DART+ West

Iarnród Éireann

Technical Note: Need for DART+ West Level Crossing Closures

MAY-MDC-SIG-LC00-ME-Y-0001

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Table of Contents

List of Figures and Tables

Figures

Tables

Abbreviations

Abbreviation	Meaning
LC	Level Crossing
PC	Public Consultation
RO	Railway Order
TPHPD	Trains Per Hour Per Direction

Executive Summary

DART+ West proposes to enhance passenger capacity in the city centre, west to Maynooth and northwest to Dunboyne. The capacity enhancement is planned to be threefold through an increase in the number of train passes on the lines by between 100% and 128% and increasing the capacity of individual trains. Proposals for achieving sustainable capacity enhancement include the following:

- Electrification of the lines;
- Resignalling the lines to facilitate a higher frequency of trains;
- Removal of the 6No. existing level crossings within the project extent.

This technical note provides information and the rationale for the closure of the existing 6 No. level crossing along the Maynooth Line to facilitate the increased train capacity associated with DART+ West. They are located at Ashtown, Coolmine, Porterstown, Clonsilla, Barberstown and Blakestown.

The presence of road rail interfaces in the form of level crossings represents an inherent risk to road and rail users. Iarnród Éireann and the Local Authorities work together to ensure all existing level crossings on the railway network are operated safely. The removal of such interfaces between road and railway traffic has however had a strong mandate from government, the Commission for Railway Regulation and Iarnród Éireann for many years. Measures implemented to remove level crossings from the network have resulted in some of the strongest safety enhancements across the network over the last 20 years. The mandate to enhance safety by the removal of level crossings remains today.

The crossings are grouped for the purposes of the assessment with Coolmine acting as exemplar for all level crossings in proximity to a train station where common control and characteristics apply. The conclusions of the study in respect of Coolmine are applied to the level crossings at Clonsilla and Ashtown. Other level crossings are considered individually.

The study examines the existing and future conditions at the level crossings in the event they are retained, and their operation enhanced, and draws conclusions on the appropriateness or otherwise of leaving the level crossings in place as part of the project.

The main elements of a basic level crossing control system with barriers are as follows:

- Strike-in point: The strike-in point is the point where the passage of a train is detected and initiates the warning and closing sequence of the level crossing barriers;
- Light signals for vehicles: visual signals that warn vehicles that the level crossing is activated and closed due to impending presence of a train;
- Audible alarm system: acoustic signals warning vehicles of impending presence of a train;
- Barriers: physical barriers that prevents access into the level crossing clearance box;
- Stop signal: Signal that indicates to the train driver if the train can proceed or not proceed through the level crossing. If the stop signal is red, it indicates that the level crossing might be obstructed for some reason and the train must stop immediately to maintain safety.

A schematic diagram representing the controls is provided in Figure 1-1.

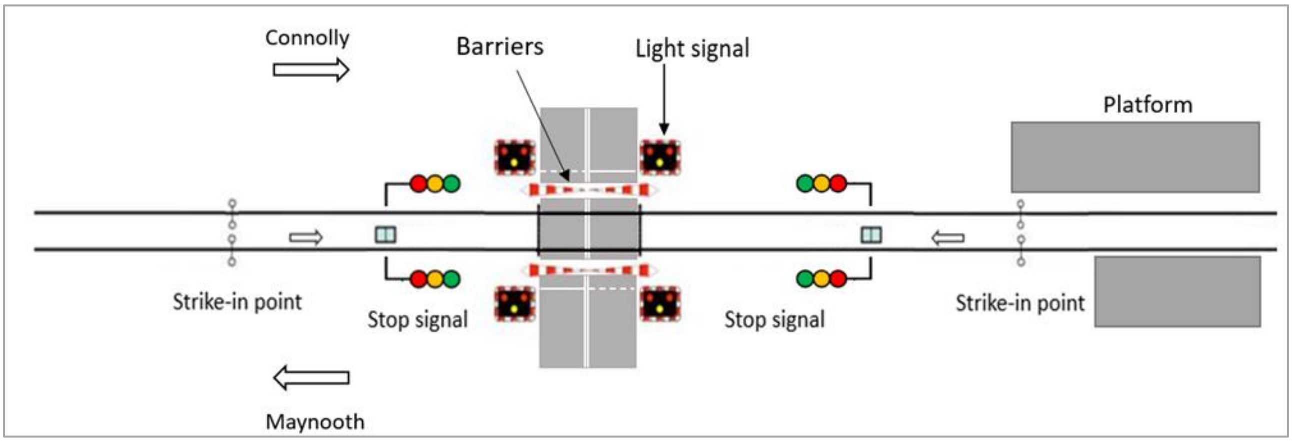

Figure 1-1 – Schematic of Level Crossing Control System

There are many factors which affect the cycle time of a level crossing but two principal elements have been focused on as they provide the principal opportunities for improvement. They are relocation of the strike in signal closer to the level crossing and equivalent treatment to the stop signal.

Coolmine, Clonsilla and Ashtown Level Crossings:

These level crossings are located on the same section of railway with equivalent projected train movements. They are also located adjacent to train stations and consequently have similar operational characteristics.

- Currently, in morning peak hour the level crossing barriers are closed up to 68% (41mins) of the hour, in the off peak up to 37% (22mins) of the hour;
- On examination of level crossing closures, without enhancement of signalling, closure of the level crossings for the full peak hours is projected on implementation of the projected train frequencies;
- With optimisation of signalling, it is not possible to place the stop signal closer to the level crossing in a way that significantly improves the total cycle time of the barriers due to constraints associated with the braking characteristics of the trains;
- Optimisation of the strike in point would require that all trains stop at the adjacent station. It is anticipated this could reduce the cumulative closure time of the level crossing to a minimum of 45 minutes in the peak hour. Trains passing in opposite directions within a single cycle will however further curtail remaining open time in the hour. Due to the presence of the adjacent station and the ambitious working timetable it is anticipated that, even with the removal of non-stopping trains, little open time will remain available in the peak hour. This is considered an unsafe situation from the perspective of road users. It is also considered highly undesirable from an operational perspective to curtail the potential for the operation of express services on the line as a consequence of the proposed capacity enhancement;
- This study does not consider the impact of isolated incidents (for example, a car hits the LC barrier) on level crossing closure periods. Rather it is noted that incidents tend to be periodic and typically result in significant interruption of service across the railway network.
- Realtime cycle durations would be increased due to poor driver and pedestrian behaviour for longer closure periods in the hour (for example, vehicles entering the space between the barriers after the bells and lights are activated, resulting in delay to barrier closure). It is not practicable to predict this user behaviour and it has not been accounted for in the study;
- Although the study has been carried out on the basis of two peak periods of one hour in the day. It is anticipated that the peak periods will extend to three hours at each end of the day as the enhanced working timetable leads to increased use of the railway. Peak periods in the future will be longer than they currently are, and train frequency will be higher throughout the day;
- Should the level crossing be retained, and enhanced, it would be closed for road users for very long periods. This can encourage dangerous behaviour in road users trying to cross the level crossing once the closing sequence has been initiated. The situation would lead to a higher occurrence rate of incidents;

- For the Off Peak hours the study identified a cumulative estimated closure time of approximately 30 minutes in the hour. Should the level crossing be retained and closed to road traffic for up to six hours of peak conditions and closed to road traffic for 50% of the remaining time it is considered that unsafe conditions would inevitably arise for road and rail users. This option is not considered further as a consequence.

Due to the anticipated effective closure of the level crossings to road users during peak hours and unsafe conditions which would arise in the event the level crossing is retained as part of the project it is concluded that <u>Coolmine, Clonsilla and Ashtown Level Crossings should be closed to road users</u> and alternative access and alternative access confirmed as appropriate to the level of use and the diversionary routes available.

<u>Porterstown Level Crossing</u>

This level crossing is located approximately mid-way between Clonsilla and Coolmine train station, east of Clonsilla Junction and carries equivalent railway traffic to the adjacent heavily loaded level crossings. It is remote from a station and consequently the strike in and stop signals are independent of other influencing infrastructure and trains travel at higher speeds. The cycle time is consequently shorter.

Opportunities to relocate the strike in signal and the stop signal don't manifest for Porterstown due to its isolation. Consequently the same opportunities for enhancement of the cycle time do not arise.

- Currently, in morning peak hour the level crossing barriers are closed 50% (32mins) of the hour, in the off peak 32% (19mins) of the hour;
- On implementation of the project working timetable the level crossing barriers will be closed for the whole of the AM peak hour and for 75% of the PM peak hour;
- The configuration of this level crossing is currently optimised. No enhancement can be achieved on the cycle time;
- This study does not consider the occurrence rate of incidents in the level crossing, but realtime cycle durations would also be increased by poor user behaviour and pedestrian and vehicle incidents (i.e., a car hits the LC barrier);
- Although the study has been carried out on the basis of two peak periods of one hour in the day, it is anticipated that the peak periods will extend to three hours at each end of the day as the enhanced working timetable leads to increased use of the railway. Peak periods in the future will be longer than they currently are, and train frequency will be higher throughout the day;
- Should the level crossing be retained and enhanced it would be closed for road users for very long periods. This can encourage dangerous behaviour of road users trying to cross the level crossing once the closing sequence has been initiated. The situation would lead to a higher occurrence rate of incidents;
- Given the effective closure of this crossing to road users during peak hours, the hazards associated with leaving it in places for off peak use are considered unacceptable from a safety perspective. This option is not considered further.

Due to the anticipated effective closure of the level crossing to road users during peak hours and unsafe conditions which would arise in the event the level crossing is retained as part of the project it is concluded that <u>Porterstown level crossing should be closed to road users</u> and alternative access and alternative access confirmed as appropriate to the level of use and the diversionary routes available.

<u>Barberstown Level Crossing</u>

This level crossing is located approximately 2km west of Clonsilla and east of Clonsilla Junction. It carries lower levels of traffic than the sections of the railway from Clonsilla east. This level crossing is remote from a station and consequently the strike in and stop signals are independent of other influencing infrastructure. The cycle time is consequently shorter.

Opportunities to relocate the strike in signal and the stop signal don't manifest for Barberstown due to its isolation. Consequently the same opportunities for enhancement of the cycle time do not arise.

- Currently, in morning peak hour the level crossing barriers are closed 43% (26mins) of the hour, in the off peak 36% (22mins) of the hour;

- On implementation of the project working timetable the level crossing barriers will be closed for 80% (47mins) of the of the AM peak hour and for 63% (37mins) of the PM peak hour;
- The configuration of this level crossing is currently optimised. No enhancement can be achieved on the cycle time;
- This study does not consider the occurrence rate of incidents in the level crossing, but realtime cycle durations would also be increased by poor user behaviour and pedestrian and vehicle incidents (i.e., a car hits the LC barrier);
- Although the study has been carried out on the basis of two peak periods of one hour in the day, it is anticipated that the peak periods will extend to three hours at each end of the day as the enhanced working timetable leads to increased use of the railway. Peak periods in the future will be longer than they currently are, and train frequency will be higher throughout the day;
- Should the level crossing be retained and enhanced it would be closed for road users for very long periods. This can encourage dangerous behaviour of road users trying to cross the level crossing once the closing sequence has been initiated. The situation would lead to a higher occurrence rate of incidents;
- Given the effective closure of this crossing to road users during peak hours, the hazards associated with leaving it in places for off peak use are considered unacceptable from a safety perspective. This option is not considered further.

Due to the anticipated effective closure of the level crossing to road users during peak hours and unsafe conditions which would arise in the event the level crossing is retained as part of the project it is concluded that Barberstown level crossing should be closed to road users and alternative access and alternative access confirmed as appropriate to the level of use and the diversionary routes available.

Blakestown Level Crossing

This level crossing is located approximately 1.7km west of Louisa Bridge Train Station and west of east of Clonsilla Junction. It carries lower levels of traffic than the sections of the railway from Clonsilla east. This level crossing is remote from a station and consequently the strike in and stop signals are independent of other influencing infrastructure. The cycle time is consequently shorter.

Opportunities to relocate the strike in signal and the stop signal don't manifest for Blakestown due to its isolation. Consequently, the same opportunities for enhancement of the cycle time do not arise.

- Currently, in morning peak hour the level crossing barriers are closed 43% (23mins) of the hour, in the off peak 21% (13mins) of the hour;
- On implementation of the project working timetable the level crossing barriers will be closed for 80% (47mins) of the of the AM peak hour and for 63% (37mins) of the PM peak hour;
- The configuration of this level crossing is currently optimised. No enhancement can be achieved on the cycle time;
- This study does not consider the occurrence rate of incidents at the level crossing, but realtime cycle durations would also be increased by poor user behaviour and pedestrian and vehicle incidents (i.e., a car hits the LC barrier);
- Although the study has been carried out on the basis of two peak periods of one hour in the day, it is anticipated that the peak periods will extend to three hours at each end of the day as the enhanced working timetable leads to increased use of the railway. Peak periods in the future will be longer than they currently are, and train frequency will be higher throughout the day;
- Should the level crossing be retained and enhanced it would be closed for road users for very long periods. This can encourage dangerous behaviour of road users trying to cross the level crossing once the closing sequence has been initiated. The situation would lead to a higher occurrence rate of incidents;
- Given the effective closure of this crossing to road users during peak hours, the hazards associated with leaving it in places for off peak use are considered unacceptable from a safety perspective. This option is not considered further.

Due to the anticipated effective closure of the level crossing to road users during peak hours and unsafe conditions which would arise in the event the level crossing is retained as part of the project it is concluded that Blakestown level crossing should be closed to road users and alternative access confirmed as appropriate to the level of use and the diversionary routes available.

Level Crossing	Proposed Treatment	Principal Reasons
Ashtown Coolmine Clonsilla	Close level crossings	• Little scope for improvement in closure times as any significant adjustment would prohibit express trains; • Planned level of service indicates level crossing effectively closed for the extended full peak hours; • Planned level of service indicates level crossing barriers effectively closed for the off peak hours; • Removal of the level crossings will be a significant enhancement to railway safety, particularly in the context of the proposed project working timetable.
Porterstown	Close level crossing	• Little scope for improvement on closure times as crossing already efficient; • Planned level of service indicates level crossing effectively closed for the extended full peak hours; • Planned level of service indicates level crossing barriers effectively closed for the off peak hours; • Removal of the level crossing will be a significant enhancement to railway safety, particularly in the context of the proposed project working timetable.
Barberstown	Close level crossing	• Little scope for improvement on closure times as crossing already efficient; • Planned level of service indicates level crossing effectively closed for the extended full peak hours; • Planned level of service indicates level crossing barriers effectively closed for the off peak hours; • Removal of the level crossing will be a significant enhancement to railway safety, particularly in the context of the proposed project working timetable.
Blakestown	Close level crossing	• Little scope for improvement on closure times as crossing already efficient; • Planned level of service indicates level crossing effectively closed for the extended full peak hours; • Planned level of service indicates level crossing barriers effectively closed for the off peak hours; • Removal of the level crossing will be a significant enhancement to railway safety, particularly in the context of the proposed project working timetable.

1. Introduction

The purpose of this technical note is to provide information and rationale for the closure of the existing 6 No. level crossing along the Maynooth Line to facilitate the increased train capacity associated with DART+ West. The six level crossings are located at Ashtown, Coolmine, Porterstown, Clonsilla, Barberstown and Blakestown.

The paper has been prepared as part of the design development process but also addresses concerns raised by members of the public as part of the non-statutory public consultation process in respect of Coolmine level crossing.

The public queried:

1. Could the level crossing be left in place with the train capacity increases envisaged by DART+ West and incorporating a different signalling arrangement; and
2. Could the level crossing remain with the train capacity increases envisaged by DART+ West and incorporating faster and more efficient level crossing closing mechanisms.

All level crossings have been examined as part of this study but where common operational characteristics exist between crossings, an exemplar has been used. Coolmine was chosen as the exemplar site, for level crossings located adjacent to train stations. It is used provide information on the operation and closure patterns associated with the current (2019) level of service and for comparison with the future operation and closure patterns associated with the enhanced DART+ West train service. Other level crossings have been considered individually.

Analysis and simulations have been conducted to consider improvements in infrastructure (signalling and level crossing mechanics) to determine the potential for retaining level crossings as part of DART+ West. This analysis and simulation is based on the estimation of the gate closure periods to facilitate train passes and the resultant period when the gates would be open to facilitate pedestrian/cyclist/vehicular movements on the road network.

Iarnród Éireann has a mandate and legal duty to manage and control the safe movement of trains on its railway network and to control risk at public interfaces. Therefore, the technical note incorporates all requirements, to ensure that passengers on trains and the public crossing the level crossings can do so safely, are maintained.

2. Background

2.1 Overview of the DART+ Project

The DART+ West Project is the first of three projects to be implemented as part of the DART+ Programme aiming to provide sustainable commuter railway capacity enhancement across much of the Greater Dublin Area. The scope of the programme is illustrated in the graphic in Figure **2-2 – Overview of** the DART+ West Project

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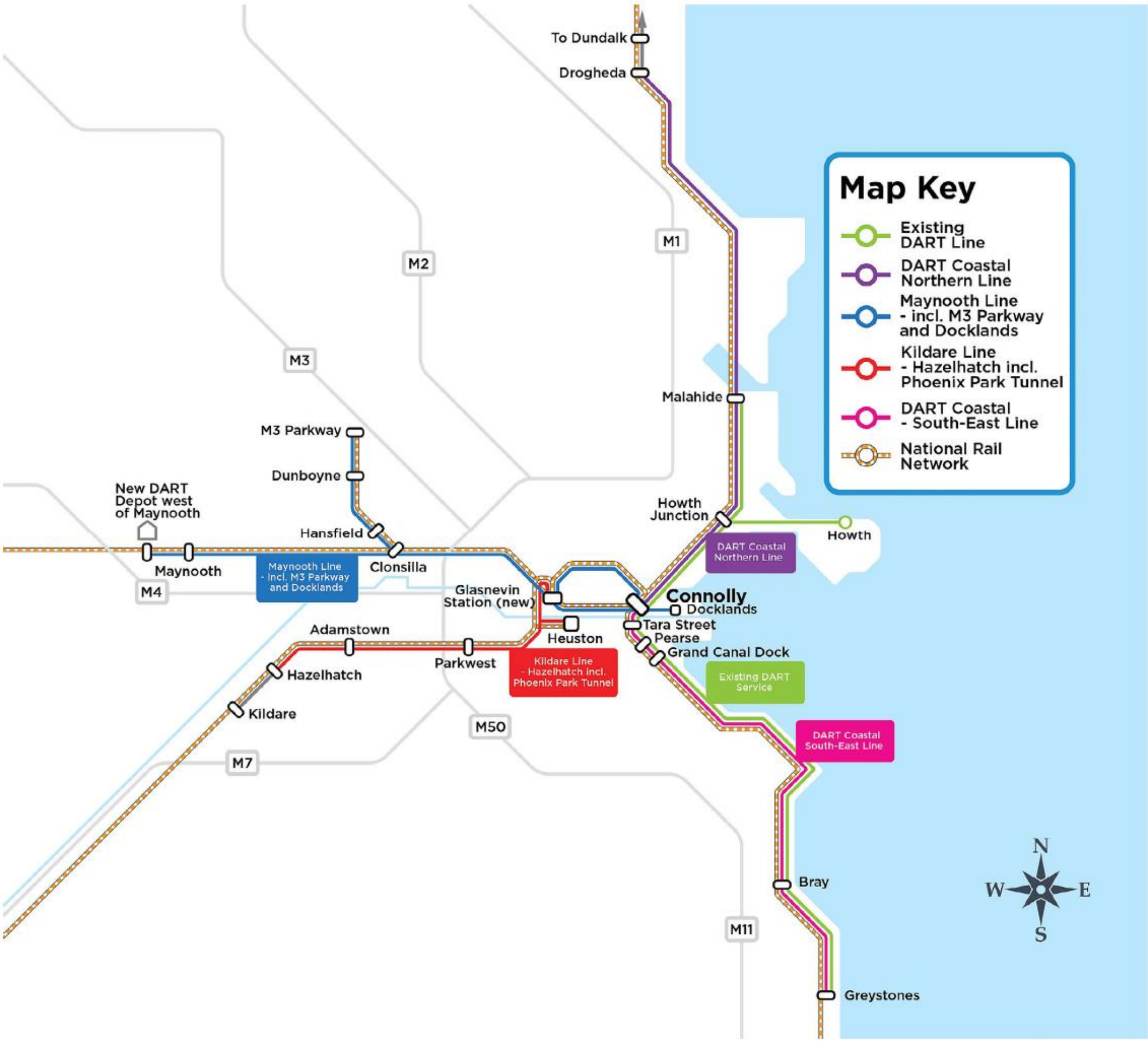

Figure 2-1 – Schematic Overview of the DART+ Programme

Dart+ West is focused on the city centre, the Maynooth Line and the M3 Parkway line and includes the following principal components:

- Electrification of the lines;
- Resignalling the lines to facilitate a higher frequency of trains;
- Improvements to track alignment and alterations to railway junctions;
- Capacity enhancements at Connolly Station;
- New station at Spencer Dock;
- New Depot west of Maynooth;

- The removal of 6No. level crossings along the Maynooth line.

A graphic illustrating the extent and principal elements of DART+ West in included in Figure 5.2 below:

Figure 2-2 – Overview of the DART+ West Project

This technical paper examines the current operating procedure at level crossings and the capacity constraints (both rail constraints and road constraints) consequent on the presence of the level crossings.

2.2 Iarnród Éireann National Level Crossing Strategy

It is the general duty of CIÉ, as detailed in Section 15 of the Transport Act 1950 (i.e. establishing legislation for CIÉ), to:

> *"provide or secure or promote the provision of an efficient, economical, convenient and properly integrated system of public transport for passengers and merchandise by rail, road and water with due regard to safety of operation, the encouragement of national economic development and the maintenance of reasonable conditions of employment for its employees and for that purpose it shall be the duty of the Board to improve in such manner as it considers necessary transport facilities so as to provide for the needs of the public, agriculture, commerce and industry".*

Similarly, the Railway Safety Act 2005 (the 2005 Act), section 36, provides that it shall be the general duty of a railway organisation to ensure, in so far as is reasonably practicable, the safety of persons in the operation of its railway.

There is also an underlying health and safety issue with any interface between a railway line and a public road. The function of a level crossing where there is an overlap in two different transportation modes is such that there is a heightened risk of an accident occurring. It is the duty of CIÉ to maintain the operational safety of the railway network and both CIÉ and IÉ have adopted a systematic approach to the removal level crossings in Ireland over the past 20 years. Reducing the risk profile is considered in the context of national infrastructure improvements, identified in the National Development Plan (2018-2027) and national policies on railway safety set out in IEs own documents and those by the Commission for Railway Regulation (CRR).

In line with Government Policy, Iarnród Éireann is seeking to enhance the national railway network to modernise and improve the existing railway infrastructure to meet passenger demand for high quality public transport. This modernisation and improvement will provide improved track corridors, electrification of lines, increased train capacity and elimination of constraints.

2.3 DART+ West Objective to Enhance Railway Capacity

Currently at peak train movements on the Maynooth line result in 7 trains running per hour per direction, nominally. A proposed working timetable has been developed and optimised for the project, taking account of proposed infrastructural enhancements and the existing constraints on the railway network. Demand modelling has been carried out to project passenger usage levels throughout the proposed electrified network. An extract from the optimised baseline working timetable is illustrated in Figure **2-3 – Extract from** Proposed Baseline Train **Service** Specification with Proposed Trains / Hour / Direction

and includes 12 commuter trains per hour per direction in the peak hours along the Maynooth Line east of Clonsilla and 8 trains per hour per direction on the Maynooth Line west of Clonsilla. The proposed working timetable is constrained by capacity restrictions at Connolly Station and Spencer Dock. Should the DART Underground be implemented at a future date the planned train service specification will provide for 15 trains per hour per direction, nominally.

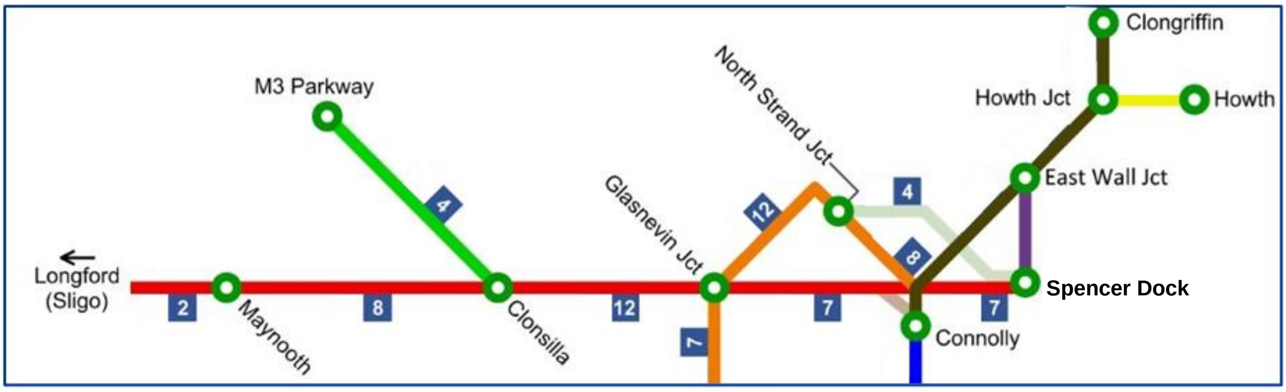

Figure 2-3 – Extract from Proposed Baseline Train Service Specification with Proposed Trains / Hour / Direction

The level crossings of concern are located on the affected sections of the network (i.e. Ashtown, Coolmine, Porterstown and Clonsilla are located between Glasnevin Junction and Clonsilla Junction, and Barberstown and Blakestown are located between Clonsilla Junction and Maynooth). DART+ West envisages removing them from the railway network so the capacity enhancement can be delivered in such way that rail services are not constrained by having to share capacity with road users at the existing level crossings. This technical paper is intended to provide clarity on this need.

2.4 Existing Level Crossings

<u>**The Legacy of Level Crossings in Ireland**</u>

Road / rail interfaces in the form of at grade level crossings are a legacy from the early nineteenth century which manifest a compromise reached during development of the railway network between construction cost, engineering constraints and landowner impacts. They were introduced into a rural railway network when there were few cars on the road. Iarnród Éireann and road authorities have worked to ensure public safety at these interfaces on an ongoing basis since that time. With ongoing and increased intensification of development in suburban areas, IE have implemented enhancements to monitoring and control of level crossings, but road / rail interfaces of this nature represent an inherent risk to road and rail users which will continue to require ongoing proactive management until they are removed from the road and railway network.

In November 1997 a passenger train derailed at a public road level crossing in Knockroghery, Co. Roscommon. Following this accident, the government commissioned a strategic review of all aspects of the safety of Iarnród Éireann's railway network Consequent on the review the Government then requested Iarnrod Eireann (IE) to prepare a Railway Safety Programme of investment in enhancement of railway safety.

As part of the safety review it was determined that level crossings pose one of the largest single risks to the operational railway. It was later confirmed that the greatest tangible gain to safety could be achieved by direct investment in the removal of level crossings. Separately, consultants A. D. Little were commissioned to carry out a safety review of level crossings and their recommendations were incorporated into the Railway Safety programme.

In 1999, an IE project team was set up to implement the recommendations of the A. D. Little report [1]. The Level Crossings Programme was established with a mandate to enhance safety through the upgrade or removal of level crossings across the Country.

The Iarnród Éireann railway network is largely rural in nature and consequently is characterised by large numbers of level crossings. This is typical of rural railway networks. **Figure 2-4 – Recent Map of** the IE **Railway** Network

shows a recent map of the IE railway network. At the outset of the Railway Safety Programme there were in excess of 2500 level crossings across all lines, over 2000 on used lines and 1600 on passenger lines. There are in total approximately 2033km of passenger line on the network. This corresponds to an average of one level crossing per km of passenger line. By the end of 2013, more than 750 level crossings had been removed from the railway network as part of the Level Crossings Programme through land acquisition, and the construction of physical infrastructure such as roads and bridges to facilitate removal of the level crossings. Since 2013 Reillys Level Crossing on the Maynooth Line in Cabra was removed as part of the programme.

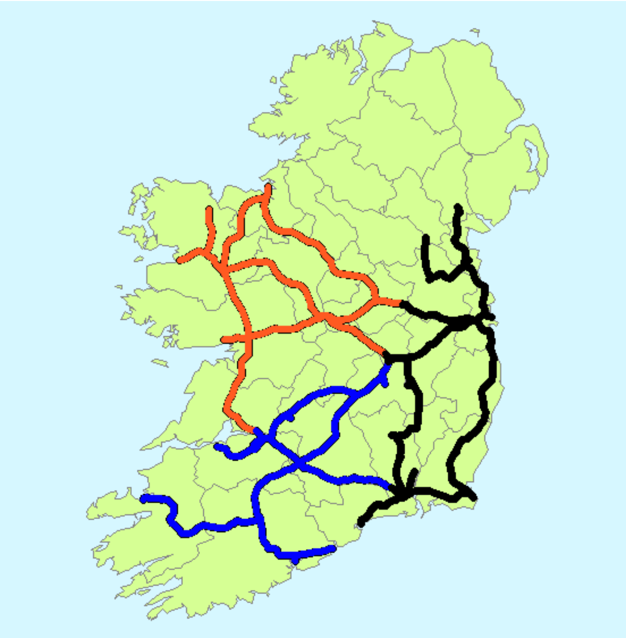

Figure 2-4 – Recent Map of the IE Railway Network

In respect of transport safety railway, level crossings continue to represent a significant safety consideration. 'Railway Safety Performance statistics in Ireland, published by the Commission for Railway Regulation in December 2017, report in respect of level crossings:

> *'Level crossings are a significant risk to the railway and to any third parties who use them. The long established trend, as shown'* in **Figure 5.5** *' is a decrease in the number of level crossings; there were 1701 level crossings in 2004 vs 948 recorded for 2016, with 23 being eliminated in 2016.'*

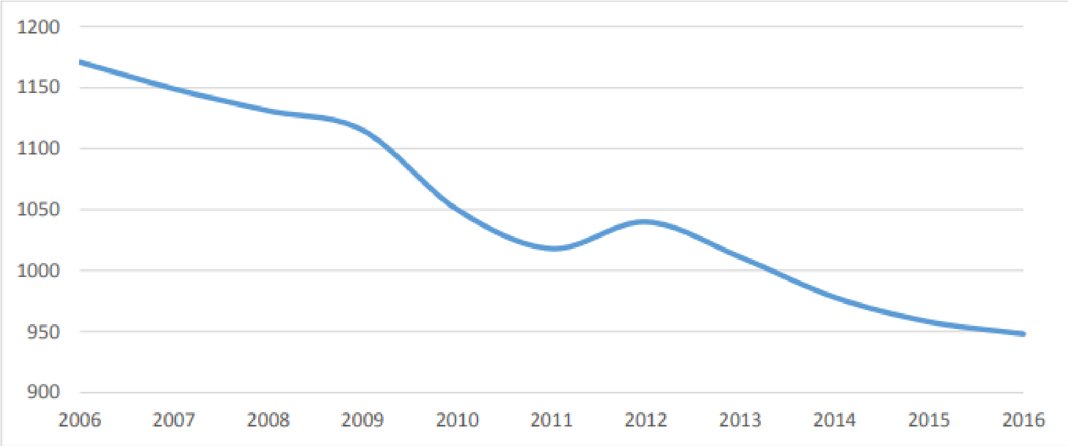

Figure 2-5 – Number of Level Crossings in Ireland by Year

'The graph also demonstrates the long term trend of level crossing elimination. Sustained efforts by Iarnród Éireann have contributed greatly to reducing the risk presented by level crossings.'

The above serves to illustrate the mandate that has been in place by IE and from government to enhance safety on the railway through the removal of road rail level crossings from the railway network. Railway Accident Statistics associated with level crossings are presented in Table 2-1.

Table 2-1 Railway accident statistics pertinent to level crossings

Category	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Train collision with a motor vehicle at a level crossing	1	2	2	1	4	4	0	2	1	2	1	2	0	0
Train collision with pedestrian at a level crossing	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Train collision with attended gates at a level crossing	2	4	2	2	2	1	0	1	0	0	0	0	1	0
Train collision with large animal(s) on the line	43	40	42	43	42	33	20	24	35	26	29	9	29	35

The CRR Statistics document reports '*Total train collisions (with obstacles/large animals) have risen to 68 in 2016 from 33 in 2015. There has been some volatility in the data between 2013 and 2016, but the trends show it continues to be a cause for concern. As discussed in previous reports, animals, (deer, cattle and sheep) are a major contributor to collision statistics in Ireland. Iarnród Éireann continues to invest in fencing systems to protect against incursions to its railway. In addition the reduction in the number of level crossings should also be assisting in this trend.*'

Iarnród Éireann maintains a safety database for the railway network. By way of example, between 2015 and 2019 for Coolmine level crossing the database records 21 incidents that impacted on rail services, road traffic or both. These are summarised in Table 2-2 as follows:

Table 2-2 IE Incident Records 2014 to 2019 Coolmine Level Crossing

Incident No	Incident Date & Time	Incident Title
INC-03169	28/04/2015 00:00	*Road vehicle strikes level crossing gate or barrier XG006 Coolmine LC*
INC-04503	20/10/2015 15:58	*Road vehicle strikes level crossing barrier at XG006*
INC-06511	30/12/2015 12:00	*Strong Wind impacts services at XG006*
INC-11048	28/06/2016 09:20	*Road vehicle strikes level crossing gate or barrier at Coolmine XG006*

Incident No	Incident Date & Time	Incident Title
INC-12070	10/08/2016 17:10	*Road vehicle strikes level crossing gate or barrier XG006*
INC-12121	13/08/2016 19:20	*Cat 1 Near miss with pedestrian at level crossing XG006*
INC-13763	08/10/2016 14:13	*MoP Trespass onto cleared LX at XG006 Coolmine*
INC-21118	28/07/2017 15:53	*Person interferes with barrier operation at XG006 Coolmine*
INC-21002	24/07/2017 08:24	*Vehicle strikes level crossing barrier at XG006 Coolmine*
INC-21573	17/08/2017 08:48	*Vehicle drives onto line during lowering sequence at XG006*
INC-23373	18/10/2017 09:56	*Trespasser (XG006) Coolmine level crossing*
INC-27463	20/04/2018 19:34	*Poor visibility at Coolmine LC XG006*
INC-29473	02/07/2018 00:00	*Trespass on railway line at XG006 Coolmine LC*
INC-30375	13/08/2018 17:57	*MoP Trespass onto cleared LX at XG006*
INC-30419	15/08/2018 09:27	*Road vehicle struck LX XG006 - No damage to crossing*
INC-30816	02/09/2018 12:35	*LX Barrier closes on road vehicle - No damage crossing No XG006*
INC-31214	19/09/2018 07:17	*CCTV camera / image failure at crossing XG006 Coolmine*
INC-32822	01/11/2018 18:23	*MoP Trespass onto cleared LX at XG006*
INC-36110	19/03/2019 18:00	*LX Barrier closes on road vehicle - No damage . crossing No XG006*
INC-37107	26/04/2019 13:31	*Cat 1 Near miss with pedestrian at XG006 Coolmine*
INC-40901	12/09/2019 19:21	*Person interferes with XG006 Coolmine*

In addition to accidents on the railway, there is evidence of hazard in respect of level crossings for road users and the public. The graphic in Figure 2-6 is a snapshot of the Road Safety Authority Road Collision Statistics in respect of Coolmine. It illustrates the record of collisions in the vicinity of Coolmine Road between 2005 and 2016. It is evident that four of the incidents are either at the level crossing or on the immediate approach to it.

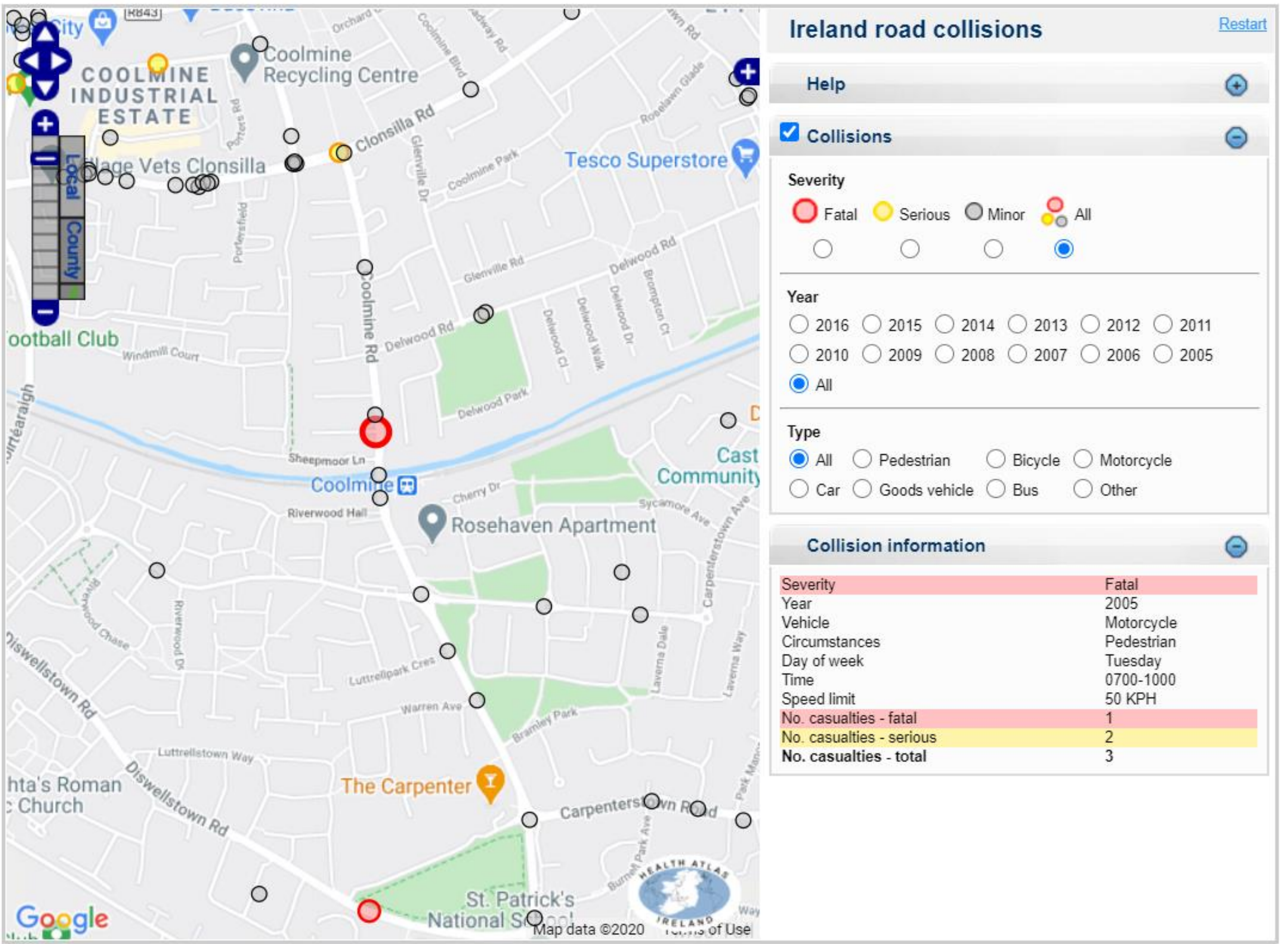

Figure 2-6 – RSA Road Collision Data for Coolmine Level Crossing

It is clear from the above that the presence of level crossings on the railway and road network is a hazard to transport users and the public. Any proposal with supports the removal of level crossings represents an inherent improvement in transport safety.

Level Crossing Types

Railway Level Crossings are typically either 'user worked' or 'railway worked'. In Ireland 80% of all level crossings are user worked, operated by landowners or the public. Most were put in place when the railway was constructed. Many of those on public roads have been specifically identified in the railway act instituting the line. Others are the subject of agreements between the railway and specific users.

The level crossings under consideration as part of DART+ West are all railway worked crossings. Two types apply as follows:

- Public Railway Worked Crossing – Gated – Closed to Railway - Attended (Ashtown & Clonsilla)

  This is controlled by an operative based local to the crossing who closes the gates before a train is due. The train is only released to cross the road when the railway boundary is secure.

- Public Railway Worked Crossing – Barriers – CCTV Control (Coolmine, Porterstown, Barberstown & Blakestown)

This is controlled by remote operative viewing the extent of the level crossing by CCTV and remotely controlling the barriers being dropped and lifted. The train is only released to cross the road when the railway boundary is secure.

The only other type of railway worked level crossings in use in Ireland are in place on the Rosslare line south of Wexford train station and at Ports where no barriers or gates are used. These are exceptional and relate to situations of very slow and controlled train movements.

Attended and CCTV controlled level crossings have superior operational safety characteristics. They are under the direct control of railway personnel and require the railway boundary to be secure prior to a train being permitted to pass through the level crossing.

The ‘automatic’ type of railway worked level crossing is used in other countries across Europe. This type of level crossing operates faster than Attended or CCTV controlled alternatives, resulting in shorter closure times, as it removes the direct control from the signalman or gatekeeper. The train passes through the level crossing whether it is clear or not. This type of level crossing has poorer safety characteristics than alternatives and has consequently never been adopted by Iarnród Éireann for use in Ireland.

Level Crossing Operation

Level crossings are an interface between a railway line and the public and are categorised by their function. As indicated above, all level crossings associated with the project are attended or CCTV controlled public road level crossings, which facilitate movement of pedestrians, cyclists and vehicles across the railway corridor.

In most simplistic terms, level crossings form a physical barrier to prevent access to a railway line. As such, they create a clear track for trains to proceed in a safe and unhindered manner. The closure of the level crossings cause regular interruption to traffic flows on the road network (for pedestrian, cyclist and motorists), which results in road congestion, delays and journey time uncertainty. They require enabling infrastructure signalling, barrier systems, and gates that can be prone to incident and malfunction. If such malfunctions occur, they can lead to cessation of train movements, road movements or both.

If the level crossing is not clear the approaching train must stop and must be given adequate time to complete the stop. Given the nature of train operation (steel wheels on steel track with low friction), the stopping time and distance for a train is considerable. A passenger train on the Maynooth Line travelling at line speed 90km per hour will need approximately 1.6km to come to an emergency stop.

The level crossings along the Maynooth Line are full barrier or gate systems, where the road and paths on the public road are blocked when a train is approaching. They incorporate traffic lights or a bespoke lighting system which flashes red before the level crossing gates are set in motion. This is an advance warning that the level crossing closure process is initiated, and pedestrians, cyclists or motorists should not enter into the level crossing box.

The main elements of a basic level crossing control system with barriers (see Figure 2-7) are as follows:

- Strike-in point: The strike-in point is the point where the passage of a train is detected and initiates the warning and closing sequence of the level crossing barriers;
- Light signals for vehicles: visual signals that warn vehicles that the level crossing is activated and closed due to impending presence of a train;

- Audible alarm system: acoustic signals warning vehicles of impending presence of a train;
- Barriers: physical barriers that prevents access into the level crossing clearance box;
- Stop signal: Signal that indicates to the train driver if the train can proceed or not proceed through the level crossing. If the stop signal is red, it indicates that the level crossing might be obstructed for some reason and the train must stop immediately to maintain safety.

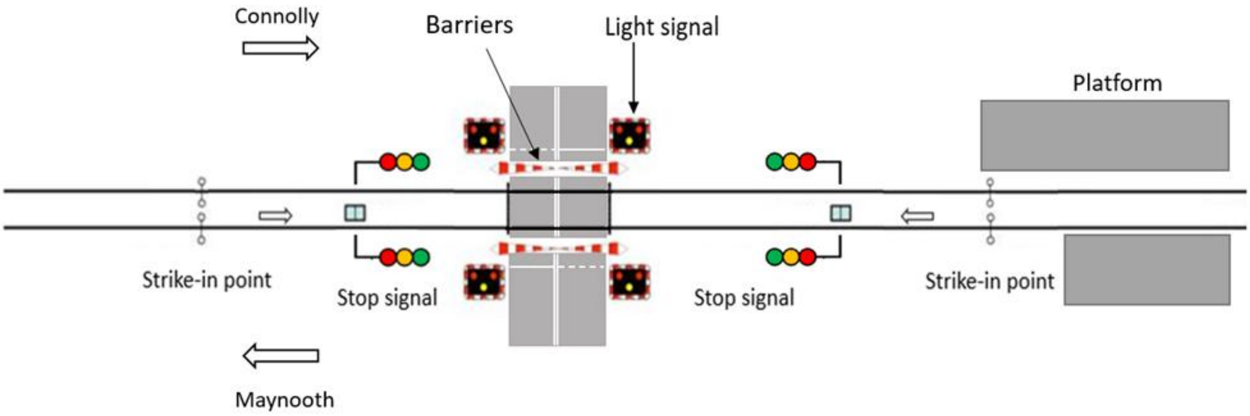

Figure 2-7 – Main Elements of a Level Crossing

Therefore, as the train moves towards the level crossing, it is detected in the strike-in point, which starts the process. The warning lights and audible alarm sound at the level crossing and after a short number of seconds the level crossing barriers start to close. When the closure process is complete and free from obstruction, as verified by the CCTV crossing keeper, the stop signal will get a green light for clearance and the train drive can proceed through the level crossing. Therefore, the full level crossing process must be completed while the train travels between the strike in signal and the stop signal.

The separation distance between the strike in signal, the stop signal and the level crossing form an important aspect in optimising the operation of the level crossing for shared rail and public interface. However, the signalling design must also always take account of the safety design issues to minimise risk to people on trains and road users.

For context, a train operating at 90km per hour travels 1,500 metres per minute and needs approximately 1,600 metres to come to a full emergency stop.

The distance between the stop signal and the strike-in point is calculated taking into account:

- The geometry and physical setting of the level crossing and the delineation to the level crossing clearance box on the road;
- The time it takes for the cycle to be completed (from when the train reaches the strike-in point until the barriers are closed);
- The speed of the train, which can be greater or lesser depending on whether the train is coming from a stop in a station or is a passing train, which has not stopped;
- The geometry and gradient of the track; and;
- The specification and braking characteristics of the train using the track.

The location of a stop signal is also related to the configuration of local track circuits. The existing signalling system is set up on the basis of electrically isolated sections of trackwork. The signalling system uses the making and breaking of electrical circuits, comprising sections of track and the axles of the train, to allow the signalman to know when the train has passed from one section of railway to another along the line.

Historically the track circuits are established around primary infrastructural elements such as stations, switches, turnouts and sidings and level crossings with a desirable section length of 700m. Within the part of the Maynooth line of interest numerous infrastructural elements manifest. There are 8No. train stations, the shortest distance between any two being approximately 600m. Several of the level crossings are in close proximity to stations while others are located farther away. In some instances there is more than one level crossing between two train stations. In addition, there are sidings at Clonsilla and a turnout for the Dunboyne line just west of Clonsilla.

The barriers may remain lowered while more than one train passes through the level crossing. This becomes inevitable as the frequency of trains increases in a given hour. Typically, the fact that more than one train is traversing a level crossing is related to the working timetable, the proximity of train stations, the proximity of adjacent level crossings, the location of stop signals and the presence of stopping and non-stopping trains on the section of the line concerned. Given this significant level of variation we find that even though level crossings may be on the same section of line the total closed period in the hour can vary significantly.

Each of the above can affect the location of stop signal and the potential for optimising the closure time for a given level crossing.

Maynooth Line Level Crossings

There are currently 6 No. level crossings along the Maynooth Line, and all are public road level crossings, which facilitate movement of pedestrians, cyclists and vehicles across the railway corridor, which is orientated an east-west from Dublin City Centre to Dublin West and into County Kildare and County Meath.

The level crossings are located at:

- Ashtown;
- Coolmine;
- Porterstown;
- Clonsilla;
- Barberstown; and
- Blakestown.

The location of the level crossings is shown in Figure 2-8Figure 2-8 – Location of Level Crossings on Maynooth Line

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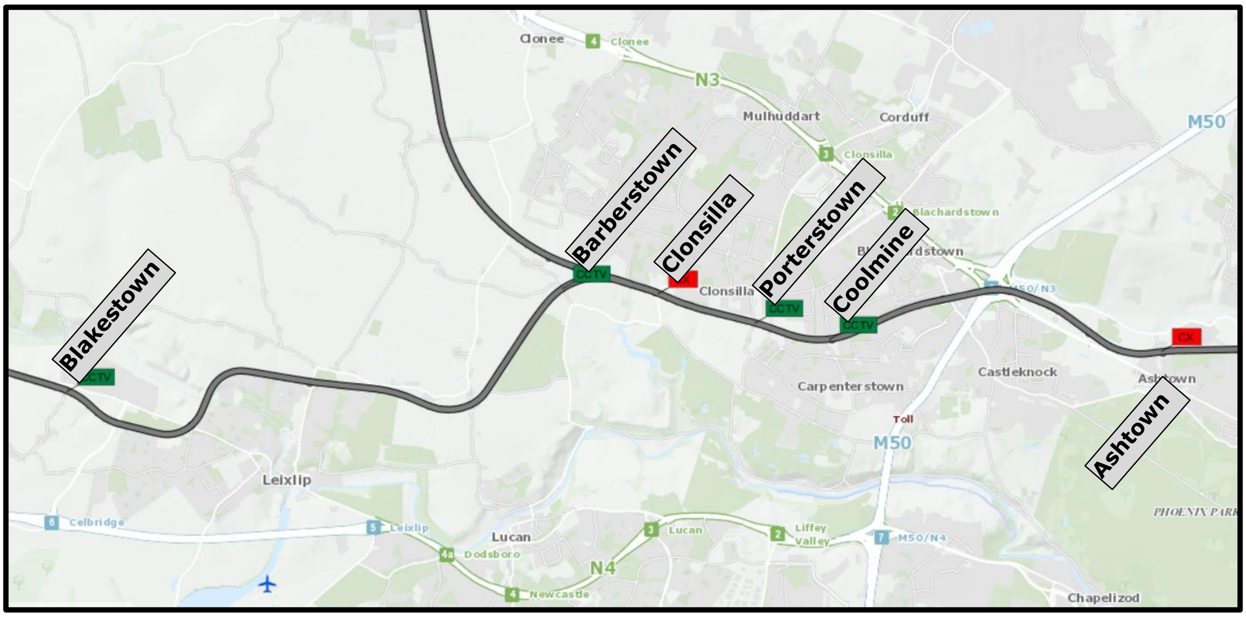

Figure 2-8 – Location of Level Crossings on Maynooth Line

Ashtown and Clonsilla are attended level crossings where the gates are manually closed, based on an alert sent to the level crossing attendant from the signalling system. The level crossing attendant ensures that the level crossing is clear before closing the gates. Coolmine, Porterstown, Barberstown and Blakestown are CCTV controlled crossings, where the gate closure process is automatically triggered by the signalling and controlled by a signalman observing by close circuit television (CCTV) to ensure the level crossing is clear of obstructions (cars, bikes, etc) and persons.

Details of the level crossings are summarised in Table 2-3.

Table 2-3 AM Peak Railway Stats for the Level Crossings

Level Crossing	Station Adjacent	Current Trains Passing (No.)	Planned Trains Passing (No.)	Uplift (%)	Current Closures (No.)	Projected Closures (No.)	Current Average Closure Duration	Current Total Closure Duration per Hour	Projected Total Closure Duration*
Ashtown (attended)	Yes	13	24	84	6	12	06:07	36:42	73:24
Coolmine (CCTV)	Yes	12	24	100	9	18	04:37	41:35	83:06
Porterstown (CCTV)	No	12	24	100	7	14	04:41	32:46	65:34
Clonsilla (attended)	Yes	12	24	100	7	14	04:25	30:58	61:50
Barberstown (CCTV)	No	9	16	78	6	11	04:21	26:03	47:51
Blakestown (CCTV)	No	7	16	128	5	11	04:46	23:48	52:26

Note: All Durations are presented in minutes and seconds per hour. Where cumulative durations in excess of 60minutes are reported this indicates the level crossing is effectively closed for the full hour.
* Projection based on average closure timed without optimisation

Table 2-4 PM Peak Railway Stats for the Level Crossings

Level Crossing	Station Adjacent	Current Trains Passing (No.)	Planned Trains Passing (No.)	Uplift (%)	Current Closures (No.)	Projected Closures (No.)	Current Average Closure Duration	Current Total Closure Duration	Projected Total Closure Duration*
Ashtown (attended)	Yes	11	24	118	6	12	06:05	36:32	73:00
Coolmine (CCTV)	Yes	11	24	118	7	18	04:53	34:14	87:54
Porterstown (CCTV)	No	10	24	100	6	14	03:20	19:57	46:40
Clonsilla (attended)	Yes	10	24	100	4	14	06:38	26:30	92:52
Barberstown (CCTV)	No	7	16	128	6	11	03:26	20:37	37:46
Blakestown (CCTV)	No	7	16	128	6	11	03:39	21:54	40:09

Note: All Durations are presented in minutes and seconds per hour. Where cumulative durations in excess of 60minutes are reported this indicates the level crossing is effectively closed for the full hour.
* Projection based on average closure timed without optimisation

A number of observations can be made on the details tabulated above as follows:

- Three of the crossings are located next to train stations and consequently have longer average closure durations associated with them;
- Porterstown level crossing, between Clonsilla and Coolmine is the only level crossing on this section of line with manifests as an isolated level crossing from a signalling perspective;
- Barberstown and Blakestown level crossings, located west of Clonsilla Junction manifest as isolated level crossings but also carry lower levels of existing railway traffic. These experience the largest percentage increase in train passes;
- Based on the anticipated working timetable and a pro-rata consideration of the additional train passes, all level crossings next to train stations exhibit saturation in peak hour;
- Porterstown, with 24 train passes in the peak hour is likely to be closed for up to 47mins in the hour;
- Barberstown and Blakestown level crossings with 16 train passes in the peak hour are likely to be closed for up to 40 minutes in the peak hour.

Surveyed road traffic counts at the level crossings, January 2019 are as presented in Table 2-5:

Table 2-5 Vehicular Road Traffic Counts for Level Crossings

Level Crossing	Station Adjacent	2019 AM SB Peak Veh/hr	2019 AM NB Peak Veh/hr	2019 PM SB Peak Veh/hr	2019 PM NB Peak Veh/hr
Ashtown (attended)	Yes	334	120	228	143
Coolmine (CCTV)	Yes	221	297	241	206
Porterstown (CCTV)	No	91	26	36	23
Clonsilla (attended)	Yes	202	143	116	215
Barberstown (CCTV)	No	73	20	28	43
Blakestown (CCTV)	No	3	9	9	4

From the above data is it noted the number of existing vehicular crossings of Porterstown and Barberstown level crossings is low and of Blakestown level crossing is very low in comparison to other crossings;

Pedestrian and cyclist counts were undertaken at Ashtown and Blakestown level crossings on Tuesday 5th February 2019 between 07:00 to 10:00 in the AM, and 16:00 to 19:00 in the PM. This data was supplemented with counts undertaken by Fingal County Council at Coolmine, Porterstown, Clonsilla and Barberstown.

The figures for each level crossing are presented in Table 2-6.

Table 2-6 AM & PM Pedestrian and Cycle Counts – CSEA Systra Oct 2019

Crossing	Time Period	Pedestrians		Cyclists	
		N/B	S/B	N/B	S/B
Ashtown	AM	150	672	65	44
	PM	574	217	53	56
Coolmine	AM	395	103	34	35
	PM	255	81	33	27
Porterstown	AM	5	123	1	37
	PM	149	24	41	13
Clonsilla	AM	23	15	1	2
	PM	441	15	12	5
Barberstown	AM	0	0	2	1
	PM	0	0	3	0
Blakestown	AM	0	0	1	0
	PM	0	2	0	2

Each of the suburban level crossings experience significant levels of both pedestrian and cycle traffic. Rural level crossings exhibit very low levels of usage.

2.5 Exemplar enhancements at level crossings

For the purposes of this study exemplar crossings have been chosen to facilitate assessment of the potential for retention of the crossings as part of the project. They are as follows:

Table 2-7 Exemplar Crossings

Exemplar	Comparable Crossings
Coolmine (CCTV)	Ashtown and Clonsilla (Attended)
Porterstown (CCTV)	None
Barberstown (CCTV)	None
Blakestown (CCTV)	None

In each case the exemplar is considered for improvement or retention with the comparable crossings treated equivalently.

2.6 Coolmine level crossing – Setting and characteristics

Coolmine level crossing links Coolmine Road (to the north) to Carpenterstown Road (to the south) in Dublin 15. Coolmine Station is immediately east of the level crossing. The rail line is orientated in an east direction and parallel to the Royal Canal which is immediately north of the rail line. The general location of Coolmine level crossing and station is shown in Figure 2-9 Figure 2-9 – Aerial Photograph of the Area of Influence of the Coolmine Level Crossing

and a street view is shown in Figure 2-10**.** Figure 2-11 shows a general location, Figure 2-12 shows aerial view; Figure 2-13 and Figure 2-14 provide example street view and track view towards Coolmine Level Crossing to demonstrate the differing public and train perspective.

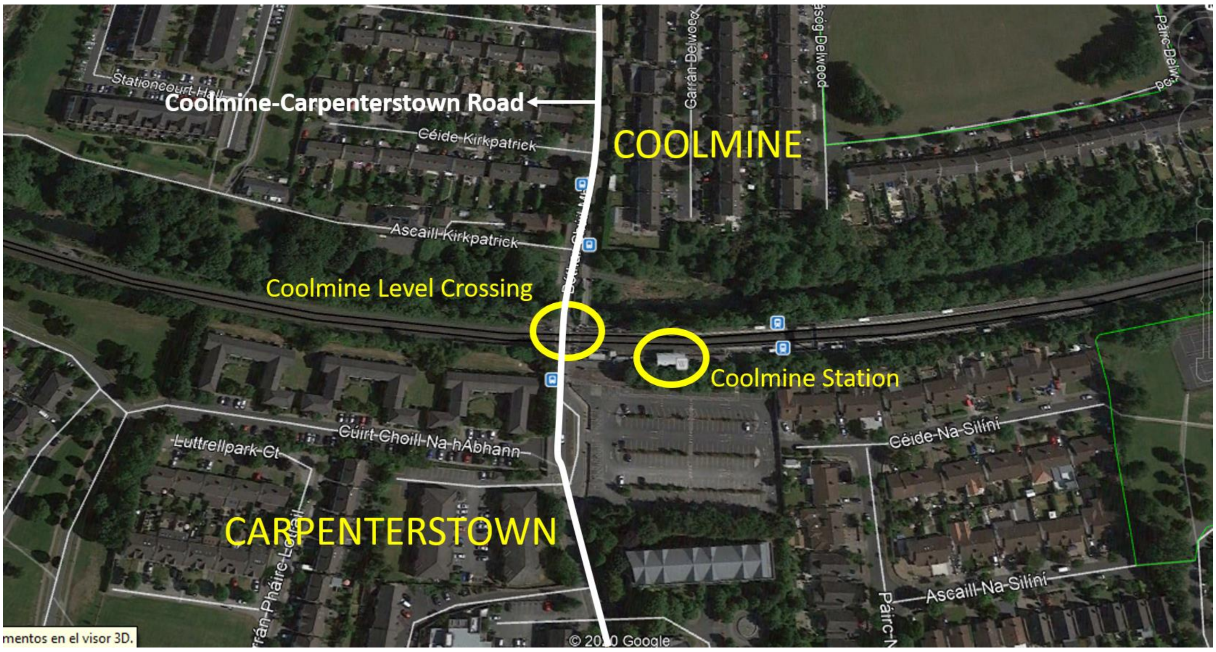

Figure 2-9 – Aerial Photograph of the Area of Influence of the Coolmine Level Crossing

Figure 2-10 – Detailed Photograph of the Coolmine Level Crossing

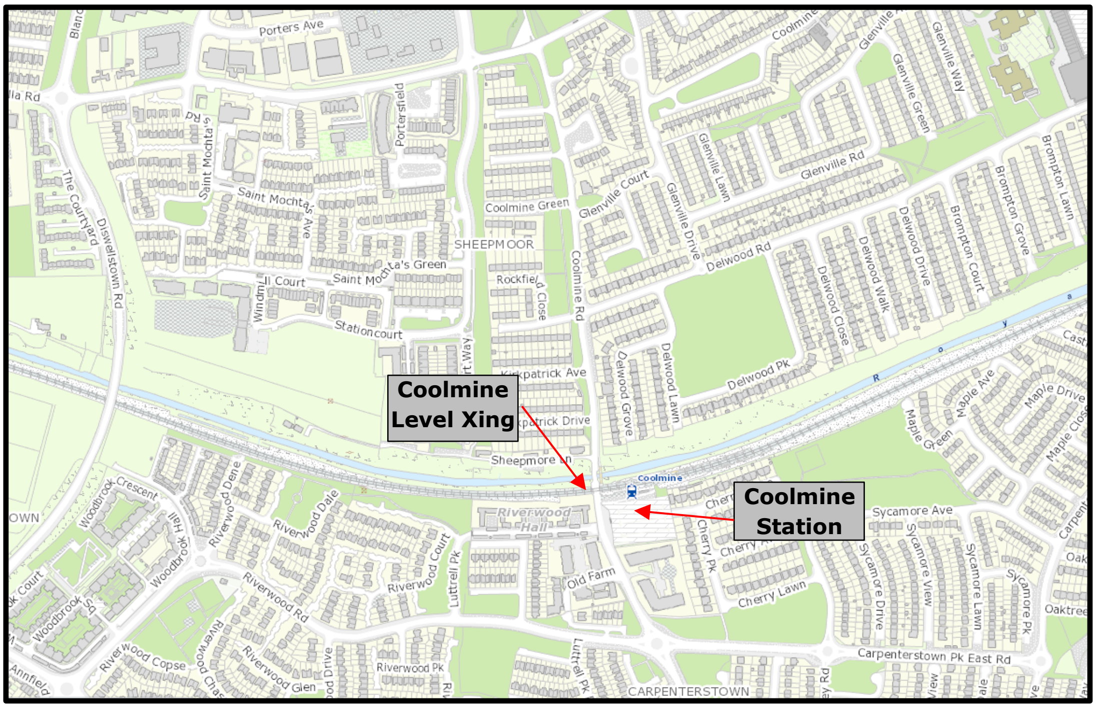

Figure 2-11 – General Location of Coolmine Level Crossing & Station

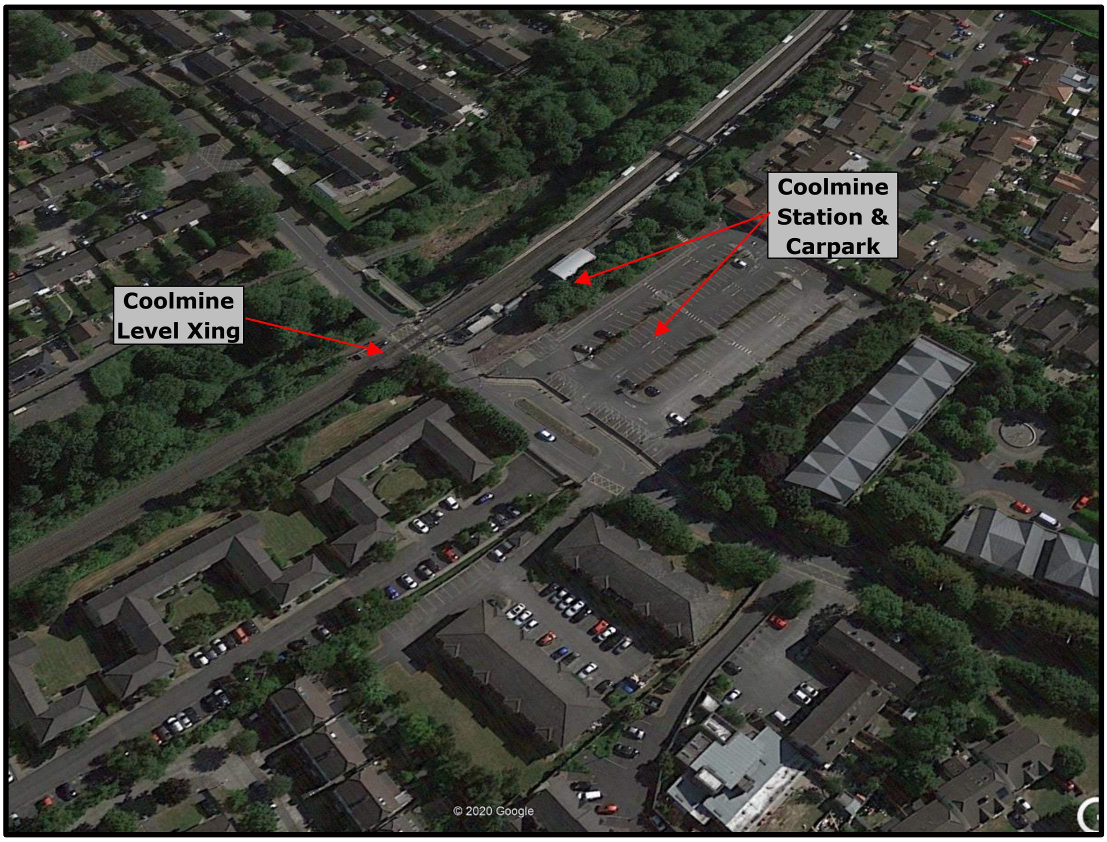

Figure 2-12 – Aerial View of Coolmine Level Crossing & Station

Figure 2-13 – Streetview of Coolmine Level Crossing

Figure 2-14 – Track View Towards Coolmine Level Crossing

A traffic survey was undertaken in January/February 2019 to assess the level of usage of Coolmine Level Crossing. This assessment concluded the following usage in the AM and PM peak.

- 7 trains per hour per direction in the AM peak hour and the PM peak hour;
- 518 vehicles movements across level crossing in the AM peak hour (297 (57%) northbound and 221 (43%) southbound);
- 447 vehicles movements across level crossing in the PM peak hour (206 (46% northbound and 241 (54%) southbound);
- 166 pedestrian movements across level crossing in the averaged AM peak hour (79% northbound and 21% southbound);
- 112 pedestrian movements across level crossing in the averaged PM peak hour (76% northbound and 24% southbound);
- 23 cyclist movements across level crossing in the averaged AM peak hour (49% northbound and 51% southbound); and
- 20 cyclist movements across level crossing in the PM peak hour (55% northbound and 45% southbound).

During the peak AM period, Coolmine level crossing was closed 9 times. This resulted in blockage of Coolmine/Carpenterstown road for approximately 41½ minutes in the 60 minutes between 0800-0900.

During the PM period, Coolmine level crossing was closed 7 times. This resulted in blockage of Coolmine/Carpenterstown road for approximately 34¼ minutes in the 60 minutes between 1700-1800.

The traffic assessment also concluded some other road geometry deficiencies with Coolmine Level Crossing:

- The bridge over the Royal Canal is a narrow protected structure.
- To cross the level crossings, pedestrian and cyclist have to share the road space with the general vehicular traffic;
- The path provided for pedestrians is narrow (less than 1m) and delineated by road markings. It must accommodate all users, i.e. pedestrian, cyclist, wheelchair users, pushchairs, etc;
- The existing Coolmine Station footbridge within the land ownership of Irish Rail is off the desire line and is not accessible to the public. It doesn’t provide ramps/lifts; therefore it is not adequate for universal access (wheelchair, cyclists, pushchairs, elderly users etc.);
- The footpath on Carpenterstown Road (south approach) is narrow on the western side;
- No pedestrian crossing provided from the western footpath to the eastern footpath and to access the train station;
- No pedestrian crossing provided on Coolmine Road (north approach);
- There are no dedicated cycle facilities. Cyclist must dismount to share the pedestrian paths or must share vehicular traffic lanes; and
- Level crossing closures results in queues and waiting times for all users.

Issue – Footbridge without universal access

Issue – Narrow path for pedestrians

Issue – Narrow footpath on the western side of Coolmine Road (northern approach), no crossing provided

Issue – Narrow footpath on the western side of Carperstown Road (southern approach), no crossing provided

Figure 2-15 – Ancillary details around Coolmine Level Crossing

2.7 Porterstown level crossing – Setting and characteristics

This section characterises Porterstown Level Crossing, it presents some of the key constraints and considerations for development and the assessment of options. Porterstown level crossing is located on the old Porterstown Road. The level crossing is currently CCTV controlled. Porterstown Road connects Clonsilla Road to the north to Diswellstown Road to the south. The crossing is located immediately adjacent to the Royal Canal, which is spanned by Keenan Bridge a masonry arch protected bridge structure. The Dublin to Sligo railway line runs east west at this location, and the level crossing is located on a straight section of railway. Figure 2-16 shows an aerial view of the level crossing and the surrounding roads.

Figure 2-16 – Aerial Photograph of the Area of Influence of the Porterstown Level Crossing

The existing road over Keenan Bridge (RPS) is only wide enough for a single lane of traffic meaning one vehicle must give way to an opposing vehicle on the approach to the bridge. The need for a full road traffic connection on Porterstown Road has been largely supplanted by the recent construction of the Porterstown Viaduct 200 metres to the east. Developments in recent years have provided connection being secured to the Porterstown Distributor Road running east west along the norther boundary of Luttrellstown Castle Estate.

A Streetview image of the approach to the level crossing is provided in Figure 2-17**.**

Figure 2-17 – Streetview of the Northern Approach to Porterstown Level Crossing

In regard to the use of this existing level crossing a number of issues arise as follows:

- The approach for a from the north narrows at the canal bridge such that opposing cars cannot pass. One must wait. This poses a risk to the operation of the level crossing;

- To cross the level crossings, pedestrian and cyclist have to share the road space with the general traffic. There is no dedicated pedestrian path on the level crossing;
- The Royal Canal overbridge is very narrow, there are no pedestrian or cyclist facilities provided;
- Narrow and discontinuous footpaths approaching from the north and the south, no pedestrian crossings provided;

Table 2-8 presents the existing AM and PM train passes over the level crossing with the projected passes consequent on implementation of the project working timetable.

Table 2-8 Railway Statistics for the Level Crossings

Level Crossing	Current Trains Passing (No.)	Planned Trains Passing (No.)	Uplift (%)	Current Closures (No.)	Projected Closures (No.)	Current Average Closure Duration	Current Total Closure Duration	Projected Total Closure Duration*
Porterstown AM	12	24	100	7	14	04:41	32:46	65:34
Porterstown PM	10	24	100	6	14	03:20	19:57	46:40

Note: All Durations are presented in minutes and seconds per hour. Where cumulative durations in excess of 60minutes are reported this indicated the level crossing is effectively closed for the full hour
* Projection based on average closure timed without optimisation

Surveyed road traffic counts at the level crossing, January 2019 are as presented in Table 2-9:

Table 2-9 Road Traffic Statistics for Porterstown

Level Crossing	Station Adjacent	2019 AM SB Peak Veh/hr	2019 AM NB Peak Veh/hr	2019 PM SB Peak Veh/hr	2019 PM NB Peak Veh/hr
Porterstown (CCTV)	No	91	26	36	23

From the above data is it noted the number of existing vehicular crossings of Porterstown level crossing is low. It is also noted that alternative vehicular access is available 200m east of the level crossing.

Pedestrian and cyclist counts were undertaken by Fingal County Council at Porterstown level crossing in January 2019.

The figures for each level crossing are presented in Table 2-10.

Table 2-10 AM & PM Pedestrian and Cycle Counts – CSEA Systra Oct 2019

Crossing	Time Period	Pedestrians		Cyclists	
		N/B	S/B	N/B	S/B
Porterstown	AM	5	123	1	37
	PM	149	24	41	13

Porterstown level crossing is located adjacent to schools and as with other crossings is adjacent to the Royal Canal.

2.8 Barberstown Level Crossing – Setting and Characteristics

The Barberstown Level Crossing is located to the approximately 1.2km west of Clonsilla Train station. It is located at Mileage 7mls 1320yds on the Dublin Sligo Railway Line. The railway at this location is twin track. There is no train station at this location. The Dublin to Maynooth railway line crosses Milestown Road, which is a local road linking the R121 Kellystown Road and R149 Barnhill Road. An aerial view of the crossing is provided in **Figure 2-18 – Aerial Photograph of** Barberstown Level **Crossing**

Figure 2-18 – Aerial Photograph of Barberstown Level Crossing

The crossing is located adjacent to the Royal Canal, which is spanned by Pakenham Bridge – a protected structure (RPS no.711). The area is rural in character with the surrounding lands predominantly used for agricultural purposes.

Figure 2-19 – Streetview image of Southern Approach to Barberstown Level Crossing

This crossing, currently under CCTV control, is situated in a rural setting and is lightly trafficked. The area is zoned for residential development within the Fingal Development Plan. Although lightly trafficked, closure of the crossing to vehicular traffic would result in a detour of approximately 5km. A Streetview image of the approach to the level crossing is provided in Figure **2-19 – Streetview image** of Southern Approach to Barberstown Level Crossing

In regard to the use of this existing level crossing a number of issues arise as follows:

To cross the level crossings, pedestrian and cyclist have to share the road space with the general traffic. There is no dedicated pedestrian path on the level crossing;

- The approach for a from the north narrows at the canal bridge such that opposing cars cannot pass. One must wait. Visibility on the northern approach to the bridge is poor. This poses a risk to the operation of the level crossing;

- The Royal Canal overbridge is very narrow, there are no pedestrian or cyclist facilities provided;
- There are no pedestrian facilities on the approaches to the level crossing;
- There are no dedicated cycle facilities in the vicinity of the level crossing.

Railway traffic statistics provided for the level crossing in Table 2-11.

Table 2-11 Railway Statistics for Barberstown Level Crossing

Level Crossing	Current Trains Passing (No.)	Planned Trains Passing (No.)	Uplift (%)	Current Closures (No.)	Projected Closures (No.)	Current Average Closure Duration	Current Total Closure Duration	Projected Total Closure Duration*
Barberstown AM	9	16	78	6	11	04:21	26:03	47:51
Barberstown PM	7	16	128	6	11	03:26	20:37	37:46

Note: All Durations are presented in minutes and seconds per hour.
* Projection based on average closure timed without optimisation

Surveyed road traffic counts at the level crossing, January 2019 are as presented in Table 2-12:

Table 2-12 Road Traffic Statistics for Barberstown

Level Crossing	Station Adjacent	2019 AM SB Peak Veh/hr	2019 AM NB Peak Veh/hr	2019 PM SB Peak Veh/hr	2019 PM NB Peak Veh/hr
Barberstown (CCTV)	No	73	20	28	43

From the above data is it noted the number of existing vehicular crossings Barberstown level crossings is low in comparison to other crossings; Pedestrian and cyclist counts were undertaken by Fingal County Council at Barberstown level crossings In February 2019.

The figures for each level crossing are presented in Table 2-13.

Table 2-13 AM & PM Pedestrian and Cycle Counts – CSEA Systra Oct 2019

Crossing	Time Period	Pedestrians		Cyclists	
		N/B	S/B	N/B	S/B
Barberstown	AM	0	0	2	1
	PM	0	0	3	0

This rural level crossings exhibit very low levels of pedestrian and cycle usage.

2.9 Blakestown level crossing – Setting and characteristics

Blakestown Level Crossing is located in Co. Kildare. Local Road (L81206) crosses the railway and adjacent Deey Bridge over the Royal Canal. Deey Bridge (and 13th Lock), is a Protected Structure (RPS No. B06-14) in the Kildare County Development Plan and spans the Royal Canal located north of the level crossing. An aerial view of the level crossing is shown in Figure 2-20Figure 2-20 – Aerial Photo of Blakestown Level Crossing

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Figure 2-20 – Aerial Photo of Blakestown Level Crossing

The L81206 is narrow local road of approximately 3m in width. It has no hard shoulders and has limited verges. To the south of the level crossing the L81206 connects to the local road network and R449 while 90m north of the level crossing the road ties into the R148 Regional Road connecting Leixlip to Maynooth. The R148 was recently realigned southwards near this junction to accommodate the expansion of the Intel Ireland campus. The R449 Regional Road which connects the R148 to the M4 Motorway lies approximately 700m east of the level crossing and provides an alternative route for local traffic accessing the R148. A Streetview image of the approach to the level crossing is provided in Figure 2-21.

Figure 2-21 – Streetview Image of Southern Approach to Blakestown Level Crossing

In regard to the use of this existing level crossing a number of issues arise as follows:

- To cross the level crossings, pedestrian and cyclist have to share the road space with the general traffic. There is no dedicated pedestrian path on the level crossing;
- The approach for a from the north narrows at the canal bridge such that opposing cars cannot pass. One must wait. This poses a risk to the operation of the level crossing;
- The Royal Canal overbridge is very narrow, there are no pedestrian or cyclist facilities provided;
- There are no pedestrian facilities on the approaches to the level crossing;
- There are no dedicated cycle facilities in the vicinity of the level crossing.

Railway traffic statistics provided for the level crossing in Table 2-14.

Table 2-14 Railway Statistics for the Blakestown Level Crossing

Level Crossing	Current Trains Passing (No.)	Planned Trains Passing (No.)	Uplift (%)	Current Closures (No.)	Projected Closures (No.)	Current Average Closure Duration	Current Total Closure Duration	Projected Total Closure Duration*
Blakestown AM	7	16	128	5	11	04:46	23:48	52:26
Blakestown PM	7	16	128	6	11	03:39	21:54	40:09

Note: All Durations are presented in minutes and seconds per hour.
* Projection based on average closure timed without optimisation

Surveyed road traffic counts at the level crossing, January 2019 are as presented in Table 2-15:

Table 2-15 Road Traffic Statistics for Blakestown

Level Crossing	Station Adjacent	2019 AM SB Peak Veh/hr	2019 AM NB Peak Veh/hr	2019 PM SB Peak Veh/hr	2019 PM NB Peak Veh/hr
Blakestown (CCTV)	No	3	9	9	4

From the above data is it noted the number of existing vehicular crossings of Blakestown level crossing is very low in comparison to other crossings;

Pedestrian and cyclist counts were undertaken at Blakestown level crossings on Tuesday 5th February 2019. The figures for each level crossing are presented in Table 2-16.

Table 2-16 AM & PM Pedestrian and Cycle Counts – CSEA Systra Oct 2019

Crossing	Time Period	Pedestrians		Cyclists	
		N/B	S/B	N/B	S/B
Blakestown	AM	0	0	1	0
	PM	0	2	0	2

This rural level crossings exhibit very low levels of usage.

3. Optimisation

3.1 Purpose and Methodology

The purpose of the optimisation exercise carried out in respect of the level crossings is to confirm if it is practicable and safe to leave the level crossing in place following the implementation of the project train service specification.

The methodology adopted includes a number of strands. Initially the level crossings are characterised in respect of the current working timetable and existing patterns of availability to road traffic. An exercise is then carried out to examine what enhancement can be made to the level crossing infrastructure and systems to reduce the closure cycle time on the level crossings. Once the optimised cycle time is identified, an exercise is carried out to determine the likely total closure period for the optimised level crossings once the project working timetable is in place.

Average cycle closure times are used to carry out the exercise as it is not practicable to predict the exact closure pattern for each level crossing at this time. The detail of the methodology is provided in Appendix A.

The duration of individual closure cycles is highly variable and depends on a number of factors including the following:

- The number of trains passing – typically between 1 and 3;
- The gap between the trains;
- The direction of travel;
- Express trains vs commuter trains;
- The presence of a train station immediately adjacent to the crossing;
- The dwell time in a station;
- Traffic conditions at the level crossing which may delay the barrier closures;

The duration of the cycle varies between 2 minutes 15 seconds in one instance and 8 minutes 10 seconds at the other extreme, at Coolmine, for example (allowing 35 seconds for activation). It is not practicable to predict the actual closure cycles consequent on the proposed working timetable at this stage of the project so the study considers two scenarios once signalling optimisation has been examined as follows:

- Case a) provides for average closure cycle based on a single train stopping at the train station and passing through the level crossing;
- Case b) provides for an average closure cycle duration based on 2No. trains passing in the cycle with a gap between trains of less than 90 seconds;

On this basis the cumulative closure time was assessed for the proposed project train service specification to determine a lower bound period during which access to road traffic over the railway is closed; In respect of Coolmine the outcome of the assessment is presented below.

As indicated above these figures represent a lower bound range. From examination of the level crossing closure times surveyed for this project, it is evident that in many instances the gap between passing trains significantly exceeds 90 seconds. At Coolmine, for instance, the morning peak hour manifests three closures of a total of nine where the average gap between trains exceeds three and a half minutes. This results in an additional closure duration of four and a half minutes in the hour. With the enhanced train service specification in place the availability of access over the railway for motorised traffic is further restricted.

3.2 Coolmine Level Crossing (Exemplar for Stations Level Crossing)

The detailed study of the optimisation of Coolmine level crossing operation is presented in Appendix A to this document. We have presented below the conclusions of the assessment.

Table 3-1 shows the current characteristics of the level crossing on a typical day during two peak hours and an off-peak hour. These real time observations have been used as an input for the simulation of the future situation scenarios.

Table 3-2 summarises the comparison of the simulations carried out for each study. The projected closure times for each period are given in minutes and seconds "Min.Sec." as well as the percentage of time the LC remains closed during the specific period.

Table 3-1 Current situation.

	Scenario	Signalling elements optimised?	Case/study	Train passing frequency (TPHPD)	Cumulative Closed time		
					Morning peak hour (8-9H) Min.Sec	Afternoon off-peak hour (13-14H) Min.Sec	End of day peak hour (17-18H) Min.Sec
Current situation	NA	NO	Current IE trains passing (CCTV data)	from 6 to 9	41.35 (70%)	20.12 (34%)	34.11 (57%)

Table 3-2 Comparison of the simulations done

	Scenario	Signalling elements optimised?	Case/study	Train passing frequency (TPHPD)	Cumulative Closed time	
					Peak period Min.Sec	Off-peak period Min.Sec
Future situation	1	NO	Case 1A	12	63.50* (100%)	47.24 (79%)
		NO	Case 1B	12 (peak hour) 6 (off-peak hour)	59.24 (99%)	29.40 (49%)
	2	YES	LC Stop signal position optimisation	12	No improvement expected	
		YES	LC strike-in point position optimisation	12 (with more than 90 sec intervals between trains)	45.00 (75%)	
				12 (with 30 sec intervals between trains)	57.00 (95%)	

(*) In some cases, the calculated closure time of the level crossing is more than 60 minutes. This is a theoretical result, and it means that the level crossing will remain closed for the whole period of one hour.

Main Conclusions:

- Currently, in morning peak hour the level crossing barriers are closed 70% (41mins) of the hour, in the off peak 34% (20mins) of the hour;
- For simulated cases 1A and 1B (common and varied average cycle duration for morning and evening peak) from Scenario 1, closure of the level crossing for the full peak hours is projected. It is evident that once the train frequency reaches 11 TPHPD the crossing is effectively closed for the full hour.
- For Scenario 2 with optimisation of signalling, it is not possible to place the stop signal closer to the level crossing in a way that significantly improves the total cycle time of the barriers, due to constraints associated with the braking characteristics of the trains. Optimisation of the strike in point would require that all trains stop at the adjacent station. It is anticipated this could reduce the cumulative closure time of the level crossing to a minimum of 45 minutes in the peak hour, supposing an ideal synchronised situation where the interval between two trains passing at the LC is longer than 90 sec, which permits the barriers being raised between trains. In a more realistic situation, where the train passing frequency is not so synchronised, intervals of 30 sec between trains would lead to a closure time of 57 min, as the barriers remain lowered for intervals shorter than 90 sec.

  Trains passing in opposite directions within a single cycle will however further curtail remaining open time in the hour. Due to the presence of the adjacent station and the ambitious working timetable it is anticipated that even with the removal of non-stopping trains little open time will remain available in the peak hour. This is considered an unsafe situation from the perspective of road users.
- This study does not consider the occurrence rate of incidents in the level crossing, but realtime cycle durations would also be increased by poor user behaviour and pedestrian and vehicle incidents (i.e., a car hits the LC barrier).
- Although the study has been carried out on the basis of two peak periods of one hour in the day. It is anticipated that the peak periods will extend to three hours, from 07:00 to 10:00 AM and from 16:00 to 19:00 PM, as the enhanced working timetable leads to increased use of the railway. Peak periods in the future will be longer than they currently are, and train frequency will be higher throughout the day.
- Should the level crossing be retained and enhanced it would be closed for road users for very long periods (3 hours in AM and 3 hours in PM). This can encourage dangerous behaviour of road users trying to cross the level crossing once the closing sequence has been initiated. The situation would lead to a higher occurrence rate of incidents.
- For the Off Peak hours the study identified a cumulative estimated closure time of approximately 30 minutes in the hour. Should the level crossing be retained and closed to road traffic for up to six hours of peak conditions and closed to road traffic for 50% of the remaining time it is considered that unsafe conditions would inevitably arise for road and rail users. This option is not considered further as a consequence.

Based on the above, it is evident that Coolmine level crossing will be effectively closed to road traffic as a consequence of implementation of the proposed project working timetable. It is considered unsafe to contemplate leaving the level crossing in place once the planned level of railway service is in place. It is concluded that Coolmine Level Crossing should be removed as part of the DART+ West project.

A further description of the scenarios and its simulations are presented in APPENDIX A to this document.

The analysis and conclusions identified in respect of Coolmine level crossing can be applied to the level crossings at Ashtown and Clonsilla. It is recommended that Ashtown and Clonsilla level crossings be removed also as part of DART+ West.

3.3 Porterstown Level Crossing

Characterisation of Porterstown level crossing is provided in Section 2.7.

It is located approximately mid-way between Clonsilla and Coolmine train station, east of Clonsilla Junction and consequently carries equivalent railway traffic to the adjacent heavily loaded level crossings. This level crossing is remote from a station and consequently the strike in and stop signals are independent of other influencing infrastructure. The cycle time is consequently shorter.

Opportunities to relocate the strike in signal and the stop signal don't manifest for Porterstown due to its isolation. Consequently the same opportunities for enhancement of the cycle time do not arise.

From the detail presented in Section 2.7 the following conclusions can be drawn:

- Currently, in morning peak hour the level crossing barriers are closed 50% (32mins) of the hour, in the off peak 34% (20mins) of the hour;
- On implementation of the project working timetable the level crossing barriers will be closed for the whole of the AM peak hour and for 75% of the PM peak hour.
- The configuration of this level crossing is currently optimised. No enhancement can be achieved on the cycle time.
- This study does not consider the occurrence rate of incidents in the level crossing, but realtime cycle durations would also be increased by poor user behaviour and pedestrian and vehicle incidents (i.e., a car hits the LC barrier).
- Although the study has been carried out on the basis of two peak periods of one hour in the day. It is anticipated that the peak periods will extend to three hours at each end of the day as the enhanced working timetable leads to increased use of the railway. Peak periods in the future will be longer than they currently are, and train frequency will be higher throughout the day.
- Should the level crossing be retained and enhanced it would be closed for road users for very long periods. This can encourage dangerous behaviour of road users trying to cross the level crossing once the closing sequence has been initiated. The situation would lead to a higher occurrence rate of incidents. In addition, this road will have high pedestrian footfall for children travelling to nearby schools. A level crossing which is closed for long periods might provoke unauthorised trespass on to the railway and significantly increase risk to public/children.
- Given the effective closure of this crossing to road users during peak hours, the hazards associated with leaving it in place for off peak use are considered unacceptable from a safety perspective. This option is not considered further.

Due to the anticipated effective closure of the level crossing to road users during peak hours and unsafe conditions which would arise in the event the level crossing is retained as part of the project it is concluded that the level crossing should be closed to road users and alternative access provided.

3.4 Barberstown Level Crossing

Characterisation of Barberstown level crossing is provided in Section 2.8.

It is located approximately 2km west of Clonsilla and east of Clonsilla Junction. It carries lower levels of traffic than the sections of the railway from Clonsilla east. This level crossing is remote from a station and consequently the strike in and stop signals are independent of other influencing infrastructure. The cycle time is consequently shorter.

Opportunities to relocate the strike in signal and the stop signal don't manifest for Barberstown due to its isolation. Consequently the same opportunities for enhancement of the cycle time do not arise.

From the detail presented in Section 2.8 the following conclusions can be drawn:

- Currently, in morning peak hour the level crossing barriers are closed 43% (26mins) of the hour, in the off peak 36% (22mins) of the hour;
- On implementation of the project working timetable the level crossing barriers will be closed for 80% (47mins) of the of the AM peak hour and for 63% (37mins) of the PM peak hour.
- The configuration of this level crossing is currently optimised. No enhancement can be achieved on the cycle time.

- This study does not consider the occurrence rate of incidents in the level crossing, but realtime cycle durations would also be increased by poor user behaviour and pedestrian and vehicle incidents (i.e., a car hits the LC barrier).
- Although the study has been carried out on the basis of two peak periods of one hour in the day. It is anticipated that the peak periods will extend to three hours at each end of the day as the enhanced working timetable leads to increased use of the railway. Peak periods in the future will be longer than they currently are, and train frequency will be higher throughout the day.
- Should the level crossing be retained and enhanced it would be closed for road users for very long periods. This can encourage dangerous behaviour of road users trying to cross the level crossing once the closing sequence has been initiated. The situation would lead to a higher occurrence rate of incidents.
- Given the effective closure of this crossing to road users during peak hours, the hazards associated with leaving it in places for off peak use are considered unacceptable from a safety perspective. This option is not considered further.

Due to the anticipated effective closure of the level crossing to road users during peak hours and unsafe conditions which would arise in the event the level crossing is retained as part of the project it is concluded that the level crossing should be closed to road users and alternative access provided.

3.5 Blakestown Level Crossing

Characterisation of Blakestown level crossing is provided in Section 2.9.

It is located approximately 1.7km west of Louisa Bridge Train Station and west of Clonsilla Junction. It carries lower levels of traffic than the sections of the railway from Clonsilla east. This level crossing is remote from a station and consequently the strike in and stop signals are independent of other influencing infrastructure. The cycle time is consequently shorter.

Opportunities to relocate the strike in signal and the stop signal don’t manifest for Blakestown due to its isolation. Consequently, the same opportunities for enhancement of the cycle time do not arise.

From the detail presented in Section 2.9 the following conclusions can be drawn:

- Currently, in morning peak hour the level crossing barriers are closed 89% (24mins) of the hour, in the off peak 22% (13mins) of the hour;
- On implementation of the project working timetable the level crossing barriers will be closed for 86% (52mins) of the of the AM peak hour and for 66% (40mins) of the PM peak hour.
- The configuration of this level crossing is currently optimised. No enhancement can be achieved on the cycle time.
- This study does not consider the occurrence rate of incidents in the level crossing, but realtime cycle durations would also be increased by poor user behaviour and pedestrian and vehicle incidents (i.e., a car hits the LC barrier).
- Although the study has been carried out on the basis of two peak periods of one hour in the day. It is anticipated that the peak periods will extend to three hours at each end of the day as the enhanced working timetable leads to increased use of the railway. Peak periods in the future will be longer than they currently are, and train frequency will be higher throughout the day.
- Should the level crossing be retained and enhanced it would be closed for road users for very long periods. This can encourage dangerous behaviour of road users trying to cross the level crossing once the closing sequence has been initiated. The situation would lead to a higher occurrence rate of incidents.
- Given the effective closure of this crossing to road users during peak hours, the hazards associated with leaving it in places for off peak use are considered unacceptable from a safety perspective. This option is not considered further.

- Due to the anticipated effective closure of the level crossing to road users during peak hours and unsafe conditions which would arise in the event the level crossing is retained as part of the project it is concluded that the level crossing should be closed to road users and alternative access provided.

4. Conclusion

This technical paper documented an assessment of the prospect of retaining the existing level crossings on the Maynooth railway line following the implementation of DART+ West.

It examined the existing conditions at the level crossings. It provided consideration of opportunities to enhance the operation of level crossings and it examined the projected level crossing activity on implemented on the project train service specification should they be retained.

It demonstrated that once the project working timetable is implemented that the frequency of trains passing through the level crossings will render them effectively closed to road traffic throughout the day. This characteristic was most pronounced for level crossings east of Clonsilla Junction but those west of Clonsilla Junction experienced periods of closure which it is considered will render them unsafe to operate as a means of road access.

In conclusion to the study, it is proposed that all level crossings on the Maynooth Line affected by the project be removed from the railway network. This includes Ashtown, Coolmine, Porterstown, Clonsilla, Barberstown and Blakestown level crossings.

The existing level crossings represent an inherent risk to the railway and to road users. Although operated safely by IE, retaining the level crossings with increased levels of railway traffic, the consequent increased road traffic congestion and the associated curtailment of access over the railway will result in increased risk for all concerned and particularly for vulnerable non-motorised users of the level crossing. It will not be practicable to deliver the level of service proposed as part of the project with the level crossings in place.

It is recommended that all level crossings within the extent of DART+ West be removed as part of delivery proposals for the project.

APPENDIX A. Optimisation of Coolmine Level Crossing

A.1. Introduction

In order to predict the impact of the increased train frequency on the Coolmine LC closure times, different scenarios have been simulated:

- **Current situation:** Study of the current situation of LC barriers opening and closure times through data of current trains passing without modifying the signalling system and the LC barriers operations.

- **Future situation:** Considers the increase of train passing frequency according to the expected future train traffic.

    - Scenario 1: considers an increase of train circulation frequency without modifying the signalling system and the LC barriers operations.

        - Case 1A: The LC will be closed 12 times in every period (12 TPHPD), two periods (peak and off-peak) considered in order to study the worst scenario.

        - Case 1B: A single LC closure time has been considered for all passing trains (average closure time of all passing trains during a whole day.

    - Scenario 2: considers an increase of train circulation frequency with an improved signalling system. Optimisation of the position of the signalling elements.

A.2. Current situation

A study was carried out of the current situation of level crossing barriers opening and closure times through data of current trains passing without modifying the signalling system and the level crossing barriers operations. This study examined the operation of the level crossing (opening and closure of the level crossing barriers) based on the current frequency of trains passing through Coolmine level crossing.

A study of the base LC closure times has been carried out for each of the following three periods throughout the day (two peak period and one off-peak periods):

- from 08 to 09 H. (peak period, when there are 7 or 8 TPHPD)
- from 13H to 14H and, (off-peak period, when there are 2 or 3 TPHPD)
- from 17H to 18H. (peak period, when there are 7 or 8 TPHPD)

A.3. Future situation

The simulation of the future situation considers an increase of train passing frequency according to the expected future train traffic. For this situation, two different scenarios have been simulated:

A.3.1Scenario 1: Higher train frequency with level crossing elements unmodified

Scenario 1 considers an increase of train circulation frequency without modifying the signalling system and the level crossing barriers operations. This scenario has been simulated in two different cases.

A. 3.1.1 Case 1A: Different average closure times for AM and PM peak hours

The project Working Timetable provides for 12 trains per hour per direction for each peak hour. The same passenger service is planned for both periods but account is taken of the fact that currently AM and PM peak cycle times differ in determining the worst-case scenario. The level crossing barriers closure time for each passing train in each period is the average time calculated from the current situation for each period.

For the purposes of the study only 12 cycles are considered in the peak hours, which is the minimum number of closures likely to arise consequent on the planned increase of train passing frequency. The maximum number of closure cycles in the future situation would be 24. Therefore, while the numbers for the optimal situation (12 LC closures) are already worse than the current situation, a real scenario (up to 24 level crossing closure cycles) would be significantly more onerous.

A. 3.1.2 Case 1B: Same average closure time for AM and PM peak hours

In this case a single level crossing closure time has been considered for all passing trains instead of calculating a closure time per period as in Case 1A. This single closure time corresponds to the current level crossing average closure cycle time of all passing trains during a whole day.

For the study only 12 level crossing closures have been considered for the peak periods and 6 for the off-peak periods, which is the minimum number of cycles based on planned train frequency. The maximum number of closures in the future situation would be 24. Therefore, while the numbers for the optimal situation (12 level crossing closure cycles) are already worse than the current situation, a real scenario (up to 24 level crossing closure cycles) would be more onerous.

A.3.2 Scenario 2: DART+ West train frequency with optimisation of level crossing signalling components

Scenario 2 considers an increase of train circulation frequency with an improved signalling system. This scenario considers the optimisation of the position of the signalling elements and envisages studying the impact of the position of the stop signal and the strike-in point on the level crossing barrier opening and closure cycles.

A.4. Simulations: Current situation

A.4.1 Description

An analysis of the current situation has been carried out in order to better understand the operation of the level crossing based on the data of current frequency of trains and characteristics of the line. This analysis will be the baseline for the study of the feasibility of keeping the Coolmine level crossing in the future situation, when the train frequency is foreseen to increase.

A.4.2 Input data

The analysis has been developed from current data received from IÉ, of the level crossing closure timings, based on CCTV observation on 22nd March 2019, in three periods: 8:00 – 9:00, 13:00 – 14:00 and 17:00 – 18:00 (morning, afternoon and end of day periods).

Calculations were made using real train timetable data provided by IÉ of a single day. Nevertheless, data could vary considerably from one day to another, since the data used correspond to one day randomly chosen in order to perform the simulations.

A.4.3 Results and discussion

The actual closure times of the Coolmine LC are shown in the following table, based on the actual number of Trains per hour per direction (TPHPD):

Table A1 – Current situation of closure timings of the Coolmine LC

Coolmine	0800 - 0900	Time - Min.Secs TRAIN ID	1300 - 1400	Time - Min.Secs TRAIN ID	1700 - 1800	Time - Min.Secs TRAIN ID
1	08.04.00 - 08.07.20	3.20 P734	12.58.04 - 13.01.06	3.02 P744	16.57.26 - 17.00.30	3.01 D311 LATE
2	08.09.35 - 08.14.35	5.00 D300/	13.04.30 - 13.10.47	6.17 D915	17.09.20 - 17.16.44	7.24 D924/P753
3	08.14.35 - 08.17.15	2.40 D906/P653	13.17.32 - 13.20.05	2.33 A906	17.18.45 - 17.23.00	4.15 D312
4	08.19.35 - 08.26.52	7.17 P653/D906	13.28.10 - 13.30.50	2.40 P745	17.25.57 - 17.33.50	7.53 P321/P754/A912
5	08.29.45 - 08.35.35	5.50 D905/A901/P303	13.37.00 - 13.41.00	4.00 D916	17.42.40 - 17.47.23	4.43 D313/D925
6	08.39.35 - 08.42.40	3.05 D301	13.51.00 - 13.52.40	1.40 A907	17.49.25 - 17.52.25	3.00 P322
7	08.44.25 - 08.48.20	3.55 P654			17.53.20 - 17.57.15	3.55 D926
8	08.49.15 - 08.56.45	7.30 D907/P304				
9	08.58.40 - 09.01.38	2.58 P735				
Total Time		41.35		20.12		34.11

Note: The timings above are taken from the instant when the barriers are fully lowered till they are fully raised. For the simulations of the future situation, additional 35 seconds have been taken into account for crossing activation to crossing deactivation (i.e., initial warning to final all clear). It is not detailed the direction of the train as it is not relevant, as the barriers are closed anyway.

Table A1 shows that between 08:04:00 and 08:07:20 (3 min 20 sec) the level crossing was closed as train P734 passed through.

Individual closure times varied, as they depend on the direction of movement of a train, its speed and dwell time at the station. The shortest single train closure was timed at for 1 minute 40 sec, and the longest was 6 min 17 sec. In some cases, even 3 trains were passing in the period of one closure, preventing any vehicle or pedestrian to cross for almost 8 min (7 min 53 sec).

Depending on the train headway (interval of time between two trains), the total time may be prolonged compared to individual closures (since the opening of the level crossing for a very short time could be potentially dangerous).

All three periods were compared, and an average closure time was calculated for each one:

- During the morning peak hour (8:00 – 9:00), the LC was closed 9 times as 14 trains passed through it (in both directions), leading to a total closure time of 41 min 35 sec.
- Between 13:00 and 14:00 (off-peak) there were 6 trains in both directions, with a total closure time of 20 min 12 sec.
- In the afternoon peak period from 17:00 to 18:00, 11 trains passed through, and the gates were closed for a total time of 34 min 11 sec.

It is needed to calculate the following average closure times to be used as inputs for the simulation of the future situation scenarios. In all cases the additional 35 seconds explained at the beginning of this chapter have been considered:

A. 4.3.1 Average LC closure time per period

The average level crossing closure time for each period, considering just the time the barriers are fully lowered, is:

- From 08:00 to 09:00: **4 min and 37 sec**, with 9 Level crossing closure cycles
- From 13:00 to 14:00: **3 min and 22 sec**, with 6 Level crossing closure cycles
- From 17:00 to 18:00: **4 min and 53 sec**, with 7 Level crossing closure cycles

The average level crossing closure cycle time for each period, adding the 35 seconds (for crossing activation to crossing deactivation), is:

- From 08:00 to 09:00: **5 min and 12 sec**, with 9 Level crossing closure cycles
- From 13:00 to 14:00: **3 min and 57 sec**, with 6 Level crossing closure cycles
- From 17:00 to 18:00: **5 min and 28 sec**, with 7 Level crossing closure cycles

Thus, the average level crossing closure cycle time for peak and off-peak periods is:

- Peak period: **5 min and 19 sec**, considering the total closure time and the total number of closures in the previous peak periods.
- Off-peak period: **3 min and 57 sec**, with 6 level crossing closure cycles.

The average closing times between peak and off-peak periods are quite different. That is because, according to the data used for these studies, in peak periods there are some situations where in a single LC closure pass 2 or more trains, which lead to a higher LC closure time, while in the off-peak period, just passes 1 train in each LC closure. For example, in the LC closure between 17:25:57 and 17:33.50 (see Table A1) 3 trains pass through the LC, which lead to a closure time of almost 8 min (7 min 53 sec).

A. 4.3.2 Whole-day average LC closure time

Considering the total closure time from the three periods studied (1 hour, 35 min and 58 sec) and the total number of closures (22 closures), the global average time for a single closure accounts for **4 min 57 sec.**

A.4.4 Simulations: Future situation

A. 4.4.1 Description

As described in section A3, a study of the future situation has been developed in order to estimate the “future” closure times of the Coolmine Level Crossing. For this study, two different simulation scenarios were developed.

Scenario 1 considers the level crossing with an increase of the frequency of trains (as part of the DART+ West project) but with no optimisation of the signalling system and the operation of the level crossing.

Two cases have been simulated:

- Case 1A considering period discrimination and
- Case 1B without period discrimination.

On the other hand, Scenario 2 has been defined considering an increase of the frequency of trains and an improved signalling system. The impact of the optimisation of the signalling elements (change of the strike-in points or/and stop signal position) has been analysed evaluating if level crossing barrier closure time could be minimised.

A. 4.4.2 Assumptions

4.4.2.1 Scenario 1

In order to estimate the total closure times for each period in the future situation, the following assumptions have been made for each case described in the previous section:

Case 1A

- In each period, the level crossing will be closed 12 times, as it is foreseen 12 TPHPD. It was considered the same TPHPD in both peak and off-peak periods in order to study the worst-case scenario.
- The closure time for each passing train will be the average time calculated from the current situation, for each period. Hence, for the peak period it will be 5 min and 19 sec and for the off-peak period 3 min and 57 sec. This closure time includes the full LC operating cycle (from the initial warning to the final all clear).

Case 1B

- In this case, in the future situation it is foreseen that Coolmine can account for 12 trains per hour per direction (TPHPD) during peak times and approximately 50% of that percentage during off-peak times (6 TPHPD), based on the frequency of trains in each period of the current situation.
- The closure time will be the same for both periods, corresponding to the global average time calculated from the current situation (4 min 57 sec), considering the total closure time and the total number of closures on a full day, as mentioned in section A. 4.3.2.

In both cases, the simulation contemplates an unlikely and optimal situation where two trains on opposite directions pass through the level crossing at the same time. In reality, if an opposing train passes through the level crossing within 90 sec of the first train, the level crossing will remain closed. Taking this into account, the total time the level crossing stays closed should be higher than the results obtained in the simulation, which could probably lead to a permanent closure of the level crossing during both periods.

4.4.2.2 Scenario 2

For scenario 2, the following assumptions have been made:

- The current level crossing operating time can be optimised, reducing the time sequence of the level crossing barriers closure. As the time sequence for an optimised barriers closure could range between 28 sec to 34 sec, the best situation has been considered for the simulation (28 sec).
- It has been assumed a maximum line speed of 95 km/h, as per IÉ speed restrictions, and an average approaching speed of 40 km/h for stopping trains.
- In the case of trains circulating in Connolly direction, the time since the train is detected until it reaches the distant signal will be 30 sec.
- By the time the train reaches the distant signal, the level crossing will be closed

In this scenario, the calculations contemplate an optimal situation where two trains on opposite directions pass through the level crossing with more than 90 sec between them, allowing to open the level crossing between trains. In the likely case a train on opposite direction passes through the level crossing within less than 90 sec from the first train, the level crossing will stay closed. Taking this into account, the total time the level crossing stays closed should be higher than the results obtained in the simulation, which could probably lead to a permanent closure of the level crossing during peak periods.

A.5. Simulations: Results and discussion

A.5.1 Scenario 1 Case 1A: Future situation considering different average times for each period.

The next table illustrates the estimated opening and closure timings of the Coolmine Level Crossing for case 1A.

Table A2 – Simulation of Level crossing closure cycles considering the increase of railway circulations of 24 trains/hour

Coolmine	Peak period	Time - Min.Secs TRAIN ID	Off-peak period	Time - Min.Secs TRAIN ID
1	08.00.00 - 08.05.19	5.19 PX/PY	13.00.00 - 13.03.57	3.57 PX/PY
2	08.05.19 - 08.10.31	5.19 PX/PY	13.03.57 - 13.07.54	3.57 PX/PY
3	08.10.31 - 08.15.44	5.19 PX/PY	13.07.54 - 13.11.51	3.57 PX/PY
4	08.15.44 - 08.20.56	5.19 PX/PY	13.11.51 - 13.15.48	3.57 PX/PY
5	08.20.56 - 08.26.08	5.19 PX/PY	13.15.48 - 13.19.45	3.57 PX/PY
6	08.26.08 - 08.31.20	5.19 PX/PY	13.19.45 - 13.23.42	3.57 PX/PY
7	08.31.20 - 08.36.33	5.19 PX/PY	13.23.42 - 13.27.39	3.57 PX/PY
8	08.36.33 - 08.41.45	5.19 PX/PY	13.27.39 - 13.31.36	3.57 PX/PY
9	08.41.45 - 08.46.57	5.19 PX/PY	13.31.36 - 13.35.33	3.57 PX/PY
10	08.46.57 - 08.52.09	5.19 PX/PY	13.35.33 - 13.39.30	3.57 PX/PY
11	08.52.09 - 08.57.21	5.19 PX/PY	13.39.30 - 13.43.27	3.57 PX/PY
12	08.57.21 - 09.02.34	5.19 PX/PY	13.43.27 - 13.47.24	3.57 PX/PY
Total Time		63.50		47.24

Note: this simulation contemplates an unlikely or optimal situation where two trains on opposite directions pass through the level crossing at the same time. In the likely case a train on opposite direction passes through the level crossing within less than 90 sec from the first train, the level crossing will stay closed. Taking this into account, the total time the level crossing stays closed should be higher than the results obtained in the simulation, which could probably lead to a permanent closure of the level crossing during peak periods.

The simulation results depicted in **Table A1** showed that the barriers will be lowered for a longer period, thus **critically reducing the capacity of the vehicles to cross during peak times.** The simulated case shows that the LC will be lowered continuously during the peak period.

Also, in the off-peak period the available time for the vehicles to cross the level crossing would decrease by 66% compared with the current situation considering the average time of (3 min 57 sec), which also shows a relevant decrease in vehicle crossing capacity.

A.5.2 Scenario 1 Case 1B: Future situation considering the global average time (mean value of all trains passing in one day).

The results for case 1B are shown in **Table A3**:

Table A3 – Simulation of Level crossing closure cycles considering the global average time (corresponding to the mean value of all trains passing in one day)

Coolmine	Peak period	Time - Min.Secs TRAIN ID	Off-peak period	Time - Min.Secs TRAIN ID
1	08.00.00 - 08.04.57	4.57 PX/PY	13.00.00 - 13.04.57	4.57 PX/PY
2	08.04.57 - 08.09.53	4.57 PX/PY	13.04.57 - 13.09.54	4.57 PX/PY
3	08.09.53 - 08.14.50	4.57 PX/PY	13.09.54 - 13.14.50	4.57 PX/PY
4	08.14.50 - 08.19.47	4.57 PX/PY	13.14.50 - 13.19.47	4.57 PX/PY
5	08.19.47 - 08.24.44	4.57 PX/PY	13.19.47 - 13.24.44	4.57 PX/PY
6	08.24.44 - 08.29.40	4.57 PX/PY	13.24.44 - 13.29.41	4.57 PX/PY
7	08.29.40 - 08.34.37	4.57 PX/PY		
8	08.34.37 - 08.39.34	4.57 PX/PY		
9	08.39.34 - 08.44.31	4.57 PX/PY		
10	08.44.31 - 08.49.27	4.57 PX/PY		
11	08.49.27 - 08.59.21	4.57 PX/PY		
12	08.59.21 - 09.04.17	4.57 PX/PY		
Total Time		**59.24**		**29.40**

Note: this simulation contemplates an unlikely or optimal situation where two trains on opposite directions pass through the level crossing at the same time. In the likely case a train on opposite direction passes through the level crossing within less than 90 sec from the first train, the level crossing will stay closed. Taking this into account, the total time the level crossing stays closed should be higher than the results obtained in the simulation, which could probably lead to a permanent closure of the level crossing during peak periods.

Thus, in the unlikely case of the off-peak traffic of 6 TPHPD, gates would be closed for 29 min 40 sec. With the peak traffic of 12 TPHPD, closure time would be 59 min 24 sec.

Since the scheduled time for trains at the level crossing cannot be guaranteed, in case those trains pass 1 min later or sooner through the level crossing (as an example), the average closure time for 1 pair of trains will increase to 5 min 57 sec, and the total closure time will account for:

- 6 TPHPD: 35 min 42 sec.
- 11 TPHPD and more: **permanent closure.**

In this situation, if trains pass 2 min later of sooner through the level crossing, the closure time will increase to 6 min 57 sec, and permanent closure would happen at the level of 9 TPHPD.

- 6 TPHPD: 41 min 42 sec.
- 9 TPHPD and more: **permanent closure.**

Again, for the study it has been considered only 12 Level crossing closure cycles for the peak periods and 6 for the off-peak periods, which is the minimum number of closures regarding the foreseen increase of train passing frequency. The maximum number of closures in the future situation would be 24 for the peak period and 12 for the off-peak period.

Therefore, while the numbers in the off-peak period might seem not so bad, a real scenario (up to 12 CL closures) will probably lead to a higher closure time as in the optimal case in the peak period (59 min 24 sec).

A.5.3 Scenario 2: Higher train frequency and signalling improvement.

Current situation

The current type of crossing is protected by road traffic light signals and lifting barriers on each side of the railway. An audible warning to pedestrians is also provided. The barriers are normally kept in the raised position, and when lowered, extend across the whole width of the carriageway on each approach.

Coolmine is currently a CCTV controlled level crossing. The closure sequence is initiated by approaching trains. Confirmation that the crossing is clear, and that railway signals may be cleared for the passage of trains, is provided by the signalman through the CCTV.

The next paragraph analyses the stop signal position in regards of the optimisation of the level crossing closure timings.

Stop signal position

The impact of modifying the position of signalling elements on the LC barriers opening and closure time has been analysed. It has been studied whether the stop signal could be moved closer to the level crossing so the level crossing engagement occurs later and thereby the total time of the barriers being closed can be reduced.

When the stop signal approaches the level crossing, the signal position must take into account trains that stop as well as those that continue passing through the Coolmine station which is close to the LC (see the location of the Coolmine Station in the snapshot of **A1**).

Figure A1 – Google Maps snapshot of Coolmine Station.

The stop signal shall be placed at the overlap distance from the LC as shown in Figure 2-7Figure 2-7 – Main Elements of a Level Crossing

. The standard overlap distance is 200 m, but for slow trains it could be reduced up to 50 m.

The fact that stopping and non-stopping trains circulate at the same time has a negative impact for optimising the strike-in point position and stop signal distance to the level crossing. The worst case (non-stopping trains) determines where the stop signal has to be placed, as the speed of non-stopping trains is considerably higher than the speed of those trains that stop at the Coolmine station, therefore the overlap distance should not be less than 200 m.

Thus, the stop signal location cannot be optimised for stopping trains and level crossing barriers will be closed for more time than strictly needed for those trains. As the stop signal distance cannot be optimised in a considerable way and the train frequency is to be increased, **any re-signalling cannot improve the timing sequence in regards of the stop signal position.**

Strike-in point position

On the other hand, since the position of the stop signal cannot be optimised, an optimisation of the LC operating time has been considered regarding the strike-in-point position as shown in Figure 2-7Figure 2-7 – Main Elements of a Level Crossing

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Optimising the LC operating time would make possible to bring the strike-in point closer to the LC, as the shorter the operating cycle is, the shorter the distance between the stop signal and the strike-in point can be. Hence, if the train is detected closer to the LC, the LC barriers would be closed for a shorter period of time.

According to CRR guidelines (RSC-G-006-B section 5.5.2), the sequence of events to close the level crossing to road traffic, once the lowering cycle has been initiated, is:

0) The train is detected by the strike-in point.
1) the amber light on each of the road traffic light signals immediately shows and the audible warning begins. The amber lights show for approximately 5 seconds.

2) immediately the amber lights are extinguished, the intermittent red lights should show.
3) The LC has 4 barriers covering half of the road on either side, that descend on the left-hand lanes first and then the right-hand lanes. Approximately 6 to 8 seconds later, the left-hand barriers should start to descend. Approximately 5 seconds after the left-hand barriers begin to descend, the right-hand barriers begin to descend. The time for each barrier to reach the lowered position should normally be from 6 to 8 seconds.
4) it should not be possible to lower the barriers, unless at least one red light in each road traffic light signal facing approaching road traffic is working.
5) once the barriers have started to descend, the lowering cycle should be completed in the normal sequence even if all the red lamps in any one of the road traffic light signals facing approaching road traffic fail. The barriers may then be raised when it is safe to do so. Where, in these circumstances, the barriers have not started to descend, they should remain in the raised position.
6) the audible warning for pedestrians should stop when all the barriers are fully lowered.
7) the intermittent red lights should continue to show; and
8) railway signals can be cleared for the passage of trains, once the “crossing clear” is confirmed.

Table A4 – Time sequence range for an optimised barriers closure

Description of LC operation	Time of operation (seconds)
Amber lights and audible warning	5
Intermittent red lights	6 – 8
Left-hand barriers descend	6 – 8
Interval	5
Right-hand barriers descend	6 – 8
Confirmation “crossing clear” from CCTV operator	0
Signal clear for train pass	0
Operating time	28 – 34

Barriers should rise as soon as practicable after all trains for which the lower sequence has been initiated or maintained, have passed clear of the crossing.

The sequence of events to open the crossing to road traffic, once the raising cycle has been initiated or maintained is:

1) all the barriers begin to rise simultaneously and should normally rise in 6 to 8 seconds; and
2) the intermittent red lights should continue to show until the barriers have fully raised.

Due to signalling and safety requirements compliance, duration from the End of barriers closure until the End of barriers opening (authorisation for vehicles to pass) cannot be optimised for any case of LC operation.

The operation time since the barriers start to descend until the level crossing is fully closed has been considered to be the minimum (28 sec).

In the future situation it is foreseen that almost all circulating trains will stop at Coolmine Station. Thus, the optimisation of the strike-in point has been studied for each running direction.

Trains circulating in the Maynooth direction

In this case, the best situation for the strike-in point has been considered. In order to achieve a lower LC closure time, the strike-in point is placed at the end of the Coolmine Station platform. Thus, the lowering cycle is initiated when the train stops at the station.

According to the current Coolmine Station situation, the strike-in point shall be placed at 90 m from the LC. Considering a stop time of 1 min and a normal train acceleration of 1 m/s^2, according to the train characteristics, the time since the train is detected at the strike-in point until it crosses it would be **1 min 13 sec** (see Table A5).

Table A5 – Time characteristics given for an optimised barriers closure until 1st train cross (Maynooth direction)

Description of LC operation	Instant of time (sec)
Train stops at Coolmine Station	0
Start of traffic lights and bells for vehicles	0
Begin of barriers closure	11 – 13
End of Barriers closure	28 – 34
Confirmation “crossing clear” from CCTV operator	28 – 34
Train leaves Coolmine Station	60
1st train pass through LC	73 – 79

In this direction (trains going to Maynooth), with the foreseen train frequency of 12 TPDPH, the total closure time would be **14 min and 36 sec**.

In case the strike-in point was placed before the Coolmine Station, the lowering cycle would begin earlier and the LC would be closed for a longer period of time including the time the train would spend until it arrives at the station and the time spent at the station. Hence, by placing the strike-in point right before the LC saves on the closure time considerably.

Trains circulating in the Connolly direction.

In the case of stopping trains going to Connolly, the Coolmine Station is situated after the LC. Thus, the strike-in point position depends on the maximum permitted line speed and safety requirements.

For this calculation the following assumptions have been considered:

- The highest permissible running speed is 95 km/h (According to IÉ speed restrictions).
- A time of **30 sec** has been considered since the train is detected until it reaches the distant signal,
- When the train is detected, the level crossing begins its closure sequence, and by the time the train reaches the distant signal, the barriers should be fully lowered.
- Considering the speed of 95 km/h, the strike-in point should be placed at 792 m from the distant signal.

The distance between the distant signal and the stop signal is 700 m due to the track section distances. On the other hand, as explained before, the stop signal must be placed at the overlap distance of 200 m from the level crossing. Thus, the total distance from the strike-in point to the LC is 1692 m. Considering and average approaching speed of 40 km/h from the strike-in point to the LC, the minimum total time since the train is detected to pass through the LC would be **2 min 32 sec** (see **Table A6**).

Table A6 – Time characteristics given for an optimised barriers closure until 1st train cross (Connolly direction)

Description of LC operation	Instant of time (sec)
Start of traffic lights and bells for vehicles	0
Begin of barriers closure	11 – 13
End of Barriers closure	28 – 34
Confirmation “crossing clear” from CCTV operator	28 – 34
1st train pass through LC	152 – 158

In this direction (trains going to Connolly), with the foreseen train frequency of 12 TPDPH, the total closure time would be **30 min 24 sec**.

Results

As in Scenario 1, the optimal situation would be if two trains circulating on opposite directions cross the LC at the same time. Regarding the cases explained before, the minimum closure time assuming that two trains in each direction pass through the LC at the same moment would be **30 min 24 sec**, as trains going to Connolly close the LC at least during 2 min 32 sec.

Another optimal situation would be if in each LC closure only passes one train. In this case, the total closure time would be **45 min**, adding the total closure times for each direction.

In real situations, where trains might not be so synchronised, the total closure time would increase even more. The previous calculus contemplates an unlikely or optimal situation where two trains on opposite directions pass through the LC with more than 90 sec between them. In the likely case a train on opposite direction passes through the LC within less than 90 sec from the first train, the LC will stay closed. Taking this into account, the total time the LC stays closed should be higher than the values obtained before, which could probably lead to a permanent closure of the LC during peak periods.

Thus, if we consider a 30 sec interval between two trains passing at the level crossing. The total time the LC would be closed would be 45 min for the crossing of trains and 12 min for the 30 sec intervals, therefore a total time of 57 min, almost permanent closure.

The worst situation would be that each time a train crosses the LC in one direction, another train crosses the LC in the opposite direction exactly 90 seconds afterwards, because then the LC would remain closed during the crossing of all trains. In this case the total time the LC would be closed would be 45 min for the crossing of trains and 36 min for the 90 sec intervals, what leads to a theoretical result of 81 min. this means that the LC would be **permanently closed**.