



Investigation Report 2011-R006



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

Document History

Title	Road vehicle struck at level crossing XM096, County Roscommon, 2 nd September 2010
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Purpose of an investigation by the Railway Accident Investigation Unit

The Railway Accident Investigation Unit (RAIU) is a functionally independent investigation unit within the Railway Safety Commission (RSC). The purpose of an investigation by the RAIU is to improve railway safety by establishing, in so far as possible, the cause or causes of an accident or incident with a view to making recommendations for the avoidance of accidents in the future, or otherwise for the improvement of railway safety. It is not the purpose of an investigation to attribute blame or liability.

The RAIU's investigations are carried out in accordance with the Railway Safety Act 2005 and European railway safety directive 2004/49/EC.

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Summary

At approximately 11:13 on the 2nd September 2010, the 09:30 freight service from Ballina to North Wall was travelling along the left hand curve on the approach to user worked level crossing XM096. As XM096 came into view, the Train Driver observed a tractor stationary on the track at the level crossing. The Train Driver sounded the horn and applied the brake. The Farmer driving the tractor was looking downwards as the train approached and had his arm between his legs in the area of the controls. Just before the train reached XM096 the Farmer looked up at the train. The tractor did not move clear of the railway line and was struck by the train. The train came to a stop 469 metres beyond the level crossing. The Farmer was fatally injured and pronounced dead at the scene.

The immediate cause of the accident was:

- The tractor was stationary on the track as the train arrived at the level crossing.

The contributory factors identified were:

- The tractor may have stalled on the track;
- Vegetation may have obscured the Farmer's view of the approaching train from his position on the track;
- The Farmer may not have been looking for an approaching train as some of the level crossing users were known to incorrectly read the green aspect on the railway signal protecting level crossing XM093 as an indication that no trains were approaching.

The underlying factors identified were:

- There was no formal process in place to ensure communication with the known users of the level crossing other than through the signage at the level crossing, including addressing known issues in relation to their use of the level crossing;
- The information provided to level crossing users through signage at the level crossing was found not to include information provided in the level crossing user booklet relating to the advice that the signals are solely for the control of train movements and on what to do in case of difficulty when crossing the railway.

The following new safety recommendations, relating to the occurrence, are made:

- Iarnród Éireann should put in place a formal process for identifying and communicating with known users of user worked level crossings;

- Iarnród Éireann 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.

A further three new safety recommendations, relating to additional observations made during the investigation but not relating to the occurrence, were also made.

A safety recommendation previously issued in June 2008 has also been reiterated.

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1 Factual information

1.1 Relevant parties

1.1.1 Parties involved in the occurrence

Iarnród Éireann (IÉ)¹ is the *railway undertaking*² that owns and operates mainline railway services in Ireland. IÉ is also the *railway infrastructure manager*, managing the design, installation, testing, inspection, maintenance and renewal of the railway's physical assets.

The IÉ departments associated with this accident are:

- The Intercity and Commuter Network Department – responsible for the supervision and operation of trains on the mainline, excluding the Dublin Urban Network. This includes the supervision of train drivers and the control of train movements through Centralised Traffic Control (CTC) in Dublin and regional controlling signal cabins;
- The Chief Civil Engineer's (CCE) Department – responsible for the design, inspection, maintenance and renewal of the railway's structural infrastructure, including Level Crossings (LCs), and the management of risks relating to the use of *passive LCs* that are operated by the LC user.

The roles involved are detailed below:

- The Train Driver – The driver of the train at the time of the accident;
- The Farmer – The user of XM096 involved in the accident. He was one of three known users of the LC designated XM096, working on farmland on both sides of the railway;
- The Mayo Line Signaller – The controlling signaller for the Athlone to Westport line between Knockcroghery and Westport, which is where the train was operating. The controlling signaller is based in Athlone.

1.1.2 Other relevant parties

The Railway Safety Commission (RSC) is the *national safety authority*, which is responsible for the regulatory oversight of railway safety in Ireland in accordance with the Railway Safety Act 2005 (Government of Ireland, 2005a) and European railway safety directive (European Union, 2004). The RSC is responsible for issuing safety certificates to railways to allow their operation, including IÉ, and for auditing and monitoring the safety management systems of those railways.

¹ All abbreviations are explained in the list of abbreviations.

² All terms in italics are explained in the glossary of terms.

The Road Safety Authority's (RSA) function is to improve road safety in Ireland, this is achieved through: information and education campaigns; improving vehicle standards; driver instruction standards; oversight of driver licensing; working with stakeholders to ensure a co-ordinated response; accident and road safety research with a view to developing measures and recommendations to improve road safety; advising the Minister for Transport on road safety policy; and road safety strategy documents.

The emergency services are the services that respond to calls made to the national emergency services telephone number 999 and the European Union emergency services telephone number 112. In this instance the emergency services that responded to the call from IÉ were An Garda Síochána, the Fire Service and the Ambulance Service.

1.2 The accident

At approximately 09:25 on the 2nd September 2010, the 09:30 freight service from Ballina to North Wall in Dublin, train identification number K801, departed Ballina. At approximately 11:13, as the train approached LC XM099, the Train Driver observed IÉ staff working and sounded the horn, which the staff acknowledged. The train then travelled along the left hand curve on the approach to LC XM096. As XM096 came into the view of the Train Driver, he observed a tractor stationary on the track at XM096. The Train Driver sounded the horn and applied the brake. The Farmer driving the tractor was looking downwards as the train approached and had his arm between his legs in the area of the controls. Just before the train reached XM096 the Farmer looked up at the train. The tractor did not move clear of XM096 and was struck by the train. The train came to a stop 469 metres (m) beyond XM096. The location of the accident is shown in Figure 1.

When the train came to a stop, the Train Driver contacted the controlling signalman, the Mayo Line signalman, to advise of the accident and request the emergency services. The Train Driver then went back to XM096 on foot.

The Mayo Line Signalman rang 999 and requested the attendance of the emergency services.

The IÉ staff working at XM099 heard the horn sounding continuously and the impact at XM096. Two of them drove to XM096 to establish what had happened. One of the IÉ staff that attended site from XM099 guided the emergency services to the scene. The emergency services arrived at XM096 at approximately 11:40.

The weather at the time of the accident was dry with good visibility.

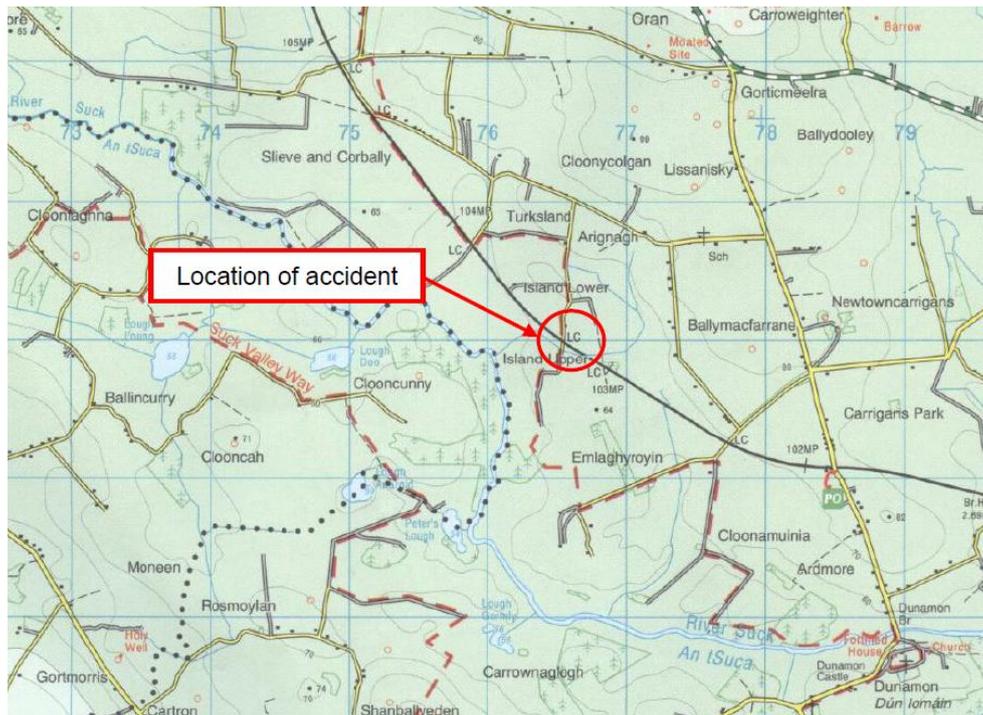


Figure 1 – Location Map (Ordnance Survey Ireland, 2003)

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1.3 Infrastructure

1.3.1 General description

The Athlone to Westport line is a single track section comprised of *Continuous Welded Rail (CWR)* on ballasted track with 54 kilogram rail on concrete sleepers. It is located in the Athlone *Division*.

The boundary fencing along the railway line is a combination of timber post and wire.

1.3.2 Level Crossing

XM096 is located at 103 miles 400 yards on the Athlone to Westport line as measured from Broadstone Station in Dublin. It is situated in the townland of Island Upper outside the town of Roscommon in County Roscommon. XM096 is an occupation on public road (OP) type LC. This means that it is situated on a public road and has manually operated gates that are opened and closed by the LC user, which are normally kept closed across the road. As with all passive LCs operated by the LC user, the LC users at OP LCs determine when it is safe to cross. An aerial view of XM096 and its approaches is shown in Photograph 1.

The railway approach to XM096 is on a curve in the direction that the train was travelling and is straight on the approach from Dublin.

There is a rising gradient on the railway approach to XM096 in the direction the train was travelling, with the gradient rising by 0.74 percent from 350 m to 60 m before XM096 and then falling by 0.14 percent over the last 60 m before XM096.

There is a rising gradient on the road approach to XM096 in the direction the tractor was travelling, with the gradient rising by 1.5 percent over from 50 m to 5 m before the track and then becoming level as it crossed the railway line.

XM096 crosses the railway line at an obtuse angle, see Figure 2. The surface of the approach road is an unsealed gravel road. The surface directly outside the rails and between the rails consists of Strail units, which are made of rubber. There are cattle grids the full width of XM096 on the railway approaches to prevent cattle straying along the railway line.



Photograph 1 – Aerial view of XM096

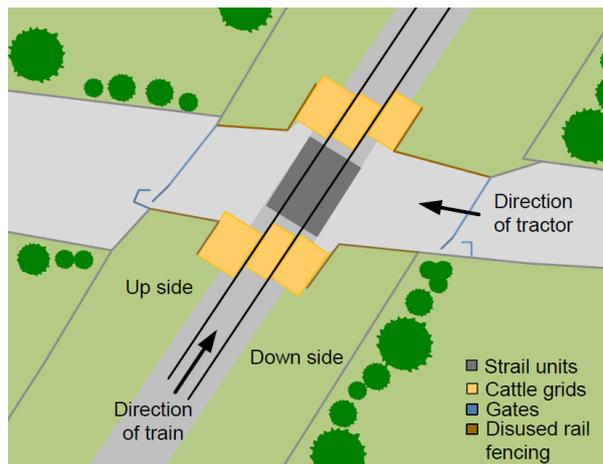


Figure 2 – Layout of XM096

There are metal gates positioned on both the *Up* and *Down sides* of XM096, see Photograph 2. The gates are positioned approximately 8.54 m from the nearest rail on the *Up side* of XM096 and 5.83 m from the nearest rail on the *Down side* of XM096.

There are metal wicket gates to the side of the metal gates across the road on both the *Up* and *Down sides* of XM096, see Photograph 2. These allow pedestrians to cross the railway without opening the gates on the road.

The fencing at XM096 is vertical metal posts made up of disused rail connected by a combination of wire and horizontal metal bars made up of disused rail, see Photograph 2.

XM096 is located on a cul de sac with the access road approaching from the Up side of the track, see Photograph 1. There is one dwelling on the Down side of the railway at XM096 that is used as a holiday home. XM096 is also on the walking route for the Suck Valley Way, which crosses the railway line at several LCs in the area (National Trails Office, undated), and it allows access to the river Suck for fishing.

XM096 is shown in Photograph 2, photographed from the Up side and showing the Down side of XM096, which is the side the tractor approached.

The direction the train was travelling from is shown in Photograph 3.



Photograph 2 – XM096 from Up side



Photograph 3 – Direction train approached from

The gates of XM096 were fitted with hooks to allow the gates to be fixed in the open position by the LC users whilst a road vehicle is crossing the railway. The hook at the gate on the Down side of the railway could not be used due to the presence of the wicket gate, which was added after the hook.

The gates at XM096 were widened by IÉ from 2.74 m to 3.65 m at the request of the regular LC users following correspondence in 1992 to allow silage cutting as the gate posts needed to be removed each silage season to allow equipment cross the railway line. The 3.65 m gates were not sufficiently wide to allow the silage cutting equipment through meaning that the gate posts still had to be removed. The gates were then widened from 3.65 m to 4.26 m between 2005 and 2009, the actual dates that the gates were widened could not be established. This demonstrates that there was active communication between known users of XM096 and IÉ.

The required IÉ signage containing the instructions on how to operate the LC was found to be in place on both sides of XM096, this included:

- 'Danger level crossing' sign, including the puffing billy image, on the approach to XM096;
- 'Stop' sign;
- 'Stop, look and listen' sign;
- 'Danger level crossing' sign, including the puffing billy image, at XM096;
- 'Keep these gates shut' sign, including the contact number for the controlling signalman;
- LC number;
- 'Have you shut the gates' sign.

The 'Danger level crossing' sign at XM096 and the 'Keep these gates shut' sign both include instructions on how to cross the railway, see Photograph 4. None of the signage was found to cover the action an LC user should take in case of difficulty crossing the railway line.

The 'Keep these gates shut' sign also advises LC users 'Never rely on railway signals or timetables. Trains can be delayed or indeed can run early', see Photograph 4. Although this does state that LC users should not rely on railway signals, it does not state that signals are provided for the control of trains and that trains can approach regardless of the aspect displayed. This information is a single point out of eight on the sign, which contains the information in both English and Irish.

The signage contained the correct telephone number for the controlling signalman at the time of the accident. There was no telephone provided at XM096.



Photograph 4 – Signage at XM096

1.3.3 LC risk management

In this instance, as the LC user was a farmer, XM096 is considered as part of his place of work and a written *risk* assessment is required to be produced under the Safety, Health and Welfare at Work Act 2005 (Government of Ireland, 2005b). It was not possible to establish if the Farmer carried out a risk assessment relating to crossing the railway. In addition, IÉ issue a booklet on safe use of user worked LCs to the known LC users to assist with their management of risk at user worked LCs. This was not provided to the Farmer.

IÉ's CCE Department manages the risk at user worked LCs through implementation of its standards:

- Hazards and risk assessments, reference CCE-SMS-006 (IÉ, 2010a);
- Track and structures inspection requirements, reference I-PWY-1107 (IÉ, 2010b);
- Technical standard for track patrolling, reference CCE-TRK-STD-1100 (IÉ, 2010c).

Standard CCE-SMS-006 governs the management of risks relating to areas within the control of the CCE Department and requires that a risk register is maintained to manage this. Any *hazards* identified are entered in the risk register along with its severity rating from 1 to 5 and likelihood rating from 1 to 5, with the numerical value assigned increasing with severity and likelihood. Multiplying the figure for likelihood and severity gives the risk rating, from 1 to 25. The level of risk increases as the risk rating increases. (IÉ, 2010a)

On the 19th August 2010, XM096 was entered into the risk register for the Athlone Division with the hazards shown in Table 1 for which a risk of collision was identified. The risk rating was considered to be high by IÉ. All of the mitigations were due to be implemented by the 31st December 2010, as of the date of the accident these had not been implemented.

Table 1 – Risk register information on XM096

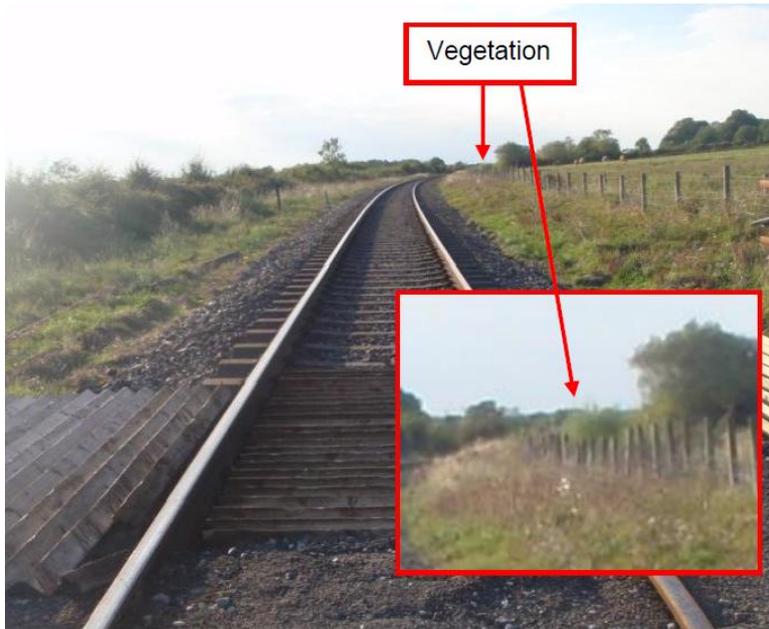
Hazard	Risk	Mitigation	Due date
Substandard sighting due to vegetation growth	High	Arrange contractor to cut vegetation	31 st December 2010
Whistleboard required at 385 m approach for Up trains		Arrange contractor to move the whistleboards	
Substandard condition of LC signage		Arrange contract to correct signage	

Standard I-PWY-1107 identified the duties of all persons with inspection responsibilities within the CCE Department.

Standard CCE-TRK-STD-1100 identified the duties of patrol gangers.

1.3.4 View of approaching trains

The Farmer had passed the viewing position on the Down side of the track when the train came into view, hence, the view from either side of the track was not relevant to his actions. There is no viewing requirement for the centre of LCs. However, it was noted that there was vegetation present on the Up side of the track positioned less than 200 m from XM096 that may have obscured the Farmer's view of approaching trains, see Photograph 5.



Photograph 5 – Vegetation on the Up side of the track

During the investigation, issues relating to the view of approaching trains from the side of the track were identified, although these did not contribute to the accident. The requirements governing these and the results of surveys are addressed in this section.

IE technical information sheet MW50 'Accommodation level crossings' (Iarnród Éireann, 1983) details the viewing requirements of approaching trains for users to cross safely with normal vigilance as user worked LCs. MW50 gives the position of measurements, called the viewing position, to be at 3.66 m from the nearest rail and at a height of 1.22 m above ground to allow for the position of the driver of a crossing vehicle. It also takes into account a reaction time of 1.5 seconds (s), a crossing speed of 1.34 m/s, a crossing distance of 5.5 m and a standard vehicle length of 7.3 m based on an agricultural tractor and trailer.

Based on the above, the viewing distance must meet or exceed the minimum viewing distance as calculated using Formula A:

$$\text{Minimum viewing distance (m)} = [\text{Safe crossing time of 11 s (crossing time + reaction time)}] \times \text{Speed of train (m/s)}$$

MW50 advised that this can be simplified to Formula B:

$$\text{Minimum viewing distance (m)} = \text{Maximum line speed (miles per hour)} \times 5$$

For XM096, Formula A gives the minimum viewing distance as 336 m and Formula B gives the minimum viewing distance as 350 m. The value used by IE is that provided by Formula B, 350 m.

The viewing position being positioned 3.66 m from the nearest rail allows for viewing of trains from a vehicle whilst ensuring that the front of the vehicle is positioned no closer to the rail than the safe distance of 2 m.

To compensate for less than required viewing distances, measured at 3.66 m from the closest rail, MW50 requires the use of *whistleboards* that advise a train driver to sound the train horn to warn of the approach of a train. The use of a whistleboard is intended to act as a substitute for adequate viewing distance. There were no whistleboards on either railway approach to XM096 for trains.

According to IÉ's records, the vegetation was cut back at XM096 prior to the accident in May 2009 and February 2010.

The viewing distances were measured twice in 2009, firstly in February, see Table 2, then in September, see Table 3.

Table 2 – Viewing distances at XM096 on 4th February 2009 (IÉ, 2009a)

Position of user	View			
	Up direction	Shortfall	Down direction	Shortfall
Up side	900 m	Not applicable (N/A)	295 m	55 m
Down side	900 m	N/A	300 m	50 m

In February 2009, only two of the four viewing distances met the 350 m viewing distance required by MW50. No whistleboards were fitted on the approach to XM096 from the Down direction as required by MW50 to mitigate the inadequate viewing distance.

Table 3 – Viewing distances at XM096 on 8th September 2009 (IÉ, 2009b)

Position of user	View			
	Up direction	Shortfall	Down direction	Shortfall
Up side	1000 m	N/A	335 m	15 m
Down side	1000 m	N/A	390 m	N/A

In September 2009, three of the four viewing distances met the 350 m viewing distance required by MW50. No whistleboards were fitted on the approach to XM096 from the Down direction as required by MW50 to substitute for adequate viewing distances.

Following the accident, the viewing distances for XM096 were measured by IÉ, see Table 4. The viewing position was at 3.66 m from the nearest rail in accordance with MW50.

Table 4 – Viewing distances at XM096 after the accident (IÉ, 2010d)

Position of user	View			
	Up direction	Shortfall	Down direction	Shortfall
Up side	1000 m	N/A	315 m	35 m
Down side	1000 m	N/A	358 m	N/A

Three of the four viewing distances met the 350 m viewing distance required by MW50, including the side that the tractor approached from. The viewing distance from the Up side in the Down direction did not meet the requirements of MW50.

Whistleboards had been requested by the LC users but were not fitted. It is noted that a whistleboard would not have been required had the required viewing distances been achieved.

1.3.5 RSC guidance on the view of approaching trains

The RSC has published guidance on the design of LCs ‘Guidelines for the design of railway infrastructure and rolling stock, Section 5 – Level crossings’, RSC-G-006-B, (RSC, 2008). It is noted that this guidance applies to new infrastructure, however, it is considered as there is no RSC guidance for existing infrastructure.

This guidance gives the viewing time of an approaching train to be the crossing time as identified by the responsible railway organisation, in this case IÉ, plus a margin of 5 s (RSC, 2008). The crossing time, including the reaction time, is defined in MW50 as 11 s (IÉ, 1983). This would give a viewing time prior to the arrival of a train of 16 s (crossing time of 11 s plus 5 s).

The RSC guidance gives a viewing time prior to the arrival of a train of 16 s, based on a crossing time of 11 s plus 5 s. This gives a viewing distance of 489 m for XM096, based on a line speed of 110 km/h, 30.56 m/s, multiplied by 16 s. This is 139 m greater than the IÉ requirement, an increase of 40 percent.

The RSC guidance also advises in clause 5.8.2.4:

- To achieve the required warning time, it may be necessary to reduce the train speed over the LC. (RSC, 2008)

The speed of trains was not reduced to achieve the 11 s warning time required by IÉ document MW50 or the 16 s warning time advised in the RSC guidance for new LCs.

1.3.6 IÉ LC user booklet

IÉ has produced a booklet for LC users entitled 'The SAFE use of unattended railway level crossings' (IÉ, 2006) advising users on how to operate user worked LCs. The booklet supplements the information provided to LC users at an LC through the signage and assists LC users with their management of risk at user worked LCs. It was not sent to the users of XM096, including three farmers that own land on the Down side of XM096 and regularly use XM096.

IÉ has a register of known LC users but does not have a formal process for identifying LC users and including them on the register.

The names of the three farmers that use XM096 regularly were posted on a sign on the gate at XM096 on the Down side of the railway. In addition, IÉ had records on file demonstrating that several users had communicated with IÉ and met IÉ at XM096 to discuss the LC. However, they were not included in the register of known users.

Clause 3.3 of the LC user booklet advises LC users:

- Do not rely on any railway signals, provided for the control of trains, to give you a guarantee that there is no train approaching. (IÉ, 2006)

It was identified that users of XM096 had been known to use the signal protecting XM093, signal XM093US, as an indication of whether or not a train was approaching.

Clause 6.4 advises:

- If you see a train approaching or hear the horn sounding do not use the LC. Clear the line immediately of any movement under way. (IÉ, 2006)

The tractor was stationary in a position on the track at XM096 as the train approached. The Farmer was looking downwards as the train approached with his arm between his legs in the area of the controls, indicating that he may have been attempting to start the tractor after it had stalled or attempting to put it into gear.

Clause 7.8 advises:

- Should a vehicle suffer a breakdown or become grounded on the LC, make sure that everybody gets out and gets clear of the line, then telephone or otherwise warn IÉ of the danger **immediately** by the best means. (IÉ, 2006)

It is not known why the tractor was stationary on the track, it is possible that it may have stalled.

1.3.7 RSC third party guidance

RSC provide guidance on the identification and management of risks to persons crossing the railway in its publication 'Third party guidance on railway risk – Volume 3: Crossing the railway', reference RSC-G-012-A, revision A, dated the 25th April 2008 (RSC, 2008b). The document includes information on how to cross the railway at an LC and on the identification of hazards.

The guidance also includes advice to LC users on what to do in case of difficulty when crossing the railway at an LC. The advice provided is shown below.

If your vehicle breaks down or you have an accident on an LC, you should:

- 1) Get everyone out of the vehicle and clear of the LC immediately.
- 2) Use a railway telephone (if available) or ring CTC (see *Section 6* for contact details) to contact the signalman as follows.
- 3) Identify yourself, your location and your status (e.g. LC user etc.).
- 4) State "This is an emergency call".
- 5) Clearly state:
 - The LC number and the line (if known);
 - Nature of emergency e.g. car stuck on line;
 - Required actions e.g. stop trains.
- 6) Give your name and contact details in case further information is required.
- 7) Follow the directions of the signalman.

The contact details for IÉ's CTC 24 hour emergency number for reporting an immediate danger is also given. (RSC,2008b)

The guidance also advises LC users:

Comprehensive guidance for the safe use of unprotected LCs is available in an IÉ booklet: 'The SAFE use of Unattended Railway Level Crossings'. Any regular user of such LC types should already be in possession of this booklet. It is available from the local divisional engineer (for contact details see Section 6).

The contact details for IÉ's divisional engineer for the Athlone Division are also included. (RSC,2008b)

1.3.8 Rules of the road

The RSA publishes guidance on using the road for all road users in the form of 'The rules of the road' (RSA, 2007). This includes advice for road users on how to operate a user worked LC, which include OP type LCs. It also includes advice to LC users on what to do in case of difficulty when crossing the railway at an LC. The advice provided is shown below.

If your vehicle breaks down or gets stuck on an LC:

- Make sure that everybody gets out and gets clear of the railway line, and
- Use the phone provided by IÉ or warn of the danger immediately as best you can. (RSA, 2007)

1.4 Signalling and communications

1.4.1 General description

Signalling on the Athlone to Westport line is *Track Circuit Block* with *colour light signals*. The signals are a combination of two aspect and three aspect signals.

Communication between the controlling signalman and train drivers on the Athlone to Westport line is by means of a train cab secure radio system and *signal post telephones*.

1.4.2 Signals adjacent to XM096

There is a signal on the Up side of XM096 for LC XM093, signal XM093US, located at 102 miles 638 yards. XM093 is a C type LC that has its gates normally closed across the road and is attended by a gatekeeper, who operates the gates for LC users.

LC XM093 is protected for train movements in the Up direction by the *protecting signal* XM093US, positioned 1160 m away from XM096 in the Up direction. This signal is visible to the users of XM096.

Signal XM093US advises train drivers for trains travelling in the Up direction if it is safe to proceed.

XM093 is also protected by protecting signal XM093DS. This advises train drivers for trains travelling in the Down direction if it is safe to proceed.

The signals protecting XM093 will only show a green proceed aspect if the gatekeeper at XM093 has opened the gates at XM093 for railway traffic, selected a proceed aspect and the section between signals XM093US and XM093DS is clear.

Signal XM093US shows a red aspect if the gates at XM093 are across the railway line, see Figure 3.

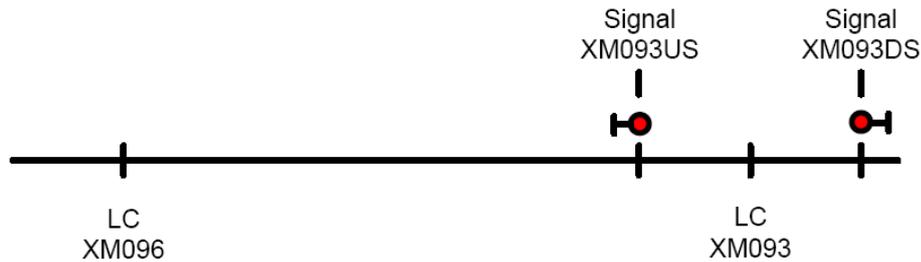


Figure 3 – XM093 clear for road traffic

When the gates at XM093 are positioned across the road by the gatekeeper located at XM093 and the gatekeeper sets the green proceed aspect, signals XM093UD and XM093US both show a green aspect, see Figure 4.

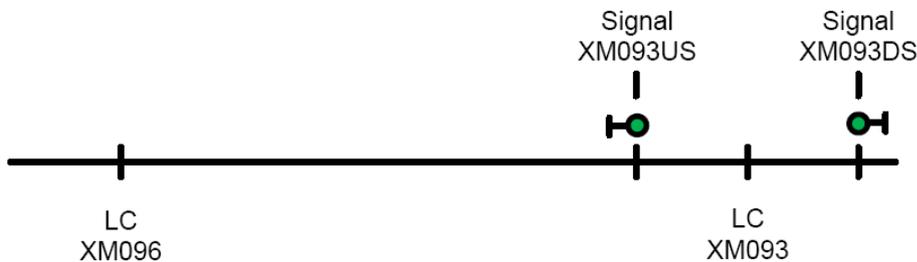


Figure 4 – XM093 clear for railway traffic

Once a train enters the section between the XM093US and XM093DS signals travelling in either direction, both signal aspects display a red stop aspect, see Figure 5.

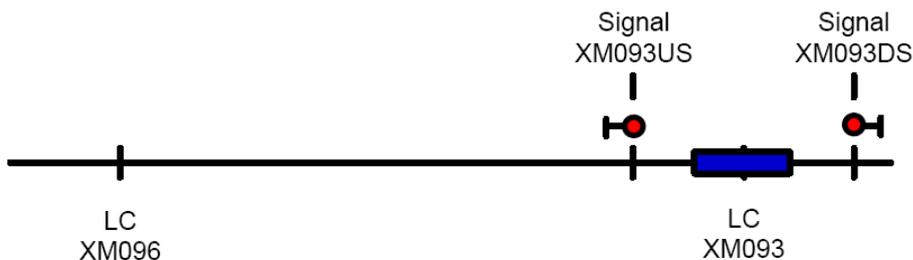


Figure 5 – Train between signals XM093US and XM093DS

On an unknown date several years prior to the accident, one of the users of XM096 contacted IÉ by telephone at Roscommon Station requesting that the vegetation be cut back to improve the viewing distances. On this occasion the LC user mentioned that all of regular users of XM096 had been reading signal XM093US as an indication of whether or not there was a train approaching and believed that XM093US would show a green aspect when there was no train approaching and a red aspect when there was a train approaching. The LC user was advised that this was not correct.

The IÉ staff member advised the LC user that although signal XM093US is not intended to be an indication of the presence of a train, the green aspect would be more likely to be shown when a train was approaching.

The IÉ staff member who spoke to the LC user in this instance advised a more senior member of IÉ staff that the users of XM096 were reading signal XM093US as an indication of the approach of trains. There is no record of any further action being taken to address the LC users reading signal XM093US as an indication of whether or not a train was approaching.

It was found by RAIU that at the time of the accident that LC users at XM096 were still reading a green aspect at signal XM093US for XM093 as an indication that there was no train approaching.

Signal XM093US shows a red aspect when a train travelling in the Down direction passed signal XM093DS, see Figure 5. This may have helped to reinforce the incorrect interpretation that signal XM093US would show a red aspect when a train was approaching.

1.5 Traction and rolling stock

The train involved was a freight train and consisted of locomotive 225 hauling wagons 30183, 30139, 30270, 30239, 30235, 30269, 30126, 30267, 30243, 30226, 30222, 30221, 30240, 30274, 30257, 30266, 30256, and 30275.

Locomotive 225 is a Class 201 locomotive, these were manufactured by General Motors and entered service in 1994. They have a mass of 112,000 kg and a maximum speed of 161 km/h. They are 20.9 m long. The front of locomotive 225 is shown in Photograph 6.



Photograph 6 – Front of locomotive 225

The 18 wagons were a combination of laden and unladen wagons, of which 15 were 47 foot 6 inch flat bogie wagons, which are 14.48 m long (approximately 15.7 m between the buffer ends) and 3 were 42 foot 9 inch flat bogie wagons, which are 13.03 m long (approximately 14.25 m between the buffer ends). According to the train manifest, the total mass of the wagons was approximately 565,000 kg.

The train had a mass of approximately 677,000 kg and an overall length of approximately 300 m.

The locomotive was fitted with an event recorder that records the status of predefined equipment on the train. The sequence of events is shown in Table 5.

Table 5 – Sequence of events based on event recorder data

Location relative to XM096	Time (s)	Train speed (km/h)	Description
350 m before XM096	-15	79	Train reaches required viewing distance for LC users at XM096.
112 m before XM096	-5	79	The train horn is sounded.
88 m before	-4	79.4	The train brake is applied. The train horn continues to sound.
At XM096	0	73.8	The train is decelerating. The train horn continues to sound.
71 m after XM096	+3.4	73.8	The train horn stops sounding.
83 m after XM096	+4	73.8	The train horn is sounded.
86 m after XM096	+4.1	73.8	The train horn stops sounding.
469 m after XM096	+39	0	Train is stopped.

The train reached the point when users positioned on either side of XM096 should have been able to see the train in accordance with MW50 15 s before the accident, the train was travelling at 79 km/h at this time. When the train reached 112 m before XM096, the Train Driver sounded the horn continuously. The Train Driver applied the train brake 1 s later. The train began to decelerate 4 s later as it reaches XM096. A portion of this deceleration would have been due to the presence of the tractor, however, it is not possible to determine the exact portion and the braking behaviour was in line with normal behaviour for this type of train. The Train Driver continued to sound the train horn until 71 m after XM096. The horn is then sounded again from 83 to 86 m beyond XM096.

The performance of the train was found not to have been a factor in the accident.

1.6 Operations

1.6.1 General description

The train was being driven as Driver Only Operation, meaning that the only crew on the train is the Train Driver. The movement of trains on the Athlone to Westport line is controlled by the Mayo Line Signalman. The speed limit on the line between the 78 ¼ milepost and the 161 ¼ milepost is 110 km/h for passenger trains and 80 km/h for freight trains.

1.6.2 Train cargo

The train was transporting 1-Hydroxyethylidene-1, 1-Diphosphonic Acid (HEDP) and 1267 Vanilla extract 4 fold bourbon natural. The cargo is classified as dangerous goods. The cargo did not breach its containment in the collision.

1.6.3 Drug and alcohol testing

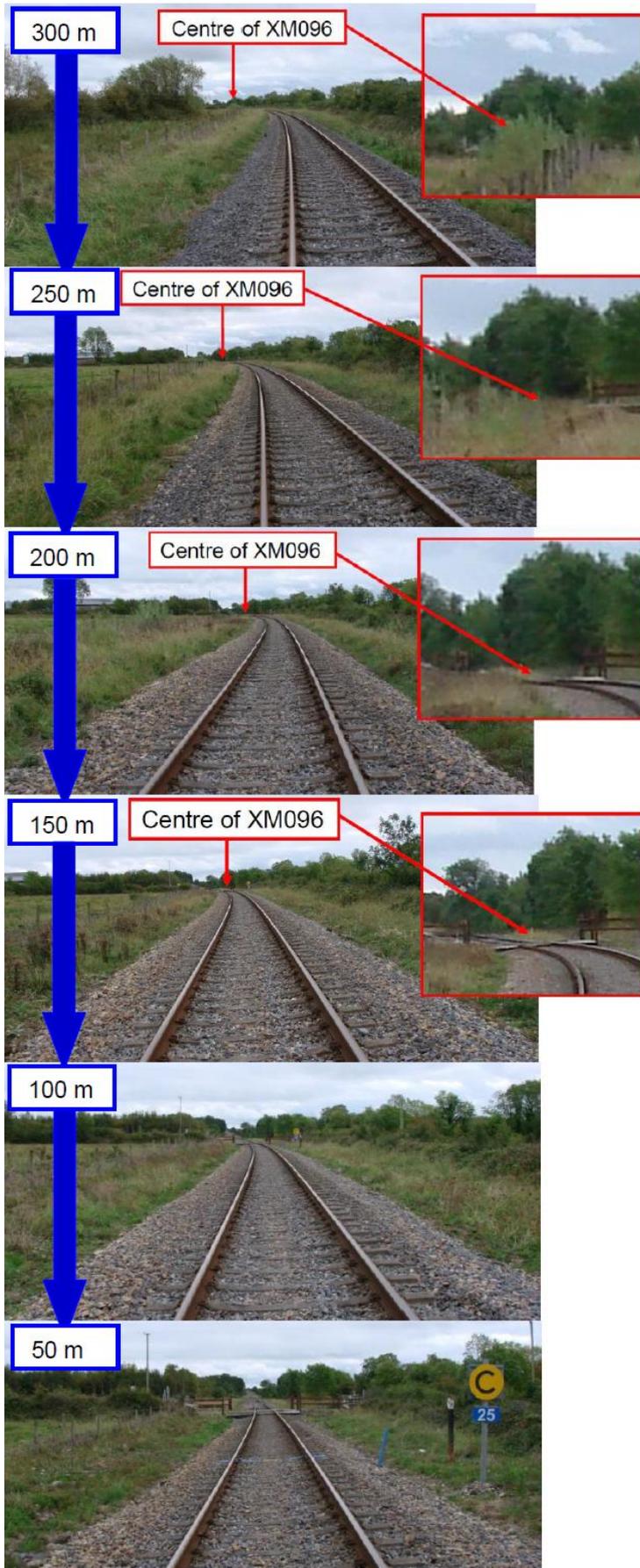
The Train Driver was breathalysed at site by An Garda Síochána and tested negative for the presence of alcohol in his system. The Train Driver was tested for drugs and alcohol by IÉ in accordance with its drugs and alcohol policy for safety critical workers and the result was negative.

1.6.4 View of XM096 from the train

The height of the head of a train driver seated in the driver's seat of a 201 locomotive cab is approximately 3.2 m above the rail level, depending on the height of the train driver and the height adjustment of the driver's seat.

Figure 6 below shows the approach to XM096 along the railway line and gives an indication of the view the Train Driver would have had. It should be noted that these photographs were taken the day after the accident when signs were put in place for a temporary speed restriction following repairs to the track. The photographs were not taken at the same height as a train driver positioned in the driver's seat of a 201 locomotive.

The tractor involved was a red Zetor 6340 with a blue bale carrier attached to the rear. The main visible element of the tractor would have been the red body work, which was less than 2 m high.



Approximately 13 s before the accident
The Train Driver may not have had a clear view of the centre of XM096 as it was obstructed by vegetation.

Approximately 11 s before the accident
The view of the centre of XM096 was not obstructed.

It may not have been possible to determine that the tractor was stopped on the track due to the time that had lapsed and the curvature of the track.

Approximately 8 s before the accident
The view of the centre of XM096 would have been unobstructed from 200 m before XM096.

Approximately 6 s before the accident
The horn is sounded 1 s after this.

Approximately 4 s before the accident
The Train Driver had already started sounding the horn 1 s before this.

Approximately 2 s before the accident
The Train Driver applied the train brakes 2 s before this.

Figure 6 – Views of XM096 on railway approach

1.7 Fatalities, injuries and material damage

1.7.1 Fatalities and injuries

The Farmer, who was crossing XM096 in a tractor, was fatally injured.

1.7.2 Infrastructure damage

There was damage to the cattle grids, primarily on the down side of the track at XM096 and between the rails. This is consistent with impacts from the front wheels of the tractor between the rails and impacts from the rear wheels on the Down side of the track, see Photograph 7.

There were markings on the corner post of the fencing at XM096 consistent with having been struck by the bale handler and markings on the horizontal part of the fencing consistent with having been struck by the rear tyres of the tractor, see Photograph 8.



Photograph 7 – Damage to cattle grids



Photograph 8 – Damage to fencing

There was also damage to sleepers and the *track gauge* had spread on the Dublin side of XM096.

1.7.3 Traction and rolling stock damage

The locomotive sustained damage to: the cowcatcher; the panelling; the headlamp assembly; the leading buffers; the air system piping; the brake system piping; train wiring; the bogies; the diesel tank; CAWS equipment; Head End Power equipment; and the main reserve tanks.

1.7.4 Third party damage

The tractor, a 1997 Zetor 6340 with 70 horsepower and a bale carrier connected to the back, was destroyed in the collision, hence, a full examination of the tractor could not be carried out.

1.8 History of similar occurrences

The history of collisions between road vehicles and trains at OP type LCs over the ten years leading up to the accident is shown below. In addition, the history of near misses between trains and road vehicles at XM096 is also included. It should be noted that the circumstances surrounding the occurrences below vary.

There were four previous collisions at OP LCs in which no one was injured:

- 1st September 2001 – A car struck a train at XN152;
- 20th December 2002 – A car was struck by an empty freight train at XL083;
- 28th November 2004 – A car struck a train at XN152;
- 31st July 2008 – A passenger train struck a car at XN125.

There was one previous collision at an OP LC in which people were injured:

- 21st April 2002 – A car was struck by a passenger train at XA099 resulting in injury to the car driver.

There have been two previous collisions at OP LCs that resulted in fatalities, these were:

- 18th July 2002 – A car was struck by a passenger train at XL032, the car driver was fatally injured;
- 28th February 2008 – A car was struck by a passenger train at XX032, the car driver was fatally injured.

There was a near miss at XM096 on the 13th March 2009 between a car and a train travelling in the Down direction.

2 Analysis

2.1 The accident

As the 09:30 freight service from Ballina to North Wall travelled along the left hand curve on the approach to XM096 and the LC came into view, the Train Driver observed a tractor stationary on the track. The Train Driver sounded the horn and applied the brake. The tractor did not move clear of the LC and was struck by the train. The train came to a stop 469 m beyond XM096. The Farmer was fatally injured and pronounced dead at the scene. It is not known how long before the train reached XM096 that the tractor stopped on the track at XM096 and at what point the Farmer became aware of the presence of the train. However, it is possible that the tractor may have stalled on the track as the Farmer appeared to have his hand between his legs in the area of the controls in the lead up to the collision.

As the Farmer had passed the viewing position on the Down side of the track when the train came into view, the view from either side of the track was not relevant to his actions. The view from the centre of XM096 is shown in Photograph 3. The Farmer's view of an approaching train may have been obscured by vegetation on the side of the track along the curve on the railway approach to XM096, see Photograph 5.

The Train Driver's view of the centre of XM096 may have been obscured by vegetation as shown in Figure 6.

The Train Driver would have required time to determine that the tractor was stationary on the track after the point at which the tractor became visible. The Train Driver's ability to identify that the tractor was on the track and stationary may have been affected by the curve on the railway approach to XM096. The curve would have led to the tractor moving along the Train Driver's horizon as the train travelled along the curve potentially affected the Train Driver's ability to determine the location of the tractor relative to XM096. When the Train Driver became aware that the tractor was on the track he sounded the horn. 1 s later the Train Driver made a brake application. The train then began to decelerate approximately 4 s later as it reached XM096 and collided with the tractor.

The Farmer would have required time to react to the presence of the train and either move the tractor clear of the railway line or get out of the tractor. The Farmer looked up at the train before the accident, however, it was not possible to determine at what point he became aware of the presence of the train prior to this. The Farmer may have read the green aspect on signal XM093US as meaning that there was no train approaching as some of the users were known to use signal XM093US, hence he may not have been checking for the presence of the train when it became visible.

2.2 Communication with LC users

Communication with LC users on how to operate a user worked LC safely is primarily communicated through the signage at the LC. This is supplemented with the LC user booklet. The users of XM096 were not included on the IÉ list of known LC users. This meant that they were not sent a copy of the LC user booklet to assist with crossing the railway. It was found that all three of the regular users had been in contact with IÉ in the past in relation to XM096. In addition, the names of the three farmers that use XM096 regularly was found to be posted on a sign on one of the gates at XM096. However, this did not prompt IÉ to include the users of XM096 as there was no formal process in place to manage the identification of known LC users and ensure they were added to the user register.

IÉ had been advised that the users of XM096 were reading signal XM093US as an indication of the approach of a train. IÉ did not take action beyond the provision of signage, which was already in place, to ensure the users understood how to use XM096, including that they should not use the signals. Clause 3.3 of the LC user booklet advises LC users 'Do not rely on any railway signals, provided for the control of trains, to give you a guarantee that there is no train approaching'. The signage at XM096 was found to advise users 'Never to rely on railway signals or timetables. Trains can be delayed or indeed may run early.', however, it was not found to provide clear instructions that the signals were only provided for the control of train movements and that regardless of the aspect of a signal trains may still approach as included in the LC user booklet.

Information on what to do in case of difficulty when crossing the railway line was found to be addressed in the IÉ LC user booklet, the RSC guidance for third parties and the rules of the road. However, it was found that the signage at XM096 did not advise LC users of what to do in case of difficulty when crossing the railway.

2.3 Fencing at XM096

The fencing at XM096 was made up of disused rail. It sustained damage in the collision, however, as shown in Photograph 8, it did not break away due to the impact. Although its effect in the accident cannot be determined, the robust nature of this fencing could increase the severity of a collision between a train and a road vehicle by not allowing the vehicle to be pushed out of the path of the train or by creating a *pinch point* between the fencing and a train in which a road vehicle could become caught leading to increased damage to the road vehicle, train or the occupants of either.

2.4 Safe crossing time

It was observed as part of the investigation, although not contributing to the accident, that IÉ had identified the viewing distances as being restricted by vegetation prior to the accident as shown in Tables 2 and 3. The risk register contained an entry relating to the risk of collision at XM096 for which the mitigations are outlined in Table 1. Table 1 shows that the risk relating to the substandard viewing distances was considered by IÉ to be high. Mitigating measures were identified to address the risk however these had not yet been implemented. No interim measures were put in place as a temporary control to manage the risk although the mitigating measures were due for completion by the 31st December 2010. The RSC guidance for new LCs advises that where the required warning time cannot be achieved that it may be necessary to reduce the speed of trains, this was not done. IÉ standard MW50 does not mention reducing the speed of trains to achieve the required warning time, it does mention the addition of whistleboards to address this, however, a whistleboard had not yet been installed for XM096.

It was also noted that the safe crossing time allowed by IÉ in MW50 does not include a margin of safety. The time allowed by the RSC guidance for new LCs provides a margin of 5 s over the safe crossing time identified by IÉ in MW50, thus allowing an additional 5 s for the train horn to be sounded, the train to slow and the LC user to take mitigating action.

3 Conclusions

As the 09:30 freight service from Ballina to North Wall travelled along the left hand curve on the approach to XM096 and the LC came into view, the Train Driver observed a tractor stationary on the track. The Train Driver sounded the horn and applied the brake. The tractor did not move clear of XM096 and was struck by the train. The train came to a stop 469 m beyond XM096. The farmer was fatally injured and pronounced dead at the scene. It is not known how long before the train reached XM096 the tractor stopped on the track and at what point the Farmer became aware of the presence of the train. However, it is possible that the tractor may have stalled on the track.

As discussed in section 2.1 of the analysis, the vegetation along the railway line may have restricted the view of the Train Driver and the Farmer as it obscured the centre of XM096 from the railway line. The curvature of the track may also have affected the Train Driver's ability to establish that the Tractor was on the track and stationary.

Section 2.2 of the analysis identifies that, although the signage was in place at XM096, there was no formal process in place to ensure the known users of XM096 were captured and IÉ did not take action following identification of an issue with LC users reading the railways signals to ensure the LC users understood how to use XM096, including that they should not use the signals.

Section 2.2 of the analysis also identifies that the signage at XM096 was found not to include some of the information in the LC user booklet on the railway signals, or, any information on the action to take in case of difficulty crossing the railway as addressed in the IÉ LC user booklet, the RSC guidance for third parties and the rules of the road.

Section 2.3 of the analysis identifies that the type of fencing used at XM096 meant that it may increase the severity of an accident as it would not break away, however, its effect in this accident could not be determined.

Section 2.4 of the analysis shows that, although not a factor in the accident, the vegetation at XM096 was identified as requiring cutting back and a high risk of collision was identified by IÉ due to substandard viewing distances. The mitigating measures identified by IÉ had not yet been carried out at the time of the accident and no interim mitigating measures had been put in place to address the risk, including reducing the speed of trains.

Section 2.4 of the analysis also noted that the safe crossing time allowed in MW50 was found not to include a safety margin in case an LC user encounters difficulty whilst crossing the railway line, whereas the safe crossing time specified by the RSC in its guidance for new LCs provides a 5 s safety margin.

The *immediate cause* of the accident was:

- The tractor was stationary on the track as the train arrived at the LC.

The *contributory factors* (CoFs) identified were:

- CoF-01 – The tractor may have stalled on the track;
- CoF-02 – Vegetation may have obscured the Farmer's view of the approaching train from his position on the track;
- CoF-03 – The Farmer may not have been looking for an approaching train as some of the LC users were known to incorrectly read the green aspect on the railway signal protecting LC XM093 as an indication that no trains were approaching.

The *underlying factors* (UFs) identified were:

- UF-01 – There was no formal process in place to ensure communication with the known users of the LC other than through the signage at the LC, including addressing known issues in relation to their use of the level crossing;
- UF-02 – The information provided to LC users through signage at the LC was found not to include information provided in the LC user booklet relating to the advice that the signals are solely for the control of train movements and on what to do in case of difficulty when crossing the railway.

The following additional observations (AOs), not relating to the occurrence, were made during the investigation:

- AO-01 – The system of risk management in place was not found to provide for interim measures to be taken to mitigate risk in advance of more long term control measures;
- AO-02 – The shortfall in the viewing distances at the LC were not proactively managed;
- AO-03 – The warning time of an approaching train specified in the governing documentation only takes into account a normal movement across the railway and does not include a safety margin to allow for difficulties that may arise when an LC user is crossing the railway;
- AO-04 – The robust nature of the fencing at the LC, which was made up of disused rail, could lead to increased severity of the outcome of a collision between a train and a road vehicle.

4 Relevant actions already taken or in progress

4.1 Actions taken by IÉ

Since the occurrence, IÉ has advised that it has taken a number of actions aimed at improving safety at XM096. These actions have been undertaken both in response to the accident itself and in conjunction with the overall on-going strategy for the management of its LCs across its rail network.

The actions and activities undertaken are outlined below under the categories:

- Audible warnings;
- Visual warnings;
- Vegetation management;
- Further infrastructure improvements.

Additionally, IÉ has advised that it continues to manage its LCs with dedicated on-going programs of work associated with the infrastructure at all LCs. Proactive attempts continue to be made in positively influencing LC user behaviour and use of LCs. Improving the infrastructure and influencing behaviour continues to be an important part of the overall asset strategy for LCs on the IÉ network.

4.1.1 Audible warnings

In relation to audible warnings, the following has been advised:

- A whistleboard was erected on the approach to XM096 for trains travelling in the Up direction on the 2nd October 2010. This whistleboard provides an audible warning to LC users of an approaching train;
- A detailed review of all LCs on the Athlone to Westport line has been undertaken and a program of work was developed from this review. The review considered viewing distances, whistleboards and other infrastructural issues at all LCs on this line;
- The program that resulted from the LC review involved increasing the provision of whistleboards at some LCs, including all OP type LCs, as well as re-positioning of some existing whistleboards to optimise their effectiveness. This review, and the subsequent work arising from it, has been completed.

4.1.2 Visual warnings

In relation to visual warnings, the following has been advised:

- The most important communication capability held by IÉ for positively influencing behaviour at LCs is through the signage provided at the LC. To this effect, improved signage was erected at XM096 following the accident.

4.1.3 Vegetation management

In relation to vegetation management, the following has been advised:

- Vegetation clearance works were undertaken at XM096;
- Vegetation clearance works were undertaken on lands outside the railway boundary with the consent of the relevant landowners;
- Programs of vegetation are carried out on a cyclic basis throughout the network. Increased surveys of LCs are to take place, associated with the strategy for management of LCs, and part of the output of these surveys is the vegetation clearance works that may be required;
- As part of the broader asset management strategy for LCs, IÉ are continually looking at ways of improving its management of these assets. One area in development since the occurrence of this accident involves the erecting of vegetation marker boards. These are boards placed at the distance required that allows safe traversing of the crossing, as set out in IÉ standards, and allows a quicker appraisal of the available views at an LC, which can then assist in focussing the vegetation management programs of work. These vegetation marker boards are currently being trialled with a view to rolling out further if found to be successful.

4.1.4 Further infrastructure improvements

The following further infrastructure improvements have been advised:

- The fencing at XM096 has been renewed and new concrete post and wire fencing is now in-situ;
- Cattle holding pens have been installed at XM096;
- The approach road surfaces have been tarred and chipped, providing an improved traversing of XM096 for all LC users.

4.2 Actions taken by the RSC

The RSC carried out a compliance inspection of IÉ following the accident in accordance with Part 7 of the Railway Safety Act 2005. The inspection report 'Compliance inspection following a fatality at level crossing XM096, 2 September 2010' (RSC, 2011) was finalised and furnished to IÉ on the 4th March 2011. The RSC have advised that their compliance inspection report will be made available publicly following the publication of this RAIU investigation report.

As a part of its compliance inspection, the RSC identified two non-compliances with IÉ's own safety management system and made seven recommendations. In accordance with Section 76 of the Railway Safety Act 2005, an improvement plan was requested from IÉ on the 4th March 2011. The plan was submitted to the RSC by IÉ in mid April 2011 and this was accepted by the RSC. The RSC has met with the IÉ CCE Department and the IÉ Intercity and Commuter Network Department since then and are satisfied that both the non-compliances and recommendations have been addressed or are in the process of being addressed.

4.3 Actions taken by the RSA

The RSA has written to IÉ offering to carry out a joint safety campaign on user worked LCs.

5 Recommendations

5.1 General description

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 RSC. The party responsible for implementing each recommendation is identified in the recommendation.

As a result of the RAIU investigation five new safety recommendations have been made, two relating to the occurrence and three relating to the additional observations made as part of the investigation. A further safety recommendation made previously by the RAIU is also being reiterated.

5.2 New recommendations relating to the occurrence

The known users of XM096 were not captured on the LC user register although they had been in contact with IÉ in the past as there was no process in place governing this, allowing the use of railway signals by LC users not to be addressed. This has led to the following safety recommendation, based on CoF-03 and UF-01:

IÉ should put in place a formal process for identifying and communicating with known users of user worked LCs.

The information provided to LC users in the signage at XM096 was not found to reflect the information in the LC user booklet on the railway signals or the action to take in case of difficulty crossing the railway, leading to the following safety recommendation, based on CoF-03 and UF-02:

IÉ should review the effectiveness of its signage at user worked LCs and amend it where appropriate, taking into account the information provided in the LC 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.

5.3 New recommendations relating to the additional observations

The risk of a collision due to the inadequate viewing distance available at XM096 was identified by IÉ in its risk register and controls were identified in order to mitigate the risk. These controls required time to implement, however, no interim measures were taken to manage the risk, such as reducing the speed of trains as advised in the RSC guidance for new LCs. This has led to the following safety recommendation, based on AO-01:

IÉ 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.

The safe crossing time allowed by IÉ includes no safety margin to allow for situations where an LC user encounters difficulty whilst crossing the railway line, the RSC guidance for new LCs includes a safety margin over and above the crossing time. This has led to the following safety recommendation, based on AO-03:

IÉ 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.

The robust nature of the fencing at XM096, that did not break away in the accident, has led to the following safety recommendation, based on AO-04:

IÉ 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.

5.4 Reiterated recommendations

The vegetation at XM096 was found to have provided restricted views that could have been improved through vegetation management, leading to the reiteration of the following safety recommendation from RAIU investigation report 'Report into the collision at level crossing XN 104 between Ballybrophy and Killonan on the 28th of June, 2007' published in June 2008 (RAIU, 2008) based on AO-02:

IÉ to develop and implement a vegetation management programme that addresses vegetation management on a risk basis, prioritising high risk areas.

6 Additional information

6.1 List of abbreviations

AO	Additional observation
CCE	Chief Civil Engineer
CoF	Contributory factor
CTC	Centralised Traffic Control
CWR	Continuous Welded Rail
IE	Iarnród Éireann
kg	Kilogram
km/h	Kilometres per hour
LC	Level crossing
m	Metre
mm	Millimetre
N/A	Not applicable
OP	Occupation on public road
RAIU	Railway Accident Investigation Unit
RSA	Road Safety Authority
RSC	Railway Safety Commission
s	Second
UF	Underlying factor

6.2 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.
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.
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.
Division		An area of infrastructure under the responsibility of a given divisional engineer.
Down direction		The direction of travel on a line away from where the mileposts are measured from.
Down side		The left side of the track when travelling in the Down direction.
Hazard		A condition with the potential for harm.
Immediate cause Incident		The situation, event or behaviour that directly results in the occurrence.
Infrastructure Manager		Any occurrence, other than an accident or serious accident, associated with the operation of trains and affecting the safety of operation.
National Safety Authority		Organisation that is responsible for the establishment and maintenance of railway infrastructure, including the management of infrastructure control and safety systems.
Passive level crossings		The national body entrusted with the tasks regarding railway safety in accordance with European directive 2004/49/EC.
Pinch point		Level crossings that have no warning system and/or protection, that activates either automatically or manually, when it is unsafe for the user to traverse the level crossing.
Protecting signal		A point between a fix object and a moving object in which another object (or person) may become caught, leading to damage or injury.
Railway Undertaking		A signal that protects trains from conflicting movements or obstructions on the railway line, such as the level crossing gates in this instance.
Risk		Organisation that operates trains.
Rolling stock		An expression of the rate of occurrence of a hazard and its severity.
Signal post telephone		Railway vehicles.
Track Circuit Block		Telephone positioned a signal post that allows communication with the controlling signalman.
Track gauge		A signalling system that uses track circuits to confirm the absence of trains in order to control the movement of trains.
Traction		The distance between the head of the inner side of the rails that form the track.
Underlying factors		Means of providing power to move railway vehicles.
Up direction		Any factor(s) associated with the overall management systems, organisational arrangements or the regulatory structure.
Up side		The direction of travel on a railway line towards where the mileposts are measured from.
Whistleboard		The left side of the track when travelling in the Up direction.
		A board positioned on the side of the track that indicates to train drivers that they are to sound the train horn.

6.3 References

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