.

Table 3-3 Level Crossing Open Time Results – range of open time and total open time in any given hour for 4 and 5 TPH

	Claremont (913)	Cosh (915)	Sutton (916)	Kilbarrack (917) (Baldoyle Road)
5 TPH per direction (shuttle service) Base Scenario	- 10 Openings -Average opening duration: 3m:22s -Sum of average opening times per hour: 33m:40s	- 5 Openings -Average opening duration: 7m:00s -Sum of average opening times per hour: 35m:00s	- 5 Openings -Average opening duration: 9m:49s -Sum of average opening times per hour: 49m:05s	- 5 Openings -Average opening duration: 7m:10s -Sum of average opening times per hour: 35m:50s
4 TPH per direction (through service) Base Scenario	- 8 Openings -Average opening duration: 4m:52s -Sum of average opening times per hour: 44m:24s	- 4 Openings -Average opening duration: 10m:00s -Sum of average opening times per hour: 40m:00s	- 4 Openings -Average opening duration: 12m:49s -Sum of average opening times per hour: 51m:16s	- 4 Openings -Average opening duration: 10m:10s -Sum of average opening times per hour: 40m:40s

4. ASSESSMENT OF PROPOSAL ON VEHICLES ON THE ROAD NETWORK

In this section of the report the effect of the Howth Branch of the DART line and the level crossings on the surrounding road network has been investigated, looking specifically at the queueing at level crossings and nearby junctions during barrier closure times. A baseline DART service of 3 trains per hour per direction (3TPH), based on the modelled 3TPH per direction barrier timings and level crossing closures during the AM peak has been modelled using the junction modelling software, LinSig[1]. This has been compared to the proposed 6 trains per hour per direction Base Scenario. A sensitivity analysis has also been carried out to understand the impact of queueing on the road network on variations from the baseline 6TPH TSS1C timetable (which also simulates train delays).

4.1 Background Information

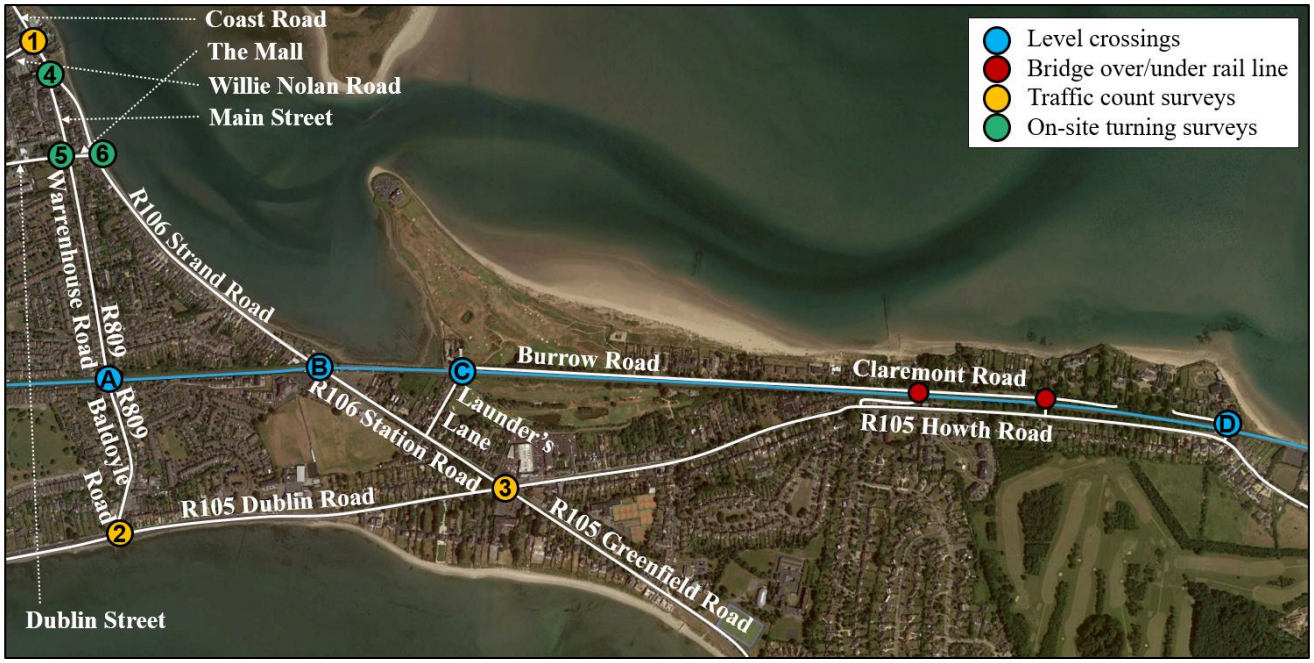

Figure 4-1 Overview of the area of interest along the Howth Branch

4.1.1 Level Crossings

There are four level crossings situated along the Howth Branch, shown in blue in Figure 4-1. They are as follows:

- 917: Kilbarrack Level Crossing (XQ001) (Baldoyle Road) – Rail line across the Baldoyle Road/ Warrenhouse Road;

[1] LinSig is an industry standard software tool which allows traffic engineers to model traffic signals and their effect on traffic capacities and queuing

- 916: Sutton Level Crossing (XQ002) – Rail line across Station Road, adjacent to Sutton Station;
- 915: Cosh Level Crossing (XQ003) – Rail line across Lauder's Lane;
- 913: Claremont Level Crossing (XQ004) - Rail line across a Private Access Road.

The level of traffic passing through each of the level crossing varies.

Kilbarrack (917) and Sutton (916) Level Crossings are the two that have the highest volumes of vehicles crossing them and have the greatest potential to cause delays on the wider network if queues form at the level crossings. As a result, these have been analysed using modelling software and quantitative methods.

Cosh (915) and Claremont (913) Level Crossings have a much lower level of vehicle traffic crossing them as they are mainly only used for local access, and they do not run the risk of causing long queues. For these, qualitative analysis methods have been applied.

More information on the assessment methodology and rationale is provided in Section 4.2.

4.1.2 Existing Barrier Closure Timings

The Howth Branch operates as a through service, with alternating trains from Dublin serving Howth and Malahide. Three to four trains per hour travel in each direction along this line equalling a maximum of eight trains in total, per hour.

Iarnród Éireann (IE) has provided data on a working timetable (WTT). With this data a timetable for 3TPH per hour per direction, based on the WTT, was modelled in RailSys. The RailSys model was calibrated using closure data from across the day and validated between the hours of 07:30 and 10:30. The output of the RailSys model has been used to calculate the closure timings and represents the baseline vehicular impact scenario for comparison purposes. This is detailed further in section 4.2.2.

4.1.3 Traffic Data

Traffic data is required to undertake the assessment and understand the impact on vehicles and queueing in the surrounding area. Traffic data surveys were carried out on Tuesday 24th May 2022. These included classified vehicle junction turning count surveys over a 14-hour time period between 0600 and 2000 at the junctions within the study area and also at the level crossings within the study area. The data also included queue length surveys and pedestrian count surveys. The AM Peak Hour was determined to occur between 0800 and 0900 and the PM Peak Hour between 1730 and 1830 (refer to Annexure A). These are the busiest periods on the road network and the impact of the proposed level crossing closures were therefore assessed for these time periods.

Historical traffic data (2018/2019) was available at some of the junctions adjacent to the Kilbarrack and Sutton Level Crossings.

A comparison of the most recent traffic data (2022) and the historic traffic data (2018/2019) has shown that traffic levels have, to a large extent, returned to pre-Covid levels in the study area. This is partly due to the constrained nature of the overall road network. Bottlenecks further upstream would only allow a certain volume of traffic to be able to reach the level crossings under normal circumstances. The most recent 2022 traffic count data was therefore considered a suitable data source for the assessment.

Table 4-1 Impact of Covid on traffic volumes

Impact of Covid		AM Peak Hour			PM Peak Hour		
		2018/2019	2022	Diff	2018/2019	2022	Diff
Kilbarrack	NB	302	303	0%	439	438	0%
	SB	508	503	-1%	342	334	-2%
Sutton	NB	360	385	7%	379	379	0%
	SB	436	543	24%	365	420	15%

4.2 Assessment Methodology

4.2.1 Approach

Two methodologies of analysis have been used as part of this assessment. Kilbarrack (917) and Sutton (916) Level Crossings have been analysed through quantitative methods, and Cosh (915) and Claremont (913) Level Crossings have been assessed using qualitative analysis methods. Cosh and Claremont Level Crossings have a much lower volume of traffic crossing them as they are mostly used for local access and therefore do not run a high risk of causing queuing that will affect the regional road network (refer to Figure 4-2).

The need for quantitative analysis at Kilbarrack (917) and Sutton (916) Level Crossing is driven by the high volume of vehicles using the crossings and the potential to, during barrier closure times, cause queuing and delays on the regional road network. Queuing could also be impacted at the junctions upstream and downstream from the level crossings.

Even though some localised impact on queuing is expected, for the purpose of this assessment it was assumed that there would be no significant impact on trip distribution (i.e., diversion of traffic), mode choice (i.e. reduction of vehicle traffic) or route choice (i.e. large scale switch between Sutton and Kilbarrack) are expected as a result of the changes to level crossing closures. The approach in assessing potential queueing was therefore robust in the sense that it was assumed that the same volume of traffic that currently arrives at the level crossings would continue to arrive in future.

The expected impact as a result of the overall scheme and the proposed DART+ Programme increase in service frequency and capacity will be assessed as part of the Environmental Impact Assessment.

The traffic assessment as part of this will confirm the degree to which car demand at the level crossings might change in future due to changes in trip distribution, mode choice or route choice. Deterministic modelling techniques (through the application of Linsig) are particularly suitable for assessing potential queueing as it allows the optimisation of signal timings and is a quick and easy tool with immediate results and ideal for optioneering. This technique does not focus on modelling different modes of transport or the wider traffic assignment, which would normally be addressed by microsimulation or tactical / strategic modelling techniques (for example through the application of Vissim or Saturn). Microsimulation or tactical / strategic modelling techniques are time consuming and require large amounts of data. The NTA's tactical / strategic Regional Modelling System (RMS) will be applied at EIA stage to assess different modes and the wider traffic assignment and the impact on car demand at the level crossings.

The level crossing closure times were simulated in a LinSig network model as signalised junctions which, in effect, represents the barriers being closed. This allowed for an understanding of the mean maximum queue (MMQ) that builds up at both the level crossings and the junctions upstream and downstream of the level crossings.

The following extract from the Linsig software manual further explains the Mean Maximum Queue: "It is the sum of the Maximum Back of Uniform Queue and the Random & Oversaturation Queue. It represents the maximum queue within a typical cycle averaged over all the cycles within the modelled time period. When a Lane is oversaturated the Maximum Queue within each cycle will grow progressively over the modelled time period. This means that the Mean Maximum Queue will be approximately half the final queue at the end of the modelled time period."

If the approaching arms to the level crossing or a junction do not have a degree of saturation exceeding 100%, the MMQ is likely to be reflective of what would happen on the ground. It will be longer 50% of the time and shorter 50% of the time, but it is likely to remain within the available queueing capacity (assuming a uniform arrival pattern). Should the arrival pattern change to a more concentrated pattern / platoon, queues may be longer. To mitigate against this risk, we highlighted any issues where queues exceed 75% of the available capacity.

The offset for the signal timings for the junctions upstream and downstream of the level crossings were set to be optimised in the LinSig simulation in the existing and proposed scenarios in order to allow them to sync up with the opening and closing times of the level crossings.

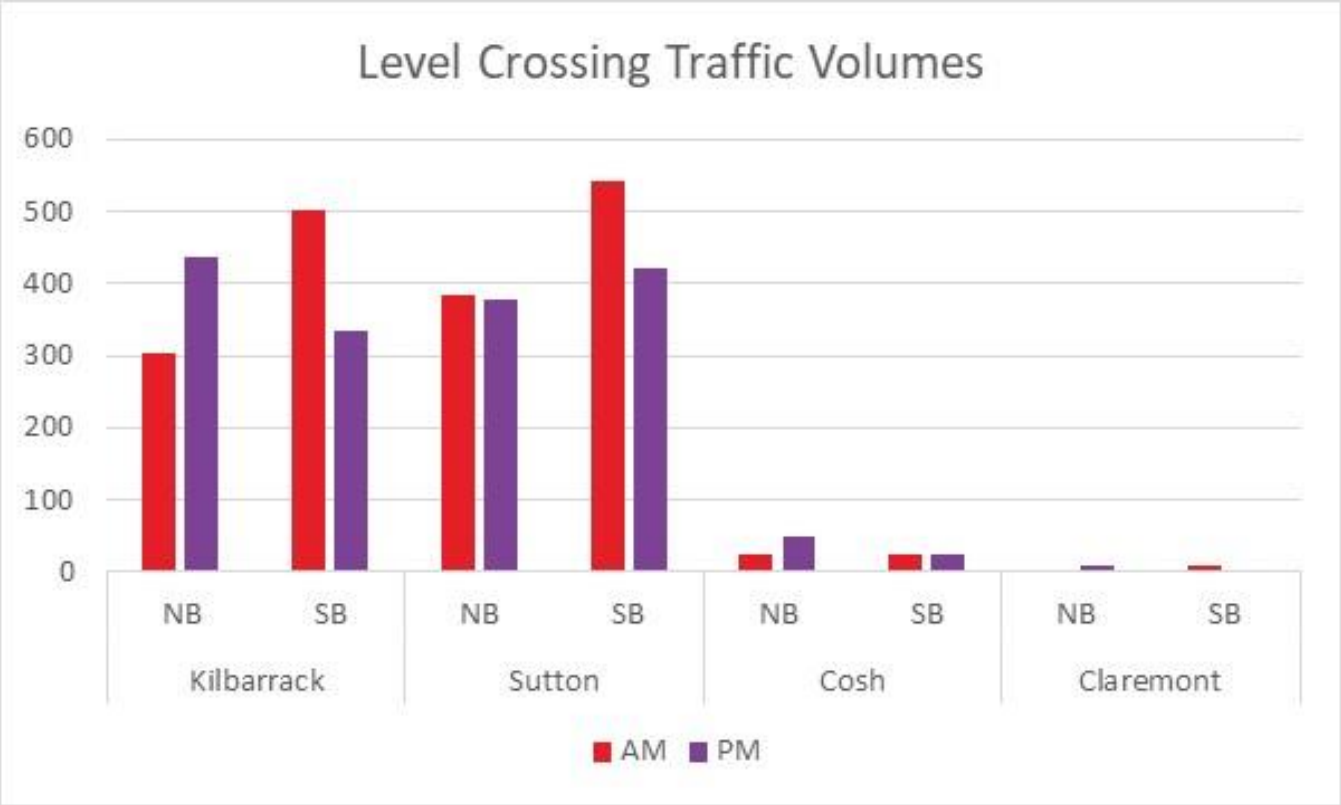

Figure 4-2 Level Crossing Traffic Volumes

4.2.2 Existing Modelled vs Existing Observed

Queue lengths are generally not used for validation purposes due to the difficulty in measuring them on the street; however, comparing modelled levels of queuing to those observed on the street can indicate where inaccuracies may exist in a model.

Queue length surveys were carried out and were compared to the modelled queue length outputs from the Linsig model to provide some confidence in the process and to illustrate that the model is a suitable tool for this type of assessment within a known margin of error.

In Table 4-3 the modelled and observed queue lengths as a result of the "observed level crossing signals" are presented. The observed level crossing times were as shown in Table 4-2:

Table 4-2 Observed Level Crossing Closure Times

Baseline 3TPH per direction	Peak Hour	Number of closures per hour	Total baseline closure time per hour	Minimum baseline closure time	Maximum baseline closure time
Kilbarrack (917) Level Crossing	0800-0900	4	00:15:20	00:02:25	00:05:17
	1730-1830	3	00:12:56	00:04:05	00:04:20
Sutton (916) Level Crossing	0800-0900	3	00:14:54	00:04:06	00:05:52
	1730-1830	4	00:16:32	00:02:40	00:05:38

From the observed data the average queue lengths and the longest queue lengths on the approaches to the level crossings were recorded. It was found that in some cases the queue lengths, expressed in Passenger Car Units (PCUs) from the model, were slightly over estimated. This was deemed acceptable as it presented a robust assessment of the potential queueing that can be expected. It was concluded that queue length outputs from the LinSig model are representative of observed queue lengths and the tool is therefore suitable.

Table 4-3 Kilbarrack (917) Existing Modelled Queue Lengths vs Observed Queue Lengths

Queue Lengths (PCUs)	Observed		Modelled MMQ	Comment
AM Peak	Average	Longest		
Kilbarrack (917) Level Crossing SB	17	29	50	Model overestimates queue
Kilbarrack (917) Level Crossing NB	11	32	29	Model within range
Queue Lengths (PCUs)	**Observed**		**Modelled MMQ**	**Comment**
PM Peak	**Average**	**Longest**		
Kilbarrack (917) Level Crossing SB	11	35	32	Model within range

Kilbarrack (917) Level Crossing NB	8	31	45	Model overestimates queue

Table 4-4 Sutton (916) Modelled Queue Lengths vs Observed Queue Lengths

Queue Lengths (PCUs)	Observed		Modelled	Comment
AM Peak	Average	Highest		
Sutton (916) Level Crossing SB	32	73	59	Model within range
Sutton (916) Level Crossing NB	19	66	58	Model within range
Queue Lengths (PCUs)	Observed		Modelled	Comment
PM Peak	Average	Highest		
Sutton (916) Level Crossing SB	17	55	50	Model within range
Sutton (916) Level Crossing NB	16	52	39	Model within range

4.2.3 Existing 3TPH Per Direction – Kilbarrack (917) and Sutton (916) Level Crossings

The existing scenario of 3TPH per direction travel has been modelled during the AM peak using the level crossing closure time data for the RailSys model, as shown in Table 4-5.

During the AM peak hour Kilbarrack (917) Level Crossing closes five times per hour and Sutton (916) Level Crossing closes three times per hour, with three trains per hour per direction passing through each one. Table 4-5 shows the closure times across the full one-hour period summarised from Table 3-2.

Table 4-5 Existing Level Crossing Closure Times for 3TPH per direction

Baseline 3TPH per direction	Number of closures per hour	%Closed	Average Closure time (mm:ss)
Kilbarrack (917) Level Crossing	5	26%	02:54
Sutton (916) Level Crossing	3	19%	03:43

4.2.4 Proposed 6TPH Per Direction– Kilbarrack (917) and Sutton (916) Level Crossings

The proposed current scheme is described in detail in section 0.

Under the 6TPH TSS1C scenario, the Howth Branch will run as a shuttle service. Six trains per hour per direction will pass through each of the level crossings, equating to a total of 12 trains passing per hour.

The proposed opening and closure times of the level crossing barriers are calculated based on outputs from the RailSys model, as provided in section 0. With six trains per direction, this in effect means a train departs each end station every 10 minutes. The Base Scenario values have been used in the traffic assessment. The relevant data from Table 3-2 has been summarised below on Table 4-6.

Table 4-6 Values used in Traffic Assessment

Proposed 6TPH TSS1C	Number of Closures per hour	Average Closure Time (mm:ss)
Kilbarrack (917) Level Crossing	6	04:50
Sutton (916) Level Crossing	6	02:11

The signal timings for the junctions upstream and downstream of the level crossings were set to be optimised in the LinSig simulation to allow them to coordinate with the opening and closing times of the level crossings. These junctions are labelled 1, 2, 3, 4, 5 and 6 in Figure 4-3 onwards.

4.3 Modelling Results - Kilbarrack (917) Level Crossing and Dublin Road/Baldoyle Road Junction (XQ001)

4.3.1 Existing 3TPH Per Direction – AM Peak Hour

Surveys have shown 303 vehicles travelling northbound and 503 travelling southbound across the railway line between 08:00 and 09:00 at Kilbarrack Level Crossing.

In the Existing Scenario of 3TPH, Kilbarrack (917) Level Crossing (point A) produces a MMQ of 204 metres at the level crossing in the southbound direction, equating to 37% of the possible capacity of the link.

The northbound MMQ at the level crossing is 114 metres and takes up 33% of the available space.

The southbound arm of the Dublin Road/Baldoyle Road Junction has a MMQ of 102 meters that takes up 29% of the available space (Junction 2).

The northbound arm of the Warrenhouse Road/Dublin Street Junction has an MMQ of 48 metres that takes up 9% of the available space (Junction 5).

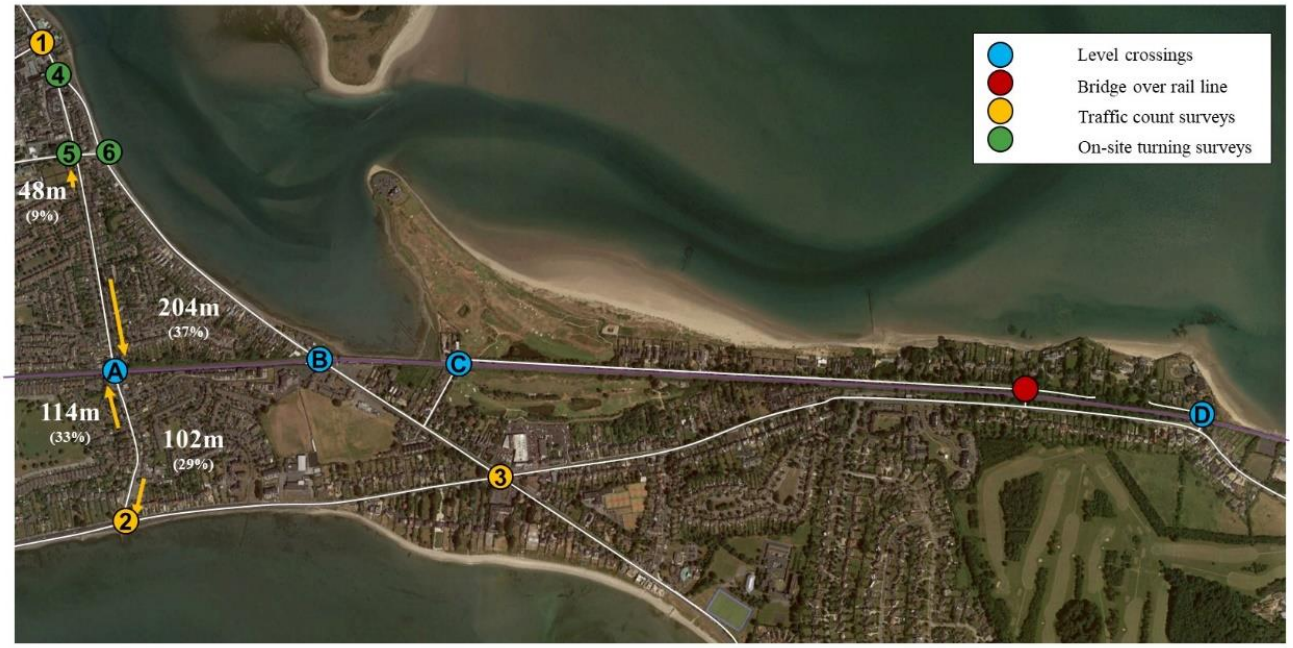

Figure 4-3 Existing 3TPH Per Direction MMQ Results – AM Peak

The modelled queue lengths in the subsequent tables for the 3TPH signals will not correspond exactly to the observed queue lengths in Table 4-3. The observed scenario is based on real world events where train timing irregularities exist, and the 3TPH scenarios are based on a regular timetable.

Table 4-7 Existing 3TPH Per Direction MMQ Results – AM Peak

Baseline 3TPH	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Kilbarrack (917) Level Crossing SB	550m	413m	34	204m	49%
Kilbarrack (917) Level Crossing NB	350m	263m	19	114m	43%
Dublin Road/ Baldoyle Road Junction SB Arm	350m	263m	17	102m	39%
Warrenhouse Road Junction NB Arm	550m	413m	8	48m	12%

These results show that in the existing scenario all queues are within the available capacity assuming the 3TPH timetable and assuming only 75% of the link length would be available in case of a more concentrated arrival pattern.

4.3.2 Proposed 6TPH Per Direction – AM Peak Hour

Under the proposed 6TPH TSS1C scenario Kilbarrack (917) Level Crossing (point A) produces a MMQ of 324 metres at the level crossing in the southbound direction, equating to 59% of the possible capacity of the link.

The northbound MMQ at the level crossing is 180 metres and only take up 51% of the available space on this link.

The southbound arm of the Dublin Road/Baldoyle Road Junction has a MMQ of 102 meters (29% of capacity) (Junction 2).

The northbound arm of the Warrenhouse Road/Dublin Street Junction has an MMQ of 48 metres that takes up 9% of the available space (Junction 5).

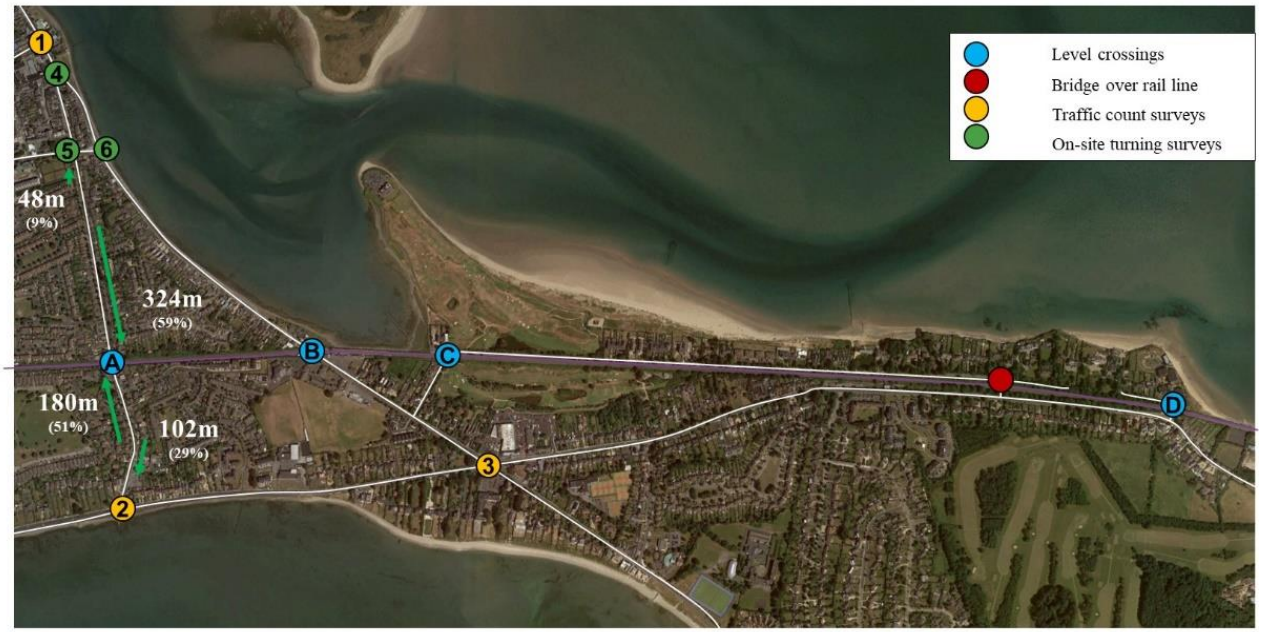

Figure 4-4 Proposed 6TPH Per Direction MMQ Results – AM Peak

Table 4-8 Proposed 6TPH Per Direction MMQ Results – AM Peak

Proposed 6TPH TSS1C	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Kilbarrack (917) Level Crossing SB	550m	413m	54	324m	79%
Kilbarrack (917) Level Crossing NB	350m	263m	30	180m	69%
Dublin Road/ Baldoyle Road Junction SB Arm	350m	263m	17	102m	39%
Warrenhouse Road Junction NB Arm	550m	413m	8	48m	12%

These results show that in the Baseline Scenario all queues are within the available capacity assuming the 6TPH TSS 1C timetable and assuming only 75% of the link length would be available, in case of a more concentrated arrival pattern.

4.3.3 Existing 3TPH Per Direction – PM Peak Hour

Surveys have shown 438 vehicles travelling northbound and 334 travelling southbound across the rail line between 17:30 and 18:30 at Kilbarrack Level Crossing.

In the existing scenario of 3TPH, Kilbarrack (917) Level Crossing (point A) produces a MMQ of 132 metres at the level crossing in the southbound direction, equating to 24% of the possible capacity of the link.

The northbound MMQ at the level crossing is 192 metres and takes up 55% of the available space.

The southbound arm of the Dublin Road/Baldoyle Road Junction has a MMQ of 72 metres that takes up 21% of the available space (Junction 2).

The northbound arm of the Warrenhouse Road/Dublin Street Junction has an MMQ of 84 metres that takes up 15% of the available space (Junction 5).

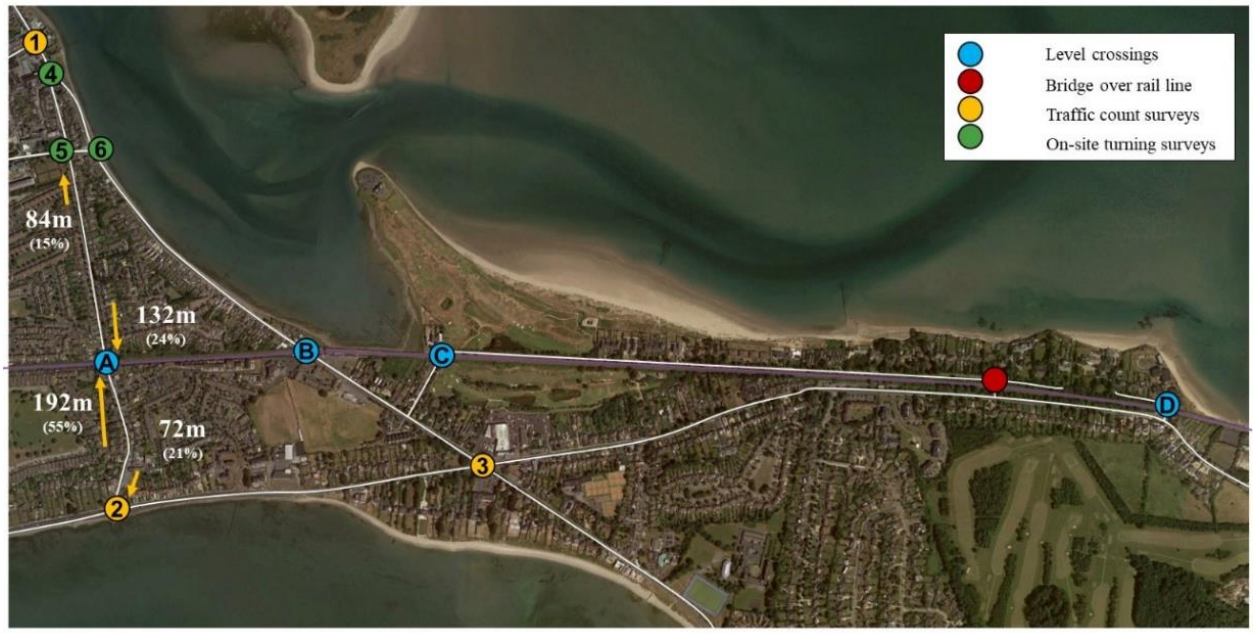

Figure 4-5 Existing 3TPH Per Direction MMQ Results – PM Peak

The modelled queue lengths in the subsequent tables for the 3TPH signals will not correspond exactly to the observed queue lengths in Table 4-3. The observed scenario is based on real world events where train timing irregularities exist and the 3TPH scenarios are based on a regular timetable.

Table 4-9 Existing 3TPH Per Direction MMQ Results – PM Peak

Baseline 3TPH	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Kilbarrack (917) Level Crossing SB	550m	413m	22	132m	32%
Kilbarrack (917) Level Crossing NB	350m	263m	32	192m	73%
Dublin Road/ Baldoyle Road Junction SB Arm	350m	263m	12	72m	27%
Warrenhouse Road Junction NB Arm	550m	413m	14	84m	20%

These results show that in the Baseline Scenario all queues are within the available capacity assuming the 3TPH timetable and assuming only 75% of the link length would be available, in case of a more concentrated arrival pattern.

4.3.4 Proposed 6TPH Per Direction – PM Peak Hour

Under the proposed 6TPH TSS1C scenario Kilbarrack (917) Level Crossing (point A) produces a MMQ of 210 metres at the level crossing in the southbound direction, equating to 38% of the possible capacity of the link.

The northbound MMQ at the level crossing is 306 metres and takes up 87% of the available space on this link.

The southbound arm of the Dublin Road/Baldoyle Road Junction has a MMQ of 72 metres (21% of capacity) (Junction 2).

The northbound arm of the Warrenhouse Road/Dublin Street Junction has an MMQ of 84 metres that takes up 15% of the available space (Junction 5).

Figure 4-6 Proposed 6TPH Per Direction MMQ Results – PM Peak

Table 4-10 Proposed 6TPH Per Direction MMQ Results – PM Peak

Proposed 6TPH TSS1C	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Kilbarrack (917) Level Crossing SB	550m	413m	35	210m	51%
Kilbarrack (917) Level Crossing NB	350m	263m	51	306m	117%
Dublin Road/ Baldoyle Road Junction SB Arm	350m	263m	12	72m	27%
Warrenhouse Road Junction NB Arm	550m	413m	14	84m	20%

These results show that in the Baseline Scenario most queues are within the available capacity assuming the 6TPH TSS 1C timetable and assuming only 75% of the link length would be available, in case of a more concentrated arrival pattern.

Reaching 117% of the available space at Kilbarrack northbound arm in the PM peak means that it is likely that the queue will block back beyond the available space regularly. However, it was noted that the baseline model overestimates queues at this location, so in practice this might not be a regular problem.

4.3.5 Comparison

Queuing depends on two factors – the duration of the closure and the frequency of the closure. An increase in frequency of the closure will not necessarily result in an increase in queueing as the duration of these closures may be shorter and therefore will prevent long queues to form.

Level crossing closures at Kilbarrack (917) Level Crossing will increase from approximately 5 times per hour to 6 times per hour in the proposed Base Scenario. The duration of these closures will also increase by about 2 minutes in the Base Scenario to varying degrees, depending on the operational timetable. These results are shown in Table 3-2.

Comparing the mean maximum queue lengths at Kilbarrack (917) Level Crossing and at the Dublin Road/Baldoyle Road Junction, the proposed scenario of 6TPH per direction shows an increase in most queues; however, all mostly remain within the available queueing capacity. Queues may occasionally block back along the Kilbarrack northbound arm in the PM peak towards the Baldoyle Road & Dublin Road junction.

The closure impacts are highly sensitive to the timetable and crossing points of trains.

As can be seen, however, from Table 3-2 - in other timetable scenarios the 6TPH service can result in 12 closures per hour at Kilbarrack (917) Level Crossing but with average closure times less than that of the existing 3 TPH service.

Figure 4-7 Comparison – Kilbarrack (917) Level Crossing and Dublin Road/Baldoyle Road Junction SB Arm Queue Length Modelling Results – AM Peak

Figure 4-8 Comparison – Kilbarrack (917) Level Crossing and Dublin Road/Baldoyle Road Junction SB Arm Queue Length Modelling Results – PM Peak

Table 4-11 Comparison – Kilbarrack (917) Level Crossing and Dublin Road/Baldoyle Road Junction SB Arm Queue Length Modelling Results – AM Peak

Location	Baseline MMQ Duration: 00:02:54 Frequency: 5 times / hour	Proposed MMQ Duration: 00:04:50 Frequency: 6 times / hour	% Change in Queue Length
Kilbarrack (917) Level Crossing SB	204m	324m	+59%
Kilbarrack (917) Level Crossing NB	114m	180m	+58%
Dublin Road/ Baldoyle Road Junction SB Arm	102m	102m	0%
Warrenhouse Road Junction NB Arm	48m	48m	0%

Table 4-12 Comparison – Kilbarrack (917) Level Crossing and Dublin Road/Baldoyle Road Junction SB Arm Queue Length Modelling Results – PM Peak

Location	Baseline MMQ Duration: 00:02:54 Frequency: 5 times / hour	Proposed MMQ Duration: 00:04:50 Frequency: 6 times / hour	% Change in Queue Length
Kilbarrack (917) Level Crossing SB	132m	210m	+59%
Kilbarrack (917) Level Crossing NB	192m	306m	+59%
Dublin Road/ Baldoyle Road Junction SB Arm	72m	72m	0%
Warrenhouse Road Junction NB Arm	84m	84m	0%

4.4 Modelling Results - Sutton (916) Level Crossing and Sutton Cross Junction (XQ002)

4.4.1 Existing 3TPH Per Direction – AM Peak Hour

Surveys have shown 385 vehicles travelling northbound and 543 travelling southbound across the railway line between 08:00 and 09:00 at Sutton Level Crossing.

In the existing scenario of 3TPH per direction, Sutton (916) Level Crossing (point B) produces a MMQ of 246 metres at the level crossing in the southbound direction, equating to 32% of the possible capacity of the link.

The northbound MMQ at the level crossing is 210 metres and takes up 42% of the available space.

The southbound arm of Sutton Cross Junction also has a MMQ of 48 metres, taking up 10% of the capacity of the link (Junction 3).

The northbound arm of the Strand Road / R809 Junction has an MMQ of 18 metres that takes up 2% of the available space (Junction 6).

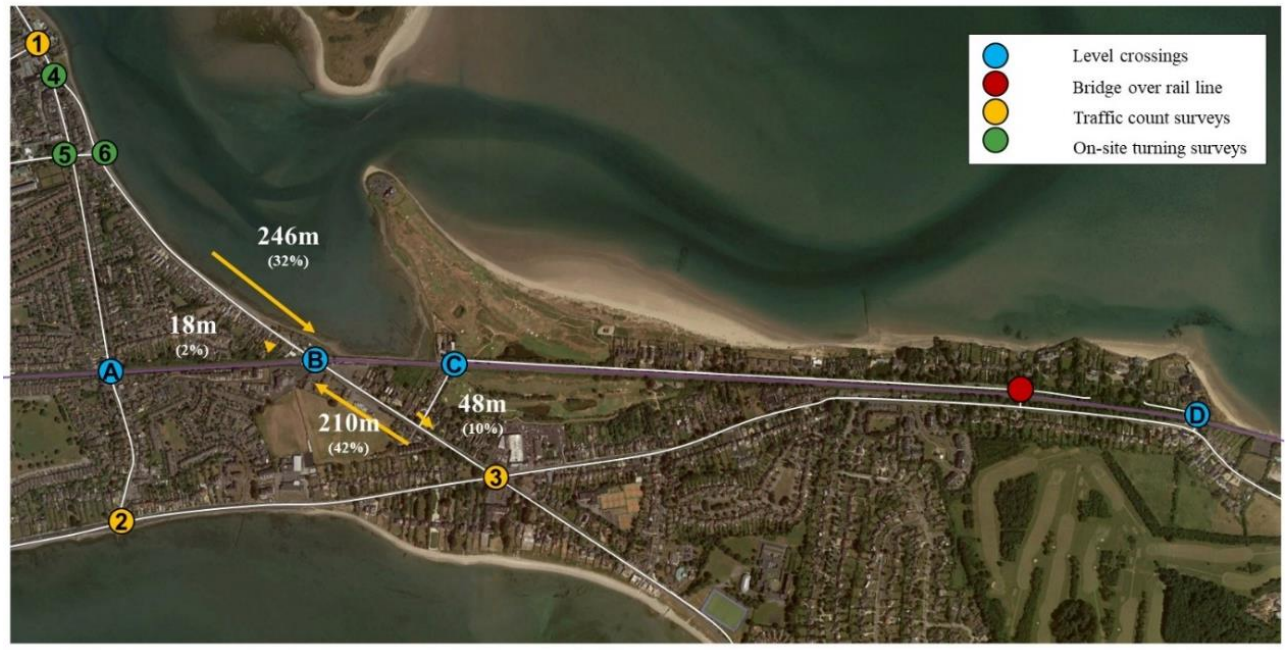

Figure 4-9 Existing 3TPH Per Direction MMQ Results – AM Peak

The modelled queue lengths in the subsequent tables for the 3TPH signals will not correspond exactly to the observed queue lengths in Table 4-3. The observed scenario is based on real world events where train timing irregularities exist, and the 3TPH scenarios are based on a regular timetable.

Table 4-13 Existing 3TPH Per Direction MMQ Results – AM Peak

Baseline 3TPH Per Direction	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Sutton (916) Level Crossing SB	760m	570m	41	246m	43%
Sutton (916) Level Crossing NB	500m	375m	35	210m	56%
Sutton Cross Junction SB Arm	500m	375m	8	48m	13%
Strand Road NB Arm	750m	563m	3	18m	3%

These results show that in the Baseline Scenario all queues are within the available capacity assuming the 3TPH timetable and assuming only 75% of the link length would be available, in case of a more concentrated arrival pattern.

4.4.2 Proposed 6TPH Per Direction – AM Peak Hour

Under the proposed 6TPH TSS1C scenario, Sutton (916) Level Crossing (point B) produces a MMQ of 156 metres at the level crossing in the southbound direction, equating to 21% of the possible capacity of the link.

The northbound MMQ at the level crossing is 132 metres and only take up 26% of the available space on this link.

The southbound arm of Sutton Cross Junction also has a MMQ of 42 metres, taking up 8% of the capacity of the link (Junction 3).

The northbound arm of the Strand Road / R809 Junction has an MMQ of 18 metres that takes up 2% of the available space (Junction 6).

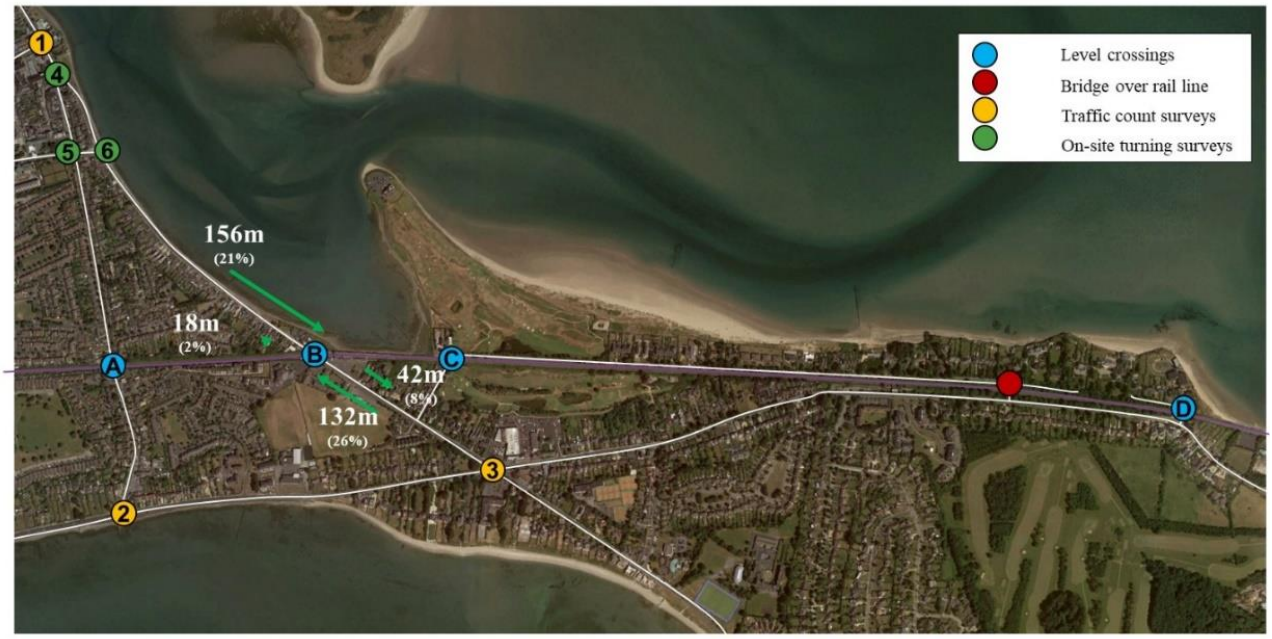

Figure 4-10 Proposed 6TPH Per Direction MMQ Results – AM Peak

Table 4-14 Proposed 6TPH Per Direction MMQ Results – AM Peak

Proposed 6TPH TSS1C	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Sutton (916) Level Crossing SB	750m	570m	26	156	27%
Sutton (916) Level Crossing NB	500m	375m	22	132	35%
Sutton Cross Junction SB Arm	500m	375m	7	42	11%
Strand Road NB Arm	750m	563m	3	18	3%

These results show that in the baseline scenario all queues are within the available capacity assuming the 6TPH TSS 1C timetable and assuming only 75% of the link length would be available, in case of a more concentrated arrival pattern.

4.4.3 Existing 3TPH Per Direction – PM Peak Hour

Surveys have shown 379 vehicles travelling northbound and 420 travelling southbound across the rail line between 17:30 and 18:30 at Sutton Level Crossing.

In the existing scenario of 3TPH per direction, Sutton (916) Level Crossing produces (point B) a MMQ of 126 metres at the level crossing in the southbound direction, equating to 17% of the possible capacity of the link.

The northbound MMQ at the level crossing is 108 metres and takes up 226% of the available space.

The southbound arm of Sutton Cross Junction also has a MMQ of 36 metres, taking up 7% of the capacity of the link (Junction 3).

The northbound arm of the Strand Road / R809 Junction has an MMQ of 18 metres that takes up 2% of the available space (Junction 6).

Figure 4-11 Existing 3TPH Per Direction MMQ Results – PM Peak

The modelled queue lengths in the subsequent tables for the 3TPH signals will not correspond exactly to the observed queue lengths in Table 4-3. The observed scenario is based on real world events where train timing irregularities exist, the 3TPH scenarios are based on a regular timetable.

Table 4-15 Existing 3TPH Per Direction MMQ Results – PM Peak

Baseline 3TPH Per Direction	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Sutton (916) Level Crossing SB	760m	570m	34	204m	36%
Sutton (916) Level Crossing NB	500m	375m	30	180m	48%
Sutton Cross Junction SB Arm	500m	375m	6	36m	10%
Strand Road NB Arm	750m	563m	3	18m	3%

These results show that in the Baseline Scenario all queues are within the available capacity assuming the 3TPH timetable and assuming only 75% of the link length would be available, in case of a more concentrated arrival pattern.

4.4.4 Proposed 6TPH Per Direction – PM Peak Hour

Under the proposed 6TPH TSS1C scenario, Sutton (916) Level Crossing (point B) produces a MMQ of 126 metres at the level crossing in the southbound direction, equating to 17% of the possible capacity of the link.

The northbound MMQ at the level crossing is 108 metres and only take up 22% of the available space on this link.

The southbound arm of Sutton Cross Junction also has a MMQ of 30 metres, taking up 6% of the capacity of the link (Junction 3).

The northbound arm of the Strand Road / R809 Junction has an MMQ of 18 metres that takes up 2% of the available space (Junction 6).

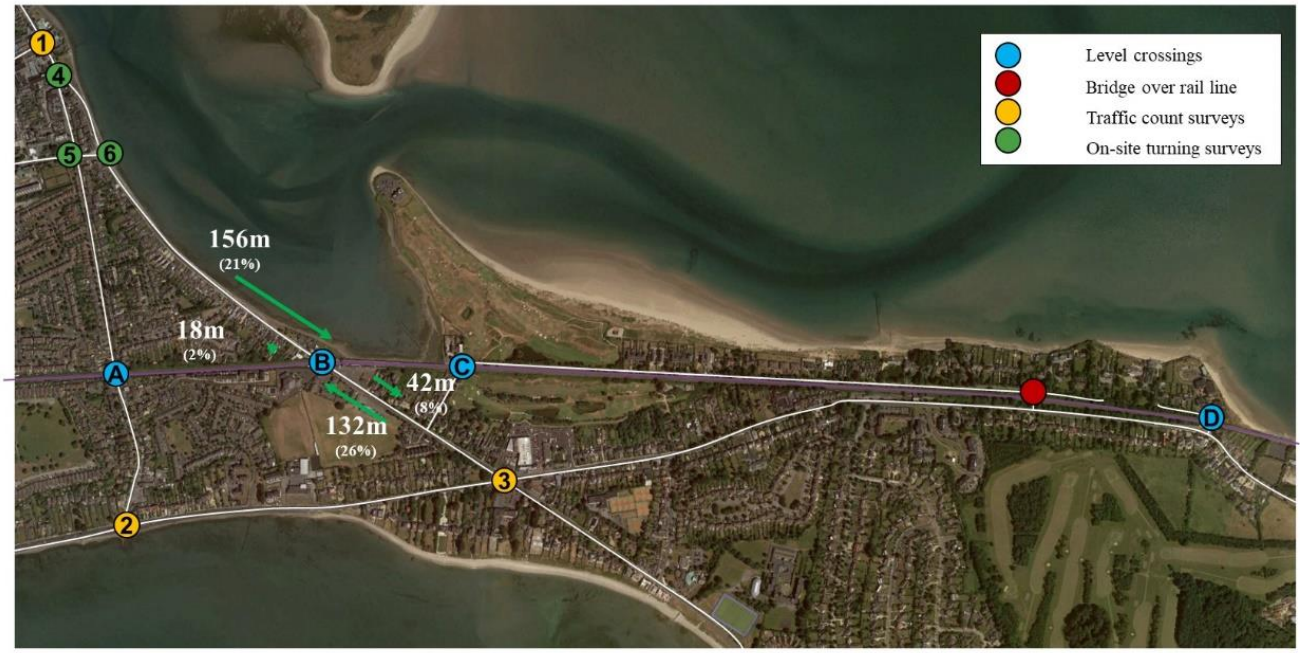

Figure 4-12 Proposed 6TPH Per Direction MMQ Results – PM Peak

Table 4-16 Proposed 6TPH Per Direction MMQ Results – PM Peak

Proposed 6TPH TSS1C	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Sutton (916) Level Crossing SB	760m	570m	21	126	22%
Sutton (916) Level Crossing NB	500m	375m	18	108	29%
Sutton Cross Junction SB Arm	500m	375m	5	30	10%
Strand Road NB Arm	750m	563m	3	18	3%

These results show that in the Baseline Scenario all queues are within the available capacity assuming the 6TPH TSS 1C timetable and assuming only 75% of the link length would be available, in case of a more concentrated arrival pattern.

4.4.5 Comparison

Queuing depends on two factors – the duration of the closure and the frequency of the closure. An increase in frequency of the closure will not necessarily result in an increase in queueing as the duration of these closures may be shorter and therefore will prevent long queues forming.

Level crossing closures at Sutton (916) Level Crossing will increase from approximately 3 times per hour to 6 times per hour in the proposed Baseline Scenario.

The duration of these closures will be less or similar in the Baseline Scenario to varying degrees, depending on the operational timetable to existing. These results are shown in Table 3-2.

In the Baseline Scenario the average closure time is forecast to reduce with 6TPH from 03:43 to 02:11. The shorter closure time allows less queueing to build up and queues can dissipate faster.

Comparing the mean maximum queue lengths at Sutton (916) Level Crossing and at the Sutton Cross Junction, the proposed scenario of 6TPH per direction shows a decrease in most queues, and all remain within the available queueing capacity.

The closure impacts are highly sensitive to the timetable and crossing points of trains. As can be seen, however, from Table 3-2 in other timetable scenarios that the 6TPH service can result in 12 closures per hour at Sutton (916) Level Crossing or with 6TPH - but with closure times up to 2 minutes longer than existing.

Figure 4-13 Comparison – Sutton (916) Level Crossing and Sutton Cross Junction SB Arm Queue Length Modelling Results – AM Peak

Figure 4-14 Comparison – Sutton (916) Level Crossing and Sutton Cross Junction SB Arm Queue Length Modelling Results – PM Peak

Table 4-17 Comparison – Sutton (916) Level Crossing and Sutton Cross Junction SB Arm Queue Length Modelling Results – AM Peak

Location	Baseline MMQ Duration: 00:03:43 Frequency: 3 times / hour	Proposed MMQ Duration: 00:02:11 Frequency: 6 times / hour	% Change in Queue Length
Sutton (916) Level Crossing SB	246m	156m	-37%
Sutton (916) Level Crossing NB	210m	132m	-37%
Sutton Cross Junction SB Arm	48m	42m	-13%
Strand Road NB Arm	18m	18m	0%

Table 4-18 Comparison – Sutton (916) Level Crossing and Sutton Cross Junction SB Arm Queue Length Modelling Results – PM Peak

Location	Baseline MMQ Duration: 00:03:43 Frequency: 3 times / hour	Proposed MMQ Duration: 00:02:11 Frequency: 6 times / hour	% Change in Queue Length
Sutton (916) Level Crossing SB	204m	126m	-38%
Sutton (916) Level Crossing NB	180m	108m	-40%
Sutton Cross Junction SB Arm	36m	36m	0%

Location	Baseline MMQ Duration: 00:03:43 Frequency: 3 times / hour	Proposed MMQ Duration: 00:02:11 Frequency: 6 times / hour	% Change in Queue Length
Strand Road NB Arm	18m	18m	0%

4.5 Qualitative Assessment of Cosh (915) (XQ003) and Claremont (913) (XQ004) Level Crossings

For Cosh (915) and Claremont (913) Level Crossings, the assessment was carried out by comparing both the frequency and length of barrier closures in the baseline 3TPH per direction scenario to the proposed 6TPH TSS1C scenario.

The baseline and proposed opening and closure times of the level crossing barriers at Cosh (915) and Claremont (913) are calculated from the outputs from the RailSys model, described in Section 0.

4.5.1.1 Cosh (915) Level Crossing

Level crossing closures at Cosh (915) Level Crossing will increase in the proposed baseline timetable scenario from approximately 3 times per hour to 6 times per hour. The duration of these closures is also expected to increase. These results are taken from Table 3-2 are summarised in Table 4-19.

Table 4-19 Comparison of Level Crossing Closure Times – Cosh (915)

Location	Number of Closures per hour	Total closure % per hour	Average opening time (mm:ss)	Average closure time (mm:ss)
Existing 3TPH Cosh (915) Level Crossing	3	19%	16:17	03:44
Proposed 6 TPH Cosh (915) Level Crossing	6	50%	04:59	05:01

The volume of vehicles crossing Cosh (915) Level Crossing is low. Surveys have shown only 23 vehicles travelling northbound and 25 travelling southbound across the rail line between 08:00 and 09:00; and 48 northbound and 24 southbound between 17:30 and 18:30. Based on the findings of the Kilbarrack and the Sutton Level Crossings it is anticipated that this level crossing will operate slightly worse for vehicles, but it is not expected to have a significant impact in terms of queueing - due to the low volumes of vehicles that cross the level crossing.

4.5.1.2 Claremont (913) Level Crossing

Level crossing closures at Claremont (913) Level Crossing will increase in the proposed baseline timetable scenario from approximately 6 times per hour to 12 times per hour. The duration of these closures is also expected to remain similar to existing. These results are taken from Table 3-2 and are summarised in Table 4-19.

Table 4-20 Comparison of Level Crossing Closure Times – Claremont (913)

Location	Number of Closures per hour	Total closure % per hour	Average opening time (mm:ss)	Average closure time (mm:ss)
Existing 3TPH Claremont (913) Level Crossing	6	27%	07:17	02:38
Proposed 6TPH Claremont (913) Level Crossing	12	53%	02:22	02:38

The volume of vehicles crossing Claremont (913) Level Crossing is very low. Surveys have shown only 4 vehicles travelling northbound and 8 travelling southbound across the rail line between 08:00 and 09:00; and 10 northbound and 2 southbound between 17:30 and 18:30.

Based on the findings of the Kilbarrack and the Sutton Level Crossings it is anticipated that this level crossing will operate slightly worse for vehicles, but it is not expected to have a significant impact in terms of queueing - due to the low volumes of vehicles that cross the level crossing.

4.6 Sensitivity Analysis – Kilbarrack (917) (XQ001) and Sutton (916) (XQ002) Level Crossings

The 3TPH closure times are based on the existing timetable. In this timetable trains meet or do not meet at different times, creating varying lengths of closure times.

The proposed 6TPH closure times are based on theoretical clockface timetables. These theoretical timetables ignore any variance caused by human input. Trains meet at exactly the same time, resulting in the exact same closure time in each instance.

To better understand how variations to the timetable and delays of the trains effect queueing along the surrounding road network a sensitivity analysis was undertaken. This sensitivity analysis was done by inputting the barrier results from the 6TPH per direction 1 to 9-minute offset outlined in Section 0. A 10-minute offset is the same as a regular timetable.

4.6.1 Level Crossings Closure Timings

4.6.1.1 Kilbarrack (917) Level Crossing (Baldoyle Road)

At Kilbarrack (917) Level Crossing an offset of 6 to 9 minutes requires the level crossing barriers to close 12 times per hour, meaning that only one train passes through the level crossing during each closure. The rest of the offsets have six closures per hour with two trains passing through each time.

The duration of closure is influenced by the different offsets, with the 5-minute offset having the longest single closure time of 5 minutes and 8 seconds.

Table 4-21 Kilbarrack (917) Level Crossing Closure Times for 6TPH per direction for Clock Face and 1–9-minute offset

Kilbarrack (917) Level Crossing	Number of Closures per hour	Total forecast closure time per hour	Average forecast single closure time
Regular	6	00:28:59	00:04:50
Offset +1min	6	00:22:59	00:03:50
Offset +2min	6	00:12:50	00:02:08
Offset +3min	6	00:18:50	00:03:08
Offset +4min	6	00:24:50	00:04:08
Offset +5min	6	00:30:50	00:05:08
Offset +6min	12	00:21:17	00:02:29
Offset +7min	12	00:28:49	00:02:29
Offset +8min	12	00:28:49	00:02:29
Offset +9min	12	00:28:49	00:02:29

4.6.1.2 Sutton (916) Level Crossing

At Sutton (916) Level Crossing an offset of 3 to 6 minutes requires the level crossing barriers to close 12 times per hour, meaning that only one train passes through the level crossing during each closure. The rest of the offsets have six closures per hour with two trains passing through each time.

The duration of closure is influenced by the different offsets, with 7-minute offset having the longest single closure time of 5 minutes and 11 seconds.

Table 4-22 Sutton (916) Level Crossing Closure Times for 6TPH per direction for Clock Face and 1–9-minute offset

Sutton (916) Level Crossing	Number of Closures per hour	Total forecast closure time per hour	Average forecast single closure time
Clock Face	6	00:13:06	00:02:11
Offset +1min	6	00:24:25	00:04:04
Offset +2min	6	00:30:25	00:05:04
Offset +3min	12	00:31:30	00:02:38

Sutton (916) Level Crossing	Number of Closures per hour	Total forecast closure time per hour	Average forecast single closure time
Offset +4min	12	00:31:30	00:02:38
Offset +5min	12	00:31:30	00:02:38
Offset +6min	12	00:31:30	00:02:38
Offset +7min	6	00:31:06	00:05:11
Offset +8min	6	00:25:06	00:04:11
Offset +9min	6	00:19:06	00:03:11

4.6.1.3 Cosh (915) and Claremont (913) Level Crossings

The closure times at Cosh (915) Level Crossing will vary between 2 minutes and 30 seconds and 5 minutes and 1 second, depending on the offset.

The closure times at Claremont (913) Level Crossing will vary between 2 minutes and 38 seconds and 4 minutes and 51 seconds, depending on the offset.

4.6.2 Modelling Results

Two additional scenarios were developed in the LinSig model to test the impact of a potential 5-minute offset and a potential 7-minute offset on queueing at Kilbarrack (917) and Sutton (916) Level Crossings. These two off-sets presented the longest potential closure times. Table 4-23 summarises the input assumptions of the two main scenarios, as discussed earlier in Section 4.2, and the two additional sensitivity scenarios.

Table 4-23 Sensitivity Tests

Baseline 3TPH per direction	Number of closures per hour	Average Closure Time (mm:ss)
Kilbarrack (917) Level Crossing	5	02:54
Sutton (916) Level Crossing	3	03:43
Proposed 6TPH TSS1C	**Number of closures per hour**	**Average Closure Time (mm:ss)**
Kilbarrack (917) Level Crossing	6	04:50
Sutton (916) Level Crossing	6	02:11

Offset +5min Proposed 6TPH TSS1C	Number of closures per hour	Average Closure Time (mm:ss)
Kilbarrack (917) Level Crossing	6	05:08
Sutton (916) Level Crossing	12	02:38
Offset +7min Proposed 6TPH TSS1C	**Number of closures per hour**	**Average Closure Time (mm:ss)**
Kilbarrack (917) Level Crossing	12	02:29
Sutton (916) Level Crossing	6	05:11

Table 4-24 and

Table 4-25 summarise the outputs for Kilbarrack (917) Level Crossing for the AM and PM peak hour. The impact on available queuing capacity is shown for both sensitivity scenarios – 5-minute offset and 7-minute offset. There will be an increase in most queues, however all will mostly remain within the available queueing capacity. Queues may occasionally block back along the Kilbarrack northbound arm in the PM peak.

However, it was noted that the baseline model overestimates queues at this location, so in practice this might not be a regular problem.

Table 4-24 Results of Sensitivity Analysis Modelling – Kilbarrack (917) – AM Peak

5-min offset 6TPH 7-min offset 6TPH	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Kilbarrack (917) Level Crossing SB	550m	413m	58 30	348m 180m	84% 44%
Kilbarrack (917) Level Crossing NB	350m	263m	32 16	192m 96m	73% 37%
Dublin Road/ Baldoyle Road Junction SB Arm	350m	263m	17 17	102m 102m	39% 39%
Warrenhouse Road Junction NB Arm	550m	413m	8 8	48m 48m	12% 12%

Table 4-25 Results of Sensitivity Analysis Modelling – Kilbarrack (917) – PM Peak

5-min offset 6TPH 7-min offset 6TPH	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Kilbarrack (917) Level Crossing SB	550m	413m	37 20	222m 120m	54% 29%
Kilbarrack (917) Level Crossing NB	350m	263m	53 28	318m 168m	121% 64%
Dublin Road/ Baldoyle Road Junction SB Arm	350m	263m	12 12	72m 72m	27% 27%
Warrenhouse Road Junction NB Arm	550m	413m	14 14	84m 84m	20% 20%

Table 4-26 and

Table 4-27 summarise the outputs for Sutton (916) Level Crossing for the AM and PM peak hour. The impact on available queuing capacity is shown for both sensitivity scenarios – 5-minute offset and 7-minute offset. There will be an increase in most queues; however, all will mostly remain within the available queueing capacity.

Table 4-26 Results of Sensitivity Analysis Modelling – Sutton (916) – AM Peak

5-min offset 6TPH 7-min offset 6TPH	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Sutton (916) Level Crossing SB	760m	570m	31 54	186m 324m	33% 57%
Sutton (916) Level Crossing NB	500m	375m	26 48	156m 288m	42% 77%
Sutton Cross Junction SB Arm	500m	375m	7 7	42m 42m	11% 11%
Strand Road NB Arm	750m	563m	3 3	18m 18m	3% 3%

Table 4-27 Results of Sensitivity Analysis Modelling – Sutton (916) – PM Peak

5-min offset 6TPH 7-min offset 6TPH	Link Length	75% Link Length	MMQ (PCUs)	MMQ	% Capacity of 75% Link Length
Sutton (916) Level Crossing SB	760m	570m	25 44	150m 264m	26% 46%
Sutton (916) Level Crossing NB	500m	375m	22 40	132m 240m	35% 64%
Sutton Cross Junction SB Arm	500m	375m	6 6	36m 36m	10% 10%
Strand Road NB Arm	750m	563m	3 3	18m 18m	3% 3%

Table 4-28 Comparison Sensitivity Analysis– Kilbarrack (917) – AM Peak

Location	Baseline MMQ Duration: 00:02:54 Frequency: 5 times / hour	Sensitivity Analysis MMQ 5-min offset Duration: 00:05:08 Frequency: 6 times / hour 7-min offset Duration: 00:02:29 Frequency: 12 times / hour	% Change in Queue Length
Kilbarrack (917) Level Crossing SB	204m	348m 180m	+71% -12%
Kilbarrack (917) Level Crossing NB	114m	192m 96m	+68% -16%
Dublin Road/ Baldoyle Road Junction SB Arm	102m	102m 102m	0% 0%
Warrenhouse Road Junction NB Arm	66m	48m 48m	-27% -27%

Table 4-29 Comparison Sensitivity Analysis – Kilbarrack (917) – PM Peak

Location	Baseline MMQ Duration: 00:02:54 Frequency: 5 times / hour	Sensitivity Analysis MMQ 5-min offset Duration: 00:05:08 Frequency: 6 times / hour 7-min offset Duration: 00:02:29 Frequency: 12 times / hour	% Change In Queue Length
Kilbarrack (917) Level Crossing SB	132m	222m 120m	+68% -9%
Kilbarrack (917) Level Crossing NB	192m	318m 168m	+66% -13%
Dublin Road/ Baldoyle Road Junction SB Arm	72m	72m 72m	0% 0%

Warrenhouse Road Junction NB Arm	84m	84m 84m	0% 0%

The results show that increases in queue lengths may be experienced along the approaches to Kilbarrack (917) Level Crossing.

Table 4-30 Comparison Sensitivity Analysis – Sutton (916) – AM Peak

Location	Baseline MMQ Duration: 00:03:43 Frequency: 3 times / hour	Sensitivity Analysis MMQ 5-min offset Duration: 00:02:38 Frequency: 12 times / hour 7-min offset Duration: 00:05:11 Frequency: 6 times / hour	% Change in Queue Length
Sutton (916) Level Crossing SB	246m	186m 324m	-24% +32%
Sutton (916) Level Crossing NB	210m	156m 288m	-26% +37%
Sutton Cross Junction SB Arm	42m	42m 42m	-13% -13%
Strand Road NB Arm	18m	18m 18m	0% 0%

Table 4-31 Comparison Sensitivity Analysis – Sutton (916) – PM Peak

Location	Baseline MMQ Duration: 00:03:43 Frequency: 3 times / hour	Sensitivity Analysis MMQ 5-min offset Duration: 00:02:38 Frequency: 12 times / hour 7-min offset Duration: 00:05:11 Frequency: 6 times / hour	% Change in Queue Length
Sutton (916) Level Crossing SB	204m	150m 264m	-26% +29%
Sutton (916) Level Crossing NB	180m	132m 240m	-27% +33%
Sutton Cross Junction SB Arm	36m	36m 36m	0% 0%
Strand Road NB Arm	18m	18m 18m	0% 0%

The results show that increases in queue lengths may be experienced along the approaches to Sutton (916) Level Crossing.

4.7 Summary of Vehicle Assessment

Queuing depends on two factors: the duration of the closure and the frequency of the closure. An increase in frequency of the closure will not necessarily result in an increase in queueing as the duration of these closures may be shorter and therefore will prevent long queues forming; - if the volume of traffic is able to dissipate within the available opening times. In general, more frequent, shorter openings are likely to perform better than less frequent, longer openings - even if the total open time within the hour decreases.

In the proposed baseline 6TPH timetable scenario the frequency of level crossing closures at Kilbarrack (917) Level Crossing will increase from approximately 5 times per hour to 6 times per hour. Kilbarrack (917) Level Crossing will operate slightly worse for vehicles as the likelihood of vehicles incurring delay at the level crossing will increase due to the increased frequency of level crossing closures here. The duration of these closures is also expected to increase.

Comparing the mean maximum queue lengths at Kilbarrack (917) Level Crossing and at the Dublin Road/Baldoyle Road Junction, the assessed Baseline Scenario TSS1C timetable for 6TPH per direction shows an increase in most queues; however, all remain within the available queueing capacity - bar the northbound approach to the crossing in the PM peak.

The sensitivity analyses of alternative timetabling scenarios simulating the delays and timetable variation show that queue lengths may increase further depending on the offset but will mostly remain within the available queueing capacity. As in the Base Scenario, queues may occasionally block back along the Kilbarrack northbound arm in the PM peak in other timetable scenarios.

The frequency of level crossing closures at Sutton (916) Level Crossing will increase from approximately 3 times per hour to 6 times per hour in the proposed baseline 6TPH timetable scenario. Sutton (916) Level Crossing will operate slightly worse for vehicles as the likelihood of vehicles incurring delay at the level crossing will increase due to the increased frequency of level crossing closures here. The duration of these closures is, however, expected to decrease in the proposed baseline 6TPH scenario.

Comparing the mean maximum queue lengths at Sutton (916) Level Crossing and at the Sutton Cross Junction, the assessed TSS1C timetable for 6TPH per direction shows a decrease in most queues, and all remain within the available queueing capacity. The sensitivity analyses show that queue lengths are dependent on the timetable/delays and may increase depending on the offset but will remain within the available queueing capacity.

It is anticipated that Cosh (915) and Claremont (913) Level Crossings will operate slightly worse for vehicles as the likelihood of vehicles incurring delay at the level crossing will increase due to the increased frequency of level crossing closures here. It is not expected, however, to have a significant impact in terms of queueing due to the low volumes of vehicles that cross at these level crossings.

5. ASSESSMENT OF PROPOSAL ON PEDESTRIANS AND CYCLISTS AT LEVEL CROSSINGS

In this section of the report, the effect of changes to the operating conditions of the Howth Branch and associated level crossings on pedestrians and cyclists has been investigated. The existing service of 3 trains per hour per direction (3TPH) and level crossing closures has been compared to the proposed 6 train per hour per direction (6TPH TSS1C). All four level crossings were assessed using qualitative analysis methods, similar to the ones used in Section 4.

The assessment looked at the changes to the quality of service for pedestrians and cyclists using the level crossings. The operation and barrier closure times of the level crossings for the baseline 3TPH per direction and proposed 6TPH TSS1C scenarios are described in Section 4.2

Figure 5-1 Overview of the area of interest for Pedestrian and cyclist Assessment

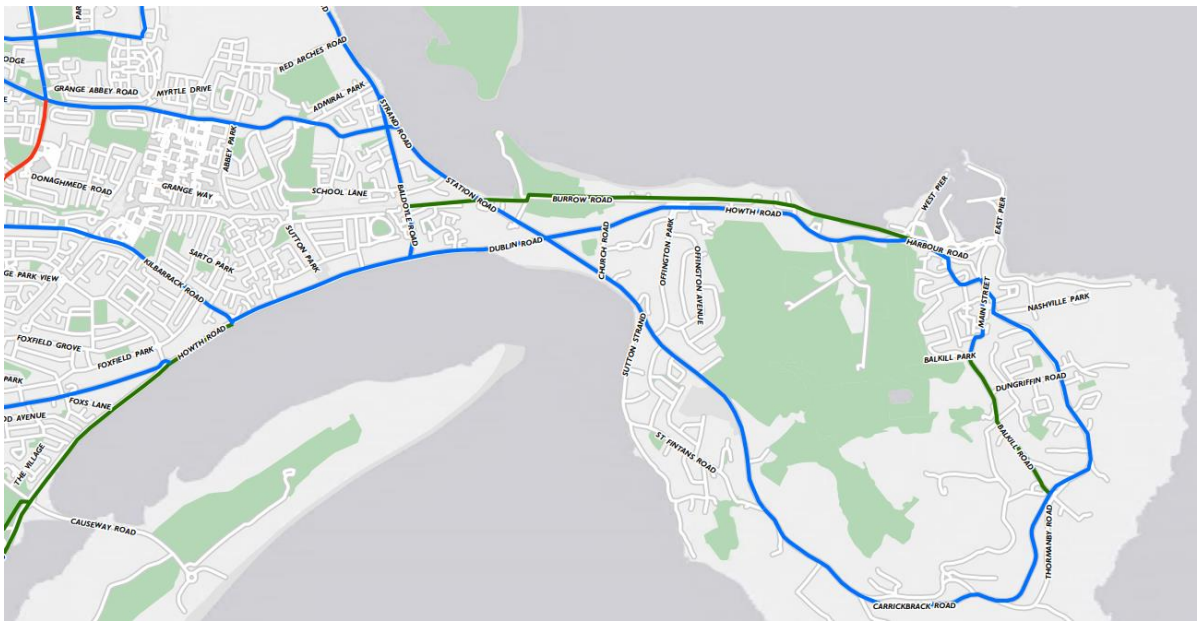

Figure 5-2 Extract from 2021 Draft GDA Cycle Network Plan

5.1 Kilbarrack (917) Level Crossing (XQ001) (Baldoyle Road) Pedestrian and Cyclist Assessment

There are pedestrian footpaths on both sides of the road on Warrenhouse Road and Baldoyle Road, running the full length of both roads. These footpaths also cross the Kilbarrack (917) Level Crossing. Surveys have shown 616 pedestrians per day crossing the level crossing between 06:00 and 20:00, of which 14% are children younger than 16 years of age.

The crossing is denoted in the Draft 2021 GDA cycle network map as a secondary cycle route. On street cycle lanes are present on both carriageways to the north and south of the crossing although they are not present for the crossing itself.

Level crossing closures at Kilbarrack (917) Level Crossing will increase from approximately 5 times per hour to 6 times per hour in the proposed baseline 6TPH scenario and therefore the likelihood for a pedestrian or cyclist to encounter a level crossing closure will increase. The wait time at these closures is likely to increase from a current average of 3 minutes to a maximum of around 5 minutes. These modelled results are summarised in Table 3-2. The baseline 6TPH timetable represents one of the longest duration closure times and as such variations in the timetable and delays are likely to reduce the closure times experienced at Kilbarrack (917) Level Crossing.

5.2 Sutton (916) Level Crossing (XQ002) Pedestrian and Cyclist Assessment

There are pedestrian footpaths running the full length on both sides of Station Road. These footpaths also cross the Sutton (916) Level Crossing. Sutton Train Station is located adjacent to the level crossing, which would attract pedestrians and cyclists.

The crossing is denoted in the Draft 2021 GDA cycle network map as a secondary cycle route. There is no cycling infrastructure current present. Fingal County Council are proposing plans to develop the Sutton to Malahide Pedestrian and Cycle Scheme. At this stage, the preferred option for the scheme development is to cross the rail line at the Sutton (916) Level Crossing One.

Surveys have shown 921 pedestrians per day crossing the level crossing between 06:00 and 20:00, of which 11% are children younger than 16 years of age.

Level crossing closures at Sutton (916) Level Crossing will increase from approximately 3 times per hour to 6 times per hour in the proposed baseline 6TPH scenario and therefore the likelihood for a pedestrian to encounter a level crossing closure will increase. The wait time at these closures is likely to be around 2 minutes lower or similar to existing. These modelled results are summarised inTable 3-2. The baseline 6TPH timetable represents one of the shortest duration closure times, and as such variations in the timetable and delays are likely to increase the closure times experienced at Sutton (916) Level Crossing.

5.3 Cosh (915) Level Crossing (XQ003) Pedestrian and Cyclist Assessment

There is only a pedestrian footpath on the west side of the Lauder's Lane running the full length of the road. There is also a footpath on the southern side of Burrow Road, just north of the level crossing.

Sutton Golf Course is split in two by the railway tracks, with the crossing providing the only way to get between the two sections of the course. As a result, golfers use this crossing regularly throughout the day. There is a footpath on both sides of Cosh (915) Level Crossing. Surveys have shown 510 pedestrians crossing the level crossing between 06:00 and 20:00.

Level crossing closures at Cosh (915) Level Crossing will increase from approximately 3 times per hour to 6 times per hour in the proposed baseline 6TPH scenario and therefore the likelihood for a pedestrian to encounter a level crossing closure will increase. The wait time at these closures is likely to be around 5 minutes. These modelled results are summarised in Table 3-2 The baseline 6TPH timetable represents one of the longest duration closure times and as such variations in the timetable and delays are likely to reduce the closure times experienced at Cosh (915) Level Crossing.

5.4 Claremont (913) Level Crossing (XQ004) Pedestrian and Cyclist Assessment

The Howth Road has a pedestrian footpath on both sides of the road running the full length of the road. These footpaths also cross the Claremont (913) Level Crossing on both sides. The private access road to the north of Claremont (913) Level Crossing has no pedestrian facilities along it. Out of all four of the level crossings this is the least used by pedestrians as it provides access to a small number of residential units. Surveys have shown only 97 pedestrians per day crossing the level crossing between 06:00 and 20:00.

Level crossing closures at Claremont (913) Level Crossing will increase from approximately 6 times per hour to 12 times per hour in the proposed baseline 6TPH scenario and therefore the likelihood for a pedestrian to encounter a level crossing closure will increase. The wait time at these closures is likely to be around 2.5 minutes - similar to existing. These modelled results are summarised in Table 3-2. The baseline 6TPH timetable represents one of the shortest duration closure times, and as such, variations in the timetable and delays are likely to increase the closure times experienced at Claremont (913) Level Crossing.

5.5 Summary of Pedestrian and Cyclist Assessment

The number of level crossing closures will increase at all crossings and therefore the likelihood of a pedestrian or cyclist incurring a delay at a level crossing will increase.

In the baseline proposed timetable scenario the duration of these closures will remain similar or lower than existing at Claremont and Sutton Level Crossings. The wait time at Cosh and Kilbarrack is expected to increase to around 5 minutes in the proposed 6TPH baseline timetable scenario.

In the event of delays or timetable variations, closure durations are expected to increase at Claremont and Sutton Level Crossings and reduce at Cosh and Kilbarrack Level Crossings. Certain timetable scenarios can introduce an increased number of closures but in doing so the closure durations will be similar or lower than existing.

6. CONCLUSION

Proposed changes to the Howth Branch, as defined in the Train Service Specification TSS1C, will see both the service frequency and capacity increase, along with improvement to the reliability of timetabling. The reliability of the Howth Branch will increase as the proposed shuttle service would mean that trains would no longer be susceptible to delays along the main line.

The level crossing closures are highly sensitive to the exact meeting point of trains in any given scenario; having trains cross simultaneously at a level crossing is the best case, as it allows two trains to pass during one closure. By contrast, the worst scenario would be two trains separated by just less than 20 seconds, meaning that the level crossing will be held down for the maximum amount of time.

A baseline timetable scenario has been used for the assessment which is based on TSS1C and has a regular timetable structure.

The effect of different train meeting points and the impacts on the barrier opening times of level crossings has been assessed for a number of timetable scenarios, which serves as a sensitivity check to evaluate how differently the level crossings will behave depending on the level of synchronization of rail services; and how this may in turn impact on queues.

It should be noted that there is the ability to optimise the timetable around minimising barrier closures to one of the two major road crossings (Sutton or Kilbarrack but not both). The baseline timetable used minimises the closure times at Sutton.

The assessment indicates that the likelihood of vehicles incurring delay at the level crossings will increase due to the increased frequency of level crossing closures. It was also found that there will be an impact on queue lengths in the study area – in some cases queue lengths may reduce; however, in some cases queue lengths will increase. The sensitivity analysis has shown that queue lengths are likely to remain within the available queueing capacity, in all these cases. However, the assessment indicates that queues may occasionally block back along the Kilbarrack northbound arm in the PM peak.

Similarly, the likelihood of pedestrians incurring delay at a level crossing will increase. In the proposed baseline timetable scenario, the average wait time for pedestrians is likely to increase at Cosh and Kilbarrack Crossings from ¾ minutes to 5 minutes. Sutton and Claremont closure durations will be similar or less than existing in the proposed baseline timetable scenario.

The assessment assumes optimisation of road junction signal timings upstream and downstream of the level crossing and, as such, these will need to be modified to sync up with the opening and closing times of the level crossings.

In terms of emergency services - there will be additional queues due to longer closure times; however, emergency services are able to bypass a general traffic queue and travel up to the level crossing.

The likelihood of being delayed at the level crossing will increase due to increased frequency of closures. However, Irish Rail is normally contacted in advance and the train is then stopped at the station beforehand, allowing the emergency service to pass through the level crossing, without any delays.

The assessment concludes that the crossings can continue to operate and provide an appropriate level of cross connectivity and accessibility whilst still meeting the increased DART service frequency requirement.

The assessment identifies that queues may occasionally block back along the Kilbarrack northbound arm in the PM peak. However, the assessment undertaken is conservative and does not consider modal shift as a result of DART+ Coastal or changing driving patterns. During the traffic assessment that will be produced as part of the EIAR, the impacts of these factors on the queuing lengths at Kilbarrack will be better understood.

6.1 Summary by Crossing

Kilbarrack

Following the implementation of the DART+ Coastal North project the number of level crossing closures at Kilbarrack (917) Level Crossing will increase from 5 times per hour to 6 times per in the baseline timetable scenario. The duration of each crossing closure will increase from an average of around 3 minutes to an average of around 5 minutes.

As the proposed baseline timetable scenario results in favouring Sutton over Kilbarrack any changes to timetabling or train delays are likely to either:

1. Increase the chance of two trains passing each other closer to Kilbarrack Level Crossing and hence reduce the closure time.

   Or

2. Increase the chance of only a single train passing during a crossing closure event resulting in a minimal closure time but double the number of closures

For the proposed 6TPH baseline timetable scenario the following impacts can be concluded:

<u>Road users</u>

At Kilbarrack (917) Level Crossing and at the Dublin Road/Baldoyle Road Junction, the assessment indicates an increase in most queues can be expected; however, generally they remain within the available queueing capacity. However, the assessment indicates that queues may occasionally block back along the Kilbarrack northbound arm in the PM peak to the Baldoyle Road & Dublin Road junction.

Road users are more likely to be stopped by the crossing barriers with the crossing expected to be closed 48% of the time compared to the current 26%.

Pedestrians and cyclists

For pedestrians and cyclists, the assessment shows that at Kilbarrick Level Crossing the total number of closures per hour will increase from 5 to 6 per hour. Alongside an increased average closure duration there is an increased chance users are stopped at the crossing (from 26% chance to 48% chance). However, the average duration of each crossing closure will be lower than the maximum existing closure time experienced and are not expected to significantly inconvenience users.

Sutton

Following the implenetation of DART+ Coastal North project the number of level crossing closures at Sutton (916) Level Crossing will increase from 3 times per hour to 6 times per in the baseline timetable scenario. The duration of each crossing closure will reduce from an average of around 3 and ¾ minutes to an average of around 2 and ¼ minutes.

As the proposed baseline timetable scenario results in favouring Sutton over Kilbarrack any changes to timetabling or train delays are likely to either:

1. Decrease the chance of two trains passing each other closer to Sutton Level Crossing and hence increase the closure time.

   Or

2. Increase the chance of only a single train passing during a crossing closure event resulting in a minimal closure time but double the number of closures

There are two reasons why the crossing closure duration is forecast to decrease in the proposed baseline timetable scenario:

The proposed baseline timetable results in trains passing at or close to Sutton; this minimises any waiting times whilst the barriers stay down awaiting a second train.

The introduction of a shuttle service on the Howth Branch allows the trains to be isolated from the rest of the network. This means that the risk of delays on the branch are significantly reduced as delays caused in other areas are not likely to impact the shuttle service. Currently trains are timetabled to allow a buffer in the run time over the branch to allow for some of the delay to be recovered. This buffer is proposed to be removed, allowing the trains to be timetabled to run quicker over the branch. Thereby reducing the times, the crossing is closed for a single train.

For the proposed 6TPH baseline timetable scenario the following impacts can be concluded:

Road users

At Sutton (916) Level Crossing, the assessment indicates a decrease in most queues can be expected, and all remain within the available queueing capacity.

The reduction in queue lengths is because of the reduction in closure duration in the proposed baseline timetable which overrides the increased number of closures as it allows queues to disperse quicker.

Road users, however, can be expected to be marginally more likely to be stopped by the barriers (22% of the time) than they currently are (19% of the time).

Pedestrian and cyclists

For pedestrians and cyclists, the assessment shows that at Sutton Level Crossing the total number of closures per hour will increase from 3 to 6 per hour. The closure duration for the reasons explained above is expected to reduce in the baseline timetable scenario.

As a combination of the above there is a marginally increased chance users are stopped at the crossing (from 19% chance to 22% chance) compared to the existing. Given the above the changes are not expected to inconvenience users.

Cosh

Following the implementation of the DART+ Coastal North project the number of level crossing closures at Cosh (915) Level Crossing will increase from 3 times per hour to 6 times per hour in the baseline timetable scenario. The duration of each crossing closure will increase from an average of around 3 and ¾ minutes to an average of around 5 minutes.

As a result of the proposed baseline timetable scenario any changes to either timetabling or train delays are likely to either:

1. Increase the chance of two trains passing each other closer to Cosh Level Crossing and hence reduce the closure time.

   Or

2. Increase the chance of only a single train passing during a crossing closure event resulting in a minimal closure time but double the number of closures

For the proposed 6TPH baseline timetable scenario the following impacts can be concluded:

Road users

It is anticipated that Cosh (915) Level Crossing will operate slightly worse for vehicles than currently, but it is not expected to have a significant impact in terms of queueing due to the low volumes of vehicles that cross the level crossing.

Road users are more likely to be stopped by the crossing barriers, with the crossing expected to be closed 50% of the time compared to the current 19%.

Pedestrian and cyclists

For pedestrians and cyclists, the assessment shows that at Cosh Level Crossing the total number of closures per hour will increase from 3 to 6 per hour. Alongside an increased average closure duration there is an increased chance users are stopped at the crossing (from 19% chance to 50% chance). However, the duration of each crossing closure will be within the range of the existing times and are not expected to significantly inconvenience users.

Claremont

Following the implementation of the DART+ Coastal North project the number of level crossing closures at Claremont (913) Level Crossing will increase from 6 times per hour to 12 times per hour in the baseline timetable scenario. The duration of each crossing closure will remain similar to existing at around 2 and ½ minutes.

As a result of the proposed baseline timetable scenario any changes to timetabling or train delays are likely to either:

1. Decrease the chance of two trains passing each other closer to Claremont Level Crossing and hence increase the closure time.

   Or

2. Increase the chance of only a single train passing during a crossing closure event resulting in a minimal closure time but double the number of closures

For the proposed 6TPH baseline timetable scenario the following impacts can be concluded:

Road users

It is anticipated that Claremont (913) Level Crossing will operate slightly worse for vehicles than currently, but it is not expected to have a significant impact in terms of queueing due to the low volumes of vehicles that cross the level crossing.

Road users are more likely to be stopped by the crossing barriers, with the crossing expected to be closed 53% of the time compared to the current 27%.

Pedestrian and cyclists

For pedestrians and cyclists, the assessment shows that at Claremont Level Crossing the total number of closures per hour will increase from 6 to 12 per hour.

The closure duration is expected to remain similar to existing in the proposed baseline timetable scenario. As a combination of the above there is an increased chance users are stopped at the crossing (from 27% chance to 53% chance) compared to the existing. Given the above, the changes are not expected to inconvenience users.