



Railway Accident Investigation Unit

Ireland



INVESTIGATION REPORT

Vehicle struck by train at Cartron level crossing, XM220, Co. Mayo, 17th August 2018

RAIU Report No: 2019 – R003
Report Published: 03/09/2019

Report publication

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The original publication details are given below:

Title	Vehicle struck by train at Cartron level crossing, XM220, Co. Mayo, 17 th August 2018
Document type	Investigation Report
Document number	2019 – R003
Document issue date	03/09/2019

Where the report has been altered following its original publication, details on the changes are given below:

Revision number	Revision date	Summary of changes

Reader guide

All dimensions and speeds in this report are given using the International System of Units (SI Units). Where the normal railway practice, in some railway organisations, is to use imperial dimensions; imperial dimensions are used, and the SI Unit is also given.

All abbreviations and technical terms (which appear in italics the first time they appear in the report) are explained in the glossary.

Descriptions and figures may be simplified in order illustrate concepts to non-technical readers.

Paragraphs from the report will be referenced throughout the report for ease of reading.

Report preface

The RAIU is an independent investigation unit within the Department of Transport, Tourism and Sport (DTTAS) which conducts investigations into accidents and incidents on the national railway network (Iarnród Éireann Infrastructure Manager (IÉ-IM) and IÉ Railway Undertaking (IÉ-RU)), the Dublin Area Rapid Transit (DART) network, the LUAS, heritage and industrial railways in Ireland. Investigations are carried out in accordance with the Railway Safety Directive 2004/49/EC enshrined in the European Union (Railway Safety) (Reporting and Investigation of Serious Accidents, Accidents and Incidents) Regulations 2014.

The RAIU investigate all serious accidents. A serious accident means any train collision or derailment of trains, resulting in the death of at least one person or serious injuries to five or more persons or extensive damage to rolling stock, the infrastructure or the environment, and any other similar accident with an obvious impact on railway safety regulation or the management of safety. During an investigation, if the RAIU make some early findings on safety issues that require immediate action, the RAIU will issue an Urgent Safety Advice Notice outlining the associated safety recommendation(s).

When the RAIU consider a full investigation is not warranted the RAIU may issue a Safety Brief to reinforce the correct adherence to existing guidelines or standards that resulted in an accident or incident.

The RAIU may investigate and report on accidents and incidents which under slightly different conditions might have led to a serious accident.

The RAIU may also carry out trend investigations where the occurrence is part of a group of related occurrences that may or may not have warranted an investigation as individual occurrences, but the apparent trend warrants investigation.

The purpose of RAIU investigations is to make safety recommendations, based on the findings of investigations, in order to prevent accidents and incidents in the future and improve railway safety. It is not the purpose of an RAIU investigation to attribute blame or liability.

Report summary

At approximately 08:47:03 hours (hrs) a Mayo County Council truck (Truck) approached and drove onto Cartron Level Crossing, IÉ-IM asset number XM220 (LC XM220) and drove onto the Level Crossing. At the same time, the 08:15hrs Ballina to North Wall Dublin goods train, Train K801, was approaching and travelled through the level crossing, striking the truck.

On impact the truck was thrown clear of the train and into the adjacent ditch before coming to a stop, the truck driver was dazed and subsequently left the scene with two colleagues before emergency services arrived and was later treated at Mayo General Hospital.

The driver of train was also conveyed to Mayo General Hospital from the scene by ambulance, he was treated for shock.

The immediate cause of the accident was that the Truck Driver did not stop at LC XM220 to look for approaching trains, as required; but instead drove onto LC XM220, into the path of the oncoming train. Contributory factors associated with the accident are:

- CF-01 – The gates at LC XM220 were left open by the previous user (which was normal at this level crossing), allowing the truck to drive onto the track without stopping to look for approaching trains;
- CF-02 – The Truck Driver may have been distracted due to the driving manoeuvre and works he was about to undertake and the weather conditions at the time;
- CF-03 – On the approach to LC XM220, the Truck Driver was not thinking about approaching trains; the traffic calming measures on site (such as the advance warning signs) may not be adequate at communicating to the users that they are approaching a railway line.

The underlying causes associated with this accident are:

- UC-01 – IÉ-IM have not taken sufficient actions at LC XM220 to prevent its regular misuse.

The RAIU made one additional observation related to this accident:

- AO-01 – Mayo County Council's Driver's Handbook does not identify the risk associated with user operated level crossings.

The RAIU made three safety recommendations as a result of this accident:

- Recommendation 2019003-01 – IÉ should consider options to upgrade LC XM220 to minimise the requirement of direct action by the users.
- Recommendation 2019003-02 – IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and should develop a programme to either close or upgrade the level crossings to minimise misuse; where possible, level crossings with the highest risks should be addressed first;
- Recommendation 2019003-03 – DTTAS should review, in consultation with the relevant stakeholders, their current advance warning signage (W 121) with a view changing the signage to make it clear to road users that they are approaching a user operated level crossing. They should also consider the introduction of other traffic calming measures in efforts to encourage safe road user behaviour. Care should be taken not to inadvertently introduce new risks as a result of their proposed measures

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The accident

Summary of the accident

- 1 At approximately 08:47 hrs on Friday the 17th August 2018, an Isuzu Light-Duty Truck (to be referred to as a Truck for the remainder of the report) drove onto Cartron Level Crossing, XM220 (which will be referred to as the LC XM220 for the remainder of the report), see Figure 1. The Truck was on-hire by Mayo County Council and the driver (to be known as the Truck Driver for the remainder of the report) was an employee of Mayo County Council.

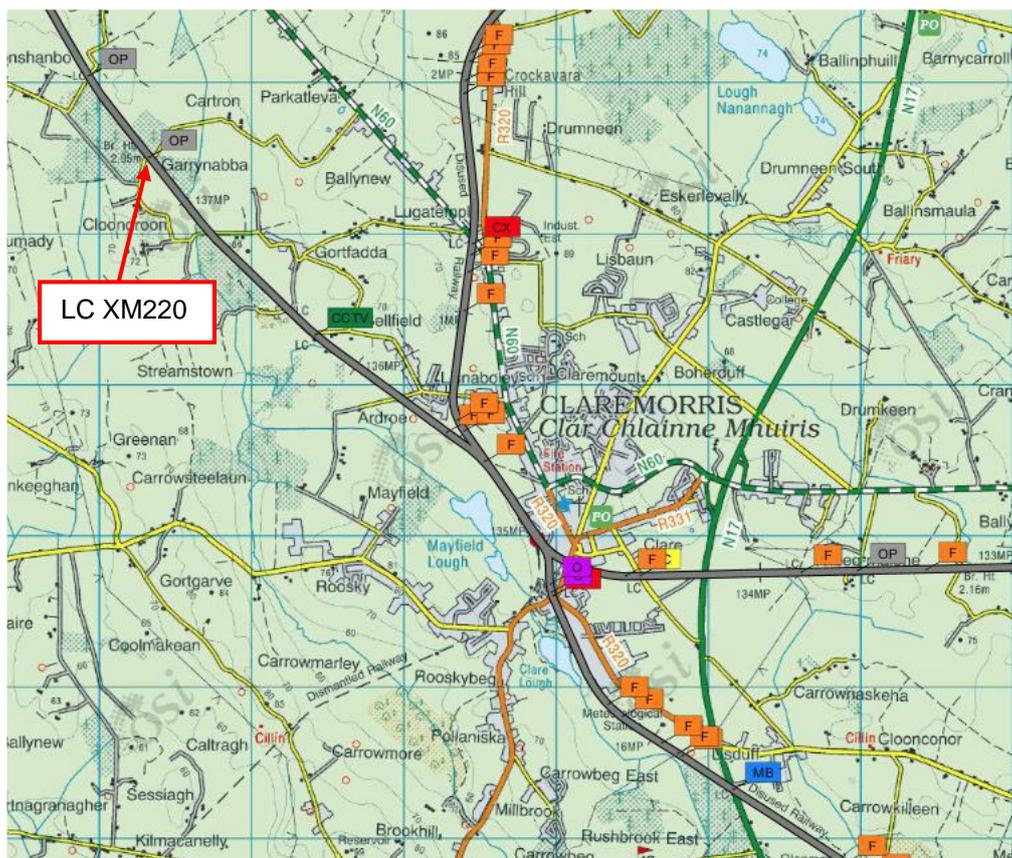


Figure 1 – Location of the accident

- 2 At the same time, the 08:15 hrs goods train from Ballina to North Wall International Warehousing and Transport Dublin (train identification number K801) was travelling towards LC XM220 and struck the Truck. On impact, the Truck was thrown clear of the train and into the adjacent boundary fence before coming to a stop. The train came to a full stop 482.43 metres (m), measuring from the front of the train, past LC XM220, see Figure 2.



Figure 2 – Scene of the accident

- 3 The Truck Driver was working with two other colleagues as part of a team repairing defects on the public road and verges. He was travelling in the Truck, placing warning signs along the road for oncoming traffic for scheduled road works at the time of the accident. His two colleagues were on the scene a few minutes after the accident but did not witness it.
- 4 The Train Driver was unaccompanied at the time of the accident; and, was conveyed to Mayo County Hospital where he was treated for the effects of shock and discharged the following day.

General description of the railway

Infrastructure

- 5 The railway line between Athlone and Westport & Ballina is a single *bidirectional line*; trains travelling towards Ballina are in the *down direction* and those travelling towards Claremorris are in the *up direction*. The track is plain line with *flat bottom continuously welded rail (CWR)* mounted on concrete sleepers in ballast. No factors in relation to the condition of the track were found to have contributed to the accident.
- 6 LC XM220 is situated approximately 2 miles and 373 yards (3.56 kilometres (km)) from Claremorris Station on the Down approach. The road access for LC XM220 is from an unrestricted third class public road, L55381, located off the N60 (Castlebar – Claremorris (County Mayo) adjacent to Lugatemple (County Mayo), to which the public have unrestricted access, see Figure 3. The third-class regional road has a speed limit of 80 kilometres per hour (km/h).
- 7 LC XM220 will be discussed further in the Evidence section of this report.



Figure 3 – Cartron Level Crossing, LC XM220

Rolling stock

- 8 The International Warehousing and Transport (IWT) Liner train involved in the accident was the 08:15 hrs Ballina (Mayo) to Northwall Liner (Dublin), train identification number K801 to be referred to as Train K801 for the remainder of this report.
- 9 The service was operated by diesel locomotive 076, hauling eighteen container wagons; 30238, 30237, 30242, 30234, 30261, 30273, 30245, 30223, 30241, 30249, 30222, 30258, 30235, 30262, 30270, 30233, 30239 and 30176.
- 10 Locomotive 076 is a 071 Class Locomotive which entered service with Irish Rail in 1976 and weigh 100 tons (90,718 kg) and measure 57 feet (17.37 m) in length. The combined weight of the train at the time of the accident was 814 tons (738,448 kg).
- 11 The maximum permitted speed of an IWT Liner train is 50 mph (80 km/h) and these trains are driver-only operated.
- 12 The *on-train data recorder* (OTDR), fitted to the leading locomotive, recorded the following:
 - The train was travelling at a speed of 42.87mph (68.99 km/h) on the approach to LC XM220, which was less than the required 50 mph (80 km/h));
 - The emergency brake was applied one second prior to the collision; and operated as expected;
 - The train horn was sounded three times. Once, as required, at the location of the *whistle board* (positioned on the approach to the LC XM220); again nine seconds later due to a habitual additional safety measure adopted by the Train Driver; and, again, for a constant sounding of the horn when the Train Driver saw the Truck;
 - The front facing lights on the train were switched on and functioning correctly.
- 13 No factors in relation to the condition of the train were found to have contributed to the accident.

Signalling and communications

- 14 The line between Athlone and Westport & Ballina are single-track and signalled using two and three aspect *colour light signals*, controlled by the Mayo Line Signaller, located in Athlone Signalling Centre. *Track Circuit Block* (TCB) regulations apply to this route. The means of communication between the train drivers and the signaller on this route is through train radio.
- 15 No factors in relation to the condition of the signalling and communications systems were found to have contributed to the accident.

Operations

- 16 The line from Ballina to Castlemorris has sixteen scheduled freight services per week Monday to Friday. Additionally, there are seven passenger services in each direction Monday to Saturday, with six on Sundays.
- 17 The maximum permitted line speed for the section of line through LC XM220 was 70 mph (110 kilometres per hour (km/h)) in the Up direction and 60 mph (95 km/h) in the Down direction as set out in the Working Timetable effective from the 9th of September 2018. The maximum speed for freight service, as in the case of this accident, is 50 mph (80 km/h).
- 18 The line is operated under the rules and regulations for trains signalled by Track Circuit Block and is controlled by the Mayo Line Signaller who is based in Athlone Control Centre.

General description of the road vehicle

- 19 The Isuzu Light-Duty Truck, similar to the truck illustrated in Figure 4 was first registered in May 2011. The vehicle had a complete service record having its last full service in March 2018 and passed the Commercial Vehicle Roadworthiness Testing at that time. It was on-hire to Mayo County Council.



Figure 4 – Isuzu Light-Duty Truck

Fatalities, injuries and material damage

Fatalities and injuries

- 20 As a result of the accident, the Truck Driver was dazed and suffered cuts and bruises he was taken from the scene by colleagues to a Mayo County Council Depot whereupon an ambulance was called, he was treated in Mayo General Hospital where he was detained for three days.

- 21 The Train driver suffered the effects of shock and was conveyed from the scene, by ambulance, to Mayo General Hospital where he was detained overnight and discharged the next day.

Material damage

- 22 The Truck suffered side and frontal damage in the impact and the rear goods carrying flat-bed behind the crew cab was dislodged by the impact, see Figure 5 illustrating where the buffers collided with the Truck.



Figure 5 – Damage to the Truck and fencing

- 23 There was damage to LC XM220 infrastructure boundary fence and cattle grid because of this accident.
- 24 The front of the train was not damaged, there were however scuff marks where the front buffers had contacted with the side of the Truck, see Figure 6.



Figure 6 – Scuff marks to front of train buffers

Parties and roles involved in the accident

Parties directly involved in the accident

- 25 IÉ-IM is the railway infrastructure manager (IM), managing the design, installation, testing, inspection, maintenance, renewal and operation of the railway's physical assets. The IÉ-IM department associated with this accident is the Chief Civil Engineer's (CCE) Department responsible for the design, inspection, maintenance and renewal of the railway's structural infrastructure, including level crossings, and the management of risks associated with these assets.
- 26 Mayo County Council, Roads Section, work to secure a safe and comprehensive roads network to satisfy the present and projected public needs of all who live and work or visit the County.

Roles directly involved in the accident

- 27 The people directly involved in the accident, were the:
- Train Driver – IÉ-IM certified competent driver, who was experienced, and records showed he was in date for the relevant assessment and competence assessment for driving the train;
 - Truck Driver – An employee of Mayo County Council and was working in the Roads Section. The Truck Driver was licenced to operate the vehicle and was experienced and familiar with the area and LC XM220. The Truck Driver had a full driving licence and held all Certificates of Professional Competence (CPCs).

Parties not directly involved in the accident

- 28 The CRR is the national safety authority, which is responsible for the regulatory oversight of the Safety Management System (SMS) and enforcement of railway safety in the Republic of Ireland in accordance with the Railway Safety Act 2005 and the European Railway Safety Directive.
- 29 The Road Safety Authority's (RSA) aim is to save lives and prevent injuries by reducing the number and severity of collisions on the road. Some of the ways that the RSA works to improve road safety in Ireland are by:
- Developing and implementing information and education campaigns to increase awareness of road safety and promote safer driving;
 - Undertaking accident and road safety research to develop measures and recommendations to improve road safety;
 - Producing road safety strategy documents and monitoring their implementation.
- 30 The role of the DTTAS is to deliver highly critical aspect of Ireland's economic activity including further development to the transport infrastructure and services and the support and enhancement of significant tourism and sport sectors.

External circumstances

- 31 The weather at the time of the accident was recorded at the Met Éireann Ireland West Airport-Knock weather station as wet, with 6.7mm of rainfall on the day with temperatures ranging from 11.7°C to 18.1°C.

RAIU Investigation

RAIU decision to investigate

32 In accordance with the Railway Safety Act 2005, the RAIU investigate all serious accidents. Given that under slightly different conditions, this accident may have led to a serious accident where there would have been potential for fatalities and serious injuries, to the Truck Driver and Train Driver due to the possible derailment of the train, a decision was made to investigate under article 19 (2) of the Railway Safety Directive (EC, 2004).

Scope of investigation

33 The RAIU must establish the extent of the investigation to ensure that only pertinent information is recovered and reviewed. Therefore, for this incident, the RAIU have defined the following scope:

- Establish the sequence of events;
- Establish, where applicable, the immediate cause, contributory factors (CF) and *underlying causes* (UC) and *root causes* (RC);
- Examine the operation of the signalling system and level crossings;
- Examine relevant records and documents from Mayo County Council in relation to the Van Driver;
- Examine Mayo County Council risk assessments and safety statements;
- Examine IÉ-IM, CRR and RSA documentation in relation to the operation of level crossings;
- Examine relevant previous RAIU safety recommendations;
- Identify any *additional observations* (AO) indirectly associated with the accident, where applicable.

Investigation and evidence

34 During the on-site and off-site investigation, the RAIU collated the following evidence:

- Witness evidence from parties involved in the accident;
- Other evidence from members of the RU and IM with information pertaining to the accident;
- RU and IM standards, procedures and other documentation;
- Standards, procedures and documentation from other relevant bodies
- RSA documentation;
- Previous RAIU reports into similar occurrences.

Evidence

Level Crossing Documentation

Technical Management Standards

CCE-TMS-380, Management of User Worked Unattended Level Crossings

35 The signage at the Level Crossing is required to be compliant with IÉ-IM Technical Management Standard CCE-TMS-380, 'Technical Standard for the Management of User Worked Unattended Level Crossings', Version 2.1, issued November 2017 (which will be referred to as CCE-TMS-380 for the remainder of the report).

CCE-TMS-360, Track & Structures Inspection Requirements & CCE-TMS-361, Track Patrolling

36 'Track and Structures Inspection Requirements' IÉ-IM Technical Management Standard CCE-TMS-360, in conjunction with IÉ-IM Technical Management Standard CCE-TMS-361 'Technical Standard for Track Patrolling' (to be referred to as CCE-TMS-360 and CCE-TMS-361 for the remainder of the report) sets the inspection regime for level crossings, In this case, the inspection of XM220 is required once a week.

Level Crossing Infrastructure

General description

37 As mentioned previously, LC XM220 is located approximately 2 miles and 373 yards (3.56 km) from Claremorris Station and 137 miles 373 yards (221 km) from Dublin (Broadstone), between Claremorris and Ballina.

38 IÉ have designated the LC XM220 as a user worked unattended occupational Level Crossing on a public road (*OP Level Crossing*). OP level crossings are unattended level crossings, on public roads, where the level crossing gates are normally closed to road traffic. They require the user to open and close the level crossing gates in order to cross the railway.

39 The gates of LC XM220 comprises of 4.26 m (14 feet) wide metal gates positioned on each side of LC XM220, which open away from the railway. The surface of the intersection of the road with the track is covered in *Stone Mastic Asphalt*, providing a level surface over the track. *Cattle grids* are installed on each side of the roadway, where it crosses the track. There is concrete post and wire fencing running between the gates and the boundary hedges.

Access to the LC XM220

40 LC XM220 is located on local road, L55381, which runs from the N60 to Streamstown and through Gortfadda. The road way where it meets the level crossing runs in a southwest direction with the railway line running north west to south east, see Figure 7.

41 The road has a tar and chip surface that was laid recently and has a speed limit of 80 km/h.



Figure 7 – View from public road L55381 on approach to XM220

- 42 IÉ-IM surveyed and measured the usage of LC XM220 over a period of seven days, twenty-four hours a day, during May/June 2015 and found that on average: nine cars, 0.9 tractors/farm machinery and 7.4 pedestrians use LC XM220 every day.
- 43 LC XM220 is not protected by roadside traffic signals and there is no *lineside telephone* provided. The signage at and on the approach to LC XM220 is discussed in the next paragraphs.

Required signage on the approach to and at user worked level crossings

- 44 In accordance with Chapter 6, Warning Signs, of the Traffic Signs Manual (published November 2010) LC XM220 in this instance is a “gated crossing with iron gates operated by the user” and requires Signs W 121 and W 122 at 100 m intervals (for a speed limit of 80 km/h) and two RUS 027: Stop signs on the gate and post, see Figure 8.

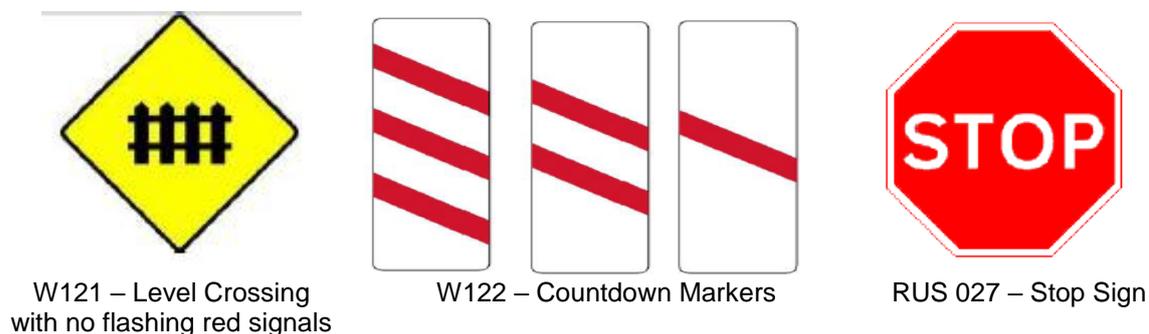


Figure 8 – Required road signs on approach to and at gated crossing

Required signage on the approach to other types of railway level crossings

45 In terms of approaching other heavy or light rail level crossings, signs W 120 and W 124 illustrate a railway vehicle, a steam train and a tram, respectively, see Figure 9; which is unlike W 121 which only displays a gate (with no reference to railway operations).



W 120: Level Crossing with Flashing Red Signals



W 124: Tram Crossing

Figure 9 – Level crossing signage

Advance Signage on the approach to LC XM220

46 The advance warning signage on the approach to LC XM220 is the responsibility of Mayo County Council in line with the Traffic Signs Manual (paragraph 44); and are verified to be in place, annually, by IÉ-IM. There are three advance warning signs on the approach at 100 m intervals, see Figure 10 for one of the signage posts 300 m in advance of LC XM220, where it can be seen there is no illustration of a train (unlike other level crossing signage (paragraph 45)).



Figure 10 – Access to LC XM220 from L55381

Signage at LC XM220

Signage present at LC XM220 on the day of the accident

- 47 The signage at the LC XM220 is required to be compliant with CCE-TMS-380.
- 48 The signage at LC XM220 was replaced by IÉ-IM in January 2010, see Figure 11; cattle grids were replaced in 2013 and vegetation boards and ‘no trespass’ signs were erected in 2014. The signage at LC XM220 at the time of the accident is illustrated in Figure 11 (photograph taken on the 21st August 2018, after the accident).



Figure 11 – Signage at LC XM220 (photograph taken on the 21st August 2018)

- 49 The signage present at LC XM220, on the day of the accident, was as follows:
- ‘Stop’ signs located within the railway boundary, on poles to the driver’s nearside behind the gates; as required by Chapter 6 of the Traffic Signs Manual (paragraph 44);
 - ‘Stop’ signs located on the centre of the metal gates, with the same specification set out above; again, as required by Chapter 6 of the Traffic Signs Manual (paragraph 44);
 - IÉ-IM ‘Danger’ sign, in the English language, including the statements: “unattended railway crossing”; “stop, look both ways, listen, cross safely, shut the gates”; “you must shut the gates – save lives” and penalty notice, see Figure 12 (signage on left);
 - IÉ-IM ‘Danger’ sign in the Irish language, including the above statements in Irish, see Figure 12 (centre signage);
 - IÉ-IM ‘Keep these gates shut’ sign which includes requirements related to closure of the gates and penalty notices associated with the failure to close gates, see Figure 12 (signage on left).
- 50 Signage on exiting LC XM220 includes the:
- IÉ-IM “Have you shut the crossing gates?” signage, which is located on the rear of the IÉ-IM “Danger” signage, see Figure 12 (signage on right).



Figure 12 – Signage at LC XM220

Signage currently present at LC XM220

51 Based on a previous RAIU recommendations in Investigation Report 2012-R001, 'Car Strike at Murrough Level Crossing, XG173, County Galway, 14th February 2011' whereby the RAIU recommended that "IÉ-IM should review the suitability of the signage at user worked level crossing on public and private roads, ensuring the human factors issues are identified and addressed"; IÉ-IM engaged external human factors consultants, to review the old signage and develop signage which was trialed on some level crossings. At the date of publication of this report, the trial has been completed and all amendments have been approved and adopted.



Figure 13 – New signage design

52 IÉ are currently in the process of fitting all O/OP crossings with the new signage. The new signage has been erected at LC XM220, see Figure 13 and Figure 14 which were photographed on site by the RAIU on the 22nd May 2019.

53 In relation to the new train signage (top of Figure 13), this is not an official road traffic sign as set out in the Traffic Signs Manual and it not recognised as such in the current edition of the Rules of the Road.



Figure 14 – New signage at LC XM220

Road markings at LC XM220

- 54 IÉ-IM have painted, what they refer to as Decision Lines, on the road, in the place of the normal Stop Line. These Decision Lines are to indicate, to the level crossing user, the safe distance that a vehicle user can stop without the vehicle encroaching onto the path of trains, this is sometimes referred to as the 'decision point' i.e. the point where the motorist decides to cross if it is safe to do so.
- 55 This was considered by IÉ-IM, in agreement with the DTTAS, as a working compromise to be used on narrow roads. The concept being that where a road was too narrow to facilitate a longitudinal line in the centre of the road the stop line was agreed as solid over two thirds of the road way and the remainder broken, so not to give the impression the road is one way.
- 56 This Decision Line is a 300 millimetres (mm) continuous white line which is painted from the left edge to a point, two-thirds across the roadway. and continues as a broken white line to the right edge of the roadway. The line is located approximately 2 m from the running edge on each side of the level crossing road approaches, see Figure 15.



Figure 15 – Approach to XM220 with Decision Line

Other traffic calming measures at user worked level crossings

- 57 Signage and road markings are *traffic calming* measures, however, there are no other physical traffic calming measures which prevent inadvertent access, restrict speeds of level crossing users approaching level crossings, or control the access onto the level crossing when the gates have been left open. Examples of physical traffic calming measures include: bollards, posts, poles, chicanes, rumble areas, raised, lowered or modified road surfaces, ramps, speed cushions, speed tables or other similar works or devices.

Viewing distance at LC XM220

- 58 The maximum permitted line speed for the section of railway line through LC XM220 is 70 mph (110 km/h) in the Up Direction and 60 mph (95 km/h) in the Down Direction; meaning that the required *viewing distances*, as set by CCE-TMS-380, are 350 m and 300 m, respectively.
- 59 The viewing distance at LC XM220 were measured at 403 m in the Up direction and 698 m in the Down direction, which means that the required viewing distances are within tolerance in both directions.



Figure 16 – Up Side looking in the Down direction to Ballina



Figure 17 – Up Side Looking in the Up direction to Claremorris

- 60 Whistle boards are located at 350 m on the Up side towards Claremorris and at 348 m on the down side towards Ballina.

Inspection and maintenance of LC XM220

- 61 IÉ-IM have an on-going process of annual level crossing checks, this includes a vegetation control process, hedge cutting, and strimming was carried out in June 2018 and vegetation spraying in May 2017 and in May 2018.
- 62 LC XM220 is patrolled each Monday by a Patrol Ganger in compliance with CCE-TMS-360 and CCE-TMS-361.
- 63 The Patrol Ganger fills in a report sheet on each crossing on the route and if the gates are found to be open, Patrol Ganger closes the gates and notes this for any subsequent action as deemed necessary; details of crossings where gates are habitually left open are centrally recorded to try and identify any known level crossing users.

Level Crossing Documentation

- 64 Risks for infrastructure assets, including level crossings, are addressed in Safety Management Standard, 'Hazards and Risk Assessments', CCE-SMS-006 (Version 4.0, published 12/03/2017); which required a Risk Register to be maintained by the Senior Track & Structures Engineer (STSE), Athlone. There were no outstanding risks on the STSE Risk Register for LC XM220 at the time of the occurrence.
- 65 Risks associated with mis-use are included in the Level Crossing Risk Model (LCRM). The LCRM is a computer-based risk ranking tool that establishes the risk at each level crossing through the inputting of the individual data of each level crossing.
- 66 Risks are calculated by collective and individual risk, as follows:
- Collective Risk – The total harm including injuries and fatalities from accidents. It includes the harm to everyone exposed to the hazards including train passengers, IÉ staff and the public using the level crossing. It is measured in units of safety loss per year, referred to as fatalities and weighted injuries (FWI) per year;

- Individual Risk – Measure of the likelihood that a person is fatally injured per year from their exposure to the railway. It is measured in the units of probability of fatality to an individual per year. For example, if a commuter had an individual risk of 1 in a thousand of 1000 (0.001) they could on average, be expected to travel for 1,000 years before being fatally injured from railway hazards. In more tangible terms, if 1,000 commuters had the same individual risk, it would be expected that one was fatally injured per year. An important factor with individual risk is a person's exposure. For passengers, their individual risk increases with the number of journeys that make per year. For example, if one person (Person A) uses the railway for a particular journey ten times as often Person B, then the individual risk to Person A will be ten times that of Person B. To assess individual risk, it is necessary to assume a level of exposure to railway hazards as it is not possible to assess every individual's use of the railway. IÉ employs the standard approach to assessing individual risk by assessing highly exposed individuals. This approach ensures that individual risk is not underestimated. In the case of passengers, the individual is assumed to be a commuter who uses the railway for travelling to and from work on a daily basis. At level crossings the typical highly exposed individual is defined as using the crossing up to 500 times per year. There is a clear difference between the risk to people who are following rules and behaving in accordance with the prescribed crossing usage procedure, those who follow rules but make an error and those who do not follow the rules. Tolerability criteria would not normally be applied to those hazards whereby people do not follow rules, so this component of the risk is excluded from the individual risk calculation.
- 67 At the time of the accident LC XM220 had a collective risk (totality of risk to all exposed groups from one or more hazardous events) of 1.7×10^{-3} FWI per year; and, an individual risk (risk to a typical person exposed to one or more hazardous events) of 3.5×10^{-5} per year. The upper limit of tolerability for level crossings is 1×10^{-4} which means that the risk at LC XM220 is high, but tolerable. It should be noted that there are no level crossings on the IÉ network whose individual risk is greater than the upper limit of tolerability. In terms of rating against other OP Type level crossings, LC XM220 has been ranking 18 out of 43 for individual risk and 15 out of 43 for collective risk.

Operation of O/OP Type level crossings

Introduction to the operation of O/OP type level crossings

68 The use of 'OP' type level crossings is specified in three publications.:

- The RSA's 'Rules of the Road', Revision No. 6, published in April 2018;
- IÉ-IM's 'The SAFE use of Unattended Railway Level Crossings', last updated in April 2013;
- The CRR's 'Third Party Guidance on Railway Risk, Volume 3, Crossing the Railway', document number RSC-G-012-A, published in April 2008.

69 In addition to the RSA's Rules of the Road and after contributions from the CRR and IÉ-IM, a stand-alone document "Safety at Level Crossings" was published by the RSA in June 2016

70 All four documents are available on their respective websites for user's information. Knowledge of the 'Rules of the Road' is required by all drivers and would be tested as part of the driving test for the issue of a full driving licence.

Operation of unattended level crossings according to the RSA's Rules of the Road

71 The RSA's 'Rules of the Road' and 'Safety at Level Crossings' documents introduce level crossings in a full page flyer type warning which has been composed by the RSA, IÉ-IM and the CRR, as illustrated in Figure 18. Note the train sign, which has not been explained further in the Rules of the Road.

72 High level basic instructions are included in both documents, namely:

- Drivers and other users should be aware of the different types of crossing, and **should** know how to cross safely. You **must** always approach a level crossing with care;
- As you approach any railway level crossing you must obey the signs and roadway markings, slow down and be prepared to stop;
- You must not enter a yellow box area unless you can clear it without stopping;
- You must never stop on the railway tracks.

73 For unattended level crossings, the RSA documents have developed a "Rail Cross Code" outlined in Figure 19.

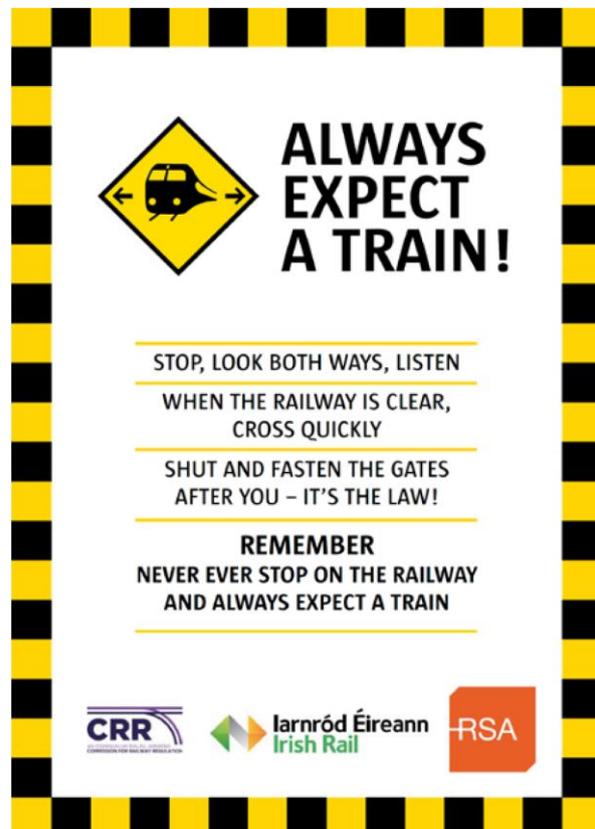


Figure 18 – Illustration from Rules of the Road

Use the **Rail Cross Code** each time you cross:

- Always expect a train
- Stop, Look and Listen
 - Stop – at least two metres before the railway line
 - Look – right and left, watching for the lights of approaching trains
 - Listen – for a train horn or whistle
- Give way to trains
Let any approaching train pass, then **look** right and left again
- When the railway is clear, cross quickly.
- If there are gates, shut and fasten them after you. It's the law.

Figure 19 – Rules of the Road “Rail Cross Code”

74 The document contains guidance on the operation of unattended level crossings with iron gates (what IÉ-IM refer to as O/OP type crossings). The document includes an illustration of the approach signage for level crossings (Ref W121 Traffic Signs Manual), see Figure 20. This sign, according to the Rules of the Road, means “Level crossing ahead, guarded by gates or lifting barriers”. The document also provides an illustration depicting an unattended level crossing, see Figure 21.



Level crossing ahead, guarded by gates or lifting barrier

Figure 20 – W121

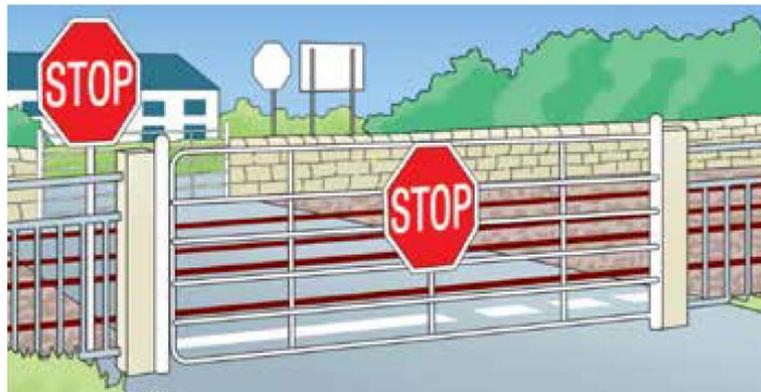


Figure 21 – Unattended Level Crossing Illustration

75 It is noted that the Rules of the Road illustration depicts the Decision Line but does not outline its purpose. No other signage (IÉ-IM signage) is depicted in the illustration.

76 The document states that “these unattended level crossings are found on minor roads. The railway is normally guarded by iron gates which must be kept shut – there is no other protection. The user has the responsibility to open and shut the gates. It’s the law”. It continues: “These crossings can be dangerous to use, and drivers **should** use all available help to cross safely. It is preferable for drivers to use a bridge or an attended or automated level crossing where one is available”.

77 The Rules of the Road describes actions that the driver “should” and “must” do when operating the level crossing, see Figure 22. These include actions related to preparation to cross, crossing and requirements to shut the gates.

Drivers – what you **should do:**

Prepare

- STOP clear of the gates.
- Switch off phone and music systems.
- Open windows on driver and passenger sides.
- Read instructions at the crossing.
- Get a helper to operate the gates if possible.

Drive across safely

- First walk across and open both gates.
- Drive forward and STOP two metres clear of the railway line.
- Apply your handbrake.
- Look right and left and listen.
- Drive across quickly when the railway is clear.
- Stop well clear of the tracks on the opposite side.

Drivers – what you **must do:**

Shut gates at unattended level crossings

- You **must** shut and fasten the gates as soon as you and any person, animal or vehicle under your care has passed through.
- Even if the gates are open when you arrive, you **must** shut and fasten them after you to protect others.
- Failure to shut and fasten the gates is an offence.

Figure 22 – Driver requirements set out in the RSA’s Rules of the Road

78 The requirement to shut the gates is further highlighted in the document, stating that failure to close to gates is an offence, see Figure 23.



Figure 23 – RSA highlighted information

IÉ-IM's The SAFE use of Unattended Railway Level Crossings

- 79 IÉ-IM's booklet 'The SAFE use of Unattended Railway Level Crossings' (to be referred to as the IÉ-IM Booklet for the remainder of this report) was first published in November 2006. The IÉ-IM Booklet is issued to known users of level crossings. The Truck Driver involved in the accident did not have a copy of the IÉ-IM Booklet as he was not a known user of the level crossing. A soft copy of the IÉ-IM Booklet is also freely available on IÉ-IM's website; and there also provisions for the issuing of hardcopies on request.
- 80 The booklet starts by introducing the dangers at unattended level crossings; some of the main dangers, relevant to this accident, include:
- Trains travel fast and cannot stop suddenly. A fast train may take between 1/2 mile and one mile to stop;
 - Leaving gates open can result in children or animals wandering on to the line and may encourage unsuspecting drivers of vehicles to go straight on to the level crossing before checking that it is safe to do so;
 - Trains can be very silent.
- 81 The IÉ-IM Booklet instructs the driver of a vehicle to:
- Stop clear of the railway line where you get a good view along the track in both distances;
 - Look for the approach of trains, especially in poor visibility or at night;
 - Watch out for the light on an approaching train;
 - Listen for horns or the sound of an approaching train;
 - When using the level crossing, open both gates before attempting to bring a vehicle across the railway line. Open the opposite gate first;
 - Before attempting to cross, always examine the railway from the best vantage point to check for approaching trains. If the location of your crossing is such that a good view is not available, you should provide yourself with the necessary assistance to enable the maximum view to be obtained;
 - Shut and fasten the gates immediately after using the crossing.

The CRR's Third Party Guidance on Railway Risk

82 The CRR's 'Third Party Guidance on Railway Risk, Volume 3, Crossing the Railway', document number RSC-G-012-A (referred to as RSC-G-012-A for the remainder of the report) identifies the hazards associated with unattended level crossing (such as O/OP crossings), see Figure 24.

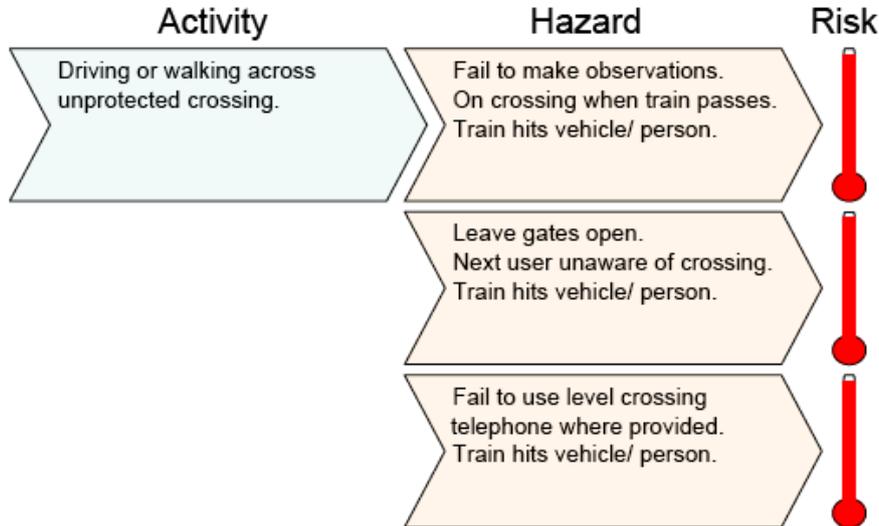


Figure 24 – Hazards associated with crossing unprotected crossings

83 RSC-G-012-A refers to the IÉ-IM booklet 'The Safe Use of Unattended Level Crossings' for comprehensive guidance related to the use of unprotected crossings.

84 RSC-G-012-A does not reference the RSA's Rules of the Road.

Failure to shut & fasten the gates after use

85 Misuse is identified as an offence in Part 14, Section 131(1) of the Railway Safety Act 2005, which states: "Where a person fails to shut and fasten the gate of a level crossing or passage to which this section applies, as soon as he or she or any animal or vehicle under his care has passed through the level crossing, he or she is guilty of an offence and is liable on summary conviction in respect of every such offence to a fine not exceeding 1000 euro".

Public awareness campaign

86 IÉ-IM, the CRR and the RSA launched a public awareness campaign in April 2013 specifically directed at preventing misuse at unattended O and OP type level crossings to educate the users and prevent accidents happening. In addition, in 2016, another awareness campaign was launched to coincide with the publication of the RSA led document 'Safety at Level Crossings' (paragraph 69).

- 87 In 2014, IÉ-IM undertook a comprehensive communications strategy throughout the year around the area of user worked level crossings, specifically:
- A number of 'event days' were undertaken with a full-day presence at high risk crossings to engage with users about their problems as users and about the dangers of user worked crossings;
 - Media events were arranged at key crossings, attended by IÉ-IM senior management, the Garda, the RSA and the CRR to bring about greater mutual understanding of the issues surrounding user worked level crossings;
 - Radio advertisement campaigns were run in March and November 2014 highlighting the issues around the safe use of level crossings. These advertisements were run on sixteen local radio stations which were chosen based on regional proximity to user worked level crossings.
- 88 The detailed communication strategy further involved positive engagement with a range of potential level crossing users including: local schools and sports clubs; Irish Creamery Milk Supplies Association (Membership 12,500); An Post; oil delivery companies; An Garda Síochána; the Civil Defence; Irish Farmers Association; Teagasc; agricultural suppliers (Glanbia, Devenish Nutrition, Wex. Field Producers); refuse collectors; veterinary doctors and medical doctors.

Operation of LC XM220

Known users of LC XM220

89 There are no known users of LC XM220, this is because LC XM220 is on a public road with many unknown users. It should be noted that historically IÉ-IM attempted to identify and log the users of level crossings, however, new General Data Protection Regulations prohibit this.

Misuse of LC XM220

90 The route including the level crossing is routinely inspected by a patrol ganger once a week, usually on a Monday. Report sheets filled out by the Patrol Ganger in the previous six months show that the gates are found to be open on each visit. The gates at LC XM220 were last reported as open on Monday 13th August 2018 (four days before the accident). As mentioned previously, the Patrol Ganger fills in a report sheet on each crossing on the route and if any are found to be left with the gates open, the gates are closed; and, details noted and sent to the Regional Manager and Infrastructure Manager.

91 During an RAIU visit to LC XM220 a rope was seen tied around both gates to allow local level crossing users to keep them open, see Figure 25.



Figure 25 – LC XM220 gates tied to keep level crossing open

Near Misses at LC XM220

92 In 2013 and 2014 there were four reported near misses at LC XM220:

- 27th March 2013 – Near miss between a train and a girl on a bike and two dogs;
- 29th April 2013 – Near miss between a train and a road vehicle;
- 2nd July 2014 – Near miss between a train and a tractor;
- 17th March 2014 – Near miss between a train and a trespasser who would not exit track.

93 There were no reported near misses at LC XM220 in 2015, 2016, 2017 or in 2018 until the time of the accident.

Mayo County Council Driver's Handbook

- 94 The Truck Driver was driving the Truck in connection with road works to be carried out for Mayo County Council.
- 95 Mayo County Council issue a Driver's Handbook (Mayo Local Authorities Drivers) to be referred to as Driver's Handbook to employees driving their vehicles, which has been reviewed by the RAIU. Section 8.4, Road Traffic Act, states that "It is the responsibility of all drivers to ensure that they are kept up to date with and comply with the Road Traffic Act and all other relevant road legislation."
- 96 The Driver's Handbook covers vehicle roadworthiness, drivers' responsibilities and fatigue. Section 7.5 highlights "driver distractions", identifying three types, see Figure 26.

Driver Distractions - Don't Be A Statistic Distractions Are Everywhere

Driving is a skill that requires your full attention to safely control your vehicle and respond to events happening on the roads around you. Driving involves constant and complex coordination between your mind and body. Events or things that prevent you from operating your vehicle safely are distractions. There are three types of distractions and they are anything that takes your:

- eyes off the road (visual).
- mind off the road (cognitive).
- hands off the steering wheel (manual).

When you think about the actions you make in your vehicle, other than just driving, you can see that they often involve more than one type of distraction. For instance, if you change your radio station, you take a hand off the steering wheel to press a button, and take your eyes off the road to look at what button you want to press

Figure 26 – Driver's Handbook Extract

- 97 There was no mention of level crossings or the railway anywhere in the Driver's Handbook.

Sequence of events

Events before the accident

- 98 At LC XM220: the signage was upgraded in 2010; the Decision Line was painted in 2012; and, vegetation and trespass signage erected at LC XM220 in 2014; advance warning signage were verified by IÉ-IM to be in place since early 2015.
- 99 LC XM220 had a history of frequent misuse related to gates being left or tied open; with the gates being found to be open on every track patrol inspection in the previous six months; with the gates last being reported open on Monday 13th August 2018 (four days before the accident); on this day, the Patrol Ganger closed the gates and recorded no other faults were recorded at LC XM220.
- 100 On Friday 17th August there was 6.7 mm of rainfall recorded in the Mayo area, resulting in slightly reduced visibility.
- 101 The Train Driver had booked on duty at 07:15 hrs to work Train K801 at 08:15 hrs to Athlone and was adequately rested from his previous turn of duty. The Train Driver carried out a brake test as part of the train preparation before the train departed Ballina at its scheduled time of 08:15 hrs and travelled without incident and within the speed limits until its approach of LC XM220.
- 102 At 08:46:41 hrs the Train Driver of Train K801 sounded the horn at the whistle board (located 350 m before LC XM220); the train was travelling at a speed of 42.87 mph (68.59 km/h).
- 103 At 08:46:50 hrs the horn was sounded for a second time, which was an additional habitual safety measure adopted by the Train Driver (i.e. not required by the driver's handbook); the speed remained at 42.87 mph (68.59 km/h).
- 104 The gates of LC XM220 were opened by a previous unknown user and were left open; it cannot be determined how long they had been left open prior to the accident.
- 105 The Truck Driver (who was familiar with LC XM220 and had approached it with the gates open on several occasions) intended to cross over LC XM220 to turn the Truck and return over LC XM220 to place signs for the local road works. On approaching with the gates open, he did not stop at a safe position in advance of LC XM220 to look for approaching trains and began to travel over LC XM220.
- 106 The Train Driver saw the Truck travelling onto LC XM220 from his left-hand-side; and at 08:47:00 hrs sounded the horn (as a long blast) and moved the throttle control to idle (to slow the train).
- 107 Two seconds later, at 08:47:02 hrs as the Train Driver realised that the Truck Driver was unaware of the approaching train and that the Truck was not going to clear LC XM220 in time, he applied the emergency brakes of the train.

Events during the accident

108 As Train K801 was about to strike the Truck, the Train Driver saw the Truck Driver react by lunging over the seats of the Truck away from the train.

109 At 08:47:03 hrs, Train K801 struck the Truck (close to the middle of the Truck). The Truck was thrown clear of the track and came to rest adjacent to the right-hand side of LC XM220.

Events after the accident

110 The Train Driver made an emergency call to the Mayo Line Signaller to report the accident and to request the attendance of emergency services.

111 During this time, the Truck Driver, who was dazed and confused from the collision was escorted away from the scene of the accident by two work colleagues who were nearby. Before leaving the scene, one of the parties closed the gates to LC XM220. The Truck Driver was driven to Mayo County Council Office at Kilcolman Road, Claremorris, where an ambulance called to convey him to Mayo General Hospital.

112 The Train Driver made his way back to LC XM220 to confirm the level crossing number and reported this to the Mayo Line Signaller. The Train Driver then approached the Truck but could not find any occupants in or around the vehicle; he began searching adjacent fields and under the train but could not find the occupant. The Train Driver did notice that the gates to XM 220 were now closed.

113 After the ambulance arrived on-site, the Train Driver was assessed and conveyed to Mayo General Hospital where he was released the following day.

Similar occurrences

O/OP Level Crossing accidents 2009 to present

114 Since the establishment of the RAIU (2007), there have been eight collisions of trains with road vehicles at similar O/OP Type Level Crossings (level crossings gates which are padlocked where not included, and accidents without road vehicles were not included), namely:

- Fatality at level crossing XX032 between Manulla and Ballina on the 28th February 2008 where a car was struck by a train and the car driver was fatally injured;
- Collision between a train and a road vehicle at level crossing XN125, Cappadine, on the Ballybrophy to Killonan line 31st of July 2008 where a private car was struck by a train; no injuries reported;
- Road vehicle struck at level crossing XM096, County Roscommon, 2nd September 2010 the road vehicle driver was fatality injured;
- Car Strike at Knockaphunta Level Crossing (XM250), County Mayo, 24th October 2010 where a private car was struck by a train; no injuries reported;
- Car Strike at Morrough Level Crossing, XG173, County Galway, 14th February where a private car was struck by a train; no injuries reported;
- XN125 –Cappadine Crossing, Ballybrophy to Killonan line, 3rd September 2012 a private car was struck by a train; no injuries reported (RAIU Preliminary Report only);
- Vehicle struck by train at Corraun level crossing, XX024, Co. Mayo, 12th February 2014 where an An Post van struck by a train; the road vehicle driver was injured;
- Car strikes train at level crossing XM250, Knockaphunta, Co Mayo, 8th June 2014 where a private car struck a train; no injuries reported.

115 Of these eight accidents, there were two fatalities and one injury to the road vehicle users.

116 The RAIU have made twenty safety recommendations (some of which are re-iterated), in relation to these type of level crossings, which are as follows:

Fatality at level crossing XX 032 between Manulla and Ballina on the 28th February 2008

117 RAIU's Investigation Report, Report 08022801, made the following safety recommendations:

- The RSC should carry out a review of the suitability of this type of level crossing on public roads. This review should include, but not be limited to, factors such as continual misuse, signage, user mobility, environmental and human factors;
- IÉ-IM should, taking into account the close proximity of the three level crossings, close or upgrade some or all of these crossings;
- IÉ-IM must identify crossings that are regularly misused and take proactive action to manage the increased risk created by this misuse;
- IÉ-IM are to put in place procedures that will capture and manage near miss reports.

Collision between a train and a road vehicle at level crossing XN125, Cappadine, 31st July 2008

118 RAIU's report, Investigation Report 08073101, made the following safety recommendations:

- IÉ-IM should assess the risks relating to road users' behaviour in identifying a safe stopping position at User Worked Level Crossings and based on the outcome of this risk assessment, IÉ-IM should introduce measures to allow safe use of this type of level crossing;
- IÉ-IM should carry out risk assessments on level crossings that fail to meet the viewing distances specified in the RSC guidance and implement appropriate measures in order to meet this guidance as a minimum.

Road vehicle struck at level crossing XM096, County Roscommon, 2nd September 2010

119 RAIU's report, Investigation Report 2011-R006, made the following safety recommendations:

- IÉ-IM should put in place a formal process for identifying and communicating with known users of user worked level crossings;
- IÉ-IM should review the effectiveness of its signage at user worked level crossings, and amend it where appropriate, taking into account the information provided in the level crossing user booklet. The review should include the information on the use of railway signals, what to do in case of difficulty when crossing the railway and ensuring the signage is illustrated in a clear and concise manner, taking into account current best practice and statutory requirements;
- IÉ-IM should update its risk management system to ensure that interim control measures are put in place where longer term controls to address risks require time to implement;
- IÉ-IM should review how it determines the safe crossing time for user worked LCs to ensure the safe crossing time allows adequate time for movements and includes a safety margin, over and above the crossing time;
- IÉ-IM should review its use of disused rail as fencing at user worked LCs to ensure it cannot potentially increase the severity of a collision and where this is the case, replace the disused rail with appropriate fencing;
- IÉ-IM to develop and implement a vegetation management programme that addresses vegetation management on a risk basis, prioritising high risk areas (re-iterated safety recommendation).

Car Strike at Knockaphunta Level Crossing (XM250), County Mayo, 24th October 2010

120 The RAIU's investigation reports into the accident, RAIU Report 2011- R007, made the following safety recommendations:

- IÉ-IM should upgrade the Level Crossing to ensure that the operation of the Level Crossing is not reliant on any direct action by the level crossing user;
- IÉ-IM must identify crossings that are regularly misused and take proactive action to manage the increased risk created by this misuse (re-iterated safety recommendation);
- IÉ-IM should assess the risks relating to road users' behaviour in identifying a safe stopping position at User Worked Level Crossings and based on the outcome of this risk assessment, IÉ-IM should introduce measures to allow safe use of this type of level crossing (re-iterated safety recommendation).

Car Strike at Morrough Level Crossing, XG173, County Galway, 14th February 2011

121 The RAIU's Investigation Report, 2012–R001, made the following safety recommendations:

- IÉ-IM should review the suitability of the signage at user worked crossings on public and private roads, ensuring that human factors issues are identified and addressed;
- IÉ-IM should liaise with local authorities where private road level crossings can be accessed from a public road to ensure there is advance warning to road users;
- IÉ-IM should ensure that they adopt their own standards in relation to design changes to any plant, equipment, infrastructure or operations that have the potential to affect safety;
- The RSC should ensure that they adopt a formal approach to submissions made by IÉ-IM in relation to design changes to any plant, equipment, infrastructure or operations that has the potential to affect safety.

Vehicle struck by train at Corraun level crossing, XX024, Co. Mayo, 12th February 2014

122 RAIU Report, R2015-001, makes the following safety recommendations:

- IÉ-IM should consider options to upgrade the crossing to minimise direct action by the users;
- IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and either upgrade the level crossing or introduce measures to minimise their misuse;
- IÉ-IM should ensure that where a Decision Line is present at a level crossing, that the purpose of this Decision Line is appropriately conveyed to the level crossing users.

Car strikes train at level crossing XM250, Knockaphunta, Co Mayo, 8th June 2014

123 RAIU Report, R2015-002, made the following safety recommendations:

- The RSC, RSA and IÉ-IM in consultation with any relevant stakeholders should agree a common policy in connection with instructions and warnings related to user worked level crossings;
- IÉ-IM should upgrade the level crossing to ensure that the operation of the Level Crossing is not reliant on any direct action by the level crossing user (re-iterated safety recommendation);
- IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and either upgrade the level crossing or introduce measures to minimise their misuse (re-iterated safety recommendation);
- IÉ-IM should ensure that where a Decision Line is present on a user worked level crossing, that the purpose of this Decision Line is conveyed to the level crossing users (re-iterated safety recommendation).

Analysis

Level Crossing Documentation

124 The RAIU have reviewed IÉ-IM's Technical Management Standards related to level crossings and have found them to be robust in their management, inspection and maintenance of level crossings with all necessities occurring at the correct intervals (paragraphs 35 - 36).

125 In addition, the risks associated with LC XM220 are adequately addressed in both the STSE Risk Register and LCRM (paragraphs 64 - 67).

LC XM220

126 The infrastructure at LC XM220, at the time of the accident, was all in accordance with the Traffic Signs Manual and IÉ-IM's documentation outlined above (paragraph 124), in that it had the required:

- Gate at the level crossing, which must remain shut across the road;
- Advance signage as set out in the Traffic Signs Manual, erected by Mayo County Council, which includes three W121 signs to warn of a level crossing with gates or barriers and three W122 signs to act as countdown markers on the approach to the level crossing (paragraphs 44,46 and 74);
- Stop signs (Sign RUS 027) on a post and on the level crossings gates as set out in the Traffic Signs Manual and IÉ-IM documentation (paragraphs 44 and 49);
- Decision Line, painted on the road to the level crossing user, the safe distance that a vehicle user can stop without the vehicle encroaching onto the path of trains (paragraphs 54 - 56, 75);
- Level crossing warning signage present at the level crossing was within the required standards (paragraphs 47 - 50).

127 Apart from the above there are no other traffic calming measures present on the approach to or at LC XM220.

128 In relation to the signage at LC XM220 and other user worked level crossing, the programme for the signage replacement was being undertaken through the whole IÉ network at the time of the accident; and, the signage at LC XM220 has now been replaced (paragraph 51).

129 Safety recommendations from previous RAIU investigations into accidents at user worked level crossings have been contributory to the infrastructure upgrades at user worked level crossings (such as improvements to signage at level crossings and the introduction of a Decision Line), paragraph 116.

130 In terms of the actual infrastructure, the only existing elements to level crossings that have remained unchanged in recent years is the advance signage, W121 and W122, "Level Crossing with no flashing red signals" and the countdown markers, respectively. This sign depicts a gate; however, in the case of users approaching misused user worked level crossings, users generally do not approach a closed gate as they normally are left open by the previous users.

131 In addition, standardised road signs mean that if you glance at a sign ever so briefly, you should get the message and go back to concentrating on driving safely; i.e. at an unconscious level, common road signs function by letting road users know exactly what to expect. However, the illustration of the gate (W 121) may not make the users automatically think of trains as user worked level crossings are relatively uncommon, which is unlike other level crossing signs (W 120 and W124, paragraph 45) which depict railway vehicles. This is particularly relevant to unfamiliar users of user worked level crossings. In relation to events on the day of the accident, it cannot be determined what the Truck Driver was exactly thinking when he arrived at the level crossing, however, it is evident he was not thinking of approaching trains.

132 In terms of the Truck Driver's viewing distances at LC XM220; viewing distances are good and exceed IÉ-IM's requirements; and, despite the weather conditions at the time of the accident the train would have been visible (headlights were illuminated).

Operation of O/OP Type level crossings

Informing the users of O/OP Type level crossings

- 133 The use of user worked level crossings is specified in the RSA's 'Rules of the Road' and 'Safety at Level Crossings', IÉ-IM's 'The SAFE use of Unattended Railway Level Crossings' and the CRR's 'Third Party Guidance on Railway Risk, Volume 3, Crossing the Railway'; all of which are available on their respective websites (paragraphs 68 - 70).
- 134 The RSA's basic instructions from both their documents for the use of user worked level crossings are set out as the 'Rail Cross Code' which requires that the level crossing user: always expects a train; stop, look and listen; give way to trains; cross quickly; and, shut the gates. The document contains guidance on the operation of user worked level crossings and includes an illustration of the level crossings, see Figure 21. However, given the misuse at user worked level crossings, with the gates frequently left open, this is unlikely to be what an unfamiliar user will encounter. The RSA also recognises the danger associated with these crossings by stating that "It is preferable for drivers to use a bridge or an attended or automated level crossing where one is available". The RSA documentation frequently mentions that the gates should be shut after use (paragraphs 71 - 78).
- 135 The IÉ-IM Booklet is a comprehensive document for the safe use of unattended level crossings and discusses all possible dangers and scenarios related to the level crossings including contact details where users require assistance. IÉ-IM make efforts to identify known users of user worked level crossings and providing them with the IÉ-IM Booklet (paragraphs 79 - 81). However, in the case of Level Crossing, there were no known users of LC XM220 (paragraph 89).
- 136 The CRR's document is not as comprehensive as the RSA's or IÉ-IM's documentation, although, it is noted that the CRR is unlikely to be the first point-of-contact for users of these level crossings (paragraphs 82 - 84).
- 137 In addition to the above documentation IÉ-IM, the CRR and the RSA launched a public awareness campaigns in April 2013 and June 2016 specifically directed at preventing misuse at unattended O/OP type level crossings to educate the users and prevent accidents happening; through the use of event days, media events, advertisement campaigns and engagement with a range of potential companies whose employees may be required to operate a user worked level crossing (paragraph 86 -88).

Misuse at O/OP Type Level Crossing

- 138 The RAIU have previously carried out investigations into eight similar accidents at user worked level crossings. In all of these cases, there has been an element of misuse by users of the level crossings, in relation to leaving the gates open or tying the gates open; with the RAIU making a number of safety recommendations related to the identification of users and requirements to prevent misuse (paragraphs 117, 120, 122, 123).

139 IÉ-IM have taken actions in relation to closing these recommendations, however all the recommendations have not been closed by the CRR.

140 It appears, despite the efforts of IÉ-IM, the CRR and the RSA the communications in terms of closing the gates have not been effective at changing the behaviour of the users of O/OP Type Level Crossings, with gates still being left open (paragraph 137).

141 The above factors, coupled with the low frequency of trains in some cases, has meant the users may not see a train at the level crossing on a regular basis; which in turn means they are not expecting a train; leading to users of O/OP Type Level Crossings not stopping to look for approaching trains.

Misuse at LC XM220

142 In terms of LC XM220, it is subject to constant misuse by users, Patrol Gangers finding that the gates are routinely left open or tied open for the convenience of users eliminating the need to stop their vehicle when using LC XM220 (paragraph 90 - 91). The low frequency of trains at LC XM220 may be contributory to the misuse of LC XM220 (paragraph 16).

143 From the evidence available, the gates were open when the Truck Driver approached LC XM220.

The Truck Driver

- 144 The Truck Driver was an competent driver (paragraph 27) and an employee of Mayo County Council and had been issued with Mayo County Council's Driver's Handbook document; this document did not reference level crossings or the railway (paragraph 95).
- 145 The Truck Driver was familiar with LC XM220 and on previous occasions stopped and looked for approaching trains.
- 146 On the day of the accident the Truck Driver was working for Mayo County Council and was due to place warning signs for road users on impending road works. The intention of the Truck Driver was to drive through LC XM220 to turn his Truck before crossing back over to commence the sign placement.
- 147 It was raining on the day of the accident which may have contributed to reduced visibility around the time of the accident, however, the train would have been visible as the headlights were illuminated.
- 148 The gates of LC XM220 were open on his approach which contributed to him not stopping; and, his work may have also distracted him from the task as he was looking for positions to place the signage. These factors may have contributed to him not look for an approaching train.

The Train & Train Driver

- 149 The actions of the Train Driver on the day of the accident were in line with IÉ-IM's requirements, in that he was rested, carried out the appropriate pre-service checks, operated the train under the speed limit, sounded the horn three times, applied the emergency brakes (paragraph 12, 101) and carried out all post- accident checks correctly (paragraphs 110, 112).
- 150 The Train also operated to standard, in that the headlights were operational, and the emergency brakes engaged on application (paragraph 12).

Conclusions

Level Crossing Documentation

151 IÉ-IM's SMS documents, Technical Management Standards, Risk Register and LCRM are robust in their management (including risk management), inspection and maintenance of level crossings with all requirements occurring at the correct intervals (paragraph 125 - 126).

LC XM220

152 The infrastructure at LC XM220, at the time of the accident, was all in accordance with the Traffic Signs Manual and IÉ-IM's documentation outlined above, in that the required advance and warning signage, stop signs, decision lines were present at LC XM220 (paragraph 126). There are no other traffic calming measures at LC XM 220 (paragraph 128).

153 One of the elements of existing physical infrastructure associated with level crossings to remain unchanged, in its design, are the advance warning signs. Given that the advance warning signs are of a gate (paragraph 44), the RAIU consider that these are ineffective at depicting what the level crossing user will actually encounter at the level crossing, in that at misused level crossings, gates continuously left open (paragraphs 138 - 143). In addition, it is the only level crossing sign that does not depict a rail vehicle; and for unfamiliar users this may not make them think of trains, either consciously or subconsciously, when they encounter them. And, although, it cannot be determined what the Truck Driver was exactly thinking when he approached the level crossing; it is clear he was not thinking of approaching trains on his approach to or at the level crossing. Given that there are three advance warning signs on the approach to O/OP Type level crossings, the RAIU consider that there are three opportunities to warn users of trains, however, in their current state, it is clear, considering the behaviour of users, that these signs are not effective.

154 The viewing distances at LC XM220 were good, despite the weather conditions, and the train was visible (headlights were illuminated) to the Truck Driver (paragraph 132).

155 IÉ-IM have upgraded user worked level crossings over recent years, partly based on safety recommendations made by the RAIU since 2008. Changes have included changes to signage at the level crossing, decision lines, etc; and, it has been noted that the signage at LC XM220 has been upgraded since the accident (paragraphs 128 - 129).

Operation of LC XM220

156 IÉ-IM, the RSC and the RSA all published documents in relation to the safe use of user operated level crossings (paragraphs 133 - 135) and had the Truck Driver adhered to these instructions on the day of accident, the accident would not have occurred.

157 There is prolific misuse of LC XM220, and other O/OP Type Level Crossings on the IÉ Network in terms of leaving the gates open, with the RAIU previously identifying misuse and making recommendations (which have not yet been closed) to reduce this misuse (paragraph 138). However, despite the continuing efforts of IÉ-IM, the CRR and the RSA (paragraph 140) the misuse continues at O/OP Type Level Crossings.

The Truck Driver

158 The Truck Driver was a competent driver who was familiar with LC XM220 and has stated that on every other occasion he operated LC XM220 safely (paragraphs 144 - 145). However, on the day of the accident, he may have been distracted by the works he was undertaking for Mayo County Council and the manoeuvre of turning the Truck and the weather conditions at the time (paragraphs 146 - 147); and, when he approached LC XM220 the gates were open allowing him to drive directly onto LC XM220 without stopping to look for trains (paragraph 148).

159 Although the Truck Driver was aware of the safe use of O/OP Type Level Crossings, it is noted that Mayo County Council's Driver's Manual does not reference the level crossings in any part of the document despite the large number of O/OP Type Level Crossings in the county.

The Train & Train Driver

160 The Train and Train Driver operated as expected and were not contributory to the accident (paragraphs 149 - 150).

Immediate cause, contributory factors, underlying causes, root causes & additional observations

161 The immediate cause of the accident was that the Truck Driver did not stop at LC XM220 to look for approaching trains, as required; but instead drove onto LC XM220, into the path of the oncoming train.

162 Contributory factors associated with the accident are:

- CF-01 – The gates at LC XM220 were left open by the previous unknown user (which was normal at this level crossing), allowing the Truck to drive onto the track without stopping to look for approaching trains;
- CF-02 – The Truck Driver may have been distracted due to the driving manoeuvre and works he was about to undertake and the weather conditions at the time;
- CF-03 – On the approach to LC XM220, the Truck Driver was not thinking about approaching trains; the traffic calming measures on site (such as the advance warning signs) may not be adequate at communicating to the users that they are approaching a railway line.

163 The underlying causes associated with this accident are:

- UC-01 – IÉ-IM have not taken sufficient actions at LC XM220 to prevent its regular misuse.

164 No root causes have been identified in this accident.

165 The RAIU made one additional observation related to this accident:

- AO-01 – Mayo County Council's Driver's Handbook does not identify the risk associated with user operated level crossings.

Relevant actions taken or in progress

Actions taken by IÉ-IM

- 166 LC XM220 has been updated with the new signage (see Figure 13 and Figure 14, paragraph 52).
- 167 IÉ-IM are currently undergoing a works programme of erecting this new signage at all the user worked level crossings; 76% of the 136 O & OP type level crossings have been completed as of the time of publication of this report, with the works estimated to be completed by the end of 2019.
- 168 IÉ-IM continue to close or upgrade level crossings across the IÉ network to improve safety for everyone and reduce the risk that level crossings present. IÉ-IM aim to prioritise the permanent closure of level crossings but also install technical enhancements to achieve risk reduction measures where closure is not possible.
- 169 IÉ-IM commenced progression of a project involving implementation of technical enhancements at user worked crossings, where it is intended these improvements will be rolled out, on a risk prioritised basis, subject to funding being available. The first of these technical enhancements is a Decision Support System (DSS) in the form of a double aspect traffic light; there will be two types of DSS: "Always On" (where the indicator lights normally remain on) and "On Demand" (where the indicator lights remain unlit until activated by the user, using an "on demand" button). The objective of the DSS at user worked level crossings is to provide the level crossing user with improved information as to the approach of trains and to assist them with their determination of when it is not safe to cross.

Actions taken by the CRR

- 170 CRR continue to work closely with IÉ-IM on promoting the safe use of user worked level crossings. The CRR have undertaken and undertake sample inspections of O/OP level crossings as an ongoing supervision activity, and when the opportunity arises engage with users, reminding them of the risk associated with such level crossings and the importance of shutting and fastening gates.
- 171 Following this occurrence, in September 2018 the CRR wrote to Mayo County Council to highlight the serious nature of this accident and to ascertain what actions Mayo County Council had/were going to take/taken to prevent a reoccurrence. Mayo County Council replied in November 2018 advising that they had issued a Safety Alert to its employees and updated its driving risk assessment.
- 172 The CRR also completed a Post Incident Inspection and determined that there was no evidence of any failure of compliance on IE-IM's part in this accident.

Actions taken by Mayo County Council

- 173 The Truck Driver was briefed on the accident.
- 174 In September 2018, Mayo County Council issued a Safety Alert to all staff in relation to accidents at level crossings.
- 175 The Risk Assessment for Drivers was updated in September 2018 to consider the risks associated with unattended level crossings and this was distributed to all staff.
- 176 Mayo County Council requested 500 IÉ-IM Booklets for distribution to its staff.
- 177 The Driver's Handbook is in the process of being updated to incorporate the information in IÉ-IM's Booklet and the RSA's Safety at Level Crossing Booklet. This is to be completed by September 2019.

Safety recommendations

General description

178 In accordance with the Railway Safety Act 2005 (Government of Ireland, 2005a) and the European railway safety directive (European Union, 2004), recommendations are addressed to the national safety authority, the Commission for Railway Regulation (CRR). The recommendation is directed to the party identified in each recommendation.

Actions taken which would otherwise have resulted in new safety recommendations

179 Mayo County Council have taken appropriate actions in relation to the accident, in that they have issued a Safety Alert and the IÉ-IM Booklet to all staff; as well as updating their risk assessment associated with driving; and, they are on target to issue a new Driver's Handbook later this year; as a result, the RAIU do not consider any safety recommendations be issued to Mayo County Council.

New safety recommendations related to the accident

180 There is prolific misuse of LC XM220 with the gates of the level crossing being left open, or in some cases, tied open. IÉ-IM, in conjunction with the RSA and the CRR, have made efforts to inform users of the importance of closing the gates at O/OP Type Level Crossings; however, there has been no apparent changes to the users' behaviours at LC XM220. Had the gates been closed as the Truck Driver approached LC XM220, it is likely he would have either been in the process of opening the gates or turning the Truck in advance of LC XM220 (CF-01, CF-02, UC-01). As a result, the RAIU make the following safety recommendation:

Recommendation 2019003-01

IÉ-IM should consider options to upgrade LC XM220 to minimise the requirement of direct action by the users.

181 There is a prolific misuse at user worked level crossings, with the RAIU identifying eight very similar occurrences in recent years, where misuse was contributory to the accident, the RAIU re-make the following safety recommendation:

Recommendation 2019003-02

IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and should develop a programme to either close or upgrade the level crossings to minimise misuse; where possible, level crossings with the highest risks should be addressed first.

182 The RAIU consider that the advance warning signage is not fit-for-purpose in that the illustration of a picket gate does not identify that it is a railway gated crossing that the driver is approaching. In addition, with the prolific misuse, it is also likely that the road user will not approach a closed gate as the gates are continuously left open. The RAIU consider that there are three opportunities to warn users of trains which these signs, however, in their current state, it is clear, considering the behaviour of users, that these signs are not effective (CF-03). As a result, the RAIU make the following safety recommendation:

Recommendation 2019003-03

DTTAS should review, in consultation with the relevant stakeholders, their current advance warning signage (W 121) with a view changing the signage to make it clear to road users that they are approaching a user operated level crossing. They should also consider the introduction of other traffic calming measures in efforts to encourage safe road user behaviour. Care should be taken not to inadvertently introduce new risks as a result of their proposed measures.

Additional information

List of abbreviations

°C	Degrees Celsius
CCTV	Closed Circuit Television
CF	Contributory Factor
DMU	Diesel Multiple Unit
DSS	Decision Support System
DTE	District Traffic Executive
ICCN	Intercity and Commuter Network Department
IE	Iarnród Éireann
IM	Infrastructure Manager
Kg	Kilogram
km/h	Kilometres per hour
M	Metre
MP	Mile Post
Mph	Miles per hour
No.	Number
OTDR	On Train Data Recorder
RAIU	Railway Accident Investigation Unit
RC	Root Cause
RSC	Railway Safety Commission
RU	Railway Undertaking
SI Units	International System of Units
SMS	Safety Management System
UC	Underlying Cause

Glossary of terms

Accident	An unwanted or unintended sudden event or a specific chain of such events which have harmful consequences including collisions, derailments, level-crossing accidents, accidents to persons caused by rolling stock in motion, fires and others.
Bi-directional line	A track on which trains may be worked in either direction under normal signalling arrangements
Causal factors	Any factor(s) necessary for an occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

Colour light signals	Signals that convey movement authority to train drivers by means of coloured lights.
Competence	IÉ-IM define competence as the ability to perform activities to the standard expected within employment. In relation to drivers, it includes the practical and theoretical knowledge, experience and skill required to drive trains to ensure the safety of any person who may be affected.
Continuous welded rail	Sections of rail that are welded together.
Contributory factors	Any factor(s) that affects sustains or exacerbates the outcome of an occurrence. Eliminating one or more of these factor(s) would not have prevented the occurrence but their presence made it more likely or changed the outcome.
Controlling signalman	The signalman designated to control a specific section of track.
Colour light Signals	Signals which convey movement authorities to drivers by means of coloured lights.
Down Direction	In this report trains travelling from Manulla Junction to Ballina
Extensive damage	Damage that can be immediately assessed by the RAIU to cost at least €2,000,000 in total.
Immediate cause	The situation, event or behaviour that directly results in the occurrence.
Incident	Any occurrence, other than an accident or serious accident, associated with the operation of trains and affecting the safety of operation.
Infrastructure Manager	Organisation that is responsible for the establishment and maintenance of railway infrastructure, including the management of infrastructure control and safety systems.
National safety authority	The national body entrusted with the tasks regarding railway safety in accordance with European directive 2004/49/EC.
Occupation (O) Crossing	User worked unattended occupational Level Crossing primarily on a private road providing access to a private dwelling(s) or in a limited number of cases, a business premises
Occupation Public (OP) Crossing	User worked unattended occupational Level Crossing on a public road.
On Train Data Recorder	Device that records data about the operation of train controls and performance

Railway Undertaking	Organisation that operates trains.
Rolling stock	Railway vehicles.
Serious accident	Any train collision or derailment of trains, resulting in the death of at least one person or serious injuries to 5 or more persons or extensive damage to rolling stock, the infrastructure or the environment, and any other similar accident with an obvious impact on railway safety regulation or the management of safety, where extensive damage means damage that can be immediately assessed by the RAIU to cost at least €2,000,000 in total.
Stone Mastic Asphalt	A deformation-resistance, durable surfacing material; with a coarse aggregate and dense bitumen content.
Stop signal	A signal capable of displaying a stop aspect or indication.
Track circuit block	A signalling system that uses track circuits to confirm the absence of trains in order to control the movement of trains.
Traffic Calming	The use of physical design and other measures to improve safety for motorists, pedestrians and cyclists.
Up direction	In this report trains travelling from Ballina to Manulla Junction.
User worked unattended level crossing	A Level Crossing which provides access between premises and a public highway or between land and/or land/premises under common ownership and occupation but divided by the railway line e.g. where a railway and a road cross on the same level or where a farmer can cross between fields on each side of the railway line. The gates are operated by the Level Crossing user.
Viewing Distance	The distance from which trains must be seen in order to give adequate warning time of approaching trains
Whistle Boards	A trackside sign which indicates a train driver must sound the horn

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