RAIB

Rail Accident Investigation Branch

Rail Accident Report

Fatality at Johnson's footpath crossing near Bishop's Stortford, Hertfordshire 28 January 2012

Report 27/2012
December 2012

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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Fatality at Johnson's footpath crossing near Bishop's Stortford, Hertfordshire, 28 January 2012

Contents

Summary

At about 11:40 hrs on Saturday 28 January 2012, a train struck and fatally injured a pedestrian who was using Johnson's footpath crossing, in Bishop's Stortford, Hertfordshire.

The pedestrian started to walk over the crossing as a train was approaching, despite warnings provided by a red miniature stop light[1] and an audible alarm, and crossed into the path of the train. The investigation found that proposals from various bodies to close Johnson's footpath crossing before 2007 had not been translated into action. In addition, Network Rail had not developed a proposal to install a footbridge to replace the crossing, after an analysis undertaken in 2007 had shown that the benefits of so doing would exceed the costs. Following a further cost-benefit analysis in 2010, a footbridge was in development and has since been installed; Johnson's footpath crossing was closed on 1 August 2012.

The RAIB has made three recommendations to Network Rail, one of which requires consultation with RSSB. These relate to an investigation into ways to make cost-effective improvements to the conspicuity of miniature stop light indications, to possible improvements in the visibility of approaching trains at level crossings equipped with miniature stop lights and to a review of options which had previously been identified for reducing risk at level crossings.

[1] See appendix B for definition.

Introduction

Preface

1 The purpose of a Rail Accident Investigation Branch (RAIB) investigation is to improve railway safety by preventing future railway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability.

2 Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

Key definitions

3 All dimensions and speeds in this report are given in metric units, except speed and locations which are given in imperial units, in accordance with normal railway practice. Where appropriate the equivalent metric value is also given.

4 The terms 'up' and 'down' in this report are relative to the direction of travel; the Down Cambridge line runs from London Liverpool Street towards Cambridge via Bishop's Stortford.

5 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B.

The accident

Summary of the accident

6 At about 11:40 hrs on Saturday 28 January 2012, train 2H22, the 10:58 hrs National Express East Anglia service from London Liverpool Street to Cambridge, struck and fatally injured a pedestrian who was crossing the railway from east to west at Johnson's footpath crossing, in Bishop's Stortford, Hertfordshire.

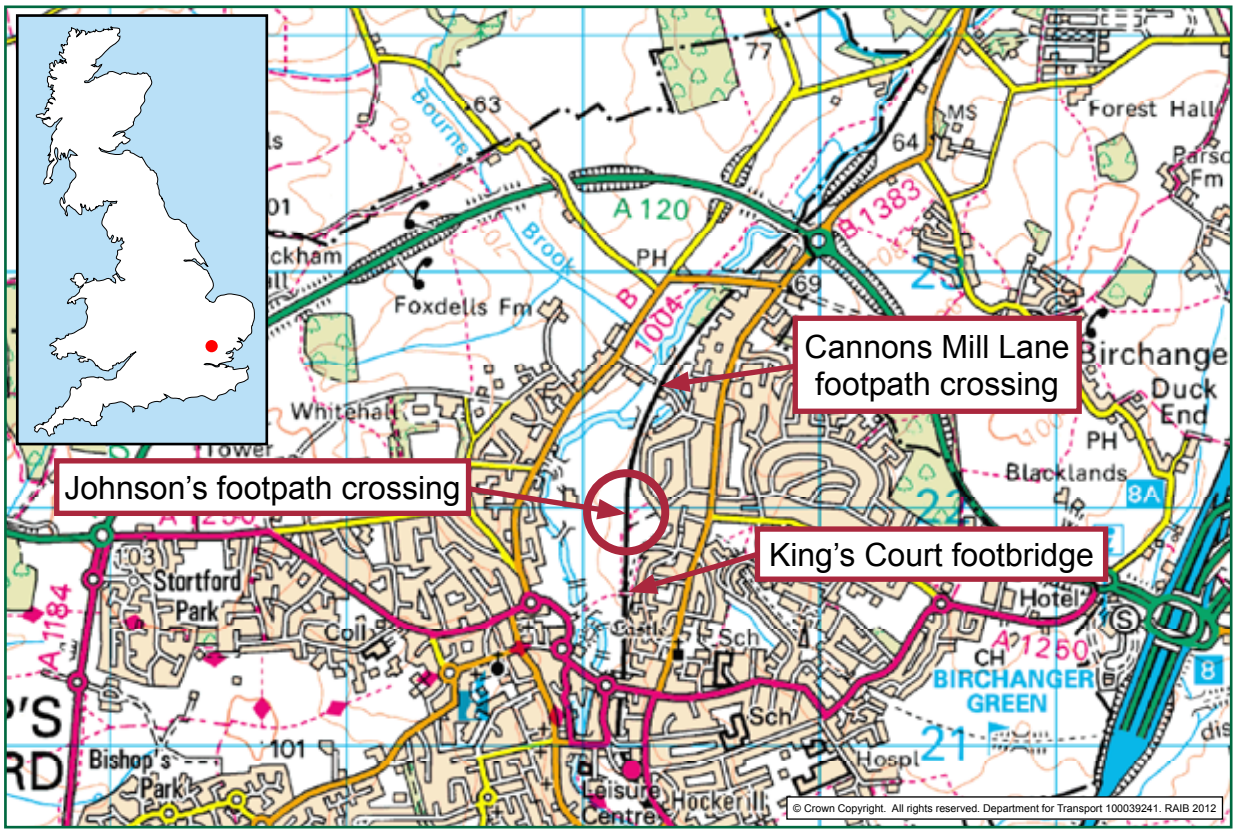

Figure 1: Extract from Ordnance Survey map showing location of accident

Context

Location

7 Johnson's footpath crossing, known locally as Cannons Close crossing, was located at 31 miles 00 chains[2] from London Liverpool Street, on the line from London to Stansted Airport and Cambridge. It was situated 0.4 mile (0.6 km) north of Bishop's Stortford station, figure 1.

8 Johnson's footpath crossing was part of a level route between a residential area and the centre of Bishop's Stortford, and also provided access to and from a leisure centre and playing fields. At this location the railway consists of two tracks, which run approximately north-south, see figures 2 and 3. There are two other crossings over the railway in the vicinity: King's Court footbridge is situated 260 metres to the south of the site of the crossing, and Cannons Mill Lane footpath crossing is 620 metres to the north.

[2] There are 80 chains in a mile.

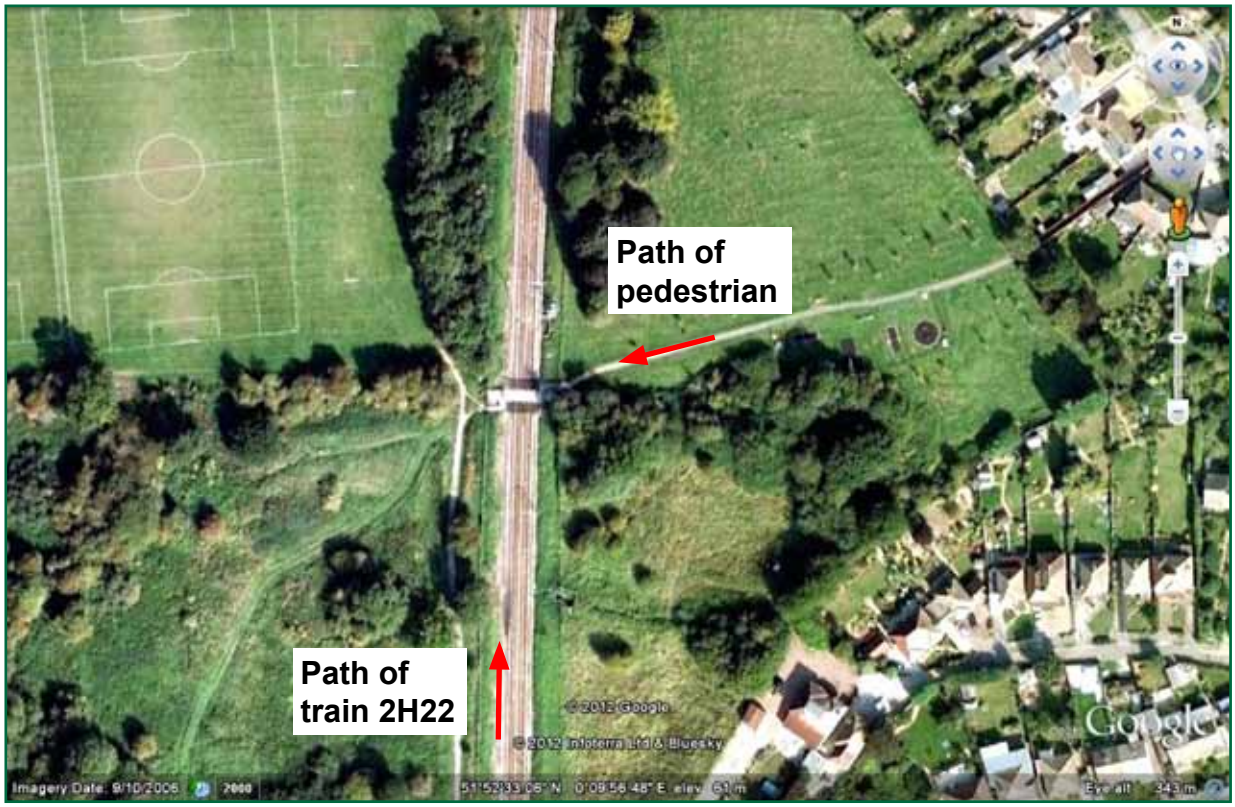

Figure 2: Aerial view of Johnson's footpath crossing

Figure 3: View from Johnson's footpath crossing, looking in the up direction (south) towards Bishop's Stortford

Organisations involved

9 Network Rail was the owner and maintainer of Johnson's footpath crossing. It also employed the staff who undertook site visits to gather data about the crossing environment and its usage, and who used that data for risk assessments in order to determine whether risk mitigation measures were adequate.

10 National Express East Anglia operated train 2H22 and employed the driver of the train. From 5 February 2012, Abellio Transport Holdings, trading as Greater Anglia, took over the rail franchise from National Express.

11 The following councils had responsibility for aspects of local planning relevant to Johnson's footpath crossing:

a. Hertfordshire County Council – transport planning;

b. East Herts District Council – planning authority (the body which is empowered to grant planning permission); and

c. Bishop's Stortford Town Council – town planning.

12 All of the organisations involved freely co-operated with the investigation.

Figure 4: Approach to Johnson's footpath crossing viewed from the east (up) side

Train involved

13 Train 2H22 was formed of a four-car class 379 Electrostar electric multiple unit. Trains of this type were built by Bombardier Transportation and were introduced into service from March 2011.

14 The RAIB has found no evidence that the design or condition of the train caused or contributed to the accident.

Level crossing infrastructure

15 The crossing was equipped with *miniature stop lights* (MSLs)[3] (located on the opposite side of the railway from approaching pedestrians), audible alarms, self-closing wooden gates and warning signs. The positioning of the MSLs on the far side of the railway corresponded with the guidance published by Her Majesty's Railway Inspectorate[4] when they were installed (refer to paragraph 29). The signs also complied with guidance at the time; additional signs reading 'Do not cross when red lights show' were positioned so that they were visible on the near side of the crossing, see figure 4. The immediate approach to the crossing on each side of the railway involved a doglegged path as indicated at figures 4 and 5.

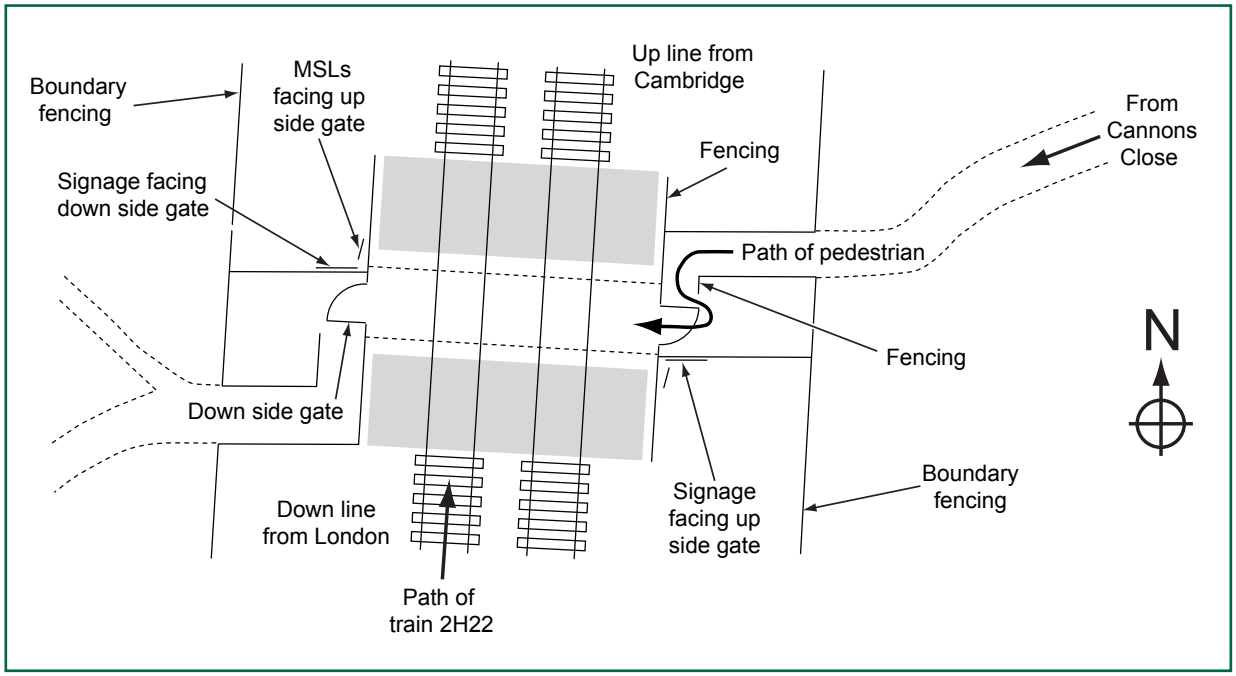

Figure 5: Layout of Johnson's footpath crossing

16 Network Rail determined that the maximum time required for pedestrians to cross safely was 12 – 14 seconds, allowing for vulnerable users[5]. Network Rail's practice is to increase traverse time by 50% if a 'higher than usual' number of vulnerable people is observed using the crossing during visits made to site by its staff to gather data for periodic risk assessments, although what constitutes a 'higher than usual' number is not defined. The MSLs and associated audible alarms provided approximately 25 seconds warning of a train approaching the crossing from either direction at the maximum permitted speed of 70 mph (113 km/h). This equipment was part of the signalling system; Network Rail tested it after the accident, and confirmed to the RAIB that it was found to be working correctly. Recordings made by the signalling data logger at the time of the accident provide supporting evidence of correct system operation.

[3] Sometimes referred to as miniature warning lights (MWLs).

[4] Her Majesty's Railway Inspectorate has since been become part of the Office of Rail Regulation. At the time that the guidance was issued, it was part of the Health and Safety Executive.

[5] Network Rail currently defines vulnerable people as 'children, elderly, disabled, vision impaired, pushchair users and those with learning difficulties'.

The pedestrian

17 The pedestrian was aged 15; she was a local resident and used the crossing frequently.

External circumstances

18 The RAIB has obtained weather data which was recorded at Stansted airport, approximately 3.5 miles (5.7 km) from Johnson's footpath crossing. This shows that, at the time of the accident, the conditions were:

- Weather: dry;
- Temperature: 3 – 4 °C;
- Sunlight: hazy (no direct sunlight);
- Wind speed: 15 – 17 km/h (9.3 – 10.6 mph); and
- Visibility: 4.0 – 4.5 km (2.5 – 2.8 miles).

19 The external circumstances did not affect the causes of the accident.

The sequence of events

20 The RAIB has analysed data from the signalling system, the *on train data recorder* (OTDR) and the forward-facing closed circuit television (CCTV) system installed on the train. The sequence of events set out in paragraphs 21 and 22 is based on this analysis.

21 Train 2H22 departed from Bishop's Stortford in the down direction just before 11:39 hrs. At the same time, the pedestrian was approaching Johnson's footpath crossing on foot from the east. The red MSL was illuminated and the audible alarm at the crossing started to sound at approximately 11:39:25 hrs. Before this, the green MSL had been illuminated for a period of approximately two minutes, following the passage of a train in the up direction. At 11:39:52 hrs the pedestrian walked through the *up side* crossing gate onto the railway.

22 The pedestrian entered the railway about 3.0 seconds before train 2H22 reached the crossing. The driver started to sound the horn when the train was 1.5 seconds from the crossing and continued to do so until the front of the train had passed over the crossing. At the time the horn started to sound, the pedestrian was crossing the adjacent up line; the train was about 43 metres from the crossing on the down line, and was travelling at 65 mph (29 metres / second). The pedestrian looked towards the train when it was about 1.1 seconds from the crossing, and then started to run towards the gate on the *down side* of the crossing, but was struck before she was able to reach a place of safety. The driver applied the *emergency brake* 1.8 seconds after starting to sound the horn and the train stopped 22.2 seconds later.

The investigation

Sources of evidence

23 The following sources of evidence were used:

- witness statements;
- data from the train's OTDR;
- data recorded by the *signalling data logger*;
- CCTV recordings from the train;
- site photographs and measurements;
- witness statements and post-mortem information provided by the British Transport Police;
- weather reports and observations at the site;
- the Network Rail level crossing file, containing details of past site visits and risk assessments;
- the results of modelling risk at the level crossing carried out by Network Rail;
- RSSB[6] level crossing research reports (Refs. T269, T335, T730 and T821), which may be found at www.rssb.co.uk;
- level crossing guidance published by the Office of Rail Regulation (ORR), which may be found at www.rail-reg.gov.uk;
- Department for Transport guidance and research carried out by the Transport Research Laboratory on *Puffin* road crossings, which may be found at www.dft.gov.uk/publications and www.trl.co.uk;
- a review of previous reported occurrences at the crossing, as recorded in the railway industry's *Safety Management Information System* (SMIS) database; and
- a review of previous RAIB investigations that had relevance to this accident.

[6] A not-for-profit company owned and funded by major stakeholders in the railway industry, and which provides support and facilitation for a wide range of cross-industry activities. The company is registered as 'Rail Safety and Standards Board', but trades as 'RSSB'.

Key facts and analysis

Background information

Level crossing risk in the United Kingdom

24 RSSB calculates the risk associated with operation of the railway, including level crossings, in a *safety risk model* (SRM), and publishes the data in its Risk Profile Bulletin. Version 7 of the SRM predicts that the overall risk from all level crossings on Network Rail managed infrastructure is equivalent to 10.5 fatalities and weighted injuries[7] per year, with 62% of this risk arising from pedestrians being struck by trains. RSSB's Annual Safety Performance Report for 2011-12 showed that there were approximately 6,500 level crossings on Network Rail infrastructure at the end of 2010, of which around 38% were footpath crossings.

25 Network Rail has processes for judging whether proposed risk reduction or mitigation measures at level crossings are reasonably practicable[8]. These are set out in its Operations Manual and include risk assessment, as well as the assessment of potential risk reduction measures (mitigations). The roles of the individuals involved are outlined at appendix D. The process requires an Operations Risk Control Co-ordinator (ORCC) to calculate the risk for an individual level crossing using a computer model known as the All Level Crossings Risk Model (ALCRM) and to consider other factors which may influence the risk at the crossing. An ORCC should use RSSB's Level Crossing Risk Management Toolkit (refer to appendix G) to identify possible measures that can be taken to mitigate or eliminate the risk. The ORCC will apply cost-benefit analysis to applicable risk mitigation measures (refer to appendix D, paragraph D7).

26 Where the *safety benefit* from a proposed mitigation exceeds the cost of its implementation, ie the benefit-cost ratio (BCR) is greater than 1.0, the Operations Manual states that this is sufficient justification to proceed with the proposed measure. This is consistent with the legal obligation to minimise risk as far as reasonably practicable, as outlined in the RSSB's guidance on safety decision-making, 'Taking Safe Decisions'[9]. Where the BCR is less than 1.0 but greater than 0.8, the manual states 'expert judgement needs to be applied to establish whether there are sound non-quantifiable safety benefits that shall support the proposed closure or mitigation being progressed'. Other factors to be considered by an ORCC are:

a. the occurrence of accidents, reports of *misuse* and *near misses* at the crossing;

b. the potential consequences of an accident at the crossing; and

c. other business benefits of the proposed risk reduction measure.

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[7] The figure for fatalities and weighted injuries is calculated by assigning a value of 1 for each fatality, 0.1 for each serious injury and 0.005 for each minor injury. This measure is used within the railway industry as a way of assessing and comparing risks.

[8] The Health and Safety at Work etc. Act 1974 places general duties on an employer (such as Network Rail) to conduct its undertaking in such a way as to ensure, so far as is reasonably practicable, that it does not expose non-employees to risks to their health and safety.

[9] Available at http://www.rssb.co.uk/SAFETY/Pages/SAFETYDECISIONMAKING.aspx.

27 The business benefits from proceeding with a risk reduction measure at a level crossing could include, for example, a reduction in maintenance costs or operational savings. The ORCC can include such wider benefits within the BCR, taking account of 'all project benefits'. In this case, evaluation of whether the business benefits are sufficient to justify the investment is carried out alongside other potential investment projects, and is dependent on the funding available for enhancement projects within the Network Rail Route concerned. There is also a separate cost-benefit analysis tool, which is sometimes used within Network Rail and which is more likely than the ALCRM calculation to generate a BCR of greater than 1.0. This alternative cost-benefit analysis tool goes beyond the legal requirement (as described in 'Taking Safe Decisions') and factors in additional non-safety benefits such as a reduction in reputational risk, the effect on stakeholders and insurance costs. This alternative model was discussed in the RAIB's report (15/2012) on the fatality at Gipsy Lane on 24 August 2011; use of this model is not mandated or recommended by Network Rail's Operations Manual, although Network Rail advises that a presentation on its use was given to Anglia Level Crossing risk personnel on 12 November 2008.

28 RSSB's research report 'Understanding human factors and developing risk reduction solutions for pedestrian crossings at railway stations', Ref. T730, was issued in January 2009 in response to recommendation 4 of the RAIB's report (23/2006) into the accident at Elsenham station crossing on 3 December 2005. Although this report considered potential risk reduction measures at station pedestrian crossings, it concluded that some of these could also be applied at footpath crossings (refer to paragraph 68). RSSB is currently carrying out further research into the safety of pedestrians at level crossings (project Ref. T984). This is intended to focus on what can be done to reduce pedestrian fatalities at all types of level crossings. The project aims to establish the underlying and generic causes of crossing user fatalities, to understand the reasons why they occur and to examine solutions, both existing and novel.

Guidance on level crossings provided by the Office of Rail Regulation

29 Guidance on level crossings is provided by the ORR[10]. The current guidance for footpath and bridleway crossings includes the provision of additional protective equipment where the *warning time* is insufficient (ie where it is less than the time required by users to cross the railway safely). Such equipment may include:

a. miniature stop lights (these were provided at Johnson's footpath crossing);

b. telephones connected to a supervising point (eg a signal box); or

c. audible warnings of approaching trains, preferably generated at the crossing itself[11] (audible alarms were provided at Johnson's footpath crossing).

[10] 'Level crossings: A guide for managers, designers and operators', Railway Safety Publication 7, 2011; this superseded the 1996 Railway Safety Principles and Guidance, part 2 section E, 'Guidance on level crossings', which had been published by the Health and Safety Executive.

[11] The 1996 guidance stated that whistle boards could be provided 'where train speeds are low and the service infrequent.'

30 The ORR has also published a guide on using level crossings safely[12]. The guide advises level crossing users that 'The safety at level crossings largely depends on you recognising the dangers and obeying instructions. If you do not follow the instructions given, you are putting yourself, other users, railway staff and passengers at great risk. You could also be prosecuted.' This is intended to make level crossing users aware of their responsibility to take reasonable care.

History of safety-related incidents at Johnson's footpath crossing

31 In the early 1990s British Rail identified that there was insufficient warning time for trains approaching Johnson's footpath crossing in the up direction at the maximum permitted linespeed of 70 mph (113 km/h)[13]. Consequently it imposed a *temporary speed restriction* (TSR) of 35 mph (56 km/h) on the approach to the crossing. There was a corresponding TSR of 60 mph (97 km/h) on the down line; this was actually provided to improve warning times for pedestrians using Cannons Mill Lane crossing, but applied before trains reached Johnson's footpath crossing. During the twenty years preceding the accident on 28 January 2012, various proposals were made to replace Johnson's footpath crossing with a footbridge, or to divert the footpath via the existing King's Court footbridge (refer to paragraph 53).

32 Following a fatal accident on 29 August 2002, the Health and Safety Executive issued an *improvement notice* to Railtrack[14], requiring the installation of MSLs at Johnson's and Cannons Mill Lane crossings, and encouraging Railtrack 'again' to consider closure of one or both crossings. As a result, Railtrack installed MSLs at both crossings; these were brought into use on 29 October 2003.

33 Safety-related incidents are recorded in the railway industry's safety management information system (SMIS), which is currently managed by RSSB; these include accidents, suicides and near misses. A summary of incidents recorded in SMIS for Johnson's footpath crossing is given at appendix E. The data indicates that the rate of occurrence of safety-related incidents did not reduce for either the up line or the down line following the installation of MSLs, see figure 6[15], although the number of incidents is too low to be able to draw meaningful conclusions on the effectiveness of the MSLs. Despite the *sighting distance* for trains approaching the crossing in the down direction being adequate, approximately half of the incidents recorded in SMIS involved down trains.

[12] This is available at http://www.rail-reg.gov.uk/upload/pdf/using_level_crossings_safely.pdf.

[13] Trains travelling in the down direction could be seen when they were more than 20 seconds away from the crossing and the sighting time thus exceeded the crossing time of 12-14 seconds (paragraph 16). Trains travelling in the up direction could be seen only when they were less than 7 seconds from the crossing; the sighting time was therefore less than the time required to cross safely.

[14] The company responsible for the national railway infrastructure before Network Rail took over in 2002.

[15] Note: this figure includes both accidental and deliberate incidents such as trespass, vandalism and suicides.

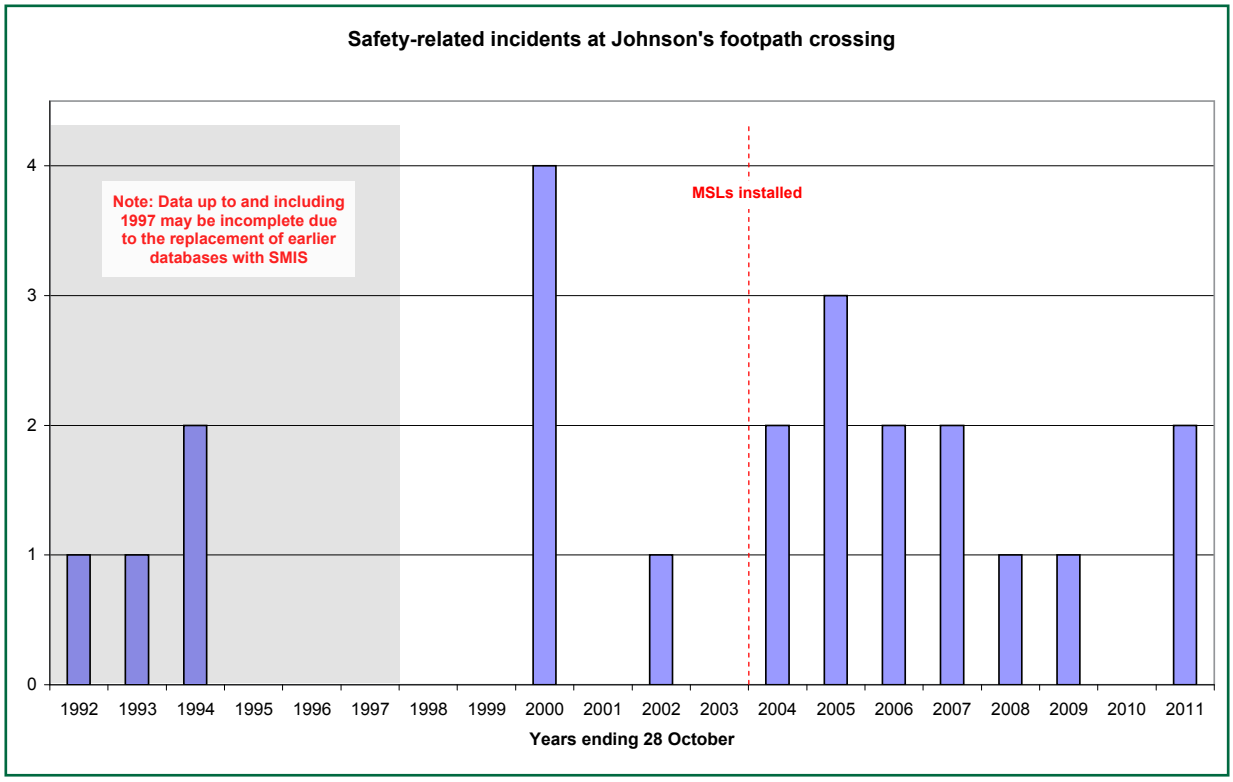

Figure 6: Rate of occurrence of incidents resulting in a near miss or fatality at Johnson's footpath crossing

34 The current ALCRM risk scoring of a level crossing (refer to paragraph D5 in appendix D) does not take account of reports of near misses or misuse, although the ORCC is required to consider such factors (paragraph 26; see also paragraph 83). There is documentary evidence that the ORCC considered the history of incidents and near misses at Johnson's footpath crossing, although it is unclear how this was factored into risk assessments for the crossing. In its report on the fatal accident at Halkirk level crossing on 29 September 2009 (RAIB report 16/2010), the RAIB noted that Network Rail's procedures did not give guidance on how the incident history of a level crossing should be used to supplement the information given by the ALCRM, in order to understand the risk and inform decisions on implementing risk reduction measures (refer to paragraph 77).

35 It is possible that the reporting of misuse at Johnson's footpath crossing increased following the installation of MSLs, as train drivers would have been more aware that a person crossing the line ahead of their train constituted misuse of the crossing.

Mitigation of risk by installing MSLs

36 The installation of miniature stop lights at a level crossing is generally seen as an effective way of mitigating risk where the warning time is insufficient. MSLs consist of red and green lights; the green light normally shows, but an approaching train changes the lights to red. At some locations, such as Johnson's footpath crossing, an audible alarm sounds while the red light is showing. Both visual and audible warnings are operated automatically by an approaching train, and are provided for at least five seconds longer than the time which has been calculated as necessary for users to be able to cross the railway safely (paragraph 16).

37 Prior to December 2010, the ALCRM over-predicted the risk at level crossings equipped with MSLs (refer to appendix D, paragraph D6). This was a consequence of the fact that MSLs were generally installed at high-risk level crossings; the SRM (paragraph 24) reflected the correspondingly poor safety record of such crossings. The way in which the calculation was carried out meant that the ALCRM predicted the risk at a crossing would be higher if MSLs were provided than if they were not. The RAIB commented on this anomaly in its bulletin on the fatal accident that occurred at Penrhyndeudraeth *user worked crossing* on 2 September 2009 (RAIB bulletin 07/2010, published June 2010). RSSB recognised that the anomaly should be corrected, and version 6 of the SRM reflected research which had concluded that the installation of MSLs appeared to be a very effective measure to reduce risk at user worked crossings[16]. The effect of the resulting modification of the ALCRM was to reduce the predicted risk (fatalities and weighted injuries) at Johnson's footpath crossing by 66%; this changed the ALCRM scoring of the risk at the crossing from A1 to C2[17]. In order to confirm the safety improvement resulting from the installation of MSLs, Network Rail reviewed eleven level crossings which have had MSLs installed, and has advised the RAIB that there appeared to be an improving trend in the number of incidents during and after the period in which the MSLs were being installed.

38 The ORR's current guidance on level crossings is that MSLs should normally be placed on the near side of the railway. This superseded the 1996 'Guidance on level crossings' (paragraph 29), which was in force at the time the MSLs were installed at Johnson's footpath crossing, and which stated that they should be placed on the far side of a footpath crossing. The ORR advised the RAIB that this change was 'in line with modern practice at road crossings'. The current preferred type of pedestrian road crossing is the 'Puffin' crossing, which was first introduced in 1997; the changes from the earlier 'Pelican' type of crossing included the mounting of the pedestrian lights on the near side of the road rather than on the far side. Appendix F contains a brief comparison of the message conveyed by the red and green lights at a footpath level crossing with MSLs and a Puffin road crossing, and identifies some important differences in the meaning of the indications and warnings provided.

39 Human Engineering surveyed users of user worked crossings (including vehicle users) on behalf of RSSB[18] as part of an investigation into the predicted user response to a proposed new type of warning device, which Network Rail was intending to test at a number of user worked crossings. Of the crossing users surveyed, 61.5% expressed a preference for MSLs to be positioned on the near side of the railway compared with 15.4% for the far side; 23.1% stated they would prefer the lights to be on both sides of the track.

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[16] RSSB report T821 'Further work on miniature warning lights at user worked crossings: Crossing data analysis.'

[17] The ALCRM classifies risk in the following ways:

- individual risk of fatality (identified by a letter A (high) to M (low)), which relates to the risk of death for an individual using the crossing on a frequent basis (500 times per year); and
- collective risk (identified by a number 1(high) to 13 (low)), which relates to the total risk generated by the crossing, taking into account the overall risk of death and injury for crossing users, train crew and passengers.

[18] RSSB report 'Investigation into user acceptance of a novel warning device', part of project T269 'User Behaviour at User Worked Crossings.'

40 The same survey also found that 29% of crossing users would consider ignoring a red light, principally if there was no train visible and / or they were in a hurry. All of the crossing users that might cross on red were found to understand the meaning of the red light. However they also underestimated the length of time it would take them to traverse the crossing.

Identification of the immediate cause[19]

41 **The pedestrian crossed into the path of the train as it approached Johnson's footpath crossing.**

42 Evidence from the train's forward-facing CCTV indicates that the pedestrian was unaware of the approaching train until the train was about 32 metres (1.1 seconds) from the crossing, and she could not reach a place of safety before she was struck (paragraph 22).

Identification of causal factors[20]

The pedestrian's lack of situational awareness

43 **The pedestrian started to walk over the crossing as a train was approaching, despite the warnings provided by the red MSL and audible alarm. This was a causal factor.**

44 The RAIB considers that there are two possible reasons why this occurred:

- the pedestrian may have been unaware of the warnings (paragraphs 45 to 47); or
- the pedestrian may have been aware of the warnings but unaware that a train was closely approaching (paragraph 48 to 50).

The pedestrian's lack of awareness of the red light and audible alarm

45 **The pedestrian may have been unaware of the warnings provided by the red MSL and audible alarm. This was a possible causal factor.**

46 It is possible that the pedestrian was distracted so that she did not see the red MSL or hear the audible alarm. The RAIB has been unable to establish whether her personal music device or her smartphone were in use at the time of the accident, or whether she was wearing earphones, which might have prevented her from hearing the audible alarm. Both devices were badly damaged in the accident and were found nearby.

[19] The condition, event or behaviour that directly resulted in the occurrence.

[20] Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

47 The far-side positioning of the MSLs may have impaired their conspicuity. The RAIB has calculated the *visual angle* as approximately 5.7° for near side and 0.57° for far side lights; this means that, if the lights at Johnson's footpath crossing had been installed on the near side of the railway, they would have appeared approximately 10 times larger to an approaching pedestrian than the existing ones on the far side. As mentioned at paragraph 38, the ORR's latest guidance is for MSLs to be installed on the near side of the railway. Although the red light would have been in the pedestrian's line of sight as she approached the crossing, the layout of the footpath required her to turn alongside the railway before turning back again to come through the gate (paragraph 15). It is possible that she did not look across the railway or see the red light before she passed through the gate.

The pedestrian's lack of awareness of the approaching train

48 **The pedestrian may have been aware of the warnings but was unaware that a train was closely approaching. This was a possible causal factor.**

49 Alternatively, the pedestrian may have been aware of the red light and / or the audible alarm but nevertheless decided to cross the railway anyway (paragraph 40). As mentioned at paragraph 42, the evidence indicates that she appeared to be unaware of the approaching train until the driver sounded the horn. This may have been because she was distracted and she probably did not look to see whether a train was approaching before she entered the railway.

50 Although the safety of the crossing did not rely on the sighting of an approaching train, due to the existence of the MSLs, there was potentially good visibility of trains approaching the crossing in the down direction (footnote 13). There was therefore an opportunity for the pedestrian to have seen the approaching train, as she was briefly facing in its direction before she passed through the gate. However, the level crossing warning signs obscured a pedestrian's view of a train approaching on the down line (figure 7). Equally, the signs would also have obstructed the driver's visibility of the pedestrian until she had stepped onto the crossing.

51 Whilst the MSLs and audible alarm provided the primary means by which pedestrians were warned of approaching trains, there was no obvious reason why these signs had to be placed in such a way as to obscure the pedestrian's view of approaching trains. The position in which they were placed denied the pedestrian the additional visual cue of train 2H22 as it approached the crossing.

The absence of a footbridge

52 In the 15 years leading up to the accident, there had been a number of proposals to improve arrangements for pedestrians to cross the railway at, or in the vicinity of Johnson's footpath crossing, but none of them had come to fruition. The following paragraphs describe the various initiatives and explain why Johnson's footpath crossing was still in use at the time of the accident.

Figure 7: Approach to Johnson's footpath crossing, looking in the up direction (south)

Proposals to close Johnson's footpath crossing prior to 2007

53 **Proposals from various bodies to close Johnson's footpath crossing before 2007 were not translated into action. This was a causal factor.**

54 Between 1996 and 2007, there had been a series of suggestions and proposals to divert pedestrians away from Johnson's footpath crossing or to replace the crossing with a bridge. The RAIB has been unable to establish fully why none of these proposals were progressed. The proposals included:

a. The 1996 Bishop's Stortford Transportation Plan, which referred to improved railway crossings for pedestrians and cyclists at King's Court and Johnson's footpath crossing (also at Cannons Mill Lane in the longer term). Note: the RAIB has seen no evidence as to whether or not the improvements proposed at this time included a new bridge.

b. A recommendation from Bishop's Stortford Town Council to Railtrack in 1998 that the provision of a bridge at Johnson's footpath crossing should be given serious consideration.

c. A remit for diversion of the footpath via King's Court bridge, which was issued by Railtrack in 2000, noting that the 'funding issue [would] need to be resolved'.

d. Letters from a member of the public to the headquarters of Railtrack and from the local member of parliament to the Railtrack Zone Director in 2002, which referred to correspondence over the preceding twenty years regarding the dangerous nature of the crossing. These letters followed the fatality at Johnson's footpath crossing in August 2002 (paragraph 32) and referred to a previous commitment, which Railtrack had made, to carry out a feasibility study into the replacement of the crossing with a bridge.

e. A proposal by Sustrans[21] for a cycle route across the railway in 2006; this would have diverted the footpath on the east side of the railway and replaced King's Court bridge with an accessible bridge. Although it did not refer explicitly to Johnson's footpath crossing, this scheme might have provided Network Rail with an opportunity to close the crossing. An issue with this proposal which apparently remained unresolved was that neither Network Rail nor the council wanted the maintenance liability for a new bridge.

55 Local opinion had historically been split between those who said 'something must be done' about Johnson's footpath crossing and those who did not want a bridge. A newspaper article in April 2012 quoted some Bishop's Stortford town councillors as stating that the installation of MSLs and audible alarms in 2003 provided sufficient protection if a crossing user was reasonably careful. The design of the bridge which has now been installed was also reported to have been criticised by members of the town council, on the grounds both that the structure was 'too large and inappropriate' and that the ramp was too steep and too narrow.

Proposal to replace Johnson's footpath crossing with a footbridge from 2007 onwards

56 **Network Rail did not follow-up a proposal in 2007 to install a footbridge to replace Johnson's footpath crossing, after analysis had shown that the benefits of so doing would exceed the costs. This was a causal factor.**

57 When the ALCRM was introduced in 2007, Johnson's footpath crossing was subjected to a risk assessment, and options for mitigating or eliminating the risk at the crossing were considered by Network Rail. The Level Crossing Risk Control Coordinator (LCRCC)[22] obtained a positive cost-benefit analysis for replacement of the crossing with a footbridge in October 2007 (the BCR was 1.2, see paragraph 26). Following this, the Route Operations Manager discussed the possible installation of a bridge with the Operations Risk Advisor (ORA) in July 2008, and approved a feasibility study. This was not done.

58 The RAIB has been unable to determine why the feasibility study was not carried out following this approval. The first step would have been to obtain funding for the feasibility study. At the time, the source of funding for mitigations at level crossings was Network Rail's Safety & Environment fund; witness evidence indicates that staff in Anglia Route believed that the rules of this fund were designed in such a way that it was almost impossible to obtain funding. A tracking sheet used by the Anglia operational risk team recorded that a submission had been made for funding by November 2008. A key witness has reported that this submission was rejected, although the RAIB has not seen any documentary evidence of this. Neither the former Route Operations Manager nor the former Route Enhancements Manager (who would normally have applied for funding, refer to appendix D, paragraph D8) could recall a proposal for a bridge or find any record that a funding submission had in fact been made.

[21] Sustrans is a British charity which promotes sustainable transport and which set up the National Cycle Network.

[22] The role of the LCRCC was subsequently expanded to include signalling risk assessments and renamed to ORCC.

59 Network Rail had reorganised the teams which carried out risk assessments of level crossings, as part of a reorganisation during 2006 known as 'safety in the line'. The newly-created operational risk team in the Anglia Route consisted of the ORA plus five people: two LCRCCs, a signalling risk control co-ordinator and two signalling inspectors. Witness evidence indicates that the LCRCC responsible for Johnson's footpath crossing did not have previous experience of operational risk assessment work and received no formal training in the role, other than in the use of the ALCRM tool. In its report on the accident at Sewage Works Lane user worked crossing on 17 August 2010 (RAIB report 14/2011), the RAIB identified that operational risk staff in the Anglia Route were not subject to probationary 'sign off' or a formal mentoring process. In addition, although the ORA did have experience of conducting operational risk assessments, this was for signalling issues rather than for level crossings.

60 Witnesses have reported that the level crossing team had a high workload and was responsible for significantly more high risk crossings than its counterparts in other Network Rail routes. The RAIB also commented on the shortfall in the processing of level crossing risk data by the operational risk team in Anglia Route between 2006 and 2009 in its report on the accident at Sewage Works Lane. The Anglia operational risk team has since been increased to consist of the ORA plus seven people, including an ORCC on secondment; the enlarged team covers the same operational area as before, with no increase in its responsibilities.

61 Witness evidence indicates that the operational risk team's priority in 2007 was reported to be to clear the backlog of risk assessments, rather than to progress mitigations.

62 The RAIB has concluded that a request for funding for a feasibility study into replacement of Johnson's footpath crossing with a footbridge was not made during 2007 or 2008 or, if such a request was made, that it was not followed up effectively. The non-delivery of required mitigation work has been identified by the RAIB in previous investigations, for example into the fatal accident at Moor Lane footpath crossing, Staines, on 16 April 2008 (RAIB report 27/2008). No recommendation is made about the ineffectiveness of the tracking of risk mitigations, as Network Rail is in the process of introducing the role of Level Crossing Manager; people in this role will be responsible for managing the risk at level crossings and will have visibility of the implementation of mitigation measures.

63 A further positive cost-benefit analysis was signed off by the new ORA in November 2010 following a census and ALCRM assessment in December 2009, and a site visit[23] by the ORCC in June 2010. Witnesses report that there is now a clearer path to obtaining funding for level crossing mitigations. This later cost-benefit analysis led to a project to install a footbridge and close the crossing that was in progress at the time of the accident (the footbridge subsequently opened on 1 August 2012).

[23] The Operations Manual requires the ORCC to carry out a 'high risk site visit' to any level crossing with a collective risk score ranking of 1 to 3.

Discounted factors

Operation of train 2H22

64 The OTDR indicated the train was travelling at around 63 mph (101 km/h) when the driver sounded the horn and applied the emergency brake; this was within the permitted line speed of 70 mph (113 km/h). The RAIB considers that the driver's actions were appropriate to the circumstances and the way in which the train was driven was not causal to the accident.

Observations[24]

Variations in the results obtained from ALCRM cost-benefit analyses

65 When Network Rail staff undertake a cost-benefit analysis of a measure to mitigate or eliminate risk at a level crossing using the cost-benefit tool in ALCRM, the analysis compares the safety benefit, expressed as a reduction in fatalities and weighted injuries, with the capital and recurring costs of implementing the mitigation. The ALCRM risk estimate for the crossing (and thus the predicted safety benefit to be obtained from mitigating or eliminating the risk) is critically dependent on the number of pedestrian-train 'moments' (pedestrian traverses per day multiplied by the number of trains passing over the crossing per day). As a result, the cost-benefit analysis is affected by the underlying variations in the estimate of the number of crossing users per day, which is usually based on a 30 minute 'quick' census (refer to appendix D, paragraph D3), as prescribed in Network Rail's Operations manual.

Date	Census (pedestrians / 24 hrs)[25]	Train frequency (trains / 24 hrs)[26]	Fatalities and weighted injuries per year	Estimated cost of footbridge (£m)	BCR
2007	189	128	0.10	1.5	1.21
2009	378	285	0.35	1.3	7.2
2010 calibration	378	285	0.02	1.6	0.35
2011	756	285	0.04	0.9	1.25
2012	319	253	0.02	0.9	0.47

Table 1: Variations in the census data and the benefit / cost ratio calculated by the ALCRM

[24] An element discovered as part of the investigation that did not have a direct or indirect effect on the outcome of the accident but does deserve scrutiny.

[25] Multiplied from the quick census result to give an equivalent usage over a 24 hour period.

[26] The ORCC enters the number of trains which have been determined from a review of the timetable, typically carried out using the *TRUST* computer system.

66 Since the re-calibration of the ALCRM in December 2010 (refer to appendix D, paragraph D6), the BCR for a footbridge to replace Johnson's footpath crossing has varied between 0.35 and 1.25 (table 1 and figure 8), where any figure in excess of 1 represents a positive case for making the investment (paragraph 26). The variations occurred principally because of fluctuations in the census data, although the predicted capital cost of a footbridge was also reduced to reflect Network Rail's modular footbridge design. The number of crossing users recorded during quick censuses at Johnson's footpath crossing varied from 7 to 28 users in a 30 minute period (the RAIB counted the number of users of Johnson's footpath crossing for a total of three and a quarter hours on 12 July 2012; the number observed was equivalent to 16 users per thirty minutes).

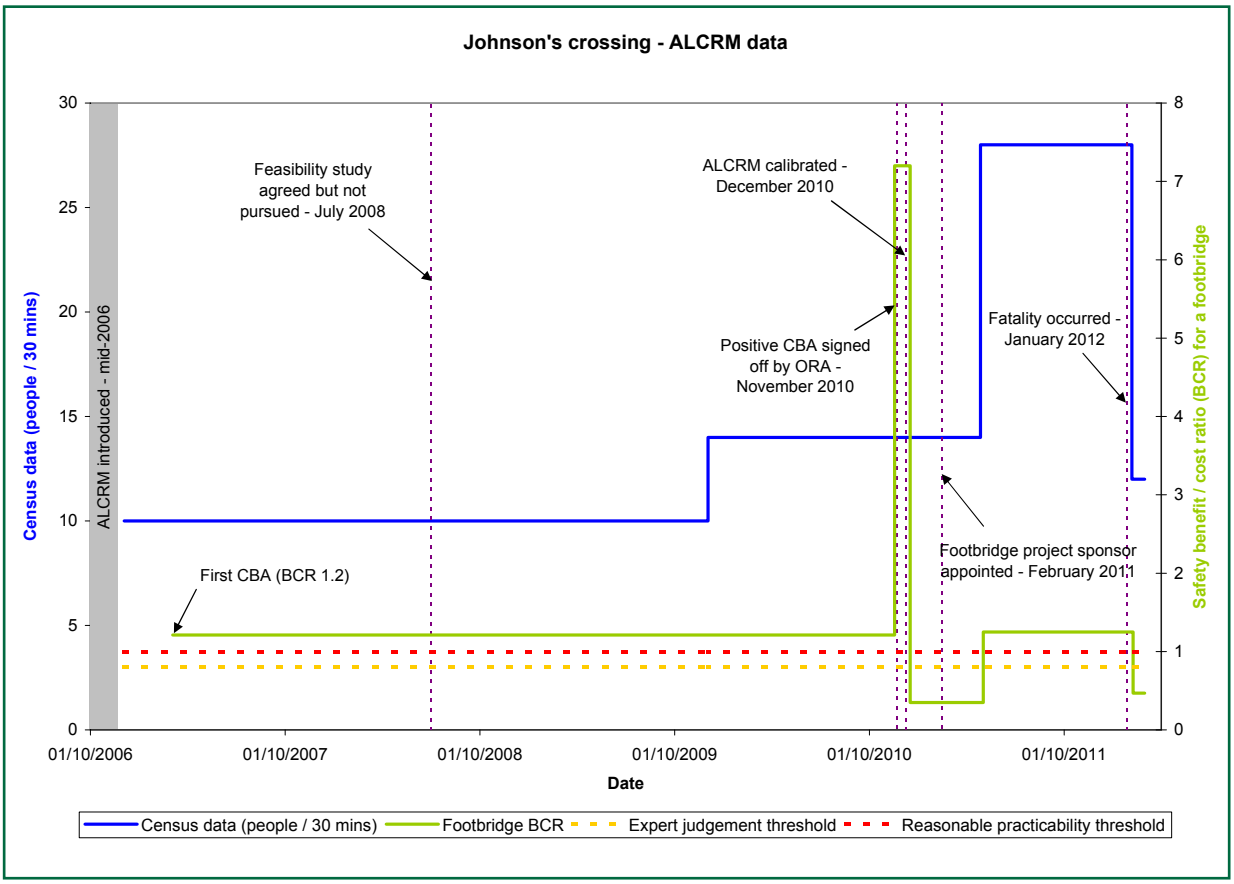

Figure 8: Variations in census data and benefit / cost ratio

67 The changes in the BCR were sufficient to cause the result of the cost-benefit analysis for building a footbridge to replace Johnson's footpath crossing to fluctuate between 'the benefits outweigh the costs' (BCR > 1) and 'the benefits do not cover the costs' (BCR < 0.8). It is possible that the train frequency recorded in 2007 was an error (for example counting the trains passing over the crossing in one direction only). In addition, despite the variations in pedestrian usage indicated at table 1, it is unlikely that the usage had in fact changed significantly in this period. The RAIB has been unable to identify any underlying changes, such as housing developments in the area, which would explain such variations. The use of the quick census is not always an effective means of gauging pedestrian crossing usage, particularly where a crossing may see increased usage at weekends, or at other times outside of those prescribed by Network Rail[27]. The RAIB has previously identified issues regarding the effectiveness of Network Rail's level crossing quick census technique in the following investigations[28]:

a. fatal accident at user worked crossing no.451 (RAIB bulletin 07/2010);

b. fatal accident at Halkirk level crossing (RAIB report 16/2010);

c. collision between an articulated tanker and a train at Sewage Works Lane (RAIB report 14/2011);

d. fatal accident at Mexico footpath crossing (RAIB report 10/2012); and

e. fatal accident at Gipsy Lane footpath crossing (RAIB report 15/2012).

The provision of information on potential mitigation measures

68 Among the conclusions of RSSB's research report ref. T730 (paragraph 28) were the identification of thirteen potentially viable options for additional risk reduction at station pedestrian crossings. Although footpath crossings were outside its scope, the report also concluded that seven of these potentially viable options might have similar benefits at footpath crossings (ie those not at stations). However, only three of the potentially viable options are explicitly referred to in the Level Crossing Risk Management Toolkit (paragraph 25), two of which were identified as relevant to footpath crossings.

69 The other risk mitigation options to which research report T730 referred included the provision of *back-to-back* or side-to-back lights. Such equipment could be retrofitted to existing crossings with MSLs, such as Johnson's footpath crossing. However, the ORR's level crossing guidance, which was updated following the publication of report T730, mentions the possibility of installing back-to-back lights only at user worked crossings for vehicles.

Previous occurrences of a similar character

70 A summary of previous recorded incidents at Johnson's footpath crossing is given at appendix E. These include near misses and fatalities, as well as both misuse and deliberate acts.

[27] The Operations Manual states that the quick census should be carried out between 09:30 and 16:30 hrs, Monday to Friday.

[28] RAIB reports are available at: www.raib.gov.uk.

71 The RAIB has conducted ten investigations into accidents involving pedestrians at level crossings since becoming operational in October 2005. None of these accidents had circumstances which were similar to those of the accident at Johnson's footpath crossing on 28 January 2012. However, the RAIB made recommendations in three of those investigations that were relevant to issues found in the investigation into the accident at Johnson's footpath crossing. Details of those recommendations can be found at paragraphs 77 and 78.

72 The RAIB recently completed investigations into fatal accidents that occurred at Gipsy Lane footpath crossing, near Needham Market, on 24 August 2011 and Mexico footpath crossing, near Penzance, on 3 October 2011. In both cases, the accidents featured pedestrians moving from a position of safety into the path of an approaching train, despite apparently being aware of the presence of the train.

Summary of conclusions

Immediate cause

73 The pedestrian crossed into the path of the train as it approached Johnson's footpath crossing (**paragraph 41**).

Causal factors

74 The causal factors were:

a. The pedestrian started to walk over the crossing as a train was approaching, despite the warnings provided by the red miniature stop light and audible alarm (**paragraph 43, Recommendation 1**). This was due to one of the following possible reasons:

i. the pedestrian may have been unaware of the warnings provided by the red miniature stop light and audible alarm (**paragraphs 45 and 81, Recommendation 1**); or

ii. the pedestrian may have been aware of the warnings but was unaware that a train was closely approaching (**paragraph 48, Recommendation 2**).

b. Proposals from various bodies to close Johnson's footpath crossing before 2007 were not translated into action (**paragraph 53, no recommendation**).

c. Network Rail did not follow-up a proposal in 2007 to install a footbridge to replace Johnson's footpath crossing, after analysis had shown that the benefits of so doing would exceed the costs (**paragraphs 56 and 80**).

Additional observations

75 Although not linked to the accident on 28 January 2012, the RAIB observes that:

a. The cost-benefit analysis result obtained from the All Level Crossing Risk Model is critically dependent on the census data (**paragraphs 65, 78 and 83**).

b. Only three of the thirteen potentially viable options for mitigating risk at station and footpath crossings identified in RSSB's research report ref. T730 are explicitly referred to in the Level Crossing Risk Management Toolkit (**paragraph 68, Recommendation 3**).

Previous RAIB recommendations relevant to this investigation

76 The following recommendations, which were made by the RAIB as a result of its previous investigations, have relevance to this investigation.

Recommendations that could have affected the factors

77 The RAIB considers that actions taken in response to its previous recommendations listed below could have addressed one or more of the factors and possibly prevented this accident:

Accident at Elsenham station on 3 December 2005, RAIB report 23/2006 published December 2006

Recommendation 4

ORR, in consultation with Network Rail and DfT, to undertake a comprehensive review of existing guidance relating to the design of station pedestrian crossings. This should include a review of current technologies and the modern understanding of human factors. This review should include … research into the technical feasibility and safety benefit of providing an additional set of stop lights on the far side of the crossing from an approaching user to repeat the indication of the lights on the near side ('back-to-back' lights)[29].

The ORR reported in January 2009 that the above recommendation had been closed as a result of the following actions:

i. ORR asked consultants to review the guidance on level crossings, including consideration of this recommendation.

ii. RSSB carried out a research project (project ref T730) to review the guidance relating to the design of pedestrian crossings at stations, including a review of current technologies and the modern understanding of human factors, in liaison with ORR and DfT. The report, 'Understanding human factors and developing risk reduction solutions for pedestrian crossings at railway stations', was in line with Elsenham recommendation 4, and informed the ORR review / rewrite of the guidance on level crossings.

[29] The review should have informed a comparison of the benefits of positioning MSLs on either side of the railway or on both.

Accident at Halkirk level crossing, 29 September 2009, RAIB report 16/2010 published September 2010

Recommendation 4

Network Rail should issue improved guidance, and brief its staff, on assessing the risk from factors that are not currently included in the All Level Crossing Risk Model when carrying out risk assessments and making decisions on implementing risk reduction measures at crossings. This should include methods to be adopted when taking into account local factors such as the previous incident and accident history.

The ORR reported in December 2011 that Network Rail had taken action to implement the recommendation, following the briefing of updated guidance to ORAs in January 2011 (see also paragraph 82).

Recommendations that are currently being implemented

78 The following recommendation was made by the RAIB as a result of a previous investigation and addresses factors identified in this investigation. It is therefore not remade so as to avoid duplication:

Accident at Gipsy Lane footpath crossing, 24 August 2011, RAIB report 15/2012 published July 2012

Recommendation 2

Network Rail should have effective systems in place for accurate information gathering during data collection visits at level crossings. Any changes from previous data collected should be clearly understood and feedback given to the relevant person where data is incorrect. This includes data relating to … the number of crossing users where the quick census is undertaken.

The ORR has not yet reported to the RAIB the actions that are planned in response to the above recommendation. Network Rail has advised that it is currently preparing guidance on the collation of census information, including reference back to previous data in order to identify significant changes; it expects to publish this at the end of November 2012.

Actions reported as already taken or in progress relevant to this report

Actions reported that address factors which otherwise would have resulted in a RAIB recommendation

79 Johnson's footpath crossing has now been closed by Network Rail and replaced with a footbridge (paragraph 63).

80 Network Rail is in the process of introducing the role of Level Crossing Manager and is consequently changing the responsibilities for managing the risk at level crossings. Level Crossing Managers' responsibilities will include overseeing the implementation of proposed mitigations; this is expected to reduce the potential for mitigation proposals to become lost between departments (paragraph 58).

Other relevant reported actions

81 Although not necessarily relevant to the accident at Johnson's footpath crossing on 28 January 2012, Network Rail ran a campaign called 'Lose Your Headphones' in August 2012. This featured the *rapper* known as Professor Green in a video on the music streaming service Spotify and social media sites such as Twitter. The intention was to persuade people to remove their headphones at level crossings, so that they are not distracted from warnings about approaching trains (paragraph 46). Network Rail also launched a general campaign on the dangers of distraction at level crossings in October 2012.

82 Network Rail issued a spreadsheet-based tool entitled 'Smart Sources of Information to support Level Crossing Risk Assessment' to its internal operational risk teams during September 2012. This is intended to allow additional sources of information on level crossing usage, such as data gathered using enforcement cameras, gate counters[30], pressure pad counters and input from train operating companies to be factored into the risk assessment process (paragraph 77b).

83 RSSB is carrying out a detailed assessment of assumptions and data, in order to enhance the ALCRM and develop new algorithms (project T936). The enhancements will include the ability to include a crossing's misuse history in the ALCRM computation. Implementation of the findings will be undertaken by Network Rail as custodians of the ALCRM, which it owns jointly with RSSB (paragraph 75a).

84 RSSB has instigated a research project (T984) to examine the causes of pedestrian accidents at all types of level crossings and to research both novel and established reasonably practicable solutions (paragraph 28).

[30] Equipment with an in-built data logger which records the opening and closing of gates at gated crossings.

Recommendations

85 The following recommendations are made[31]:

1 *The intent of this recommendation is to identify reasonably practicable ways of improving the conspicuity of miniature stop light indications at pedestrian crossings, in order to reduce the potential for a level crossing user to be unaware of a red light. This is increasingly important where pedestrians may be distracted by personal music devices and smartphones.*

Network Rail should investigate ways to make cost-effective improvements to the conspicuity of visual warnings of approaching trains, taking account of the findings of relevant RSSB research projects. Such improvements might include moving existing miniature stop light indications to the near side of the railway, or the provision of 'back-to-back' or 'side-to-back' indications. The results of this investigation should be used to determine the optimum configurations for new installations, as well as the situations in which it would be reasonably practicable to enhance existing installations. If appropriate, Network Rail should then arrange for the Level Crossing Risk Management Toolkit to be updated accordingly (paragraph 74a).

2 *The intent of this recommendation is to prevent signage from obscuring approaching trains at crossings which are equipped with miniature stop lights, thus providing users with an additional warning of an approaching train.*

Network Rail should amend its guidance on risk mitigations to take account of possible improvements in the visibility of approaching trains at level crossings equipped with miniature stop lights, particularly where signage or other level crossing equipment may obscure the view of the line (paragraph 74a).

continued

[31] Those identified in the recommendations have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others. Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail Regulation to enable it to carry out its duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on RAIB's website www.raib.gov.uk.

3 *The intent of this recommendation is to make a comprehensive set of risk reduction measures available to level crossing managers.*

Network Rail, in consultation with RSSB, should review the thirteen level crossing risk reduction options identified in RSSB research report T730, to determine whether or not each option should be included as a mitigation available to those responsible for managing the risk at level crossings (paragraph 75b). Network Rail should embed the findings of this review in its management of level crossing risks, and communicate these changes to all relevant staff. Guidance should be provided to the relevant staff on potential costs and benefits, as well as the specific circumstances in which each measure might be effective.

Appendices

Appendix A - Glossary of abbreviations and acronyms

ALCRM	All Level Crossing Risk Model
BCR	Benefit / Cost Ratio
BTP	British Transport Police
CCTV	Closed Circuit Television
FOC	Freight Operating Company
LCRCC	Level Crossing Risk Control Co-ordinator
MSL	Miniature Stop Lights
ORA	Operations Risk Advisor
ORCC	Operations Risk Control Co-ordinators
ORR	Office of Rail Regulation
OTDR	On-Train Data Recorder
RAIB	Rail Accident Investigation Branch
RSSB	Rail Safety and Standards Board
SMIS	Safety Management Information System
SRM	Safety Risk Model
TOC	Train Operating Company
TOPS	Total Operations Processing System
TRUST	Train RUnning System on TOPS
TSR	Temporary Speed Restriction
UWC	User Worked Crossing

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com.

Back-to-back (and side-to-back) lights	Miniature stop light indications which are repeated so that an approaching crossing user can see the lights on both sides of the line. Side-to-back lights are similar, with the near side lights typically being mounted at 90° to those on the far side.
Decision point (taken from 'Level crossings: A guide for managers, designers and operators')	A point where guidance on crossing safely is visible and at which a decision to cross or wait can be made in safety.
Down side	The west side of the railway (the far side from the point of view of the pedestrian). Trains on this side of the railway travel towards Cambridge or Stansted airport.
Emergency brake	The position on the brake control that applies the maximum possible braking effort. This is beyond the normal service brake position.
Improvement notice	An enforcement notice requiring remedial action because of a contravention of the provisions of the Health and Safety at Work etc. Act 1974.
Miniature stop lights (MSLs)	Small red and green lights mounted on a board adjacent to a user worked level crossing or footpath crossing. The lights are operated by the passage of trains. They are sometimes called miniature warning lights.
Misuse (taken from the Operations Manual)	For a footpath crossing with MSLs, misuse is defined as crossing [the railway] when the MSLs are red.
Near miss	A situation which did not result in an accident, but potentially could have done so under slightly different circumstances. The railway industry generally regards the need for a train driver to use the emergency brake as the criterion for determining that a near miss has occurred.
On train data recorder	A data recorder collecting information about the performance of the train, including speed, brake control positions, etc.
Puffin	The 'Pedestrian User-Friendly Intelligent' crossing is a signal-controlled facility. The pedestrian signals are normally mounted on the near side of the crossing and are positioned to allow pedestrians to watch approaching traffic, while keeping the signal in their field of view.

Rapper	A person who performs rap music.
Safety benefit	A financial measure of the value of a risk mitigation, determined from the predicted reduction in fatalities and weighted injuries.
Safety management information system	A computer database used by the railway industry to record incidents and accidents.
Safety risk model	A computerised model managed by the RSSB which is a quantitative representation of the potential accidents resulting from the operation and maintenance of Britain's rail network.
Sighting distance (taken from 'Level crossings: A guide for managers, designers and operators')	The distance measured along the railway from a decision point to the point at which an approaching train becomes visible in any direction from which a train may approach.
Signalling data logger	Equipment used to record the time of operation of electrical circuits within the signalling system.
Temporary speed restriction	A speed restriction imposed for a short time, generally as a result of engineering work, to guarantee safe passage of trains.*
TRUST	A computer system that processes reports of train operation and compares it with the scheduled timetable.
Up side	The east side of the railway (the near side from the point of view of the pedestrian). Trains on this side of the railway travel towards Bishop's Stortford and London.
User worked crossing	A private level crossing, usually protected by outward opening crossing farm type gates. Many are fitted with telephones which users crossing in a vehicle, or with animals, are required to use to obtain the permission of the signaller to cross. Some are fitted with MSLs.
Visual angle (taken from the Oxford online dictionary)	The angle formed at the eye by rays from the extremities of an object viewed.
Warning time (taken from 'Level crossings: A guide for managers, designers and operators')	The shortest possible time for trains to travel the sighting distance or, where whistle boards are provided, the shortest time between the sound being heard at the crossing and the train arriving at the crossing. In calculations of warning time the highest attainable train speed should be used.

Appendix C - Key standards current at the time of the accident

Operations Manual Procedure 5-24 'Use of the All Level Crossing Risk Model (ALCRM)', Issue 3, June 2008	Network Rail
Railway Safety Principles and Guidance, part 2 section E, 'Guidance on level crossings', 1996	Health and Safety Executive

Appendix D - Network Rail's procedures for managing level crossing risk

D1 The current version of Network Rail's Operations Manual[32] identifies the roles and responsibilities of those involved in level crossing risk assessment and mitigation as follows:

a. Route General Managers (RGM) are responsible for the management of risk reduction at level crossings.

b. Operations Risk Advisors (ORA) ensure that all completed level crossing risk assessments are reviewed by a competent person; they also review and approve proposals for level crossing closures and review risk reduction and mitigation recommendations proposed by Operations Risk Control Co-ordinators (ORCC).

c. Operations Managers are responsible for appointing trained personnel to carry out level crossing site visits, including a census at the level crossing, and review recommendations on risk reduction and mitigation proposed by the ORCCs.

d. ORCCs are responsible for:

- managing the programme of level crossing risk assessment;
- identifying and analysing risk mitigation measures;
- providing advice on level crossing matters; and
- maintaining level crossing records.

e. Mobile Operations Managers (MOM) are required to complete level crossing site visits to gather data and to complete a census in accordance with an agreed programme; this information is used as an input to level crossing risk assessments.

D2 The Operations Manual requires that a risk assessment of each footpath crossing on its network is carried out at least every three years. Additional risk assessments are required when there has been an accident or incident (eg a near-miss) or where a concern about the level crossing has been raised by Network Rail, a train operating company or a relevant authority such as a local council or highways authority.

D3 A census of level crossing usage is required to inform the risk assessment. For footpath crossings, this is done every three years at the time of the data collection visit. It is permissible for the census to be estimated if no users are seen during the period of the site visit. The census must be done on a weekday between the hours of 09:30 hrs and 16:30 hrs. Normally a 'quick' census is undertaken, typically for a period of 30 to 60 minutes. The number and type of user is recorded, and the number of users is then multiplied (for example, by 27 for a 30 minute census) to obtain an equivalent usage for a 24 hour period.

[32] Procedure 5-16, Issue 2, June 2012.

D4 Network Rail introduced the All Level Crossing Risk Model (ALCRM) as part of the level crossing risk assessment process in 2007. The results from the ALCRM are particularly sensitive to the census data on the number of trains and pedestrians using the crossing; other factors which can influence the predicted risk include the type of crossing users, poor sighting and glare from the sun at certain times of day. Local factors such as the near miss history and any problems with sighting distances are considered separately.

D5 The ALCRM provides an estimate of risk which is classified in the following ways:

a. individual risk of fatality, identified by a letter A (high) to M (low), which relates to the risk of death for an individual using the crossing on a frequent basis (500 times per year); and

b. collective risk, identified by a number 1 (high) to 13 (low), which relates to the total risk generated by the crossing. This takes into account the overall risk of death and injury for crossing users, train crew and passengers.

D6 The ALCRM was re-calibrated in December 2010, to align it with version 6 of the RSSB's safety risk model (paragraph 24). At the same time, Network Rail corrected an issue with the software itself. The combined effect of these changes was to reduce the predicted risk (fatalities and weighted injuries) at Johnson's footpath crossing by 94%, see table 1 after paragraph 65.

D7 Once the risk has been modelled using the ALCRM, the ORCC carries out a cost-benefit analysis to determine the reasonable practicability of possible mitigations (ie risk reduction measures) using RSSB's Level Crossing Risk Management Toolkit (refer to appendix G). The ALCRM calculates the BCR for each proposed mitigation, based on assumptions about the capital and recurring costs and the benefits. The principal factors that are considered when assessing the potential benefits of a proposed risk mitigation are the effectiveness and longevity of risk reduction, compared with the cost of the measure proposed. The ALCRM provides two calculations of the BCR: one for the predicted safety benefits (based on a reduction in fatalities and weighted injuries) and the second to take account of any wider 'business benefits', such as a reduction in annual maintenance costs.

D8 In 2007, the Operations Manual procedure[33] was for the ORA to review a recommendation from the Level Crossing Risk Control Coordinator (LCRCC), together with each of the proposed risk reduction and mitigation measures, whether or not they were deemed to be reasonably practicable. Where a measure was proposed to be progressed, the ORA was required to review the proposal with the Route Operations Manager (who held overall responsibility for having processes in place so that risk at level crossings should be reduced so far as is reasonably practicable). If the measure was deemed to be reasonably practicable, it should then have been progressed through the Route Enhancement Manager.

[33] Procedure 5-24 Issue 3, June 2008.

Appendix E - Previous incidents at Johnson's footpath crossing

The following is a brief summary of incidents recorded in SMIS for Johnson's footpath crossing:

Date	Train direction	Incident	Extract from SMIS
30/08/1992	Down	Fatality	Person struck by the 1830 Liverpool Street to Stansted Airport train. She had been removed from the crossing earlier in the day by the police.
26/04/1993	Down	Near miss	Woman had stood on crossing with her back to the train as it approached.
17/01/1994	Down	Near miss	Driver reported that a person had crossed in front of his train. The driver sounded a warning on his horn, but the pedestrian seemed to ignore.
09/09/1994	Down	Near miss	Near miss with a young boy.
10/06/2000	Up	Near miss	Children ran across right in front of train.
17/06/2000	Up	Near miss	Near miss with an elderly lady.
27/06/2000	Up	Near miss	Near miss with pedestrian. Driver stopped and walked back to check person out. Person informed of the error of their ways.
06/07/2000	Down	Near miss	Driver reported a near miss with 3 elderly people.
29/08/2002	Up	Fatality	Driver reported that he had struck an old woman and her dog.
29/10/2003	***n/a***		***MSLs commissioned.***
16/12/2003	Up	Emergency stop – 'not a near miss'	Children playing around.
10/02/2004	Up	Near miss	Near miss with a lady pedestrian.
29/03/2005	Down	Near miss	The driver reported a near miss with a person crossing the line as the train approached.
01/04/2005	Up	Near miss	Near miss involving a member of the public.
31/05/2005	Up	Near miss	The driver reported that he had a near miss with a pedestrian.
26/01/2006	Down	Fatality	Person stepped into the path of the train with her hands covering her head. Coroner's verdict: Open.
03/04/2006	Down	Near miss	Driver was involved in a near miss. The signaller had reported that there had been children trespassing on the crossing.
03/11/2006	Down	Near miss	The driver reported a near miss with a group of youths.
04/05/2007	Down	Near miss	The driver had suffered a near miss with children standing on crossing.
14/09/2008	Up	Fatality	Male ran out onto crossing in front of train. Coroner's verdict: Took his own life because he suffered from a mental illness.
27/02/2009	Up	Vandalism	Driver reports hitting a bike.
14/04/2011	Down	Near miss	The driver reported a near miss with an elderly person. The person crossed over as the train approached.
08/07/2011	Up	Near miss	The driver reported a near miss with a member of the public who walked across the lines immediately in front of the train.

Appendix F - Meanings of indications at road and rail pedestrian crossings

The table below provides a comparison of the meanings of the red and green lights which are provided as indications to pedestrians at Puffin road crossings and railway footpath crossings with MSLs.

Puffin road crossing	**MSLs at a footpath level crossing**
Pedestrian road lights normally display a red man unless a crossing demand is made. No signage is provided. The red man indicates that a pedestrian using the crossing is not currently protected by road traffic signals. In some situations, this may be interpreted by pedestrians as 'cross with care', although that is not the intention of the indication.	MSLs normally display a green light unless a train is coming. The red light indicates that a train is approaching. Signage states that the red light means 'stop / do not cross'.
The green figure is an 'invitation to cross'.	The green light means that the crossing is clear (ie no train is approaching).
At some crossings an audible tone sounds during the 'invitation to cross' period (ie when it **is** safe to start to cross).	Where provided, an audible tone sounds while a train is approaching (ie when it **is not** safe to cross).
Nearside crossing lights (Puffin crossings) are intended to encourage those using the signal demand button to look in the direction of traffic flow.	The ORR has stated that installing MSLs on the nearside of the railway may cause users to be more alert to their surroundings when crossing, not focusing solely on a green lamp ahead. However, the ORR considers that these benefits are probably marginal, and that existing installations in which the MSLs are on the far side of the railway do not need to be modified.

Table F1: Comparison of Puffin road crossing and MSLs at a footpath level crossing

Figure F1: Puffin crossing showing orientation of nearside lights relative to oncoming traffic

Appendix G - Possible mitigation measures

The following mitigation measures are taken from RSSB's Level Crossing Risk Management Toolkit (www.lxrmtk.com). The mitigations included here have some relevance to the circumstances of the accident at Johnson's footpath crossing on 28 January 2012, and are those listed as relevant to a footpath crossing with MSLs and a similar configuration to Johnson's footpath crossing.

ID	Name	Description	Category	Cost
51	Maintenance - competence, training, consistency	Ensure all inspectors are competent, trained and carry out their duties consistently, in accordance with standards and in a timely manner.	Enabling	Unknown
9	Increase audible warning volume	Increase the volume of the audible warning to the maximum permitted level to make the alarm more conspicuous and potentially deter pedestrian abuse.	Engineering	Low (£0 - £10k)
36	Level one/two safety meetings	Level One Safety Meetings (Director's Liaison) provide an opportunity for Network Rail, Train and Freight Operating Companies (TOCs and FOCs) to interact and share information about level crossings...	Enabling	Low (£0 - £10k)
37	Consistency between TOC and FOC training	Ensure that the content of training and education materials presented to drivers by both TOCs and FOCs is consistent.	Enabling	Low (£0 - £10k)
42	Review signage	Ensure signage is appropriate for the status and specific risks at a crossing. Signage should also accommodate and aid the form of protection (eg telephones) installed at the...	Engineering	Low (£0 - £10k)
44	Enhanced signage	A range of enhancements could be implemented: Provision of yellow 'backing' boards on advance warning signs Duplication of advance warning…	Engineering	Low (£0 - £10k)
50	BTP monitoring	Deploy a temporary BTP presence (eg for one day) at problem crossings to review use and prosecute misuse. The presence of the BTP staff will help to mitigate the potential for user...	Enforcement	Low (£0 - £10k)
66	Improve sighting distance: Remove foliage and other obstructions	By cutting back vegetation and removing obstructions the sighting distances for users up and down the track and to signs / warning lights are lengthened. ORR emphasises the importance of…	Enabling	Low (£0 - £10k)
82	Joint Action Planning meetings	Joint Action Planning meetings provide an opportunity for Network Rail, local authorities and BTP to interact and share information about level crossings. Meetings should be held regularly to allow...	Enabling and Enforcement	Low (£0 - £10k)
88	Education campaign - Local	Targeted, local education campaigns can be used to address crossing violations in specific populations (eg the elderly, schoolchildren) or specific crossings with a history of violation. For...	Education	Low (£0 - £10k)

ID	Name	Description	Category	Cost
90	Gate counters	A mechanical device attached to gates at UWCs which counts the number of times the gate is opened. Allows better estimates of crossing use and can be used to compare the number of calls a signaller...	Engineering	Low (£0 - £10k)
101	Education campaign - Safe use	An education campaign designed to instruct crossing users how to use the crossing safely rather than simply focusing on the risks and consequences of unsafe usage. This type of…	Education	Low (£0 - £10k)
103	Extended census	Conducting censuses longer than the standard 'quicktime' census (30 minutes) will provide a more accurate understanding of the crossing utilisation. For example, extended censuses can be conducted...	Enabling	Low (£0 - £10k)
109	Use of mirrors to improve sighting distance	Provision of mirrors at crossings to improve the sighting distance for crossing users where there are obstructions on the nearside. Mirrors can also be provided to improve the sighting for train...	Engineering	Low (£0 - £10k)
1	CCTV monitoring	Provision of CCTV surveillance cameras to deter misuse at a particular crossing and to capture evidence of misuse when it arises.	Enforcement	Medium (£10 - £100k)
11	Crossing approach surface	Alter the level crossing approach surface so that it provides a greater indication to the road user that a crossing is ahead. Alteration to the crossing approach surface can...	Engineering	Medium (£10 - £100k)
30	Interlocking of barriers / gates	On some footpaths and UWCs with miniature warning lights the barriers / gates are manually opened. Interlocking the barriers / gates with the warning lights will mean that users cannot open them...	Engineering	Medium (£10 - £100k)
53	Closure	Closure will remove all of the risk associated with a crossing. It is important to make the distinction between complete closure of the crossing and bypassing the crossing eg via a tunnel or...	Enabling	Medium (£10 - £100k)
76	Prosecution of all level crossing violators	Employ a strategy that ensures all people who violate level crossings are prosecuted. This could reduce the probability of risk taking behaviour at those sites.	Enforcement	Medium (£10 - £100k)
48	Education campaign - National	An education campaign will highlight the major risks associated with crossings to all members of the public. Network Rail's current national TV and Radio safety campaign is called…	Education	High (over £100k)
72	Install a bridge/ underpass	Provide a bridge for road and pedestrian traffic in order to by-pass the level crossing. Installing a bridge should result in closure of the crossing but without the need to divert traffic...	Engineering	High (over £100k)

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