The Network Rail (Tackley Level Crossing) Order

Appendices to Proof of Evidence

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JG1

The Planning Inspectorate

Order Decision

Inquiry opened on 16 October 2019

Site visits made on 16, 22, 24 October 2019

by Martin Elliott BSc FIPROW

an Inspector appointed by the Secretary of State for Environment, Food and Rural Affairs

Decision date: 27 December 2019

Order Ref: ROW/3217265

- This Order is made under Section 118A of the Highways Act 1980 (the 1980 Act) and Section 53A(2) of the Wildlife and Countryside Act 1981 and is known as the The Dorset County Council (Footpath 14, Wool at East Burton) Rail Crossing Extinguishment Order 2018.
- The Order is dated 16 March 2018 and proposes to extinguish public footpath 14 in the Parish of Wool as shown on the Order plan and described in the Order Schedule. If confirmed, the Order will also modify the definitive map and statement for the area, in accordance with Section 53(3)(a)(i) of the Wildlife and Countryside Act 1981, once the provisions relating to the extinguishment come into force.
- There were four objections outstanding at the commencement of the inquiry.

Summary of Decision: The Order is confirmed subject to modifications.

Procedural Matters

1. I opened a public local inquiry at East Burton Village Hall on 16 October 2019. The inquiry sat for six days. I did not carry out an accompanied site inspection as no parties required me to do so. However, I carried out a number of unaccompanied site inspections of the Order route and surrounding area.

2. Dorset Council took a neutral stance with respect to the confirmation of the Order and the case for confirmation was made by Network Rail (NR). Although the Parish Council indicated that they wished to speak at the inquiry, in opposition to the Order, they did not do so. In reaching my decision I have regard to all submissions made in respect of the Order.

3. Complaints were made prior to the inquiry[1] in relation to the conduct of NR. It was asserted that NR, given Dorset Council were taking a neutral stance, failed to comply with the timetable for the submission of Statements of Case (SoC). This despite being advised by the Planning Inspectorate that NR should submit their SoC as if they were the Order Making Authority (OMA). It was contended that objectors were put at a disadvantage as they only saw the primary case for NR after the submission of their own SoC.

4. In cases where the OMA is taking a neutral stance the supporter of the Order (in this case NR, the applicant) is encouraged to submit a SoC by the deadline set out in the Notice of Order for the OMA. In this case NR submitted their SoC in accordance with the deadline for those who have made objections, representations or wish to speak at the inquiry.

[1] Open Spaces Society (OSS), Ramblers' Association (RA) and Professor Divall

5. Although it would have been helpful for NR to have submitted their SoC at the time when the OMA were required to submit their SoC there is no mandatory requirement to do so. In this case the parties concerned were able to submit rebuttal proofs having had sight of NR's SoC. The issue to be considered is whether there has been any prejudice and whilst I note the concerns there is nothing to suggest that anyone has been prejudiced. The parties concerned were able to make further submissions in response to NR's SoC. It is also noted that NR only submitted summary Proofs of Evidence shortly before the inquiry. Again there is nothing to indicate that anyone has been prejudiced by their late submission.

6. The Order route has no recorded width. In the absence of a width and to ensure, in the event of confirmation, the whole width of the Order route is extinguished it is appropriate to include the words 'the whole width'. The Order, if confirmed, will be modified accordingly.

The Main Issues

7. The Order has been made under Section 118A of the Highways Act 1980 because it appeared to Dorset Council expedient in the interests of the safety of members of the public using it or likely to use it that the footpath should be stopped up.

8. Before confirming the Order I must be satisfied that it is expedient to do so having regard to all the circumstances, and in particular to—

   (a) whether it is reasonably practicable to make the crossing safe for use by the public, and

   (b) what arrangements have been made for ensuring that, if the order is confirmed, any appropriate barriers and signs are erected and maintained.

9. Defra[2] Circular 1/09 (the Circular) (at paragraph 5.49) advises that all the relevant factors should be taken in to consideration, which may include the use currently made of the existing path, the risk to the public of continuing such use, the effect that the loss of the path would have on users of the public rights of way network as a whole, the opportunity for taking alternative measures to deal with the problem, such as a diversion order or a bridge or tunnel and the relative cost of such alternative measures.

10. Paragraph 5.48 of the Circular informs that care should be taken to avoid the creation of a cul-de-sac that would encourage trespass on to the railway. Section 118A(2) provides that the order may extinguish the right of way on the crossing itself and for so much of its length as the authority deems expedient from the crossing to its intersection with another highway over which there subsists a like right of way.

Reasons

Background

11. The railway line (the Bournemouth main line/Wessex route) on which the crossing is located was authorised by the Southampton and Dorchester Railway Act 1845. The crossing falls within enclosure 41 in the Parish of Newburgh and the Book of Reference describes the enclosure as an Occupation Road. The

[2] Department for Environment Food and Rural Affairs

crossing was therefore originally provided as a private access. A public footpath was subsequently recorded over the crossing under the National Parks and Access to the Countryside Act 1949. All private access rights were released in 1965.

12. The line, runs between London Waterloo and Weymouth. Footpath 14 (A-D[3]), which links East Burton Road to footpath 13 uses the crossing (B-C) known as 'Darkies' (the crossing). The 'Up' line carries trains from Weymouth towards Poole and London and is the northernmost pair of rails. The 'Down' line taking trains from London and Poole is the southernmost pair of rails. The line speed at the crossing is 85 mph on the up line and 80 mph on the down line. The lines running over the crossing are in 24 hour use with 68 passenger services, Monday to Saturday, 06:17 to 23:59 hours, with 31 passenger services on a Sunday between 08:10 and 23:20 hours. There are three pathways for freight trains between 21:35 and 00:20 hours, Monday to Friday, although currently there are no freight trains running over the crossing. Other services run on an unscheduled basis such as heritage trains, empty stock and engineering trains.

Safety at the crossing

Sight lines

13. Darkies is a 'passive' crossing meaning that there is no direct method of warning people who use the crossing. Stop, Look and Listen (SLL) signs are the only warning at the crossing. These are regarded as being at the decision points for the crossing; the point at which a user determines whether it is safe to cross. At an anticipated walking speed of 1.2 m/s the crossing time between safe locations (9.6 metres) is 8.07 seconds for an able-bodied pedestrian (neither encumbered or vulnerable (non-vulnerable user)). For an encumbered or vulnerable user (vulnerable user) the traverse time is increased by 50% (the 50% safeguard) at 12.11 seconds.

14. NR have calculated the minimum sighting distance, using the NR sighting requirements calculation tool. On the basis of those measurements, line speeds and the time required to traverse the crossing NR have concluded that in respect of non-vulnerable users using the crossing from B to C the sighting distance of a downline train (sight line B (SLB)) is deficient. The sighting distance being only 210 metres with a minimum sighting distance required being 289 metres and therefore deficient by 79 metres; the sighting distance provides a warning time of 5.87 seconds. In respect of the other sight lines NR have concluded that these are sufficient to allow time to cross the crossing. Professor Divall agreed with NR that with the exception of SLB the warning times provided are compliant for non-vulnerable users. It should be noted that irrespective of whether use is by vulnerable or non-vulnerable users SLB is deficient in terms of affording a safe crossing.

15. Professor Divall queried the accuracy of the measurement for SLB being based on a measurement using lineside vegetation. He said that it could not be certain that the feature used equated to a train coming around the corner. Whilst I note the concerns, the measurement has been taken in accordance with industry practice. Although there has been some variance in the previous measurements taken by NR I do not consider that this means that the 210 metres is inaccurate. In any event Professor Divall accepted in cross-

[3] Letters A to D relate to points shown on the Order map

examination that SLB was about 210 metres, did not question the methodology and as noted above agreed that SLB was deficient.

16. Professor Divall contended that in terms of SLB this is restricted by trackside vegetation on the inside curve on the up side. It is suggested that if vegetation was cleared in accordance with the industry standards it was possible to make SLB compliant. He fairly accepted that he could not say if NR were not meeting the required standard for vegetation clearance. He nevertheless questioned if NR were doing all that is reasonably practicable to improve SLB. However, Mr Pead was clear that even if the vegetation could be cut back on 365 days of the year the limitation on the sight line was in consequence of a permanent structure (an embankment) and the curvature of the track. There is nothing before me to suggest that NR are not complying with their responsibilities in respect of vegetation clearance or that SLB would be any different in the absence of any vegetation.

17. Professor Divall referred to early findings of T984[4] that showed that pedestrians using crossings do not behave typically in the way assumed. It was stated that pedestrians decide for themselves when and where to check for trains. The concept of decision points should be replaced with decision paths as the decision to cross is not taken at a specific point.

18. Whilst I note the findings, the decision point is taken as 2 metres from the rail and is identified by the SLL sign. I would acknowledge that those using the crossing will continue to check for trains as they cross. However, the evidence from Mr Pead is that the decision path does not apply at the crossing as the decision to cross is from a position of safety. Any decision taken beyond that point falls within the 'Danger Zone' where crossing users are less likely to step back. It was in his view necessary to apply objective procedures.

Train speeds

19. It is suggested that NRs evidence on warning times relies heavily on theoretical assumptions on matters such as train performance. In respect of the crossing times this is based on the track line speeds set out at paragraph 12 above.

20. In terms of actual train speeds on the down line at the crossing the evidence of NR is that for those trains stopping at Wool Station[5] a speed of 67 mph could be attained by the time the crossing is reached. A speed of 67 mph gives a user a warning time of 7.01 seconds and this is still lower than the required minimum time of 8.07 seconds for a non-vulnerable user. For a vulnerable user the warning time will be 12.11 seconds and again is deficient by 5.1 seconds.

21. For trains which do not stop at Wool Station[6], all of which have to adhere to the Permanent Speed Restriction of 60 mph through the station, a train will have attained the speed of 74 mph by the sighting point, and will still be accelerating, with the capacity to reach a speed of 76 mph by the time the crossing is reached. Based on the speed of 74 mph the sighting time will be 6.35 seconds and is therefore deficient by 1.72 seconds for the non-vulnerable user. In terms of a vulnerable user the deficiency will be 5.76 seconds. Given

[4] Research into the causes of pedestrian accidents at level crossings and potential solutions (Rail Safety and Standards Board (RSSB))
[5] 22 trains each weekday, 22 on Saturday and 15 on Sunday
[6] 7 trains each weekday, 12 on Saturdays and 1 on Sundays

that a train will still be accelerating the sighting time will be reduced further and is estimated to be 6.18 seconds. This is only a very small reduction in the sighting time but in any event is deficient both for the non-vulnerable user and the vulnerable user.

22. Given the above whilst trains on the down line may not be travelling at line speed their speed will still mean that the crossing from B to C is non-compliant for both stopping and non-stopping trains.

23. Professor Divall questioned whether the warning times estimated by NR corresponded to actual warning times at the crossing. His 'rough and ready' lineside observations suggested that warning times from the upside decision point are significantly longer than the theory suggests. His estimate was that no train took less than 9 seconds. Mr Pead acknowledged Professor Divall's estimates but he explained that in assessing the crossing it was necessary to produce an objective repeatable process and the timing was a result of a calculation. He pointed out that even at 9 seconds the crossing remained non-compliant; this will be the case for vulnerable users. In my view some weight should be given to the assessment carried out by NR carried out in accordance with an objective and repeatable process as opposed to a 'rough and ready' calculation.

Passing trains

24. NR contend that passing trains import a further risk and the evidence to the inquiry demonstrated the potential risks arising from such a scenario. Indeed it does not seem to be disputed that passing trains are potentially a hazard. Mrs Thorpe gave evidence of an incident arising from passing trains at the crossing.

25. Whilst passing trains pose a risk to users the evidence as to passing trains at the crossing is limited and it does not appear that NR place any great reliance on this risk. Although it is possible that trains do pass in the vicinity of the crossing NR provide no qualitative or quantitative assessment and it is difficult to put any significant weight on this potential risk. Nevertheless passing trains will pose a risk to crossing users.

Variation in train speeds

26. NR say that a person's judgement of speed is intuitive and often based on their daily experience of road vehicles. It is suggested that this can give a highly inaccurate perception of the speed of an approaching train in an environment where there are not the usual markers. Whilst the evidence indicates that train speeds will vary over the crossing NR do not specifically state whether this has significant implications in respect of the crossing. However, given the variation in train speeds this may have some safety implications.

Whistle Boards

27. As the sighting at the crossing is not sufficient to provide a suitable warning of an approaching train whistle boards are located on the approach to the crossing. In respect of the downside line the whistle board is placed at 400m from the crossing. NR Guidance in respect of the location of whistle boards indicates that the maximum distance for a whistle board to remain effective is 400m(+/-10%). The distance of the whistle board is calculated on the basis of

the speed at which sound travels versus the speed of the train and is not related to the sighting of trains.

28. NR advise that the whistle boards mitigate the risk from deficient sighting. Nevertheless it is said that their effectiveness can be questioned as this is reliant on the driver to sound the horn and the users ability to hear the horn which can be reduced by ambient noise or even a passing train.

29. It is acknowledged that drivers do sometimes fail to sound horns at all or in the correct place[7] accepting that train drivers will be qualified to work on any particular route and should reasonably be expected to apply the horn at appropriate points. In terms of ambient noise, whilst this may present a problem, I have no evidence that this is an occurrence at the crossing although it is not disputed that on occasions the ambient noise may reduce the effectiveness of whistle boards.

30. Bearing in mind the above, whilst the whistle board on the downline mitigates the deficiency in SLB there are some limitations as to its effectiveness.

31. In the Night Time Quiet Period (NTQP) between midnight and 06:00 hours trains do not sound their horns unless they see a person at an unlit crossing. As such there will be no additional protection from whistle boards. I note the comment of NR that the users sighting of a train will be impaired by darkness but trains have high intensity headlights which will identify the presence of an oncoming train. Nevertheless I would acknowledge that whistle boards do not provide the same levels of protection in the NTQP. I note the suggestion that use of the crossing will be lower during the NTQP. However, the risk to the individual using the crossing will remain.

32. In respect of vulnerable users any whistle board would need to be positioned at 484 metres. This is clearly further away from the crossing than guidelines allow and any whistle board at this distance would not provide mitigation.

Vulnerable users

33. It is NRs case that the definition of vulnerable use is not conclusive in respect of the Order as the crossing is non-compliant for non-vulnerable users; it follows that the crossing is also non-compliant for vulnerable users. NR acknowledge that no users of the crossing have been recorded who have difficulty in walking because of stiles which restrict such use; use is also restricted for wheelchair users and those with prams. However, the term vulnerable user is not restricted to those with impaired mobility and may include children or older children in groups, those using headphones and wearing clothing which might obstruct vision (e.g. hoodies). Users may also be those who are 'encumbered' who may be classed as vulnerable because they may be carrying bags or may be walkers with dogs on or off the lead.

34. The Census Good Practice Guide (inquiry document 5) identifies those with vulnerabilities and provides an illustration as to whether the 50% safeguard should be applied. However, the guidance makes it clear that it is for the assessor to decide whether the 50% safeguard should be applied to protect any minority user group or single person. Even where the vulnerable use falls below the majority of users it is open to the assessor to have regard to such use. Professor Divall acknowledged in cross-examination that it was open to

[7] Office of Road and Rail (ORR), Health and Safety Report 2016-17 (July 2017) para 37

Mr Pead to conclude that the majority of use of the crossing is by vulnerable users.

35. NR carried out a census at the crossing (July 2019) when it was observed that the crossing was used by both the young and elderly as individuals or in groups. Such users are categorised as being vulnerable. No evidence is before me that the crossing is used by vulnerable users such as those wearing headphones or hoodies. It is also acknowledged that the 2018 Narrative Risk Assessment (NRA) makes no reference to vulnerable users other than dog walkers and the recent census (July 2019) identifies this use as 54% of total users. A census carried out as part of the 2018 NRA showed that at that time some 40% of dogs were off the lead when using the crossing. Although there are no figures as to the percentage of dogs off leads in the July 2019 census there is nothing before me to suggest that this percentage will have changed. It is more likely than not that the percentage has not changed significantly. Whilst there is no data as to the number of vulnerable users, other than those with dogs, the 54% figure relating to users with dogs clearly shows use by vulnerable users and it is appropriate to apply the 50% safeguard.

36. The table in the Good Practice Guide identifies circumstances where dog walkers are not normally considered vulnerable, namely when they are observed using the crossing correctly and safely whilst keeping dogs on leads and under control. I do not accept that the circumstances where dog walkers are not normally considered vulnerable could only apply when all users are to be observed to be using the crossing in the identified manner. I recognise that a further survey as part of the 2018 NRA showed that dog walkers were using the crossing safely and correctly. Nevertheless the 2018 NRA identifies 40% of dog walkers had dogs off their leads and therefore vulnerable. Applying the guidance it is open to the assessor to apply the 50% safeguard.

37. Bearing in mind the above and noting the crossing times identified at paragraphs 13 and 21 above, notwithstanding the fact that the crossing is non-compliant (SLB) in respect of non-vulnerable users, the crossing is also non-compliant in respect of vulnerable users. Although there is some criticism as to the assessment by NR it was carried out in accordance with the Census Good Practice Guide. Some weight should be given to the conclusions reached in accordance with such guidance.

Pedestrian behaviours

38. In opposition it was contended that whilst there were many patterns of behaviour which can increase the risks to pedestrians NR had failed to show that there was any pattern of deliberate misuse or misjudgements by pedestrians at the crossing. However, whilst NR outline that young people in groups exhibit more risky behaviour this was not a consideration at the crossing at present. The NRA 2018 indicates that those using the crossing did so safely and correctly and that there were no recorded incidents of misuse. Nevertheless NR anticipated that with further residential development in the area such behaviour was likely to increase. There is nothing to indicate that NR have relied on elements of risky behaviour in assessing the safety at the crossing in the 2018 NRA or subsequent assessment (paragraph 47).

Supplementary Aids

39. It is suggested by objectors that the position of the barriers at the Burton Road crossing and a signal on the down line (PW5627) can assist those using the

crossing. It may be the case that some who use the crossing use these two features to assist in determining whether it is safe to cross. However, as Mr Pead stated these features are unreliable and outside any regulatory guidance. Observation of the Burton Road crossing might be hindered by poor visibility. In respect of the signal the use of this may distract the crossing user from observing SLB and it is possible that a train could still be proceeding towards the crossing even if the signal were showing red. The use of this feature also relies on the crossing user understanding the operation of the signal. Professor Divall acknowledged that the signal could not be relied upon but thought that the signal was a useful aid.

Quantitative Risk Assessment - All Level Crossing Risk Model (ALCRM)

40. NR have undertaken a quantitative assessment of risk using ALCRM. The purpose of ALCRM is to provide a consistent method for assessing safety risks to crossing users, train passengers and train staff at level crossings on NR controlled infrastructure. The model has recently been reviewed by RSSB with respect to pedestrian risk and found to be robust. NR recognise that it provides a quantifiable risk score which allows comparison with other crossings and a ranking of risk. Professor Divall acknowledged that ALCRM is a sophisticated and powerful algorithm for modelling the dangers associated with any crossing. He also did not dispute the professional integrity and the expertise of those carrying out the assessments although noted some inconsistencies in the assessments.

41. To calculate risk ALCRM requires specific information about each asset. Information is gathered from existing records, stakeholder engagement and from a site visit. Features observed on site include aspects such as crossing orientation, census, users and the visibility of the crossing when approaching. The outputs of ALCRM enable NR to better identify hazards and risks at each crossing and to enable Level Crossing Managers to better select appropriate risk controls.

42. ALCRM reports two measures of risk. Collective risk is a measure of total harm, or safety loss, and is expressed in terms of Fatalities and Weighted Injuries (FWI) per year. Collective risk is reported in a simplified numeric form (1 to 13) where 1 represents the highest risk and 13 representing nil risk. The score is independent of crossing type. Crossings which are relatively busy with lower degrees of protection will receive the highest rankings. Conversely lightly used crossings with high levels of protection will receive lower rankings.

43. The second measure of risk is to the individual crossing user presented as an individual risk of fatality per year. ALCRM calculates this risk as the 'probability of fatality' and is expressed as a letter (A to M) with A representing the highest risk and M nil risk. Crossings with higher degrees of protection, such as manually controlled barriers will be grouped at the lower end (towards M) with less well protected crossings, such as footpath crossings, around the higher end (towards A).

Qualitative Risk Assessment

44. A qualitative risk assessment is applied by the Level Crossing Manager throughout the risk assessment process. Information to support the judgement is derived from a collation of evidence from a site visit, application

of local knowledge, smart intelligent sources, stakeholder engagement and analysis of previous assessments and accident/incident data.

Narrative Risk Assessment

45. The NRA is the means of presenting the output of routine level crossing risk assessments. The NRA adopts the quantitative risk and the qualitative commentary/observations recorded by the Level Crossing Manager in ALCRM.

46. The most recent NRA is January 2018 which provides a score of C6 (0.000278125 FWI). This is based on use by an average of 9 people a day (July 2018 census), no deficient sighting or vulnerable use and a line speed of 85 mph in both directions. The 2018 NRA ranked the crossing as the 58th riskiest crossing out of 151 on the Wessex route. However, NR recognised that the inadequacies of the 2018 NRA did not reflect the actual risk at the crossing. The NRA did not recognise that the crossing had deficient sighting or that the line speed varied.

47. NR have carried out an over-check risk assessment on the basis of a new census (July 2019) showing an average of 13 users a day, the actual sighting distance (SLB of down line trains being deficient) and a line speed of 80 mph on the down line and 85 mph on the up line. The assessment was based on there being no vulnerable users. The newly calculated score is C6 (0.000483334 FWI). A rating of C6 places the crossing at a medium to high risk. Although this updated rating does not form Part of an NRA it clearly provides an update to the 2018 NRA which, in part, no longer represents all circumstances relevant to the crossing.

48. I acknowledge the criticisms of NR in respect of the assessment of the crossing safety which I have considered above. However, some significant weight should be given to the assessment using a well-developed methodology carried out by those with the professional knowledge to carry out such assessments. Whilst there are some criticisms, there is nothing before me which fundamentally challenges the assessment carried out by NR. It should be noted that the risk score contained in the NRA 2018 has been subject to further scrutiny as a result of the inquiry and the risk score has been updated.

Relative risk

49. Professor Divall contended that the breakdown of the ALCRM score suggests that the risk to an individual falls within a range which the Health and Safety Executive and ORR regard as 'tolerable'. It is asserted that NR have not produced any evidence to show that using the crossing is intolerably dangerous when compared to similar activities allowed by British society.

50. I would acknowledge, as suggested by the OSS, that in everyday life we take risks and in using the crossing there is an element of risk. It may also be the case that the risk in using the crossing falls within what might be seen by some as tolerable within society with regard to certain common forms of transport. However, NR is under a duty (ultimately regulated and enforceable by the ORR and the Secretary of State for Transport) to operate the rail network efficiently and safely in accordance with its licence. Further, the ORR is responsible for the regulation of the railway industry in Great Britain and is the health and safety regulator for the rail industry. The ORR endorses the closure of level crossings where there is a risk to public safety and where there is no other viable option to sufficiently mitigate or reduce that risk. Mr Greenwood

informed the inquiry that whilst NR developed policies and practices the ORR maintained an oversight over NR. ALCRM itself had been developed between the Rail Safety and Standards Board (RSSB), NR and Arthur D Little since the 1990s with further extensive upgrading completed in 2018. The ORR are aware of the application by NR in respect of the crossing and support the proposal.

51. Whilst I note the comparative risks, in respect of the assessment of rail crossing safety, such an approach is at odds with approved and regulated industry practices. Some weight should be given to risk assessments carried out in accordance with objective standards, measurements and assessment tools which have been developed by the industry and are under scrutiny from the ORR. It is not a requirement that any crossing is intolerably dangerous for an Order to be made or confirmed under section 118A of the 1980 Act. The Order has been made because it is expedient in the interests of the safety of members of the public using or likely to use the crossing that the footpath should be stopped up. Circular 1/09 advises that consideration should be given to the risk to the public of continuing use. The safety interests need to be balanced against other factors as set out above.

Conclusions on safety at the crossing

52. Having regard to all of the above and the various submissions the ALCRM score indicates that the crossing poses a medium to high risk to pedestrians. It is of note that SLB is insufficient to provide a safe crossing time between points B and C for non-vulnerable users and vulnerable users. The updated risk score does not take into account the use of the crossing by vulnerable users, in this case dog walkers. If vulnerable users were taken into account then the risk score would increase. On the evidence before I conclude that the crossing poses a risk to the safety of members of the public using it or likely to use it such that the crossing is unsafe.

Whether it is reasonably practicable to make the crossing safe for use by the public

53. NR's overall funding is authorised for 5 year periods (Control Period – CP). For the current CP (2019 to 2024 CP6) NR has been authorised £34 billion from its regulator the ORR granted pursuant to a robust business plan. NR as a Government funded organisation is required to adhere to guidance in the Government Handbook 'Managing Public Money'. NR would need to justify any additional expenditure where other safer and more cost effective alternatives exist. In terms of the crossing it is likely that the ORR would refuse to allocate additional funding to provide an alternative to the crossing. If any alternative solution for the crossing were to be achievable then this would be at the expense of other committed projects. On the Wessex route there are currently a number of funded crossings to be provided with engineering solutions such as bridges and MSLs. These are crossings within the top 10% highest risk crossings with significant irremovable safety features where no viable alternatives have been identified.

Footbridge

54. A ramped footbridge would cost in the region of £2.5 million although a stepped bridge would cost less at £1.2 million. However, there is insufficient room to provide a ramped or stepped footbridge due to there being insufficient land within the operational corridor and the close proximity of neighbouring

residential properties. NR outlined the engineering difficulties in the construction of a bridge including the need for reinforced foundations due to the area being susceptible to flooding; the underground conditions were largely unknown and could result in delays and additional costs. There are also accessibility issues for crane access and the need for a compound. It was also unknown as to whether planning permission would be granted.

55. It is suggested in opposition that the Order should not be confirmed and that, in the light of the proposed development of the area, funding could be provided by a developer through a section 106 agreement[8]. However, although the adjacent area is likely to be developed there can be no certainty as to the funding of a bridge at its existing location, or at a point further west suggested by Mr Hook, through any Section 106 agreement or from any other funding source. Further, there is no evidence that the local planning authority would seek the construction of a bridge funded by a developer or that a developer would be prepared to fund such a project. In any event there are other constraints which would need to be overcome as outlined at paragraph 54 above as well as the implications for funding other projects in CP6.

56. Looking at the evidence as a whole, notwithstanding the potential costs, whilst a bridge would remove the risk at the crossing, it is not reasonably practicable to construct a footbridge.

Miniature Stop Lights (MSLs)

57. MSLs could be provided at the crossing at a cost in the region of £170,000 (NRA 2018) (although evidence from Mr Greenwood is that such a system would cost £250,000). However, such systems only mitigate a proportion of risk. The ALCRM rating being reduced from C6 to D6 with a reduction in the FWI from 4.83334E-04 to 1.85801E-04. Such a system still relies on pedestrians observing lights and signage. NR advise that there is still a high rate of fatalities occurring at crossings with MSLs. In terms of the cost benefit analysis carried out by NR, taking into account the costs (£170,000) and the fact that MSLs do not fully control the risk, this option has been rejected.

58. It is noted that MSLs have been installed at Bailey's Drove and a number of individuals suggested that such a system should be installed at Darkies. However, in respect of Bailey's Drove MSLs have been installed on the basis that the cost of a footbridge could not be justified and that there was insufficient land for its construction. Additionally after public consultation NR concluded that closure of the crossing could not be achieved due to the absence of a suitable alternative route. I also note that the Bailey's Drove crossing is comparatively well used when compared with Darkies. Furthermore, in respect of Darkies there are alternative routes which could be used.

59. Whilst MSLs at the crossing are possible, given the cost of their implementation and the level of risk reduction, I do not consider their provision to be reasonably practicable.

Whistle Boards

60. As noted above, whistle boards are in situ and provide some mitigation in respect of using the crossing from B to C. However, in respect of vulnerable

[8] Section 106 of the Town and Country Planning Act 1990

users the positioning of a whistle board at 484 metres would be outside the guideline limits for effectiveness and therefore would not provide adequate mitigation.

Tunnel

61. NR advise that it would not be possible to construct a pedestrian tunnel under the railway line due to the need to construct ramps down to a lower level. There is also insufficient land within the operational railway to construct an underpass. The area surrounding the crossing is on a flood plain and is not ideal for building on. Any tunnel is likely to be subject to flooding. The estimated cost is between £4M and £6M. Given the practical difficulties and the estimated costs it is not reasonably practicable to make the crossing safe through the provision of a tunnel.

Supplementary Audible Warning Devices (SAWD)

62. SAWD is a radar based solution which detects an approaching train and then activates an audible warning system at the crossing. The system does not rely on integration with the existing signalling system. However, the system has limitations and the radar equipment is fallible. SAWD is only therefore approved as a secondary support to whistle boards and viewed as a temporary measure which is still under consideration and development. However, given that the whistle boards are non-compliant for vulnerable users and SAWD is a supplementary device this system is considered unfeasible.

Physical improvements at the crossing

63. The RA make the point that the stiles adjacent to the railway crossing are not compliant with the British Standard BS5709. Whilst this is likely to be the case the stile is said to be compliant with NR standards. Nevertheless the stiles are set back from the decision point and whilst some may find difficulty in using them they will not have any bearing on the crossing of the railway lines.

64. Reference is also made to a step onto the crossing which constitutes a trip hazard. Evidence of Mr Pead is that slips and trips are a recurrent theme reported as a cause of users being struck by trains. He acknowledged that the removal of the step would make a small change to the safety of the crossing. However, there is nothing before me to suggest that there would be any significant change to the crossing risk if the step were to be removed.

Restrictions relating to dogs

65. The RA, recognising that the Order route is used by dog walkers, suggest that an inexpensive measure to improve safety at the crossing would be to make an Order, either under section 27 of the Road Traffic Act 1988 or by way of a Public Space Protection Order under the Anti-social Behaviour, Crime and Policing Act 2014, requiring dogs to be kept on the lead. The OSS thought that a bylaw could be made to keep dogs on a lead and that this would enhance safety. However, walkers with dogs on leads will remain vulnerable users and the crossing is non-compliant for such users. Furthermore this will not remediate the vulnerability of other vulnerable users or indeed walkers. The crossing remains non-compliant.

66. It is noted that NR have erected notices at the crossing advising that dogs should be kept on leads. Whilst this may improve safety, noting that not all

users comply with signage, I revert to my previous comments which are equally applicable.

Conclusions on making the crossing safe

67. Bearing in mind the above I do not consider that any of the potential mitigation measures are reasonably practicable to make the crossing safe. I note the suggestion of Professor Divall that the ORR and NR expect new, and possibly lower cost, mitigations to be introduced in the near future. Mr Pead advised that whilst there are new technologies which are anticipated NR had considered all reasonable options currently available. In the absence of those new technologies and costs I am unable to give this suggestion any weight.

Whether it is expedient to confirm the Order having regard to all the circumstances

68. Before confirming the Order I must be satisfied that it is expedient to do so having regard to all the circumstances. Whilst the primary focus is the safety of the public it is clear that other factors can be taken into consideration. These other factors need to be put in the balance when considering whether it is expedient to confirm the Order.

Safety of alternative routes

69. Concerns are raised as to the safety of the East Burton Road and Burton Road which would need to be used as alternative routes in the event footpath 14 is closed. In respect of East Burton Road this has a 30 mph speed limit and is essentially a residential road although semi-rural in character. A narrow footway runs along the road for part of the length. The road appears to be lightly trafficked although the RA indicate that the road is used by motorists seeking to avoid waiting whilst the level crossing on the A352 at Wool is closed. Mr Hook also pointed out that with a shift change at the Police Headquarters at 7.00 in the mornings, access to the Technology Centre at 8.00 and the school run at the same time there was an increase in traffic in the area at these times.

70. Noting the above Mr Hajnus outlined that NR had had extensive consultations with the relevant highway authority, Dorset Council, who have raised no concerns as to the safety of East Burton Road. Neither has the Highway Authority seen it necessary to consider any additional safety measures on the road. It is accepted that Dorset Council now take a neutral stance in respect of the Order; that being due to a balance between the safety of the crossing and the safety of the alternative route which members felt difficult to determine. Nevertheless Dorset Council raise no concerns that use of the road by pedestrians is unsafe and they do not oppose confirmation of the Order. There is no evidence before me, even taking into consideration certain busy times and the use of the road when the crossing at Wool is closed, that East Burton Road is unsafe for pedestrians. Closure of the footpath will not result in any significant increase in pedestrian traffic and it should be noted that users of footpath 14 may well at present use part of East Burton Road as part of a circular walk.

71. The OSS provided information from 'Crashmap' which records 5 accidents on East Burton Road in a twenty year period, one of those being to the west of Burton Road. One incident involved a slight injury to a pedestrian who was in the carriageway but not crossing; this was at a location where there is a footway. In the absence of more details it is difficult to reach any conclusions

in respect of the incident. Nevertheless the 'Crashmap' figures do not suggest that East Burton Road is subject to a high level of incidents.

72. In respect of Burton Road, this has a 30 mph speed limit for much of its length with a short section at the southern end being 60 mph. There are very short sections of footway and the road is similar in character to East Burton Road although sections are too narrow to enable two vehicles to pass. Census data for the Burton Road level crossing indicates that the road is used by some 675 vehicles, 54 pedestrians and 54 cyclists in a 24 hour period. However, this is an extrapolated figure using a standard multiplier of 27 based on a 30 minute count. Nevertheless the count does not suggest that the road is heavily used by vehicles and no evidence has been put before me of any accidents taking place on this road. I revert to my comments at paragraph 70 which are equally relevant here. I note Mr Holmes and his wife found the road hazardous when the level crossing gates created a surge in traffic flow but there is no evidence that the road is unsafe for use by pedestrians.

73. The OSS referred to the Memorandum of Understanding[9] (MoU) and stated that in future a full road safety audit will usually be undertaken. The MoU states that where the public are displaced onto the local highway network then the alternative routes should be assessed by a full road safety audit. However, the MoU was not in place when the Order was made. In any event NR has undertaken consultation with the highway authority and there is nothing to indicate that the alternative routes are unsafe such that it is not expedient for the Order to be confirmed.

Effect on the rights of way network

74. Although it is contended that some members of the public use footpath 14 to gain access to the facilities in Wool neither the OSS or the RA suggest that any facilities or destination point would require walking a greater distance. Mr Hajnus provided a comprehensive assessment of the accessibility of amenities and facilities in Wool. The closure of footpath 14 would not result in any additional inconvenience in accessing amenities and facilities. It is accepted that there might be some amenity value in being able to use footpath 14 to gain access to Wool but this must be seen in the context that the footpath is unsurfaced and prone to becoming wet and muddy. In contrast the alternative routes are surfaced.

75. In terms of other amenity attractions in the area, and in particular those to the north of East Burton Road, I acknowledge that footpath 14 could be used to access these attractions. However, the closure of footpath 14 will not increase the walking distance to these attractions, albeit other routes will have to be used. There is nothing to indicate that there will be any significant loss of convenience when accessing these attractions.

76. The OSS contend that most of the users of footpath 14 are local, or very local leisure walkers, usually with dogs. The evidence from the crossing census suggests that 54% of users are dog walkers. The OSS assert that footpath 14 forms an essential part of the rights of way network and the closure will seriously inconvenience such users.

[9] Public Rights of Way, Level Crossings on the Rail Network, Memorandum of Understanding between Network Rail, ADEPT, LGA & IPROW

77. I would accept that footpath 14 forms a short circular walk although in the context of such a walk it will be necessary to use East Burton Road and possibly Burton Road. A number of individuals gave evidence to the inquiry to this effect. It is also noted that the footpath forms part of a through route to the north along an unclassified road (D53110).

78. NR contended that the comparative amenity value/enjoyment of the circular walk was doubtful and must be viewed in the context of the existence of other nearby circular walks, the existence of other pleasant walking routes and the existence of large open spaces accessible on foot or by a short car journey.

79. I acknowledge that there are other potential circular walks in walking distance of footpath 14, some of these, for example the permissive path across The Moors, are already well used which suggests that they are suitable for leisure walking with or without dogs. However, the use of these routes will mean that any replacement circular walk is likely to be longer. It is accepted that use of these routes are for leisure including dog walking and that in many cases the additional distance will not amount to any inconvenience. However, there is some merit in footpath 14 providing a short circular walk for some path users.

80. It is also acknowledged that there are areas of open space which are accessible by a short car journey. However, access to these areas relies on the availability of suitable vehicular transport and these areas are not immediately accessible to those who use footpath 14 for leisure walks. As such this amounts to some inconvenience.

81. Footpath 14 also links directly with the D53110 which can be used to access the permissive path to Wool Bridge, Water Meadow Lane and Footpath 17. If the Order were to be confirmed then direct access over East Burton Road to the D53110 would not be possible. Nevertheless access would still be possible from East Burton Road and access to the permissive path, Water Meadow Lane and footpath 17 will not be prevented.

82. I note concerns of the OSS that the permissive path could be withdrawn at any moment. Whilst this might be the case there is no indication that such permission will be withdrawn. It is therefore appropriate to consider the permissive route in relation to alternative routes. It may also be the case that the permissive footpath becomes impassable due to flooding; Mr Hook said that the path was often flooded in winter. However, whilst at times the path may become inaccessible, there is nothing to suggest that other routes are not available or that the permissive path is inaccessible outside the winter months. It is noted that footpath 14 is also prone to flooding particularly towards the railway line at point C.

83. In relation to the amenity value of the path, whilst at present the section of footpath 14 C to D passes through an open field the adjoining land is essentially a built environment. Although there is some amenity value to the path any loss should be seen in this context. Additionally the land is identified in the Local Plan for development albeit partly as recreational space. Consequently the amenity of the area will be changed considerably when the land is developed.

84. The OSS states that dog walkers will be further inconvenienced as, along the alternative roads, walkers will not be able to let their dogs off the leads. Others mentioned the fact that their dogs were able to be let off the lead when

using footpath 14 and one individual mentioned using the land over which the footpath passes for dog training. However, whilst dogs are a usual accompaniment on a public right of way, this does not mean that dogs are free to roam over the land; use is effectively confined to the right of way[10]. Additionally when livestock are present it is an offence to allow dogs to be at large which is defined as not on a lead or under close control; it is known that livestock is on occasions kept in the field crossed by footpath 14 C to D. Whilst dogs may need to be kept on a lead when using the vehicular highway as part of any alternative route any loss of convenience for dog walkers should be seen in the above context. I do not consider any loss to be significant.

85. In respect of tourism and access to the coast, footpath 14 is at a significant distance from the coast and there is no evidence that the footpath provides a coastal link. I would acknowledge that it is possible to use footpath 14 as part of a route to the coast but its closure would not prevent such access. There is also no evidence that footpath 14 is promoted as a link to the coast, that with expanding tourism the route will be promoted as such or that closure of the footpath will have an adverse effect on promoting tourism.

Operational efficiency/Statutory duties

86. NR is a regulated statutory undertaker bound by a statutory framework including the Railways Act 1993 (as amended)(the 1993 Act). The 1993 Act established the Rail Regulator under the Strategic Rail Authority (now the ORR). NR has a legally prescribed duty and responsibility to promote safety, improve railway efficiency and to enhance and improve the network in operational terms. NR is required to comply with the licence issued under Section 8 of the 1993 Act which is enforceable by the ORR by way of enforcement orders.

87. NR also have legal duties and responsibilities in terms of public safety and level crossings (section 117 of the 1993 Act) and the Health and Safety at Work Act 1974 (the 1974 Act). Under the 1974 Act NR is responsible for the health and safety and welfare of persons from risks to health and safety in connection with its undertaking. This responsibility extends to those using level crossings in addition to those who may misuse those crossings or trespass onto the line. Section 55 of the British Transport Commission Act 1949 provides for prosecutions in respect of trespass on the line.

88. I was referred to the case of *The Ramblers Association v Secretary of State for Environment Food and Rural Affairs [2017] EWHC 716 (Admin)* where Dove J found a clear public interest in excluding trespassers from the railway line who may not only come to harm themselves but also give rise to health and safety risks to those working on the railway. Bearing this in mind the requirement, under the terms of a licence, to provide for public safety is also in the interest of the public.

89. It is acknowledged that there have been no known fatalities at the crossing and the NRA 2018 records that no safety events had been known to occur in the previous 12 months. However, the crossing is non-compliant in respect of SLB for both non-vulnerable and vulnerable users and is ranked as high to medium risk. Ongoing use of the crossing, the potential for a change in the user profile from adjacent residential development, the increased scope for misuse,

[10] Although footpath 14 has no defined width it is likely that rights extend beyond the worn surface of the path

trespass and accidental human error raises the possibility that continued use of the crossing will fail to promote operational efficiency and safety. Should an incident occur at the crossing then any temporary speed restrictions or line closure would result in delays to train services and the potential for timetable disruption. Mr Greenwood explained that where a train runs late due to incident or temporary speed restriction it can cause a knock-on effect across the network. Each delayed train can further compound the situation causing delays across the network. The closure of the crossing would reduce the risk of any incident or need for a temporary speed restriction thereby reducing any potential impacts on the rail network and any compensation to the train operating companies.

90. Mr Greenwood said that any compensation (Schedule 8 payments) needs to be paid out of the 5 year allocation meaning there will be less money for other schemes including mitigation. I note the observations of Professor Divall in respect of Schedule 8 payments and it may be the case that the recipient of the payment might spend the money on other safety related improvements. However, Mr Greenwood was clear that in respect of Schedule 8 payments there was a net loss to NR which detracted from other schemes and meant that there was less money for mitigation.

91. In addition to compensation to train operating companies any unnecessary disruption to train services could amount to a breach of the operating licence with the potential for enforcement orders from the ORR. This again would have adverse impacts on NR. In the event of an accident at the crossing there would also be the potential for prosecutions/penalties under the 1974 Act.

92. Bearing in mind the above, whilst the crossing remains open there is the potential that an incident might occur which impacts on the operational efficiency of the line and result in additional costs for NR. NR also may be subject to enforcement action from the ORR. The closure of the crossing will reduce the potential for such impacts and therefore is a factor which needs to be put into the balance of expediency.

93. NR make the point that level crossings are a long term restriction to promote the effective and efficient use and development of train capacity on the network by restricting line speed enhancements and the number of trains which can run. This, it is stated, is contrary to NRs objectives under its operating licence and restricts wider government policy to improve the rail network.

94. In terms of proposed enhancement of the network Mr Pead explained that there was currently a bid to increase the number of services on Sundays with an aspiration to increase services on a Saturday as well; there was also a possibility of additional freight trains. Professor Divall contended that NRs strategic plan showed no improvements in services are likely before 2043.

95. Whilst level crossings have the potential to inhibit improvements to services it seems unlikely that any proposed increase in services will be hampered to any significant level by the existence of the crossing. As Mr Pead pointed out, whilst in some instances requests to increase services cannot be accommodated, in respect of the increased services on the Wessex line these could be slotted into the timetable. Further, whilst I note NRs objectives and wider government policy I have no evidence to indicate any future proposals which might be hindered by the crossing. Nevertheless the crossing will have

the potential to inhibit improvements and although I give this element very little weight in terms of the expediency test it is a matter which should be put in the overall balance.

Noise Amenity

96. NR contend that the whistle board sounding is an arguable harm caused to the residential amenity of many. Mr Greenwood stated that the noise generated when horns are sounded had lifestyle and health implications for residents in the proximity of whistle boards and this had been identified in reports by the RSSB. It was the source of numerous complaints.

97. Mr Payne supported the closure of the crossing as this would remove the need for horns to be sounded by passing trains. In his view the horns regularly disturbed East Burton residents early morning and late at night; he was certainly disturbed by the noise. Mrs Thorpe said that the sounding of horns was intrusive and had become the source of broken sleep since the shortening of the NTQP. Inquiry document 4, correspondence from a local resident, also refers to the noise pollution generated by the blowing of horns and that their children had been woken by some of the louder horns. Another local resident, Mr Munro, also expressed concerns as to the impact of the horns on his enjoyment of his property.

98. Although few residents gave evidence to the inquiry as to the disruption caused by the sounding of horns in response to the whistle boards it is clear that residents suffer a degree of disturbance which has an adverse effect on the amenity of their property and lifestyle. The closure of the crossing will remove the need to sound horns and will therefore be of benefit to residents living in East Burton.

Retention of crossing

99. Professor Divall suggested that the annual costs of maintaining the crossing as is might be a reasonable sum to pay to retain the crossing. I note Professor Divall's submissions on the annual costs and Mr Greenwood acknowledged that costs in the region of £2000 were not high. However, to leave the crossing open would not mitigate against the risk of using the crossing. The closure of the crossing is not without cost but removes the risk to the public altogether.

Alternative proposals

100. NR have considered four options for a new path from the crossing to Bailey's Drove level crossing. However, NR have been unable to secure agreement with the affected landowners and there is insufficient land within the operational corridor to accommodate a link between the crossing and Bailey's Drove. In the circumstances such a diversion is not a viable option.

101. The OSS, whilst totally opposed to any extinguishment, asked that if it is considered that the level crossing should be closed then the section C to D should be retained. Whilst it is open to me to modify the Order accordingly the Circular cautions against the creation of a cul-de-sac. A cul-de-sac may well encourage trespass onto the closed crossing, and other land, and there is no place of popular resort in this instance that the public might wish to visit. Although the retention of the footpath will allow continued enjoyment of the footpath C to D and the surrounding land I do not think that the advantages outweigh the disadvantages.

102. It was also suggested by the OSS that if the crossing is closed then a diversion of the path from point C to Giddy Green Lane would be valuable in avoiding this section becoming a cul-de-sac. However, there is nothing before me to indicate that such a proposal could be taken forward and is therefore not a matter which I can take into consideration.

103. The RA contend that the footpath could be retained and taken into account when the land over which the footpath passes is developed. There is no certainty as to whether any developer would be prepared to make provision for the existing route, or any alternative route, in any development. As such I do not consider this to be a viable option. In any event, as accepted by the RA, this course of action is unsatisfactory as any safety risk would remain.

Health benefits/alternative transport

104. The RA, and others, argue that there is a need for a path network which encourages walking and connects communities. It is also suggested that walking should be encouraged so as to promote sustainable transport and reduce carbon emissions. I would acknowledge that there are health benefits in walking and that the Government is encouraging more sustainable forms of transport which will include walking. Whilst there will be a net loss to the network if the Order is confirmed there will remain opportunities to walk and the extinguishment of footpath 14 will not prevent access to local amenities on foot or render such access less convenient.

Heritage value

105. It is stated that public rights of way are part of our heritage and many are centuries old, the crossing has a history which deserves to be acknowledged. Whilst I note the observation there is nothing before me to indicate that the footpath is of historic origins such that this should add weight against confirmation of the Order. The crossing was established, in consequence of the construction of the railway line, as an occupation road. I do however note the name 'Darkies' Crossing/Lane/Corner refers to the name of a dray horse which hauled ale to the Seven Stars public house.

Future development of Wool

106. It is the secondary case of NR that if it is considered that the expediency test in respect of public safety terms is not made out then the overall case for expediency is well demonstrated when taking into account the increased public safety risk from the increased use of the crossing in consequence of a large housing development adjacent to the crossing.

107. The Purbeck Local Plan is currently under review and requires formal adoption; formal adoption is not expected before early 2020. However, there are no proposed modifications to policy H5 which provides for an allocation of up to 470 houses and a 65 bed care home in the vicinity of the crossing. The areas immediately adjacent to the railway line have been identified for housing and public open space. No planning applications have yet been submitted in respect of the land parcels making up the Wool H5 housing allocation although an EIA[11] Screening Option Request has been submitted to Dorset Council.

[11] Environmental Impact Assessment

108. Whilst I note the observations that development is unlikely for many years, given the inclusion in the Local Plan as an area for development it is more likely than not that development will take place in the near future. Such development may not be imminent but it is appropriate to consider the future development of the area in terms of expediency.

109. In the event of development taking place there is likely to be a marked increase in the use of the crossing. It is also likely that the user profile will change, particularly bearing in mind the potential increase in family homes in the area. There will be a consequential increase in the potential for use by vulnerable users, particularly children and younger users and a likely increase in use by dog walkers. Although I recognise that NR have made assumptions as to the change of use the risk has been calculated by NR as increasing from the current risk level of C6 (4.83E-04) (C5 (5.25E-04) (based on the census data of July 2019) to C4 (0.00297) which equates to a five fold increase on the original risk. Professor Divall acknowledged that in the event of the area being developed mitigation would be required as the crossing would be unsafe and the ALCRM score would increase.

110. I recognise that with development of the area footpath 14 could play a more important part in the rights of way network but, noting my comments in respect of the provision of a bridge, it cannot be assumed that external resources will be made available to upgrade or replace the crossing. It may also be the case that any development may increase traffic along East Burton Road and Burton Road. However, if any safety implications arise from any proposed development then measures will need to be taken to remedy the situation. I note the observation that the closure of the crossing will facilitate the development but given the Local Plan it is likely that development will take place regardless of whether or not the crossing is closed. Nevertheless as noted above any development is likely to increase the risk at the crossing.

Arrangements for ensuring that, if the Order is confirmed, any appropriate barriers and signs are erected and maintained

111. Should the Order be confirmed NR will extend the existing boundary to fully close out the crossing with palisade fencing at point B with the existing post and wire fence at point C being extended. A 'No Trespass' sign will be erected at point B and all existing signage will be removed. Upon carrying out the above works NR will remove all crossing furniture, including decking and anti-trespass boards. NR will also, subject to any direction from Dorset Council, display all appropriate signs. Accordingly the necessary arrangements have been made.

Conclusions on main issues

112. The crossing has been assessed as being high to medium risk and some considerable weight should be given to the safety of those who use or are likely to use the crossing. NR clearly has an obligation towards the safety of the public and those who work on the railway. NR have considered a number of options to make the crossing safe but none of these are reasonably practicable. Other options have been put before me but none of these will make the crossing safe or are reasonably practicable. If the Order is confirmed NR will maintain and erect suitable barriers and signs.

113. I recognise that the closure of the crossing will have an adverse effect on the rights of way network. However, the closure of the crossing will not prevent anyone from accessing the wider rights of way network or any local facilities or amenities in the area. The closure of the crossing will mean the removal of the need for trains to sound their horns when approaching the crossing. This will be of benefit to local residents who are disturbed by the noise of the horns. There will be some benefits in respect of operational efficiency.

114. Whilst other factors, as considered above, can be taken into account in determining the Order the primary considerations are those specified in section 118A of the 1980 Act set out above at paragraph 8 above. Taking all matters into consideration, although very finely balanced, I conclude that it is expedient to confirm the Order. In reaching this decision I have not had regard to the implications arising from the development of land in the vicinity of the crossing (NRs secondary case). If I were to have regard to these element then this would add further weight to the confirmation of the Order.

Other Matters

115. Concerns were raised in respect of the maintenance of ditches alongside the section of Footpath 14 A to B and the registration of the land. Representations were made in relation to the design and visual issues in respect of the footbridge near to the Ship Inn and the design of the Bailey's Drove crossing. Opposition was also raised to the development of the land over which footpath 14 passes. Whilst I note these concerns they are not matters for my consideration. The relevant issues are set out at paragraph 8 above.

116. The RA questioned why, if the crossing was deemed to be unsafe, had there not been a temporary traffic regulation order imposed on the crossing. This would appear to have been an option. However, NR explained that the temporary closure of the crossing would have hindered consultation with the local community and NR noted that there was some discernible local sentiment against closure.

117. Representations have been made in respect of comments made by the Council relating to improvements in accessibility. Whilst I note these concerns they do not have any bearing on my decision.

Conclusions

118. Having regard to these and all other matters raised at the inquiry and in the written representations I conclude that the Order should be confirmed subject to modifications.

Formal Decision

119. I confirm the Order subject to the following modifications.

- At paragraph 7 of the Order after the words '**THIS ORDER EXTINGUISHES**' insert the words '*the full width of*'.
- At Part 1 of the Schedule to the Order at line 1 delete '*From*' and insert '*The full width of the footpath from*'.

Martin Elliott

Inspector

APPEARANCES

For Dorset Council

Mr P Crowther	Solicitor

For Network Rail (The applicant)

Mr J Lopez	Of Counsel
who called	
Mr J Greenwood	
Mr S Pead	
Mr D Hajnus	

Also in support of the Order:

Mr P Payne
Ms S Thorpe
Mr V Osmond

In opposition to the Order:

Mr A Wickett	
Mrs V Palmer	
Mr D Blackmore	Statutory objector
Mr B Shepard	
Mrs D Parry	
Mr R Caudell	
Mr S Hook	
Professor C Divall	
Dr J Davis	Ramblers' Association
Mr R Holmes	Open Spaces Society

Inquiry Documents

1 Correspondence from Wool Parish Council to Planning Inspectorate (2 October 2019)
2 Correspondence from Open Spaces Society to Planning Inspectorate (10 October 2019)
3 Correspondence from Ramblers, Dorset Area Footpath Secretary (4 October 2019)
4 Email to Planning Inspectorate (8 October 2019) (redacted)
5 Census Good Practice, National Level Crossing Team July 2017 (NR1)
6 Rail Accident Report - Fatal accident at Grimston Lane footpath 23 February 2016, Report 23/2016, November 2016 (NR2)
7 Location Plan (NR3)
8 Wool Amenity Plan (NR4)
9 Photograph of Darkies Crossing (NR5)
10 Correspondence from East Burton resident to Dorset County

Council 2018 (redacted) (28 November 2018) (NR6)
11 Rail Accident Report – Fatal accident at Tibberton No. 8 footpath crossing 6 February 2019, Report 13/2019, October 2019
12 Email correspondence between Savills and Dorset Council regarding Purbeck Local Plan (15 October 2019) (NR7)
13 Statement of Mr A Wickett (16 October 2019)
14 Correspondence from Ms S Thorpe to Dorset County Council (1 December 2018)
15 Statement of Mr D Blackmore
16 Correspondence from Prof. Divall to Planning Inspectorate (3 October 2019)
17 Statement of Mr P Payne
18 Statement of Mr B Shepard
19 Statement of Mr R Caudell
20 Statement of Mrs D Parry
21 Statement of Ms S Thorpe
22 Extract of RSSB T984, Factors associated with crossing users (NR9)
23 Note of Network Rail on census dates (NR10)
24 Note of Network Rail on S118A(4)(b) 'Arrangements' (NR11)
25 Summary of Consultation Responses
26 Extract of RSSB T984 table of critical errors/violations and influencing factors against user type (NR12)
27 Correspondence of Dr R S Farr to Planning Inspectorate (9 October 2019)
28 Extracts from Crashmap (traffic accidents along East Burton Road)
29 Note of Network Rail on distances to local dog walking/recreation areas (NR13)
30 Plan of local dog walking/recreation area (NR14
31 Note of Network Rail on train speeds approaching Darkies crossing on the down line (NR15)
31 Note of Network Rail on whistle boards at Darkies crossing on the down line (NR16)
32 Purbeck Local Plan Review, extract from Dorset Council website (NR17)
33 Schedule of main modifications to Purbeck Local Plan 2 August 2019 (NR18)
34 Dorset Council Response to: Actions arising August 2019 hearings held as part of the Examination of the Purbeck Local Plan (2 October 2019) (NR19)
35 Note of Network Rail on census results at East Burton Level Crossing (NR20)
36 RSSB Operations and Management Research into the causes of pedestrian accidents at level crossings and potential solutions Appendices – Revision 1 (CD1)
37 Note by Prof. Divall on timetabled passing trains (CD2)
38 Correspondence from Open Spaces Society to Dorset Highways (April 27 2018)
39 ORR's Annual Health and Safety Report of Performance on Britain's Railways: 2015-16, July 2016 (CD3)
40 Plan of permissive path towards Police HQ at Winfrith (Ramblers 1)
41 Additional Statement of Mr R Caudell

42 Statement of Mr V Osmond
43 Closing Statement of Prof. Divall
44 Closing Statement of the Ramblers
45 Closing Statement of the Open Spaces Society
46 Closing Submissions on behalf of Network Rail including *The Ramblers Association v Secretary of State for Environment Food and Rural Affairs [2017] EWHC 716 (Admin)*

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RSSB | A Better, Safer Railway

Leading Health and Safety on Britain's Railway

A strategy for working together Issue 3: April 2020



Foreword

Passenger journeys on Britain's rail network have doubled over the last 20 years. While that rise has been interrupted by the outbreak of COVID-19, a worldwide pandemic, the opportunity remains in the future to demonstrate how vital the railway is to the nation as we continue to transport vital workers and distribute essential freight.
The challenge that this brings is made more acute by the current restrictions on daily life, as well as by our usual challenges: complex timetables and limited maintenance windows, compounded by limited resources and public pressure to deliver. To overcome these challenges, and maintain our value to the nation, our industry must work collaboratively.

Britain's railway is one of the safest in the world and has continued to improve over the past 10 years. This bears testament to the great efforts made across the industry—2018/19 saw the fewest ever fatalities at level crossings and a significant fall in public fatalities, from 42 in 2017/18 to 25.

However, in some risk areas performance has deteriorated. Thirteen passengers died in 2018/19 compared to six the previous year. Seven of the 13 were fatalities at the platform-train interface. Of the public fatalities, 22 of the 25 were a result of trespassing. These remain areas of concern in which individual organisations need to collaborate to improve their, and the industry's, maturity and performance in health and safety management.

Two railway workers were killed in 2018/19 and two more in 2019/20. So, there is still much work to do in the area of workforce safety. The number of signals passed at danger without authority has also increased, with the number of incidents ranked 'potentially severe' rising from 10 to 16, and the overall severity of events rising by some 30 percentage points in the year to September 2018 against the 2006 baseline.

The rail industry has a long history of reporting and sharing information about safety events and has benefitted from the risk and evidence-based approach to safety management that this enables. There is now a need now to take a similar approach focusing on the management of health.

Resources like the Safety Risk Model, which provides an objective understanding of residual safety risk across the network, help to set strategic priorities and make sure resources are focused on the right things. System-wide safety monitoring draws attention to potential issues and provides assurance that improvement initiatives are working. This includes measures like the Precursor Indicator Model (PIM), which tracks the underlying risk from train accidents. Some of these measures—including the PIM—show that the rate of safety improvement has started to slow and, in some cases, gone into reverse in recent years. This strengthens the case for re focusing collaborative effort on those areas.

When Leading Health and Safety on Britain's Railway (LHSBR) was first produced, in 2016, it identified 12 specific risk areas. These were areas where collaboration between duty holders, and others, would be essential to deliver continued improvements in our health and safety management maturity and performance. That challenge remains. Organisations from across the industry, suppliers and buyers, must work together to design out hazards in the planning stages of all projects, from component design to infrastructure

maintenance and rebuild. Each risk group needs to create and implement its own plans to address the strategic risk areas that it can control. Working together to meet challenges not only improves health and safety, but also enhances the industry's reputation as a trusted, respected, and essential service provider to the nation.

Leadership is at the heart of all this and is vital to develop the capabilities needed to meet the challenges outlined herein. Employees at all levels need to be empowered to collaborate and deliver results more effectively and efficiently.
The purpose of this strategy is to encourage leaders to make a commitment to collaborate and align their organisations' business plans to support achieving the vision in LHSBR. As leaders and suppliers of the rail industry, we're committed to improve health and safety performance.

We know there are challenges ahead-with more change coming to our climate and demands on the system. Yet while there are increasing expectations to demonstrate value for money, our awareness of the importance of the health and wellbeing of rail colleagues must grow.

> I welcome this strategy and the industry doing what it does best: coming together to innovate and improve, and drive health and safety management and risk control, particularly in these challenging times.

Steve Murphy MD MTREL and Chair of SSRG

Lastly, for rail to be the mode of choice for passengers and an efficient way of moving freight, industry needs to have a common focus on collaboration. It is a key enabler for rail to have an essential positive impact on the environment and for the industry to thrive. However, although collaboration is vital, the underpinning requirements for collaboration must be explicit, the commitments articulated clearly, and benefits expressed in measurable terms.

With this in mind I welcome the endorsement of leading members of our industry and their commitment to collaboration, and providing leadership that will make its vision a reality.



Mark Phillips,
Chief Executive Officer



“

As Chair of the System Safety Risk Group (SSRG), I am privileged to see the hugely impressive work carried out by teams of volunteers from right across the wider industry, to lead groups focused on the key industry risks with the sole objective of making our railway healthier and safer for everyone.

However, we need to remain attentive to the risks, especially those that are increasing, and ensure we continue to tackle them diligently, and contribute to the railway’s performance and long-term achievements.

I want to see new dedicated, full time teams in place to support all the excellent volunteers in the risk management groups and working groups across the railway. This will ensure their excellent work can move at the pace the industry needs, allowing us to keep up with the evolving, changing nature of our key risks.

Steve Murphy, MD MTREL and Chair of SSRG

I am looking to industry to go further in its understanding and management of health and safety, by understanding the risk, committing to probing investigations of health and safety incidents, and adopting and applying RM3 within businesses and the supply chain.

ORR's challenge to duty holders aligns well with this Strategy: to support our people, manage increasing pressure on the system, and harness the opportunities of new technology and its safe design, change management and introduction.

Ian Prosser, Chief Inspector of Railways and Director, Railway Safety, ORR

Every one of us who work in Britain's rail industry should be rightly proud of our safety record. This is in part because we are free to collaborate effectively despite the complexity of our structure and its commercial and competitive pressures.

By working together we can marshal data, research and expertise to understand the changes in the profile of the risk we're facing. This means tackling risks to health such as fatigue, physical and mental health as much as traditional safety risks on the operational railway.

This refreshed strategy highlights areas where we can get the industry to make a significant step forward in both health and safety management, and it's a step we are actively choosing to take together.

John Halsall, Managing Director Southern Region and chair of HWPG

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Achieving results by working together

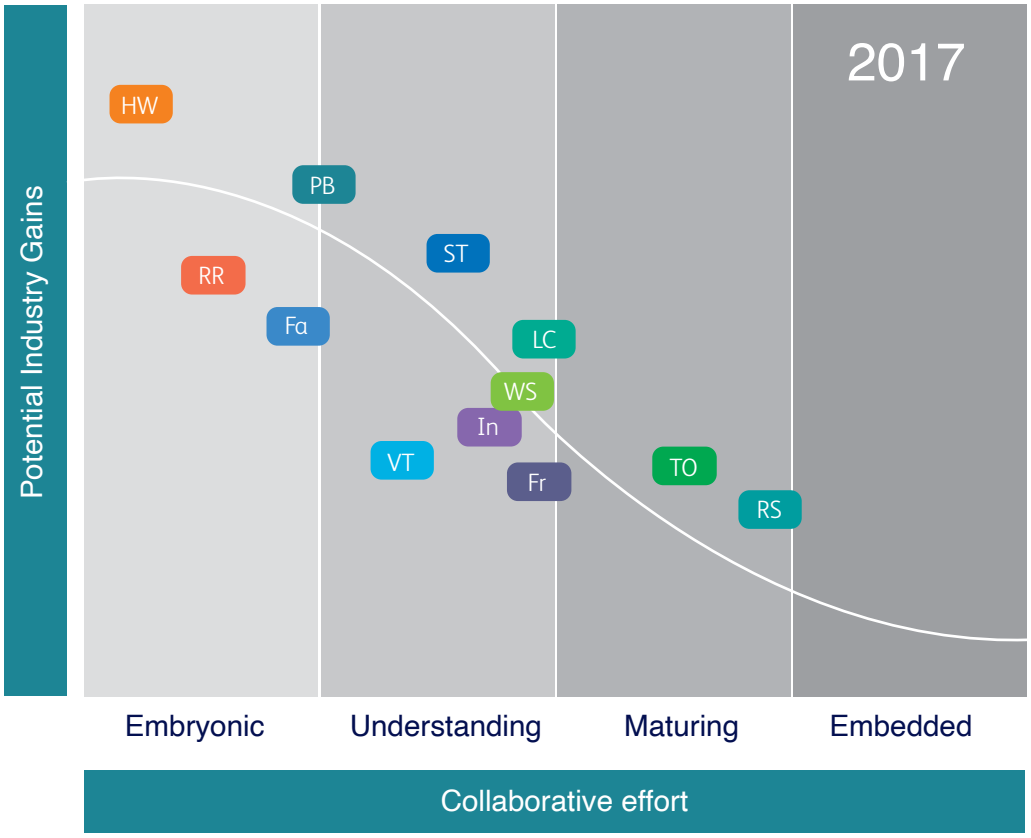
Leading Health and Safety on Britain's Railway (LHSBR) is about cross-industry collaboration. It is about how working better together can deliver continual improvement in health and safety risk management and achieve the vision set out in this strategy. When LHSBR was first issued in 2016 it focused on leadership and how health and safety issues were managed at the time. Having consulted the industry during 2019, this issue includes a succinct industry vision for each strategic risk area. It sets out the current state, and the challenges that must be addressed to achieve that vision.

RSSB has delivered this third issue of Leading Health and Safety on Britain's Railway to give a high-level view of the next steps the industry can take to make progress. Not necessarily to achieve the ultimate objective, but to take significant steps towards medium-term, measurable and achievable goals. Significant steps that will increase the maturity of how both health and safety cultures are embedded, how decisions are taken, and how safety management systems operate. The recording, analysis and use of health data lag behind that of safety data. The current pandemic, and its effects on both physical and mental health, reinforce the need for this to be addressed urgently.

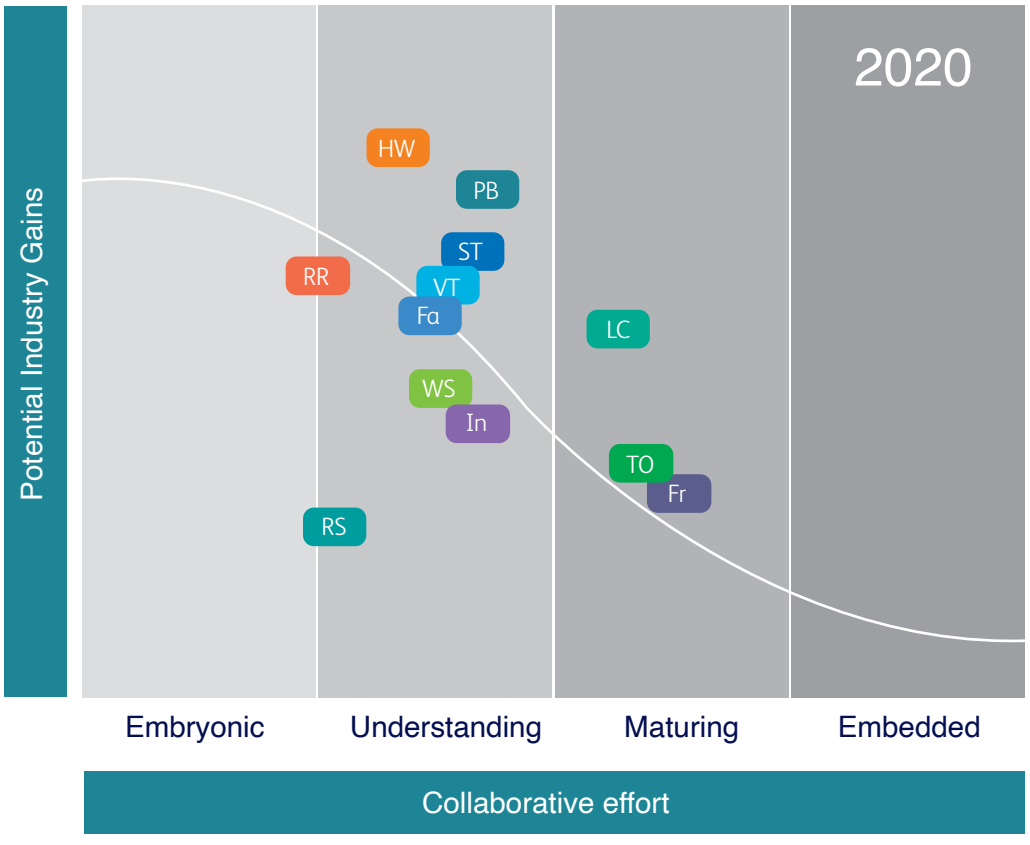
Collaboration is essential to reap the greatest benefit from this strategy. For example, while road risk may seem to be an area on its own, it is not. There are crossovers with the workforce health and wellbeing, fatigue, workforce safety, and freight areas. The industry has established national, sector and regional arrangements as part of a collaboration framework to facilitate the understanding and improvement of health and safety risk across the 12 risk and 5 capability areas identified in this strategy. At the national level there are a number of industry risk groups established to support collaboration. Details of the collaboration arrangements and the governance of this structure are detailed in the LHSBR Implementation Document.

The maturity of collaboration varies across the 12 risk areas. Figures 1 and 2 demonstrate the perceived maturity in 2017 and an update for 2020, against the potential industry gains in performance through collaboration. This assessment takes a system-wide view of maturity and, as such does not consider local variations in the extent of collaborative working. In some of the less mature areas the focus is still on establishing an improved understanding of the risk.

1: Maturity of collaboration and potential gains



2: Maturity of collaboration and potential gains



HW
Health and Wellbeing

PB
Public Behaviour

ST
Station Operations

RR
Occupational Road Risk Management

LC
Level Crossings

Fa
Fatigue Risk Management

WS
Workforce Safety

In
Infrastructure asset integrity

VT
Work-related violence and trauma

TO
Train Operations

Fr
Freight Derailment

RS
Rolling stock asset integrity

This updated strategy:

- identifies specific areas where cross-industry collaboration and action will deliver improved health and safety performance benefits
- provides a clear vision to improve health and safety in these risk areas
- sets out strategic activities to reduce harm and improve performance in each identified risk area
- provides a common view of priorities for improving capability in the industry
- gives guidance on where to find out more and how to get involved.

The strategy is primarily aimed at leaders and senior managers of railway duty holders, safety professionals, and those who participate in the collaborative group framework. Leaders and senior managers from all organisations in GB Rail should:

- understand, endorse, champion and communicate the strategy within their companies and the wider industry
- use the strategy to inform business, joint and sector-level strategic plans
- actively support the establishment of cross-industry arrangements to facilitate delivery of the strategy
- empower their teams to engage with and support cross-industry collaboration arrangements to address risk and improvement opportunities
- explain the purpose of the strategy to their teams, and how their work impacts on it.

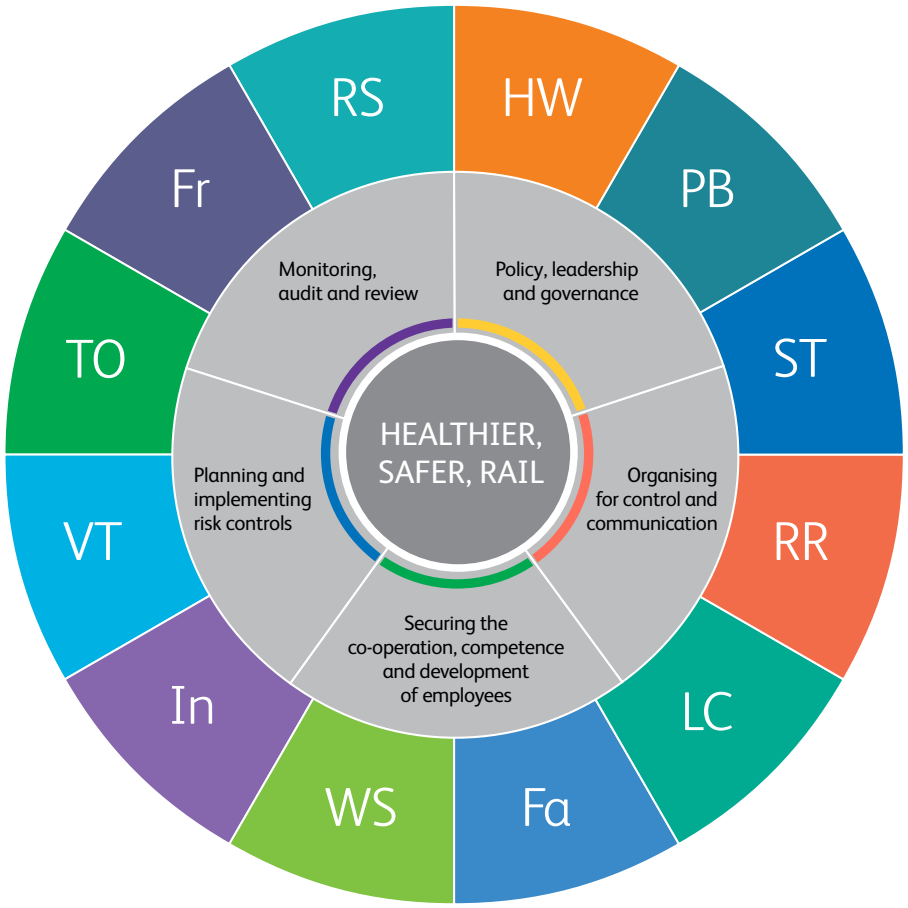


Our priority risk areas

LHSBR sets out 12 priority risk areas to manage, and 5 capability areas for development. The industry has agreed that each will deliver a railway that is healthier and safer, and provides a best-in-class service to customers.

Some of the priority areas cover risk that is wholly generated by rail activity and is the responsibility of the relevant rail duty holder(s). Others cover risk that is subject to societal or individual behaviours (for example, at level crossings). While we cannot control all risks, we can try to influence and manage them.

The 12 priority risk areas are:



HW	Health and Wellbeing
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RS	Rolling stock asset integrity

1 Health and Wellbeing

Vision

The railway will become an industry in which 'everybody takes responsibility for Health and Wellbeing and benefits from it'.

Where are we now?

In the three years since the LHSBR health and wellbeing section was published, the rail industry has seen these developments:

- RSSB has established an operating model and centre of excellence to deliver a roadmap of industry agreed H&W projects.
- Awareness of the social and financial impacts of wellbeing has been raised using conferences, policy and good practice information, and a cost-benefit tool.
- Support has been provided to manage health and wellbeing risks, including creation of a Health by Design knowledge hub, research into the effects of work-related violence and trauma, and risk assessments of work associated with ballast dust.
- A greater focus has been placed on the understanding and management of mental health. Research has provided an evidence base for mental health training for line managers, guidance is available for managing those affected by trauma, and the 'Time to Change' campaign has started to change attitudes towards mental health.

To achieve the vision, industry now needs to focus effort on these strategic challenges:

Strategic Challenge 1: There is inconsistent health and wellbeing engagement from railway leadership which impacts the industry's ability to implement the H&W roadmap at pace.

Strategic Activity: Provide a forum to support industry to come together to share good practice.

Strategic Activity: Industry leaders shall introduce sustainable health and wellbeing initiatives, frameworks, guidance and tools to their companies and to their supply chain.

Measures of success: Rail industry companies can demonstrate sharing of practices and embedding findings from initiatives.

Strategic Challenge 2: H&W initiatives are not consistently aligned to business needs or seamlessly integrated into the company activities.

Strategic Activity: Identify the business case criteria needed by industry leaders to make greater investment in workforce health and wellbeing.

Measures of success: Industry-wide investment in health and wellbeing management increases, and individual company management maturity levels rise.

Strategic Challenge 3: The rail industry lacks an occupational health (OH) capability that is fit for the future.

Strategic Activity: Re-design the industry's OH assurance Framework so that it delivers better assurance of employee health for rail companies.



Measures of success: The OH assurance Framework is enhanced and embedded within operators' and their OH providers' practices.

Strategic Challenge 4: We do not fully understand the occupational hygiene risk within the rail industry, which is particularly problematic considering increasingly stringent legal exposure requirements.

Strategic Activity: Collaborate to provide a clearer picture of the industry's occupational hygiene risk profile and develop strategies to tackle the key risks.

Measures of success: A clear industry profile of occupational hygiene risk is developed, and companies put management systems in place to manage the key risks.

Strategic Challenge 5: Companies do not have good quality data, or consistent evidence-based, approaches to support employee mental wellbeing.

Strategic Activity: Collect data on the prevalence of mental health conditions to inform company strategies and prioritise resources.

Strategic Activity: Provide and help embed consistent, evidence-based approaches to support the mental health priorities of industry.

Measures of success: Good quality data on mental wellbeing is available, interventions are evaluated, and good practice is embedded.

Strategic Challenge 6: Unhealthy railway environments and practices make it difficult for individuals to make healthy lifestyle choices.

Strategic Activity: Introduce a health behaviour change programme to support individuals to make healthier choices.

Strategic Activity: Communicate health behaviour change techniques to support organisations to create healthier environments for employees.

Measures of success: Companies sign up to a healthy lifestyle programme.

Strategic Challenge 7: MSDs are one of the biggest contributors to absence in the rail industry.

Strategic Activity: Design out musculoskeletal disorder (MSD) hazards in the workplace.

Strategic Activity: Develop understanding of the links between mental health and MSDs and consider the levers to reduce the incidence of these within rail.

Measures of success: Reduce work related MSD absence within rail companies.

Where to get support

To find out more about the HWPG and get involved: **https://www.rssb.co.uk/Insights-and-News/Industry-Topics/Health-and-Wellbeing/Rail-industry-collaboration-on-health-and-wellbeing**

2 Public Behaviour

Vision

To achieve a continuous, sustainable reduction in suicide and trespass incidents on Britain's railway.

Where are we now?

In the three years since the LHSBR public behaviour section was published, the rail industry has seen the introduction of the following improvements in suicide and trespass risk management:

Suicide

- Relationships with partners such as Samaritans have matured
- Training of staff in managing suicidal contacts has resulted in an increase in staff interventions
- Launch of Small Talk Saves Lives and Brew Monday campaigns to promote interventions in suicide attempts by the public
- Launch of a rail suicide prevention website
- Innovative academic research extending our understanding of suicide and the societal complexity of suicides
- Consolidation of the process to address suicide clusters
- Introduction of resources to support suicide prevention and trauma management

Trespass

- Over four million children reached through the online learning platform Learn Live
- You Vs Train Campaign, community outreach partnerships with the English Football league and Street Games
- Formation of the Trespass Risk Group and the Trespass Improvement Programme
- Launch of the industry trespass website to facilitate the sharing of good practice
- The industry Trespass risk conference has been established

To achieve the vision, industry will now need to focus effort on addressing the following strategic challenges:

Suicide

Strategic Challenge 1: Suicide is a societal problem that cannot be fully addressed by any one organisation within or outside the rail industry.

Strategic Activity: Collaboration between railway and non-railway organisations to harmonise prevention activities and develop common suicide prevention plans.

Strategic Activity: Identify locations that are particularly vulnerable to suicide and implement targeted actions to mitigate against those risks.

Measures of success: Duty holders' prevention plans are shared, that identify and include local third parties, and coherent plans are developed at a Network Rail route level.



Strategic Challenge 2: Suicide can happen anywhere on the network and few people who take their lives are known to us.

Strategic Activity: Increase the capability of front line staff and members of the public to recognise people in crisis and intervene across the network.

Strategic Activity: Progress methodologies that allow a picture of real time pre-suicidal activity on the rail network to be assessed.

Measures of success: Increasing numbers of employees trained in intervention techniques and using data captured through analysis of pre-suicidal data to influence prevention activities.

Strategic Challenge 3: Lack of awareness of support communities and the mechanisms that can help those in crisis.

Strategic Activity: Building on the success of previous campaigns such as Small Talk Saves Lives, the industry will come together to promote messages that address mental health and suicide and encourage help-seeking behaviour, among men in particular.

Measures of success: Successful campaign penetration within the key populations.

Strategic Challenge 4: Trauma after witnessing or being involved in a suicide event can be long lasting and debilitating.

Strategic Activity: Actively promote support to help individuals become psychologically resilient to these events before they occur, awareness of support mechanisms for those affected, and consideration of the impact of such events on customers is necessary.[1]

Measures of success: Front line staff awareness and take up of support increases.

Strategic Challenge 5: Approaches to reducing the appeal of the railway as a means of suicide are not fully understood.

Strategic Activity: Identify ways to reduce the appeal of the railway as a means of suicide.

Measures of success: Greater understanding of the appeal of the railway as a means of suicide allows more targeted mitigation measures to be devised and implemented at high-incidence and high-likelihood locations.

Strategic Challenge 6: Achieve a better understanding of the factors that drive individuals to take their lives on the rail network.

Strategic Activity: Undertake research that allows the profiles of those taking their lives on the rail network to be established.

Measures of success: A greater understanding of the characteristics that lead individuals to take their lives on the railway and consider how the findings may influence prevention activities.

Strategic Challenge 7: The funding structure for suicide prevention activities impacts delivery.

Strategic Activity: If suicide numbers are to reduce further on the network it is imperative that appropriate funding mechanisms are put in place to allow this to be achieved.

Measures of success: Adequate funding is agreed to support the implementation of the action plan.

[1] The Work-Related Violence and Trauma Chapter identifies key strategic activities for managing the impact of traumatic events.



Trespass

Strategic Challenge 1: There is no single, easily accessible source of trespass data, which makes it difficult to predict where trespass is most likely.

Strategic Activity: There is a need to draw together various trespass data sources into one easily accessible location, to support informed decision making around measures and action plans to mitigate trespass risks.

Measures of success: Trespass data recording is standardised and is recorded in one database that is easily accessible to those who need it. Training materials, standards and guidance are updated based on this improved understanding.

Strategic Challenge 2: Public awareness raising of the dangers of trespassing has, to date, mainly targeted youth trespassers who account for 20% of the events.

Strategic Activity: Increase awareness of the dangers of trespass to the general public, ensuring the widest possible reach through thematic campaigns to alter attitudes and behaviours, with a particular focus on hotspots.

Measures of success: Innovative methods of engaging with the general public are identified and messages are focused at and communicated to the relevant target audiences leading to behavioural and attitudinal change.

Strategic Challenge 3: There is lack of consistency in the approaches used to understand, mitigate, and respond to trespass.

Strategic Activity: Enhanced risk assessment and data analysis processes and tools to improve decision making and support the creation of more informed interventions around trespass.

Strategic Activity: Having implemented trespass mitigations, continually assess their effectiveness; and review risk assessment after later trespass events.

Measures of success: Trespass interventions are identified and prioritised using a common framework.

Strategic Challenge 4: There has been little or no major investment in innovation or technology to manage the challenge of trespass over recent years.

Strategic Activity: New technologies and processes should be investigated to predict, prevent, or deter trespass.

Measures of success: New technologies and processes that predict, prevent, or deter trespass are implemented, that do not add risk to the live operational environment.



Strategic Challenge 5: There is inconsistent co-ordination between industry and stakeholders in response to the challenges posed by trespass.

Strategic Activity: Co-operation and alignment between the rail industry and external stakeholders are increased to maximise the impact of responses to the national challenges presented by trespass.

Measures of success: A culture of co-operation is created, which has the buy-in and sustained engagement of industry and external stakeholders at all levels.

Strategic Challenge 6: Trespass is a problem that can occur anywhere on the network, or in sidings and depots.

Strategic Activity: Increase the capability of front line staff to recognise the potential for trespass and engage them in preventing trespass, including by changing societal attitudes.

Measures of success: Increase in reporting of trespass, fewer trespass related deaths, injuries and delay minutes.

Where to get support

Suicide

The industry has a number of approaches to address suicides on the network. More information can be found here:

https://railsuicideprevention.co.uk/

https://www.rssb.co.uk/Standards-and-Safety/Improving-Safety-Health--Wellbeing/Enhancing-Safety-Health--Wellbeing-Through-Collaboration/Suicide-Prevention

For advice on rail related suicide issues contact the rail industry's national suicide prevention team at **suicideprevention@raildeliverygroup.com**.

Trespass

The Trespass Risk Group monitors the effectiveness of control arrangements. It identifies and sponsors improvement opportunities, including research and relevant products and services. It learns from and promotes good practice and facilitates cooperation.

The Trespass Improvement Programme has been formed with input from BTP, ORR and other industry bodies. It provides a framework, guidance and best practice to address trespass sites, and publicity to change public behaviour.

The industry trespass website shares good practice, case studies and resources aimed at preventing trespass. It hosts resources such as the 'You vs Train' Campaign.



https://www.rssb.co.uk/Standards-and-Safety/Improving-Safety-Health--Wellbeing/Enhancing-Safety-Health--Wellbeing-Through-Collaboration/Trespass

3 Station Operations

Vision

Our focus will be on the customer's end to end journey, where collaboration increases efficiency and safe movement and reduces harm at stations, and on platforms and trains.

Where are we now?

In the three years since the LHSBR station operations section was published, the rail industry has seen these developments:

- Research projects developing guidance and solutions on train doors, dispatch, crowding, step/gaps, platform markings, and staff behaviours. Innovation in areas such as customer communication, unsafe behaviour detection in dispatch and kneeling trains.
- Enhancements to existing rail industry standards in train dispatch, platform safety, On-Train Camera Monitors for Driver Controlled Operation, and design and maintenance of station platforms.
- Implementation of tools and new approaches to understanding station operations risk. This includes the RSSB PTI Risk Assessment Tool; and the use of bowties to understand slip, trips, and falls in stations, as well as passenger risk at the platform edge.
- Safety by Design principles used on Mersey Rail and developments in simulated modelling to inform platform and station design. For example, the Siemens Sheffield Advanced Multi-model Simulator (S2AM) and the Ratesetter modelling.
- Professionalism of station management using VR (LNER and Transport for Wales) and game-based approaches (Aston University, Chiltern Railways & RSSB) to training.

To achieve the vision, industry now needs to focus effort on addressing these strategic challenges:

Strategic Challenge 1: Non-technical skills are not integrated into training for all staff who can positively influence passenger behaviour and improve operational safety performance.

Strategic Activity: Enhance the non-technical skills and knowledge of employees (on and off the train) to reduce harm and improve safe performance at stations and on platforms.

Measures of success: Duty holders demonstrate training provided to employees (on and off the train) has an increased focus on passenger and staff interactions, and use of NTS.

Strategic Challenge 2: There is an overreliance on using posters for safety messaging and less consistency in approaches to communication.

Strategic Activity: Enhance customer communications, especially safety messaging, by increasing the consistency and range of communication methods used.

Measures of success: Industry implements consistent approaches to safety messaging, using different communication methods which have a proven impact on behavioural change.



Strategic Challenge 3: Change that affects station operations is not always managed in a collaborative manner.

Strategic Activity: Improve collaboration between DFT, Network Rail, rolling stock operating companies, duty holders, train manufacturers, and other transport authorities when station operation changes are proposed.

Measures of success: Increased use of the RSSB Taking Safe Decisions model to facilitate collaboration.

Strategic Challenge 4: Only 7% of platforms conform with the platform position set out in RIS-7016-INS.[2]

Strategic Activity: Develop and implement a programme of work to reduce the size of steps and gaps across the network, which encompasses the step and gap between the train and the platform, train bodyside gaps, and intervehicle gaps.

Measures of success: DfT, Network Rail, rolling stock operating companies, duty holders, train manufacturers, and other transport authorities develop and implement a programme of work.

Strategic Challenge 5: Industry is not fully using and realising the benefits technology can bring to station operations.

Strategic Activity: Introduce new technology to improve safety and customer service in station operations.

Measures of success: Duty holders can demonstrate an increased uptake of new technology to improve safety and customer service in station operations.

Where to get support

There are many groups that support improvements to station operations. Industry is particularly encouraged to work with, or join, these groups:

- People on Trains and Stations Risk Group (PTSRG): aims to create and facilitate implementation of an industry delivery plan to achieve the station operations strategic activities: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/PTSRG**
- RDG Passenger Operations Safety Group (POSG): aims to brings all TOCs together to improve safety across the industry. This includes station operations: **https://www.raildeliverygroup.com/**
- Platform-Train Interface Working Group (PTIWG): supports the PTSRG-developed delivery plan. It focusses on existing and emerging risk at the platform-train interface and ways to reduce this risk: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/PTSRG/PTI-WG**
- PTI Good Practice Group (PTIGPG): supports the PTSRG-developed delivery plan by sharing good practice to reduce risk at the PTI, on the platform, and in the station.

[2] Rail Industry Standard (RIS-7016-INS) *Interface between station platforms, track, trains and buffer stops*

4 Occupational Road Risk

Vision

The industry working together to reduce work related road risk exposure to the workforce, passengers and the public

Where are we now?

In the three years since the LHSBR road risk section was published, the rail industry has seen the introduction of these improvements in occupational road risk management (ORRM):

- The formation of the RSSB Road Risk Group (RRG) with representatives from each of the sector/ region groups, with additional representation from: ORR, Highways England, RoSPA, TfL, HS2 and Trade Unions
- A collaborative partnership between RSSB and Highways England that has delivered a 'Driving for Better Business' (DfBB) programme developed specifically for the rail industry and supply chain
- The introduction of the RSSB rail industry road risk resource centre promoting:
  - The 10 steps to effective road risk collaboration
  - The introduction of three monthly RSSB road risk safety performance reports
  - Access to the DfBB programme, with tools, guidance and case studies to help rail companies effectively manage occupational road risk

To achieve the vision industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: There is not a consistent understanding of the benefits from effective occupational road risk management

Strategic Activity: Introduce a common approach to managing road risk by delivering the Driving for Better Business programme across the rail industry and supply chain.

Measures of success: The rail industry and supply chain adopt the '*Driving for Better Business*' programme.

Strategic Challenge 2: There is a lack of consistency in how rail companies assure that the supply chain is able to demonstrate legal compliance in occupational road risk management.

Strategic Activity: Development and introduction of a National Supply Chain Road Risk Accreditation scheme for the procurement of transport services.

Measures of success: Industry adoption of the scheme.

Strategic Challenge 3: The road risk safety performance data is unreliable and cannot be used to fully inform business and collaborative management decisions.

Strategic Activity: To increase the quality and completeness of reporting road traffic accident (RTA) event data into SMIS.

Strategic Activity: Research and develop processes for capturing key telematic data; to inform journey management, vehicle selection, driver behaviour, and sustainability improvement decisions.

Management



Measures of success: Increase in RTA event data reported into SMIS, Close-Call & CIRAS, and closed out by an appropriate investigation.

Strategic Challenge 4: There are currently no consistent or robust collaboration arrangements that enable sector and regional collaboration groups to share and promote road risk good practices with their rail company members.

Strategic Activity: Introduce a national network of rail company road risk champions, to work in conjunction with Highways England's DfBB representatives to support the implementation of the DfBB programme.

Strategic Activity: Introduction of sector and region collaboration arrangements to deliver LHSBR road risk collaboration improvement initiatives.

Measures of success: Rail company business plans identify resources to implement LHSBR road risk collaboration improvement initiatives.

Strategic Challenge 5: There are no existing tools to assist rail companies and collaboration groups to measure increased effectiveness in occupational road risk management.

Strategic Activity: Introduction of an approach to measure rail company compliance with legal requirements.

Strategic Activity: Introduction of an approach to assess increased effectiveness of occupational road risk management.

Measures of success: Published rail industry ORRM maturity evaluation.

Where to get support

- The Road Risk Group (RRG) is a cross-industry collaboration group with representatives from each industry sector. The RRG group monitors road risk safety performance, highlights emerging issues and, with support from RSSB, sponsors LHSBR road risk collaboration improvement programmes: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/RRG**
- RSSB rail industry road risk resource centre provides information on how to get involved with road risk collaboration, and access to RSSB road risk safety performance reports and the DfBB 7 steps to excellence: **https://www.rssb.co.uk/Standards-and-Safety/Improving-Safety-Health--Wellbeing/Enhancing-Safety-Health--Wellbeing-Through-Collaboration/Rail-Industry-Road-Risk-Resource-Centre**
- Highways England's Driving for Better Business website provides a range of work related road risk tools, guidance and case studies, including an 'occupational road risk management assessment process': **https://www.drivingforbetterbusiness.com**
- Royal Society for the Prevention of Accidents (RoSPA) provides a range of guidance and tools specifically designed to help rail companies with the 'management of occupational road risk': **https://www.rospa.com/Occupational-Safety/Our-Projects/MoRR**

5 Level Crossings

Vision

The industry working together to continually improve level crossing risk management.

Where are we now?

Level crossings are sited where roads and paths cross the railway. So, the potential for collisions between users and trains is ever present. While Network Rail leads on level crossing management for the railway, there is a large community of public highway owners and users that has an influence on level crossing risk. Over recent years significant effort has been put into reducing the risk arising from level crossing use, and we have one of the best safety records in Europe. This has included closures, upgrades, implementation of new technologies such as automated full barrier crossings, improvements to the risk assessment process and educational campaigns like *Stay Safe with Thomas*.

Network Rail is committed to making the railway a safer place and has developed its own long-term strategy '*Enhancing Level Crossing Safety 2019 -2029*'. The principles set out in the strategy reflect a vision of continuous improvement and ultimately zero harm from level crossings by removal, enhancement, education, and enforcement.

Level crossing incorrect use is addressed through education and enforcement. BTP leads enforcement and there is a need for Network Rail and BTP to continue to work together to deploy resources in the most cost-effective way.

To achieve the vision industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: There are around 6000 level crossings on GB railways and no two are the same. Each needs a unique risk assessment to inform decisions around its management.

Strategic Activity: Improve the quality of risk assessments undertaken by level crossing managers.

Strategic Activity: Improve the number and quality of reports of near miss and close call incidents at level crossings.

Measure of success: Provision of improved evidence in decision making in the deployment of risk reduction measures.

Strategic Challenge 2: Closing and upgrading level crossings has the most impact on the underlying risk however there are many obstacles in achieving this.

Strategic Activity: Improve stakeholder management to make better and more informed cases for crossing closures.

Strategic Activity: Research and develop emerging technologies that will lead to cost effective level crossing upgrades.

Measure of success: Level crossing closures and approval of new level crossing technologies.

Strategic Challenge 3: Many level crossing users are unaware of the risks associated with level crossings and how to use them properly.

Strategic Activity: Collaborate to deliver consistent messages to the public in relation to level crossings and related topics such as trespass and security.



Strategic Activity: Design and implement educational material that targets 'last mile' delivery drivers.

Measure of success: Reduction in public behaviour related incidents around level crossings.

Strategic Challenge 4: Incorrect use of level crossings is a significant risk contributor; so, enforcement and publicity of enforcement action can act as a deterrent.

Strategic Activity: Improve provision of information to BTP to enable more targeted enforcement.

Strategic Activity: Publicise successful prosecutions.

Measure of success: Increased enforcement, prosecutions and a reduction in incorrect use by road vehicles.

Where to get support

- The Level Crossing Strategy Group oversees the delivery of this chapter of the strategy and is a cross-industry group dedicated to discussing the topic.
- The RSSB Level Crossing Digest (available to members only), provides a history of level crossings and uses rail accidents to explain developments in level crossing safety: **https://www.sparkrail.org/Lists/Records_StaffMembers/DispForm.aspx?ID=950**
- Network Rail provides information relating to its management of level crossings here: **https://www.networkrail.co.uk/running-the-railway/looking-after-the-railway/level-crossings/**



6 Fatigue Risk Management

Vision

Work practices that manage fatigue and reduce the associated health and safety risk are embedded in the industry. All aspects of work, including travel, are designed so that fatigue risk is minimised, and everyone understands their role in managing fatigue.

Where are we now?

In the three years since the LHSBR fatigue chapter was published, the rail industry has seen these improvements:

- Sector-based (passenger, freight and infrastructure) fatigue working groups have been formed to develop and share good practices in fatigue risk management, coordinated and supported by an industry Champion and Sponsor.
- The Freight Fatigue Code of Practice has been published.
- Network Rail has established a Fatigue Reduction Programme.
- The Rail Industry Fatigue Survey results have been published, giving a snapshot of staff perceptions and experiences of fatigue and fatigue risk management.
- The Fatigue and Alertness topic area on **rssb.co.uk** has been launched as a one-stop shop for resources on fatigue risk management and to share good practices.

This has built understanding and put in place a framework which will enable the industry's approach to fatigue to mature in the coming years.

To fully achieve its vision, the industry will now need to focus effort on addressing the following strategic challenges:

Strategic Challenge 1: The industry is progressing its use of high-level principles (fatigue factors) and tools to risk assess rosters for fatigue. But there is still considerable reliance on the out-dated 'Hidden' requirements to manage fatigue. New good practices are often not applied to actual working patterns, overtime and on-call work.

Strategic Activity: Duty holders, contractors, trades unions and researchers will collaborate to enable companies to develop work patterns that minimise fatigue risk and give appropriate consideration to needs such as sleep and rest.

Strategic Activity: Duty holders will, in contracting and planning processes, adopt good practice principles for the design of working patterns. These will include the consideration of fatigue risk from work-related road driving, overtime and 'on-call' arrangements.

Strategic Activity: Work specifications and local 'terms and conditions' will be reviewed with the objective of aligning them with fatigue risk management good practice principles.

Measure of success: Fatigue risk management is integrated into contracting, planning, scheduling and real time operations. Base and actual working patterns are developed to minimise fatigue and meet needs for sleep and rest.



Strategic Challenge 2: Working hours aren't always accurately recorded, particularly for those who work across multiple companies or industries. As a result, it is difficult to assess and control fatigue risk associated with excessive working hours.

Strategic Activity: The industry will develop mechanisms to reliably review and, where it affects fatigue, control actual hours worked. It will take reasonably practicable steps to understand and consider the work that staff may carry out for other organisations and in other industries.

Strategic Activity: Cross-industry collaboration will reduce, and where possible remove, practices that incentivise or tolerate excessive working hours.

Measure of success: The industry has confidence in the accuracy of its data on working hours. Organisations have plans to control the risk indicated by data; an educated workforce participates to control working hours.

Strategic Challenge 3: Fatigue and sleep are not always fully integrated into fitness for duty checks or declarations. Reporting systems are under-used and principles for responding to fatigue reports are not established.

Strategic Activity: The industry will collaborate to develop common guidance for considering fatigue within processes to assess and declare fitness for duty at the beginning of, and during, each duty period (including travel). Organisations will use this guidance to develop easy, accessible, and fair processes.

Measure of success: Staff who are educated and trained in fatigue management proactively report fatigue concerns within a transparent and fair culture. They are supported by their organisation and its senior management to consider fatigue in fitness for duty decisions. Actual reports of fatigue increase to align more closely with the findings of industry surveys.

Strategic Challenge 4: Information on fatigue is available to staff but it is under-used.

Strategic Activity: The industry will share good practice and agree the best approaches to training and development on fatigue.

Strategic Activity: Duty holders will deliver training and education that supports employees to fulfil their personal responsibility to manage fatigue. Tailored training will be developed and delivered to those who have responsibilities under a fatigue risk management system, notably rostering personnel.

Measure of success: Employees have received the training and education they need to understand fatigue risks and to support them to fulfil their responsibilities under a fatigue risk management system. They participate to manage fatigue risk because they believe it is the right thing to do and are fully supported by their organisation.

Strategic Challenge 5: Fatigue-related data has quality problems and does not give a clear indication of the health of a Fatigue Risk Management System. There is no cross-industry agreement on what data should be collected and shared, or how.

Strategic Activity: The industry will collaborate to develop and share good practices on gathering and using data from day-to-day activities—such as sleep disorders, the role of fatigue in incidents; and from fatigue reports.



Strategic Activity: The industry will explore technologies that aid fatigue data collection and collaborate to develop appropriate leading and lagging indicators of fatigue risk at company and industry levels.

Strategic Activity: Duty holders will develop and implement fatigue risk management systems. These will be underpinned by fatigue risk management plans which promote continuous improvement.

Measure of success: Organisations in the rail industry gather reliable data from their operations. They use this to measure their fatigue risk management maturity and improve risk controls. A core set of leading and lagging indicators is shared at an industry forum and used to define collaborative activities.

Where to get support

- Health and Wellbeing Policy Group oversees the delivery of this chapter of the strategy: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Health-and-Wellbeing/HWPG**
- The industry's Fatigue Champion co-ordinates the activities of the Train Operating Companies Fatigue Working Group, the ISLG Fatigue Working Group and the NFSG Fatigue Subgroup: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/ISLG**

  https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/NFSG
- RSSB Fatigue and alertness webpages bring together a wide range of guidance and tools on managing fatigue. The resources are displayed by role, covering those that are relevant to all staff, those for planners and rostering staff, supervisors and line managers, incident investigators, and those who are setting up and running Fatigue Risk Management Systems: **https://www.rssb.co.uk/Insights-and-News/Industry-Topics/Fatigue--Alertness**
- You can find the ORR guidance on managing fatigue, including the legal requirements, on its Working patterns-fatigue webpage: **https://orr.gov.uk/rail/health-and-safety/health-and-safety-strategy/working-patterns-fatigue**



7 Workforce Safety

Vision

To achieve full collaboration to reduce workforce harm on Britain's railway.

Workforce safety is a wide term for a wide topic. Many aspects of it are covered elsewhere, for example in the workforce assaults and trauma, station operations and road risk chapters. This chapter, however, focuses on two significant areas of workforce safety not covered elsewhere: infrastructure worker safety, and yards, depots and sidings safety.

Where are we now?

Infrastructure worker safety

In the three years since the LHSBR workforce safety section was published, the rail industry has seen the introduction of these improvements in infrastructure safety management:

- A Network Rail Workforce Safety Task Force has been formed to target track worker safety. This will be a partnership with all key industry players and will accelerate the associated Near Miss Reduction Programme (NMRP).
- A sector-wide survey on pressure in the workplace was undertaken, which highlighted that pressure made some exert more effort, ask questions and think on their feet. But it also had a detrimental effect and made others lose focus, cut corners and make mistakes. It also related sleepless nights, headaches and sickness, which made some more aggressive, impatient and irritable.
- A study of the protection of staff in line blockages was sponsored by Infrastructure Strategy Leadership Group. The resulting report was fed into both the NMRP and RAIB's class investigation into factors affecting safety-critical human performance in signalling.
- Introduction of new technology that provides additional or alternative warning and protection for those working on the track.
- Roll-out of Network Rail's Safety Hour programme and Think RISK initiative to encourage front line workers to discuss safety issues and identify and manage risk more effectively.

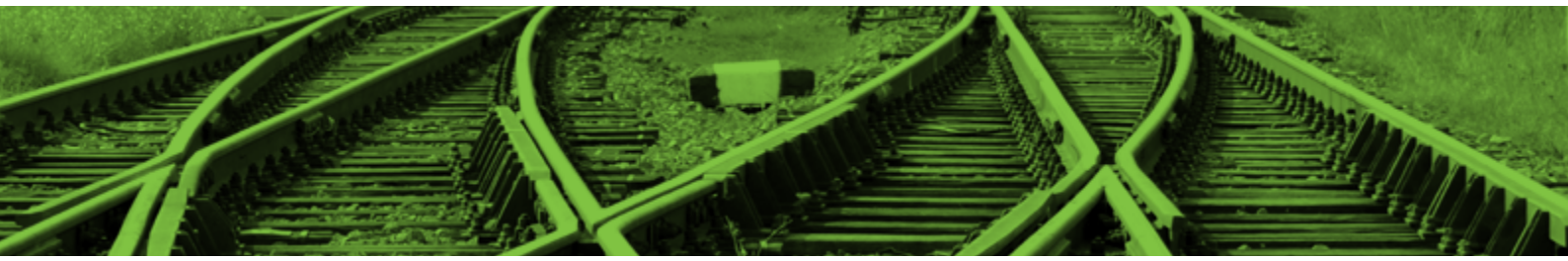
To achieve the vision, industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: There is a lack of clarity in roles and responsibilities, developing and maintaining competence, and safety culture among trackside workers and managers.

Strategic Activity: Develop evidence-based competence management systems and improve clarity on roles and responsibilities.

Measure of success: Successful introduction of the new Person in Charge role. Fewer incidents with culture, competence or clarity of roles and responsibilities in the causal chain.

Measure of success: An enhanced Sentinel system that better tracks competence and supports an evidence-based approach for matching supply to demand.



Strategic Challenge 2: There is inconsistency around planning and implementing safe systems of work with a high level of protection.

Strategic Activity: Support planners by providing better information to improve protection system design.

Strategic Activity: Enhance safe work packs to be risk-based and easier to use.

Strategic Activity: Consider maintenance and maintainability in a more integrated approach to franchising and timetabling and continue move to predict-and-prevent rather than reactive maintenance.

Measure of success: More usable systems for planning and a more intelligent process for understanding where and when to grant line blocks and possessions. A more transparent and effective system for planning track access and safe systems of work.

Strategic Challenge 3: Insufficient use is being made of digital technology in reducing the risk to those working on or about the track.

Strategic Activity: Design and develop new protection and warning systems to warn workers of approaching trains and provide additional protection in line blockages.

Strategic Activity: Improve how site access is planned and monitored by enabling digital sign-in at access points.

Measure of success: Risk-based roll-out of new technology to improve track worker safety. Reduction in near misses between trains and track workers. Fewer incidents in which access point issues result in a loss of safety or productivity.

Strategic Challenge 4: Management has limited visibility of the risk to infrastructure workers because of deficiencies in monitoring, supervision, and assurance.

Strategic Activity: Improve the consistency of investigations and how learning from them is recorded, valued and shared.

Strategic Activity: Develop better track worker safety metrics, including close calls, with better information on losses of controlled separation.

Strategic Activity: Introduce leading indicators, including exposure metrics such as the level of protection achieved, to track and influence behaviours and drive a sustained approach to improving safety and productivity.

Measure of success: Richer information on infrastructure worker safety helps to prioritise improvement effort, make the business case for improvement initiatives, and track their impact. Measurable progress in phasing out the use of unassisted lookouts where other options exist.

Strategic Challenge 5: Collaboration in this sector has often been found to be wanting.

Strategic Activity: Strike the right balance between sharing local innovation and adopting industry best practice.

Measure of success: Industry sharing and take-up of best practices demonstrably increases.


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Depot safety

Operators and maintainers of rail vehicles manage risk in their depots. Accidents in depots are reported and shared via SMIS by train operators but not by other organisations that carry out train care and maintenance.

To achieve the overall vision, industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: There is no clear industry-wide picture of risk and safety performance in depots.

Strategic Activity: Improve industry-wide understanding of risk in depots by improving the quality of accident and incident information.

Strategic Activity: Improve the sharing of experience and best practice to understand and manage the operational risks and mitigation measures in depots.

Measure of success: Improvements in reporting levels and increased understanding and activity on depot safety.

Where to get support

Infrastructure worker safety

- ISLG is an RSSB-supported cross-industry collaboration group with representatives from the contractor community. Part of its remit is to establish and implement arrangements to address the 'duty of cooperation' across the mainline and non-mainline rail networks: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/ISLG**
- RSSB rail industry workforce safety resource centre provides information on the strategies, tools, and other resources pertinent to workforce safety: **https://www.rssb.co.uk/RSSB-and-the-rail-industry/Products-and-Services/Workforce-safety**
- Network Rail's Safety Central website provides a range of health and safety materials, including safety alerts, briefing notes and videos: **https://safety.networkrail.co.uk/**

Yards, depots and sidings safety

- TARG is an RSSB-supported cross-industry collaboration group with representatives from passenger train operators: **https://www.rssb.co.uk/en/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/TARG**
- Rail Freight Operators Group is an RSSB-supported collaborative group that oversees rail freight operational safety and standards: **https://www.rssb.co.uk/en/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/NFSG/RFOG**

8 Infrastructure asset integrity

Vision

Stakeholders in the industry and supply chain work effectively together to minimise the incidence of unsafe failures of infrastructure assets, and provide transparent assurance that this has been achieved across integrated systems.

Where are we now?

The integrity of infrastructure assets is the responsibility infrastructure managers (IM) and the relevant parts of the supply chain. Cross-industry collaboration on matters related to infrastructure asset risk had been assigned to the Train Accident Risk Group (TARG) but will now be driven by the Asset Integrity Group (AIG).

In the three years since the LHSBR infrastructure asset integrity section was first published, the rail industry has seen the introduction of some improvements in the collaborative management of infrastructure asset risk, including:

- New rules for Emergency Special Working which allow trains to be moved more quickly and more safely following a major signalling failure.
- Introduction of passenger fleets equipped with unattended asset monitoring equipment. These include Crossrail and Thameslink EMUs (electric multiple-unit) in London and Inter City Express Trains for the Great Western and East Coast main lines.
- Formation of the Vehicle Introduction forum which enables collaborative discussions between the infrastructure manager and parties introducing new trains.

To achieve the vision industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: There is inconsistent understanding about the key safety requirements for infrastructure assets in an integrated operational system.

Strategic Activity: Promote understanding of the key safety requirements of infrastructure assets as part of an integrated operational system.

Measure of success: Demonstrable improvement in levels of understanding of key stakeholders. Enhanced processes and plans to develop appropriate competence for all stakeholders to enable effective and safe procurement, build, operation and maintenance of infrastructure assets.

Strategic Challenge 2: There is insufficient collaboration across industry to report and address emergent hazards and risks associated with infrastructure resilience and integrity at the interfaces with rolling stock assets.

Strategic Activity: Enhance collaboration across the supply chain to reduce the risks associated with the failure of infrastructure assets and their impact on interfacing systems and subsystems; improve operational performance.

Strategic Activity: AIG to identify the key activities and areas for collaboration on infrastructure asset risk which have the potential to deliver the most benefit to industry.



Measure of success: Define and deliver a fit for purpose integrated defect reporting and corrective action system. Information on asset condition is shared with operators and other infrastructure managers, ensuring that key safety functions and interfaces are covered.

Measure of success: Develop a prioritised roadmap of collaborative activities for industry stakeholders to manage infrastructure asset risk.

Measure of success: Significantly improved behaviours and supporting collaborative processes for assuring a high level of asset integrity and resilience, including for software-based, safety critical and safety related trackside systems.

Strategic Challenge 3: The processes for providing safety assurance on critical infrastructure assets, their fitness for use, and their limit-state conditions are poorly understood and/or inconsistently applied.

Strategic Activity: Develop standardised and common methods and capabilities to provide better assurance for the safe use and continued performance of infrastructure assets, including at interfaces with low-high integrity systems.

Measure of success: Introduce suitable and cost-effective processes and/or tools to increase transparency and sharing of safety assurance cases for infrastructure assets and applications. There is evidence of greater visibility, assurance and trust among all stakeholders.

Measure of success: Clear descriptions are published of key assurance roles and activities in the infrastructure asset approvals process. Especially the key statutory assurance role played by the infrastructure manager.

Measure of success: The industry skills base is enhanced to enable the safe interrogation of integrated trackside and train software systems. To include root-cause analysis and decision support for executing corrective actions across the supply chain.

Strategic Challenge 4: Operators and suppliers need continued and ongoing assurance that consistent collaboration will be maintained at the route and regional levels, including for the recording and reporting of safety and performance data.

Strategic Activity: Advance and closely monitor the effectiveness of collaboration in implementing the requirements published in railway industry standards and guidance.

Measure of success: OPSRAM and TOSG are established and working to ensure industry conformance, and to report on the effectiveness of collaboration during the transition and following devolution.

Where to get support

The Asset Integrity Group (AIG) will become the group to oversee the development of this area, and the cross-industry group dedicated to leading collaborative activity on the topic.

- Network Rail has an asset management policy and an asset management strategy. These define the key principles and requirements Network Rail applies to assets and set out the key areas of improvement needed to support excellence in asset management: **https://www.networkrail.co.uk/running-the-railway/looking-after-the-railway/asset-management/**
- Network Rail has a geotechnical strategy which articulates its priorities and key activities for long-term safety improvement: **https://cdn.networkrail.co.uk/wp-content/uploads/2018/07/Earthworks-Technical-Strategy.pdf**
- Network Rail's delivery plan for CP6 includes details of the Intelligent Infrastructure programme of work: **https://www.networkrail.co.uk/who-we-are/publications-and-resources/our-delivery-plan-for-2019-2024/#downloadall**
- RSSB publishes the Precursor Indicator Model each reporting period. This includes data-driven indications of how the train accident risk associated with track, earthworks signalling, and structures might be changing: **https://www.rssb.co.uk/en/Standards-and-Safety/Tools--Resources/Rail-Risk-Toolkit/Precursor-Indicator-Model**
- RSSB has published resources designed to help understand Emergency Special Working: **https://www.rssb.co.uk/en/Insights-and-News/Industry-Topics/Peformance/Emergency-Special-Working**




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9 Work-related violence and

Vision

Work-related violence continually reduces as a result of staff training, and appropriate aftercare is consistent and available to all who need it.

Where are we now?

In the three years since the LHSBR work-related violence and trauma chapter was published, the rail industry has seen these improvements:

- A cross-industry strategic police and partners group has been established to set out national best practice and lead decision making body in work-related violence (WRV).
- A standardised definition of WRV has been agreed and is being adopted by industry.
- A standardised pledge to staff affected by WRV has been developed.
- BTP provide quarterly reports to industry on reported WRV.
- RSSB's survey on WRV has been published, giving a snapshot of its prevalence.
- RSSB has published guidance and a supporting toolbox on responding to potentially traumatic incidents.
- An evaluation of body worn cameras has been undertaken.

To fully achieve its vision, the industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: Data on WRV and trauma are inconsistently gathered and reported; this undermines their capacity to support risk management and interventions.

Strategic Activity: Stakeholders will develop mechanisms to improve reporting, data sharing, and data quality.

Strategic Activity: New technologies to improve reporting will be researched.

Strategic Activity: Companies will use data to complete risk assessments that identify hotspots and inform interventions.

Measures of success: Incidents of WRV and trauma are reliably recoded with data quality assured across the industry. Companies use data to assess and manage risk.

Strategic Challenge 2: While work-related violence and other traumatic events should never be 'part of the job', recruitment and onboarding processes do not adequately equip and prepare staff to manage risk.

Strategic Activity: Recruitment processes will outline the nature of the work to prospective employees, including the potential for physical and psychological hazards that may be foreseeable.

Strategic Activity: Competency management systems will include evidence-based training for managing foreseeable WRV and other traumatic events.

Measures of success: Staff are aware of the nature of their work and prepared using training that is evaluated and embedded in competency management systems.

trauma



Strategic Challenge 3: The physical environment influences emotional states and behaviour. Good workplace design plays a key role in preventing and reducing the impact of incidents. Insufficient evidenced-based environmental controls have been identified and adopted.

Strategic Activity: Platform planning, design and management will consider people-environment factors and psychosocial impact.

Strategic Activity: Strategies for improving passenger information, especially during disruption, will be considered as a mechanism for reducing work-related violence.

Strategic Activity: Body-worn cameras will be rolled out along with associated training, following consideration of local operational requirements and risk assessments.

Measures of success: Psychosocial factors and environmental controls for WRV and trauma are evaluated and considered as part of the design process.

Measures of success: Strategies to improve passenger information during disruption are developed and implemented to reduce WRV and trauma.

Measures of success: Body-worn cameras and associated training are rolled out strategically across industry.

Strategic Challenge 4: Workplace policies and practices can increase the risk of work-related violence and other traumatic events. The effectiveness of organisational policies and practices are not systematically evaluated, and good practice shared.

Strategic Activity: The effectiveness of company policies and supporting procedural documents in managing WRV and trauma are evaluated. Good practice for mitigating the impact of work-related violence and trauma before, during and after incidents is shared.

Strategic Activity: Policies and procedures for managing psychosocial risk will dovetail with other crisis management and business continuity policies, lone working policies, and other care and support systems.

Measures of success: Company policies and procedures align with good practice guidance, including RSSB's Guidance on Responding to Potentially Traumatic Incidents.

Strategic Challenge 5: Chain-of-care and post-event support is inconsistent with industry guidance at an individual and organisational level.

Strategic Activity: Companies to review chain-of-care and post-event support to ensure alignment with RSSB's Guidance for Responding to Potentially Traumatic Incidents.

Strategic Activity: Managers and peer supporters will be trained to provide post-event support.


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Strategic Activity: Companies will develop accessible referral pathways for specialist psychological intervention post-event.

Strategic Activity: Staff affected by work-related violence to be given reasonable release to provide statements to BTP and, if required, to attend court.

Measures of success: There is evidence that chain-of-care and post-event support has been reviewed and updated appropriately. Managers and peer supporters are competent in post-event support, and there is an increase in staff providing statements.

Where to get support

RSSB's website provides a range of resources on trauma support, including guidance, templates, and other materials:
https://www.rssb.co.uk/Insights-and-News/Industry-Topics/Health-and-Wellbeing/Mental-wellbeing/Responding-to-traumatic-incidents-in-rail

These groups collaboratively identify and disseminate good practice relevant to work-related violence and trauma:

- The Work-Related Violence Strategic Group sets out the desired national best practice and is the lead decision making body in the area of work-related violence. The group reports to the RDG Policing and Security Group.
- The Mental Wellbeing Subgroup manages the mental wellbeing components in the health and wellbeing roadmap. This includes the psychosocial consequences of work-related violence and other traumatic events.
  The group reports into the Health and Wellbeing Policy Group:
  https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Health-and-Wellbeing/HWPG
- The People on Trains and Stations Risk Group looks for new ways to reduce the risk associated with station operations:
  https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/PTSRG
- The Suicide Prevention Duty Holders' Group aims to reduce the potential for suicide on the rail network, the impact of suicide events on staff and customers. These efforts are driven through trauma management and support, and disruption and delay caused by fatalities:
  https://www.rssb.co.uk/Standards-and-Safety/Improving-Safety-Health--Wellbeing/Enhancing-Safety-Health--Wellbeing-Through-Collaboration

10 Train Operations

Vision

The operation of trains sees a continuous, sustainable reduction in risk.

Where are we now?

In the three years since the LHSBR train operations section was published, the rail industry has seen the introduction of these improvements in train operations risk management:

- Launch of the Signals Passed at Danger (SPADs) Risk Reduction Strategy
- New requirements for defective on-train equipment, that reduce early train termination with no significant effect on safety risk
- Launch of the Red Aspect Approach to Signals Toolkit (RAATS)
- Publication of the sixth edition of the Low Adhesion Manual
- Improved collaboration at the route and national level
- Publication of tools to help manage train driver cognitive underload
- Publication of the Safety Critical Communications Manual
- Improved functionality in SMIS for reporting the causes of safety events

To achieve the vision, industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: There is inconsistency across the industry in how SPAD risk is managed.

Strategic Activity: Share cross-industry good practice, initiatives and activities that have positively impacted on SPAD risk management.

Measure of success: An effective SPAD strategy is developed, embedded and used within the industry to manage and reduce the risk from SPADs.

Strategic Challenge 2: The industry doesn't fully understand the context in which signals are approached at danger and where the likelihood of a SPAD is greatest.

Strategic Activity: Maintain and develop the Red Aspect Approaches to Signals (RAATS) toolkit.

Strategic Activity: Develop the Red Aspect Approaches by Train Service (RABYTS) extension to RAATS.

Measure of success: The industry is using RAATS and RABYTS information to normalise SPADs and better understand which signals are most at risk from a SPAD. More targeted intervention measures are being put in place.

Strategic Challenge 3: Currently the industry doesn't have a detailed migration strategy for how existing and novel train protection solutions should be implemented over the next 50 years.

Strategic Activity: Novel train protection solutions will be evaluated along with a review of how the existing Train Protection and Warning System (TPWS) is applied, to determine an optimal train protection strategy that facilitates the roll-out of European Train Control System (ETCS).

Measure of success: An industry train protection strategy is developed and there is a clear implementation path to fitting ETCS where applicable, and alternative solutions where not.



Strategic Challenge 4: The risk from overspeeding and the effectiveness of controls and mitigations are not fully understood.

Strategic Activity: Understand the hazard of trains 'going too fast', the associated risks, and the effectiveness of related controls.

Measure of success: Production of an industry-wide strategy to improve the management of trains overspeeding.

Strategic Challenge 5: Safety critical communications continue to be a significant factor in incidents.

Strategic Activity: Develop, promote, and monitor the uptake of an industry-wide safety critical communications strategy, based on the Safety Critical Communications Manual.

Measure of success: Launch and embedding of a safety critical communications strategy.

Strategic Challenge 6: There is inconsistent collaboration in managing train accident risk at the route and regional levels.

Strategic Activity: Encourage and monitor collaboration and implementation of the requirements published in RIS 3704 TOM.

Measure of success: Local operation safety groups are established and working in line with RIS 3704 TOM.

Where to get support

- TARG is an RSSB-supported cross-industry collaboration group overseeing activity relating to train accident risk: **https://www.rssb.co.uk/en/Learn-and-Connect/ Groups-and-Committees/Safety/SSRG/TARG**
- The Adhesion Working Group has published a low adhesion manual. It documents best practice for managing adhesion on the mainline railway. It is available from the Rail Delivery Group's website: **https://www.raildeliverygroup.com/component/arkhive/file/39-publications/469773735-2018-01-managing-low-adhesion-ed6-0-pdf.html?Itemid=101**
- RSSB has launched the SPAD management good practice guide, designed to make the next step change in reducing and managing SPAD risk: **https://www.rssb.co.uk/Insights-and-News/Industry-Topics/SPAD-Good-practice-guide**
- The Precursor Indicator Model, published each period, provides data-driven indications of how train accident risk might be changing: **https://www.rssb.co.uk/en/Standards-and-Safety/Tools--Resources/Rail-Risk-Toolkit/Precursor-Indicator-Model**
- The Red Aspect Approaches to Signals (RAATS) toolkit is designed to estimate the number of times a signal is approached at red. It provides a breakdown of the different types of approaches and considers factors such as the train type, the time of day and day of week: **https://catalogues.rssb.co.uk/safety-risk-model/raats-toolkit**
- The Cognitive Underload Toolbox, to help drivers manage the risks of cognitive underload: **https://www.rssb.co.uk/en/Standards-and-Safety/Improving-Safety-Health--Wellbeing/Understanding-Human-Factors/The-underload-toolbox**

11 Freight Derailment

Vision

The risk relating to freight derailments will continue to reduce.

Where are we now?

Freight is a wide term for a wide topic. This risk area focusses on freight derailment. Many aspects of freight risk are covered elsewhere in priority areas such as the Fatigue, Trespass, Workforce Safety and Road Risk chapters.

In the three years since the LHSBR freight chapter was published, the freight sector has implemented these improvements:

- There is improved collaboration between infrastructure manager, freight operating companies and their customers.
- A rail freight project charter and integrated freight safety plan have been developed and its progress is regularly reviewed.
- Development of a freight derailment bowtie analysis and quantified risk analysis.
- Wheel Impact Load Detection (WILD) reports on offset loads are being used in collaboration between Network Rail, freight operating companies, and major bulk loading customers, to reduce the risk of freight derailment.
- In collaboration with other stakeholders, the Cross-Industry Group on Preventing Freight Derailment Prevention (XIFDPG) has published a code of practice on bulk loading.
- Sharing best practice in loading scrap metal containers has virtually eliminated end-to-end offset loads.

To achieve the vision industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: The railway doesn't always have control over the loading of wagons that it transports.

Strategic Activity: With our customers, develop approaches to ensure vehicles and wagons are loaded in compliance with loading standards.

Measure of success: A reduction in the number of vehicles and wagons that are not loaded in compliance with the loading standards.

Strategic Challenge 2: There is no single, easily accessible or reliable source of data that allows easy identification of wagons that are unevenly loaded.

Strategic Activity: Development of an approach to link WILD activations with specific vehicles and wagons, to reduce offset load risks relative to derailment.

Measure of success: A single source of data that reliably identifies unevenly loaded wagons.

Strategic Challenge 3: Currently industry has difficulty in measuring track twist at low speed, particularly at crossovers.

Strategic Activity: Develop more effective approaches to monitoring dynamic track twist.

Measure of success: An efficient way to identify track twist at crossovers has been developed.



Strategic Challenge 4: There is lack of understanding concerning the risk of vehicles entering the network in an unsafe condition and the associated potential for freight train derailment.

Strategic Activity: Quantify risk and identify emerging trends of vehicles entering the network in an unsafe condition and develop a risk management plan that identifies immediate risk reduction initiatives and long-term mitigation objectives.

Strategic Activity: Standardise and embed best practices and suitable control measures within the safety management systems of all operators, to mitigate the emerging trends identified and prevent future recurrences.

Measure of success: A reduction in the number and frequency of freight trains being stopped due to an unsafe condition.

Strategic Challenge 5: There is a lack of visibility of how freight risk is changing across the sector as a whole.

Strategic Activity: Monitor the profile of freight risk and prioritise collaborative activities to address key and emerging risks.

Strategic Activity: Develop better metrics for tracking trends in freight train accident risk.

Measure of success: More consistent reporting across the freight sector.

Where to get support

The RSSB website hosts a topic hub to help duty holders and XIFDPG members enhance their understanding of, and engagement with, how to reduce freight derailment risk: **https://www.rssb.co.uk/Standards-and-Safety/Improving-Safety-Health--Wellbeing/Enhancing-Safety-Health--Wellbeing-Through-Collaboration/Tackling-Freight-Derailment**

Freight industry groups are in place to work together to identify and disseminate good practice relative to freight. All parties across industry are encouraged to engage with these groups:

- National Freight Safety Group: the collaborative group overseeing rail freight safety: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/NFSG**
- Freight Technical Committee: the engineering focused group: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Standards/ISCC/RST-SC/FTC**
- Rail Freight Operations Group: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/NFSG/RFOG**
- Cross-Industry Group on Preventing Freight Derailment: reports to NFSG, and focuses on reducing the risks of freight derailment due to combinations of dynamic track faults, wagon faults, and offset loads: **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/NFSG/XIFDPG**

12 Rolling stock asset integrity

Vision

Stakeholders in the industry and its supply chain work together to minimise the incidence of unsafe failures of rolling stock assets, and to provide transparent assurance that this has been achieved.

Where are we now?

In the three years since the LHSBR rolling stock asset integrity section was published, the extent and pace of increased collaborative activity in risk management across the industry has been minimal. Significant work remains to fully achieve the vision.

To achieve the vision industry will now need to focus effort on addressing these strategic challenges:

Strategic Challenge 1: Funders, owners, manufacturers, supply chain, operators, maintainers and the regulator do not have a consistent, shared understanding of the safety requirements of the most recent design configurations of rolling stock. They are unable to fully assure each other that these requirements have been met throughout the asset lifecycle.

Strategic Activity: Close coordination is needed between relevant industry parties to identify and promote understanding of the key safety requirements, especially of modern rolling stock, where local application requires variation of approach.

Measure of success: Directory of key safety requirements, and the risk analysis underpinning them, to be made available as a sharing resource across specifiers, procurers, designers, suppliers, operators, and others.

Strategic Challenge 2: Funders, owners, manufacturers, supply chain, operators, and maintainers do not collaborate adequately, or in a fully integrated manner across whole-system interfaces.

Strategic Activity: Enhance collaboration across and within the supply chain to reduce the risks associated with systematic and random faults and failures of rolling stock and interfacing infrastructure systems.

Strategic Activity: Develop a process for all relevant industry parties to collaborate and better understand, monitor, and manage the risks from safety critical and safety related defects.

Strategic Activity: Define requirements, seek industry funding and buy-in for an integrated, system-wide safety defect reporting and corrective actions system.

Strategic Activity: Reporting processes and associated data quality initiatives to be updated to ensure raised awareness of any train-side failures of systems that lead to failure of the defined safety critical railway functions.

Measure of success: Fewer rolling stock and infrastructure interface faults and failures are recorded, and operational performance improves.

Measure of success: There are fewer safety critical and safety related defects in rolling stock, and performance improves across the asset lifecycle.

Measure of success: Improved root-cause analysis and decision support for executing corrective actions across the supply chain. This should include an asset management system for rolling stock and infrastructure assets. In doing this, ensure that all key safety functions are covered.



Measure of success: Updated reporting processes and data quality initiatives to ensure raised awareness of any train-side failures of electrical, electronic and programmable electronic systems that lead to failure of the defined safety critical railway functions. Improved root-cause analysis and decision support for executing corrective actions across the supply chain.

Strategic Challenge 3: The functionality of modern rolling stock is increasingly delivered through an international and multi-tiered supply chain. It is also increasingly complex, and software driven. As a result, there is the potential for a growing gap in safety assurance particularly as new hazards and threats evolve.

Strategic Activity: Develop standardised and common methods to provide improved assurance for the safe use and continued performance of rolling stock assets to a high level of safety integrity.

Measure of success: Introduce suitable and cost-effective processes and/or tools to increase transparency and sharing of safety assurance cases for rolling stock platforms and applications between all stakeholders to build greater visibility, assurance and trust.

Measure of success: Production of key materials, for example: a clear list of railway safety functions and their required safety integrity level (SIL); reference functional architectures of rolling stock showing how these functions are typically implemented.

Measure of success: Clear descriptions of key assurance roles and activities in the rolling stock approvals process, especially the key statutory assurance role played by Assessment Bodies, with the aim of producing effective guidance on good practice for this assurance activity.

Strategic Challenge 4: There is an uneven base level of skills and competencies in industry to manage the risks from EEPE (electrical/electronic/programmable electronic) system failures.

Strategic Activity: Develop and run an educational campaign to demystify the key concepts around safety assurance of complex, integrated electrical, electronic and programmable electronic systems, including root-cause analysis of defects; providing industry a common understanding of how to realize these capabilities in their various roles.

Measure of success: Demonstrable improvement in levels of understanding and capability of key stakeholders. Enhanced processes and plans for development of competences for all stakeholders to enable effective and safe procurement (build, test, commission, operate and maintain), and enhanced awareness of cyber security as it affects software safety.

Measure of success: Improved behaviours and competencies in response to, for example, the RAIB Cambrian Line investigation recommendations on the development of collaborative processes for assuring high integrity, software-based safety critical and safety related train-side systems.

Where to get support

- RSSB provides the industry with a range of products and services designed to help buyers in the GB rail market ensure their suppliers have the right competence and resources to consistently deliver to the right specification: **https://www.rssb.co.uk/Standards-and-Safety/Tools--Resources/Supplier-assurance**
- The Asset Integrity Group (AIG) will become the group to oversee the development of this area, and the cross-industry group dedicated to leading collaborative activity on the topic.

Improving our Capability

Vision

The GB railway is an industry where everyone takes responsibility for improving health and safety and benefits from it.
Rail companies see health and safety as an integral part of an effective and efficient business. They take risk-based decisions in the interests of passengers, staff and other stakeholders and work together to develop the people, processes, tools and information needed to deliver world class health and safety management.

Where are we now?

GB rail has benefitted from a well-established risk and evidence-based approach to safety management. It has begun to build the foundations for a similar capability for health and wellbeing risk but there is further to go.

In the three years since the LHSBR Improving our Capability chapter was published, the rail industry has seen these improvements:

- Widespread use of the Risk Management Maturity Model (RM3), with ORR launching a new version in 2019 to push the boundaries of excellence.
- Update and relaunch of Taking Safe Decisions and a programme to embed its principles.
- The Connected Leaders programme has been established to bring senior figures together to solve industry problems.
- An increased focus on health and wellbeing, and a start on developing the competences, processes, tools and information required to manage it.
- Launch of the new Safety Management Intelligence System (SMIS).
- Increased adoption of close call reporting systems to bring about culture change and improve understanding of health and safety risk.
- Improved use of non-technical skills, through training and integration of non-technical skills into company competence management systems.
- Greater application of risk bowties to understand threats to safety, the risk controls in place to manage them, and their effectiveness.
- An improved Rail Industry Supplier Qualification Scheme (RISQS), run by the industry for the industry, and the capability for suppliers to benchmark performance against their peers.
- Revision and reissue of the Rail Industry Standard for Accident and Incident Investigation supported by training and other resources.
- More use of data from operational and engineering systems to deliver safety insights and target risk reduction activities.

Strategic Challenges

This section identifies strategic capability improvement challenges structured around the five criteria groups from RM3.

Policy, leadership and governance

Strategic Challenge A1: Good practice in health and safety management systems is not applied consistently across activities and organisations.

Strategic Activity: Continuously improve risk management capability through widespread and effective application of RM3.

Measure of success: High levels of engagement with RM3 and sustained improvement in assessment results.

Strategic Challenge A2: Organisations need to take decisions that protect people's safety, satisfy the law, respect the interests of stakeholders, and meet wider business objectives. Lack of clarity over legal requirements can create unnecessary cost.

Strategic Activity: Embed the principles in Taking Safe Decisions.

Measure of success: Relevant aspects of Taking Safe Decisions are understood and applied by senior leaders, engineers, project managers and planners, as well as health and safety professionals.

Strategic Challenge A3: Rail operations increasingly rely on digital technology. This brings security threats that can lead to safety risk.

Strategic Activity: Build capability in security and cyber security risk management.

Measure of success: The principles for managing safety-related security and cyber security risk have been agreed and embedded.

Strategic Challenge A4: Many of the big health and safety challenges facing the industry can only be addressed effectively by taking a systems approach and working across organisational boundaries.

Strategic Activity: Work together through the Connected Leaders programme to improve health and safety culture.

Strategic Activity: Maintain effective structures and delivery mechanisms for realising the vision set out in Leading Health and Safety on Britain's Railway.

Measure of success: Strong commitment to, and effective delivery of, the activities in this strategy results in health and safety improvements.

Organising for control and communication

Strategic Challenge B1: Different organisations and projects have different ways of describing hazards and controls. This inhibits the efficient sharing and re-use of information about how risk is managed.

Strategic Activity: Establish and embed a common structure and language for hazards and risk controls.

Measure of success: Widespread use of a common structure and language supports efficient and effective hazard identification and provides a recognised way to map between requirements in standards and the hazards they manage.

Strategic Challenge B2: Trusted information on safety performance and risk is needed to support local and national decisions.

Strategic Activity: Make the industry's Safety Management Intelligence System (SMIS) easier to use and provide assurance on the data it contains.

Strategic Activity: Evolve the models and tools that industry uses to support risk management activity, such as the Safety Risk Model and Precursor Indicator Model, to meet the needs of a devolved railway.

Measure of success: SMIS is the trusted single source of the truth for system-wide event data that industry has agreed to share. Common risk models and tools are used to support decisions at a system, company, region and route level.

Strategic Challenge B3: Management of health and wellbeing risk is less mature than the management of safety risk. The foundations for a risk and evidence-based approach are still being built.

Strategic Activity: Develop a more structured approach to understanding threats to health and wellbeing and the controls available to manage them.

Strategic Activity: Improve how health and wellbeing data is recorded, shared and used.

Measure of success: Decisions that affect health and wellbeing are risk-based and supported by evidence.

Securing the co-operation, competence and development of employees

Strategic Challenge C1: Front line workers and managers need to take timely risk-based decisions, adapt quickly when circumstances change and know when to bring in professional health and safety expertise.

Strategic Activity: Create resources that support the development of basic risk assessment skills.

Strategic Activity: Integrate non-technical skills into company competence management systems.

Measure of success: Good uptake of resources by rail companies and their workforce. Front line staff have the competence and confidence to take sound decisions that affect health and safety.

Strategic Challenge C2: Learning opportunities are missed if information about accidents, incidents, unsafe acts and unsafe conditions is not reported and shared. Sometimes this is because those involved believe they will be unjustly blamed; sometimes it is because reporting channels are unclear or difficult to use.

Strategic Activity: Develop a culture in which people and organisations report, share and learn from accidents, near misses and close calls.

Strategic Activity: Establish widespread adoption and use of close call reporting systems.

Measure of success: Increased reporting of health and safety related events, acts and conditions results in better understanding and management of risk.

Planning and implementing risk controls

Strategic Challenge D1: Effective health and safety management needs to be built on a good understanding of risk controls and their effectiveness.

Strategic Activity: Increase use of risk bowties based on good practice from within GB rail and from other sectors.

Measure of success: New bowtie guidance is produced and adopted, resulting in greater use and more consistent application of the bowtie method within rail companies. An agreed set of industry-level bowties is available to support the collaborative activity of cross-industry risk groups.

Strategic Challenge D2: The rail industry is going through a period of change. Effective change management exploits opportunities to improve health and safety and manages threats to health and safety.

Strategic Activity: Promote industry guidance and develop supporting case studies to raise awareness and improve application of the risk management process from the Common Safety Method on Risk Evaluation and Assessment, which is mandatory for significant change.

Measure of success: Proposers of change use an effective risk management process and adopt health and safety by design principles.

Strategic Challenge D3: The health and safety challenges facing the industry over the longer term are not always taken into account when decisions are made.

Strategic Activity: Develop a systematic approach for evaluating how changes within and outside the industry will shape its future risk profile.

Measure of success: Strategic risk reduction activity is supported by horizon scanning and risk forecasting. Opportunities for health and safety improvement are integrated into the Rail Technical Strategy.

Strategic Challenge D4: Introducing new technology can be slow and expensive because of actual and perceived barriers. It can also introduce risk if there has not been adequate consideration of human factors and the operational environment.

Strategic Activity: Take a risk-based approach to removing barriers to the adoption of new technology.

Strategic Activity: Ensure closer cooperation between designers, manufacturers and operators, and adopt the human factors integration principle of technology and people as a team.

Measure of success: Technology that delivers incremental health and safety improvements is delivered quickly and cost-effectively.

Strategic Challenge D5: A key interface is that between rail industry buyers and suppliers. Buyers need confidence in the products and services they procure, and suppliers need an efficient way of demonstrating their capability and benchmarking performance.

Strategic Activity: Continue to develop and embed the use of a consistent, efficient and risk-based approach to supplier assurance, supported by relevant systems and tools.

Measure of success: There is mutual confidence between buyers and suppliers and supply side risks are effectively managed.

Monitoring, audit and review

Strategic Challenge E1: Some accident and incident investigations do not look beyond immediate causes and so learning opportunities are lost.

Strategic Activity: Embed good practice in accident and incident investigations through guidance, training and an increased awareness of human factors.

Strategic Activity: Improve how investigation outcomes are shared within GB rail and with other railways and other sectors.

Measure of success: Accident and incident investigations consistently identify root causes. Investigation findings are shared and implemented.

Strategic Challenge E2: Most health and safety monitoring is reactive and outcome based.

Strategic Activity: Establish greater use of activity indicators to support proactive monitoring.

Measure of success: Rail companies use a mix of outcome and activity indicators to monitor the health of their critical and vulnerable risk controls and to track improvement initiatives.

Strategic Challenge E3: There is no industry level solution for reporting and monitoring railway system faults and failures.

Strategic Activity: Establish a collaborative industry process for reporting and sharing information on railway system defects and corrective actions and the systems required to support this.

Measure of success: A solution has been developed for rail vehicles that is extendable to other areas and able to meet the needs of the future digital railway.

Strategic Challenge E4: There is untapped potential in the large volumes of information being generated by an increasingly data-enabled railway.

Strategic Activity: Exploit open or shareable data sources, unlock access to other relevant data, and apply new analysis techniques to better understand and manage risk.

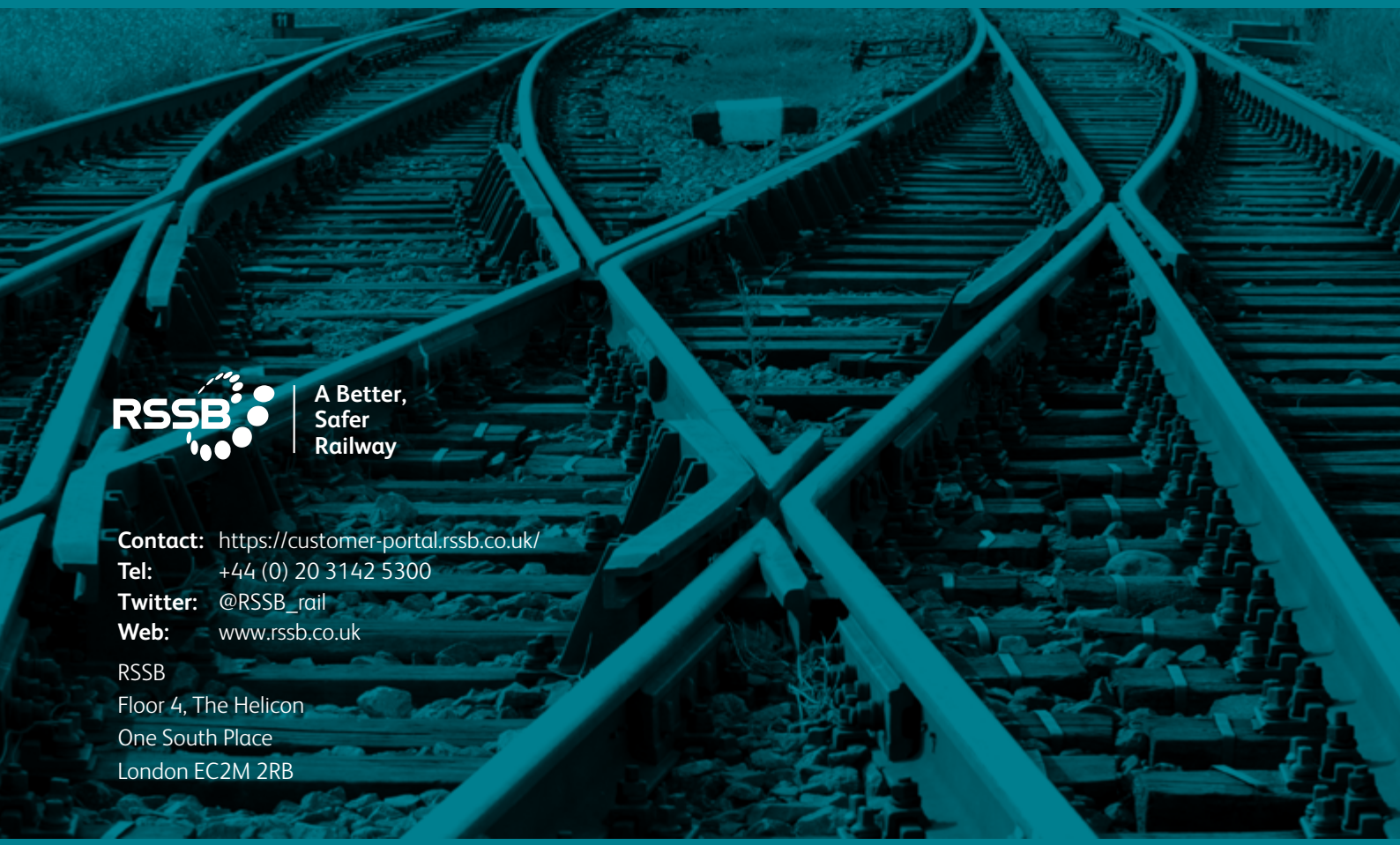
Measure of success: Health and safety requirements are integrated into initiatives like the Rail Data Action Plan. New data sources and analysis techniques are generating new health and safety insights.

Where to get support

- The Office of Road and Rail's website hosts the Risk Management Maturity Model (RM3) and supporting material: **https://orr.gov.uk/rail/health-and-safety/health-and-safety-strategy/risk-management-maturity-model-rm3**
- The Improving Safety, Health and Wellbeing section RSSB's website hosts Taking Safe Decisions as well as guidance on different aspects of risk management, information about RSSB-managed risk models and tools, and intelligence on safety performance. RSSB also provides a health and wellbeing topic hub, which covers aspects of health and wellbeing risk management capability: **https://www.rssb.co.uk/Standards-and-Safety/Improving-Safety-Health--Wellbeing/**
- The Risk Management Capability Group (RMCG) is a senior strategic group that supports the delivery of strategic risk management capability improvement initiatives to support of the vision set out in this document. It advises RSSB on its activities and facilitates and monitors collaborative industry effort. Its members represent passenger train operators, freight train operators, infrastructure contractors, Network Rail and the ORR:11 mins is good **https://www.rssb.co.uk/Learn-and-Connect/Groups-and-Committees/Safety/SSRG/RMCG**




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The Planning Inspectorate

Order Decisions

26 September 2023

by Claire Tregembo BA(Hons) MIPROW

An Inspector appointed by the Secretary of State for Environment, Food and Rural Affairs

Decision date: 17 November 2023

Order Ref: ROW/3302626 **Extinguishment Order**

- This Order is made under Section 118A of the Highways Act 1980 and is known as Doncaster Borough Council Public Footpath Rossington Number 10 (Part) Rail Crossing Extinguishment Order 2019.
- The Order is dated 25 June 2019 and proposes to extinguish the public right of way shown on the Order plan and described in the Order Schedule.
- There was one objection outstanding when Doncaster Borough Council submitted the Order to the Secretary of State for Environment, Food and Rural Affairs for confirmation.

Summary of Decision: The Order is confirmed.

Order Ref: ROW/3282627 **Creation Order**

- This Order is made under Section 26 of the Highways Act 1980 and is known as Doncaster Borough Council Public Footpaths Rossington Numbers 17 and 18.
- The Order is dated 25 June 2019 and proposes to create two public footpaths as shown on the Order Plan and described in the Order Schedule.
- There was one objection outstanding when the Doncaster Borough Council submitted the Order to the Secretary of State for Environment, Food and Rural Affairs for confirmation.

Summary of Decision: The Order is confirmed.

Procedural Matters

1. I undertook an accompanied site visit on 26 September 2023 with representatives of Network Rail (NR), Doncaster Borough Council (the OMA), the owner of the land and the objector. The crossing is currently closed by a Temporary Traffic Regulation Order and the decking has been removed, so we could not cross it. The Level Crossing Manager opened the locked gate on the western side of the railway to allow us to view it from the crossing point. The gate on the eastern side is welded shut so it was not possible to view it from this side.

2. Following the making of the Orders, an objection to the Extinguishment Order (EO) was made by a resident. Since the Orders were made, the land on the east side of the railway line has changed hands and the new owner objects to the Creation Order (CO). Section 26 of the Highways Act 1980 (the 1980 Act) does not require permission from the landowner for a right of way to be created over land.

3. When the Orders were made, there was a proposal for a development for a golf course and approximately 500 houses which would increase the use of Penny's Crossing. This development is no longer going ahead. NR asked the OMA to withdraw the Orders so they could submit a new application based on the current situation. However, the OMA still considers the EO necessary on the grounds of public safety and declined to withdraw the Orders. NR's statement of case is based on the current situation with no consideration given to any future development proposals.

The Main Issues

4. The section of footpath proposed to be extinguished crosses the East Coast Main Line (ECML) railway at grade.

5. The CO would create footpaths on both sides of the railway to link to an existing footbridge to allow the public to cross the railway.

6. Under Section 26 of the 1980 Act, if I am to confirm the CO, I need to be satisfied there is a need for the footpaths and that it is expedient that they should be created having regard to:

   a) the extent to which the paths would add to the convenience or enjoyment of a substantial section of the public, or the convenience of persons resident in the area; and

   b) the effect which the creation of the paths would have on the rights of the persons with an interest in the land, account being taken of the provisions for compensation.

7. Under Section 118A of the 1980 Act, if I am to confirm the EO, I need to be satisfied that it is expedient to extinguish the footpath over the level crossing, having regard to all the circumstances, and in particular to:

   a) whether it is reasonably practicable to make the crossing safe for use by the public, and

   b) what arrangements have been made for ensuring that, if the Order is confirmed, any appropriate barriers and signs are erected and maintained.

8. I consider the key points to be considered are:

   a) the extent to which the CO would provide an alternative path;

   b) the current safety of the pedestrian railway crossing for the public;

   c) whether any improvements to the pedestrian crossing, so as to make it safe, are reasonably practicable; and

   d) whether, if the Order is confirmed, adequate arrangements have been made to secure the redundant crossing.

9. I must have regard to 'all the circumstances' and these could include the use currently made of the existing path, the risk to the public, the effect the loss of the path would have on users of the public rights of way network as a whole, the impact on the owner of the land and their agricultural activities, the options for alternative measures and the relative cost of such measures.

10. I must also have regard to any material provision of any Rights of Way Improvement Plan (ROWIP) for the area and to the Public Sector Equality Duty (PSED).

Reasons

The Creation Order

11. The CO would provide two new footpaths on either side of the railway line between Rossington 8 and 10. Rossington 17 is on the western side of the railway shown

between A and C on the CO plan appended to the end of my decision and Rossington 18 is on the eastern side shown between B and D.

The need for the proposed paths

12. I am advised that a definitive map modification order application (DMMOA) has been made for a footpath between B and D supported by evidence of use for twenty years. I have not seen this application or the evidence which supports it, but the claim could suggest there is a need for this footpath. There is also a very clear worn line along the proposed footpath indicating it is well used.

13. NR believe the footbridge on Rossington 8 is the preferred route over the railway and most walkers cross here and walk along the Rossington 18 to reach Common Lane. The objector advises that regular dog walkers use the footbridge to cross the railway and walk a circular route using Penny's Crossing and the CO footpaths as do other walkers and joggers.

14. I am satisfied that there is a need for the proposed footpaths.

The extent to which the paths would add to the convenience or enjoyment of the public or the convenience of residents

15. Most of those walking this path network will be starting from New Rossington to the north of the Order route.

16. Rossington 17 would provide a traffic-free alternative to Stripe Road for anyone who wanted to walk in that direction. Stripe Road has a 40 to 60 mph speed limit and south of Hall View Road, there is no pedestrian footway. Therefore, Rossington 17 would provide a safer route for public use.

17. Looking at the wider path network, Rossington 18 would ensure a footpath that could be used as part of a circular walk adding to the enjoyment of the public. The DMMOA and the worn line would suggest this footpath would add to the enjoyment of the public or residents.

18. For these reasons, I consider the proposed footpaths would add to the convenience and enjoyment of the public and residents.

The effect on persons with an interest in the land

19. The proposed footpath on the western side of the railway is over land owned by NR who requested the Order.

20. When the CO was made, the owner of the land on the eastern side of the railway agreed to the creation of the footpath. However, the land has since been sold and the new owner does not support the creation of Rossington 18.

21. The new owner intends to use the land for agricultural purposes and his farming business includes breeding sheep and cattle. They are likely to use it to graze their livestock. The owner considers the footpath would need to be fenced off from the field for health and safety reasons and to reduce the likelihood of dog attacks on livestock and injuries to walkers. NR are willing to fund the provision of a stock-proof fence if the CO is confirmed.

22. If the Order is confirmed, the owner would be entitled to statutory compensation for depreciation in the value of the land and disturbance under Section 28 of the 1980 Act which NR are prepared to pay.

23. The objector also has concerns about what would happen if the land was developed or if the owner prevented access. If the CO is confirmed, the footpaths would be recorded on the definitive map and statement for public use and would need to remain open and available unless they were legally diverted or extinguished.

24. Although the creation of Rossington 18 would affect the interests of the owner, NR are willing to fund stock-proof fencing alongside the proposed footpath and pay any compensation for the depreciation in the value of the land and disturbance to the owner. I consider any negative impacts can be addressed by way of compensation.

Conclusions on the Creation Order

25. I consider there is a need for the proposed footpaths and that it is expedient to create them taking into account the beneficial effects of the creations for the public, which are not outweighed by any adverse effects upon the rights of the persons with an interest in the land.

The Extinguishment Order

26. Rossington 10 runs along Common Lane and crosses the railway over a pedestrian level crossing known as Penny's Crossing. It is shown on the EO plan between A and B appended to the end of my decision. It is a passive crossing which relies on those using it to 'stop, look, and listen.' There are two sets of pedestrian gates on either side of the railway, at the line side and set back from the railway.

27. NR advises that Penny's Crossing is compliant with level crossing standards, but a compliant crossing is not the same as a safe crossing. They consider there are factors that make it a high-risk crossing which cannot be made safe and therefore should be closed.

The extent to which the Creation Order would provide an alternative way

28. The alternative route would be along the proposed footpaths shown in the CO plan to reach Rossington 8 which crosses the railway line using an existing footbridge. The proposed footpath on the western side of the railway would be along an access track owned by NR and used for maintenance purposes. On the eastern side, it would be along a field edge path.

29. The proposed footpaths are already securely fenced off from the operational railway. There appears to be limited vehicular use of the maintenance track. The owner of the field may keep livestock in it which they consider could put the public at risk. However, NR is prepared to fund stockproof fencing to separate the public from livestock. Therefore, I consider the proposed alternative route would be significantly safer than Penny's Crossing.

30. The footpaths in the CO are 570 metres and 580 metres long. Therefore, anyone wishing to walk the full length of Common Lane would have to walk approximately 1.2 km further. This additional distance would be less convenient to the public. However, Common Lane does not provide access to any amenities or points of interest. The footpath and connecting path network are used for recreational and

dog walking purposes. There are few properties and limited paths south of Common Lane.

31. Whilst the additional distance weighs against the EO, it is a recreational path network, and the additional length is unlikely to discourage use of Common Lane. Although the alternative would not be as convenient, it would not be significantly less convenient given its recreational use and the safety considerations.

32. The proposed footpaths are both level with mostly grass and earth surfaces, although some sections of the maintenance track have a stone surface. There are some puddles within the vehicular tracks on the western side of the railway but the ground between them is dry. On the eastern side, the walked line is dry and level. There are no steps on the existing footbridge. I do not consider the surface would affect the convenience of the public.

33. The proposed footpath on the eastern side of the railway has good views across open fields and appears to be a popular route. Views on the western side of the railway were limited by a tall sweetcorn crop. However, the crop would not be present all year round. Furthermore, Rossington 8 is a similar width with sweetcorn growing on either side. Given the number of walkers I saw, the crop did not appear to deter use or reduce its enjoyment.

34. It is claimed the crossing is used to access horse fields off Stripe Road, but no owners of the fields have come forward in objection to the closure of the crossing.

35. A census of Penny's Crossing in Summer 2022 showed average daily use by 34 people, which I consider to be low.

36. I consider the proposed alternative route, if I were to confirm the CO, would be significantly safer and as enjoyable as the existing footpath. The increased distance would make it less convenient, but I do not consider it to be significantly less convenient given the recreational nature of the footpath and surrounding path network.

Whether the current crossing is safe

37. Penny's Crossing is over two high-speed tracks used by InterCity trains with speeds of up to 125 mph and long freight trains with speeds of up to 75 mph. The ECML is used by 212 trains daily and has the capacity to run up to 310 trains which is approximately five times the national average. NR considers the ECML to be the most important route in the UK railway network and it connects London with the North East, East and Scotland.

38. NR uses an application called All-Level Crossing Risk Model (ALCRM) to provide a consistent method of assessing safety risk at level crossings. It incorporates a quantitative and qualitative approach to achieve a rounded and balanced analysis of risk. It has been developed through extensive research and a collaborative partnership between NR and the Rail Safety Standards Board.

39. The most recent level crossing risk assessment determined an ALCRM Risk Rating of B3 which is a high-risk category. The letter represents the risk to an individual per traverse. A represents the highest risk and M the lowest. The number represents the collective risk based on total harm or safety loss with 1 representing the highest risk and 13 representing no risk.

40. Although Penny's Crossing has good sight lines, the speed of the approaching trains gives little time to cross safely. From the shortest sighting distance, a train takes 16 seconds to reach the crossing. A fit and healthy person requires 9 seconds to cross, with vulnerable users requiring 13.88 seconds. A safe crossing relies on the path user crossing quickly and continuously checking for approaching trains. NR considers the margin for error on Penny's Crossing is very low.

41. A census in 2019 found all users were considered to be vulnerable. Vulnerable users include older users, those with mobility issues and young people who may not be fully aware of the dangers of using a level crossing. Sight lines can also be reduced by rain, fog, snow, and sun-glare. The crossing is primarily used by dog walkers and the Rail Accident Investigation Board advises that a high proportion of fatalities at level crossings involve pedestrians with dogs. I am satisfied that, given the number of dog walkers and vulnerable users, the crossing times are marginal and would be a risk to public safety.

42. The variations in speed difference between the InterCity trains and freight trains is at least 50 mph. This makes it more difficult for path users to judge the speed of the trains. The freight trains can also take over a minute to pass through Penny's Crossing which can make path users impatient. I consider this speed variation could pose a risk to public safety.

43. The InterCity trains are 260 metres long and freight trains vary in length from 420 to 775 metres. This can lead to trains being hidden by trains passing in the opposite direction. London North East Railway company have confirmed many of their trains pass each other close to Penny's Crossing making this a significant risk and hidden trains have been the cause of many near-misses and actual fatalities. During the site visit, two trains passed each other close to the crossing. Given the marginal crossing times with full sight lines, I consider hidden trains a significant risk to public safety in this location.

44. Between 2006 and 2022, 56 incidents were recorded at Penny's Crossing. These include three fatalities, six significant near misses where train movements were suspended, seven incidents of obstructions being placed on the line and five reports of deliberate misuse. Twelve of these events occurred between March 2022 and 2023, including two fatalities and three attempted suicides.

45. Penny's Crossing is in a quiet, rural location and attracts young people who have been photographed sitting on the crossing and loitering around it.

46. There were three suicides at Penny's Crossing between 2017 and 2022. During this time there were 173 suicides nationally, with 13 level crossings having two suicides and only two having three. Its quiet location could be a factor in the number of suicides and attempted suicides.

47. Due to the ALCRM risk rating, the limited crossing time, the train speeds, the significant risk of hidden trains, and the number of incidents on the line, I consider Penny's Crossing does present a risk to the public.

Whether it is reasonably practicable to make the crossing safe for use by the public

48. Several measures have previously been implemented to try and reduce the risk at Penny's Crossing. These included straightening the deck to reduce crossing times, anti-slip surfacing, clearly defining the decision point, corral fencing to prevent

users from deviating off the approaches, signs with contact details for the Samaritans and the installation of CCTV and signage to deter misuse. Security patrols by NR and British Transport Police were increased and focussed safety campaigns were used to highlight the issues to residents and children. These measures do not remove the risk of human error and appear to have had limited impact on safety or misuse.

49. A wider deck would enable users to pass each other more easily. However, this would also require wider gates which would allow the crossing to be accessed by horse riders, motorbikes, and quad bikes, leading to an increase in risk.

50. Illuminating the crossing could lead to an increase in people gathering at night, anti-social behaviour, misuse, and trespass. Common Lane and the surrounding area are unlit. Illuminated crossings in an otherwise dark environment can cause distractions to train drivers and make it more difficult for path users to see approaching trains.

51. Whistle boards need to be fitted 400 metres from a crossing to be heard. At Penny's Crossing the whistle boards would need to be erected 776 metres from the crossing to provide the minimum 14 second warning. Therefore, this is not feasible and is likely to lead to complaints from residents of New Rossington where a whistle board would need to be located.

52. Supplementary audible warning devices would give an audible warning at the crossing when a train passes a whistle board. However, they can only be installed with a whistle board. There is no way for crossing users to tell if they are not working and they can be a target for regular vandalism which makes their efficiency questionable.

53. Reducing the line speed would cause delays to train services on the line and have an effect on services to the North East, East Coast, Scotland, and London. NR advises the operational efficiency of this strategic railway line needs to be maintained and Government expectation is that line speeds should be maintained, services and capacity increased and journey times reduced. Therefore, this is not considered to be a feasible option.

54. Miniature Stop Lights (MSL) could be installed. However, due to the location of Auto Stop signals, the cheaper overlay MSL cannot be used. The more expensive integrated MSL would cost at least £1 million but the cost-benefit analysis determined this would be disproportionate to the benefits it would give. A flex MSL is currently under development but does not have safety approval. The effectiveness of MSL at Penny's Crossing would be significantly reduced by the variations in train speeds and lights would be red for a significant amount of time and for prolonged periods. The installation of MSLs would only achieve a partial and inadequate risk reduction.

55. A stepped footbridge would cost approximately £2.7 million, a ramped footbridge approximately £4.5 million and a subway approximately £6.5 million. The census undertaken in summer 2022 recorded a low number of users. Therefore, I consider the cost of these options to be disproportionate to the benefits achieved.

56. For the above reasons, I consider it is not reasonably practicable to make the crossing safe for use by the public.

Arrangements for appropriate barriers and signs to be erected and maintained

57. NR has entered into an agreement with the OMA to defray any expenses incurred in the erection or maintenance of barriers and signs. At the time of my site visit, the high outer security gates were locked on the western side of the railway and welded shut on the eastern side. The gates on the western side would be welded shut on confirmation of the extinguishment order. Therefore, I am satisfied appropriate arrangements would be made to secure Penny's Crossing and erect appropriate signage if I were to confirm the EO.

Other Considerations

58. NR has a duty to promote operational efficiency of the railway network by virtue of the Railways Act 1993. Operational efficiency is affected by delays to train services, timetable disruptions, compensation payments to train operators and reduced scope for enhancing services, increasing speeds, or reducing journey times. When trains are delayed or services suspended due to an incident on a line, it almost inevitably affects the wider network.

59. For every incident that requires the suspension of train services NR is required to pay around £100 compensation for every minute of delay for every train that is affected. Following the fatality on Penny's Crossing in May 2022, four services were cancelled, and 1,594 minutes of delays occurred. The total cost of compensation paid was £180,191.

60. Given the number of incidents at Penny's Crossing which resulted in delays, stoppages, or suspension of services, the closure of the crossing would promote operational efficiency on the ECML and given the importance of the line, potentially the wider rail network.

Conclusions on the Extinguishment Order

61. I am satisfied that it is expedient to extinguish the footpath across Penny's Crossing having regard to all the circumstances, and in particular to whether the crossing can be made safe and the arrangements for appropriate barriers and signs.

Rights of Way Improvement Plan

62. The ROWIP for the area includes policies for developing the rights of way network by creating new routes and improving safety when the network interacts with railways. The Orders would meet the aims of these ROWIP policies.

63. Where NR wish to close level crossings the ROWIP aims to ensure that the alternative route is not less convenient or not substantially longer than the route to be extinguished. The OMA accepts the alternative route is longer than the crossing to be extinguished. However, they do not consider this to be a negative factor given the recreational nature of the footpath and the opportunity to connect with other rights of way.

Public Sector Equality Duty

64. The alternative routes are level and in a similar condition to the existing footpath network with no gates or stiles. There are no steps on the footbridge on Rossington 8. There are four gates on the section of Rossington 10 proposed to be extinguished which could restrict access to people with mobility issues. The

alternative route would be longer than the existing footpath proposed to be extinguished. However, use of this footpath network is predominantly for recreational purposes and most path users access it from Rossington 8 rather than Rossington 10. Therefore, I consider the PSED to be discharged.

Overall Conclusions

65. Having regard to these and all other matters raised in the written representations I conclude that the EO and CO should be confirmed.

Other Matters

66. References were made to the safety of, and proposals for other crossings in the area, but I am only able to consider the Orders before me.

Formal Decision

The Creation Order

67. I confirm the Order.

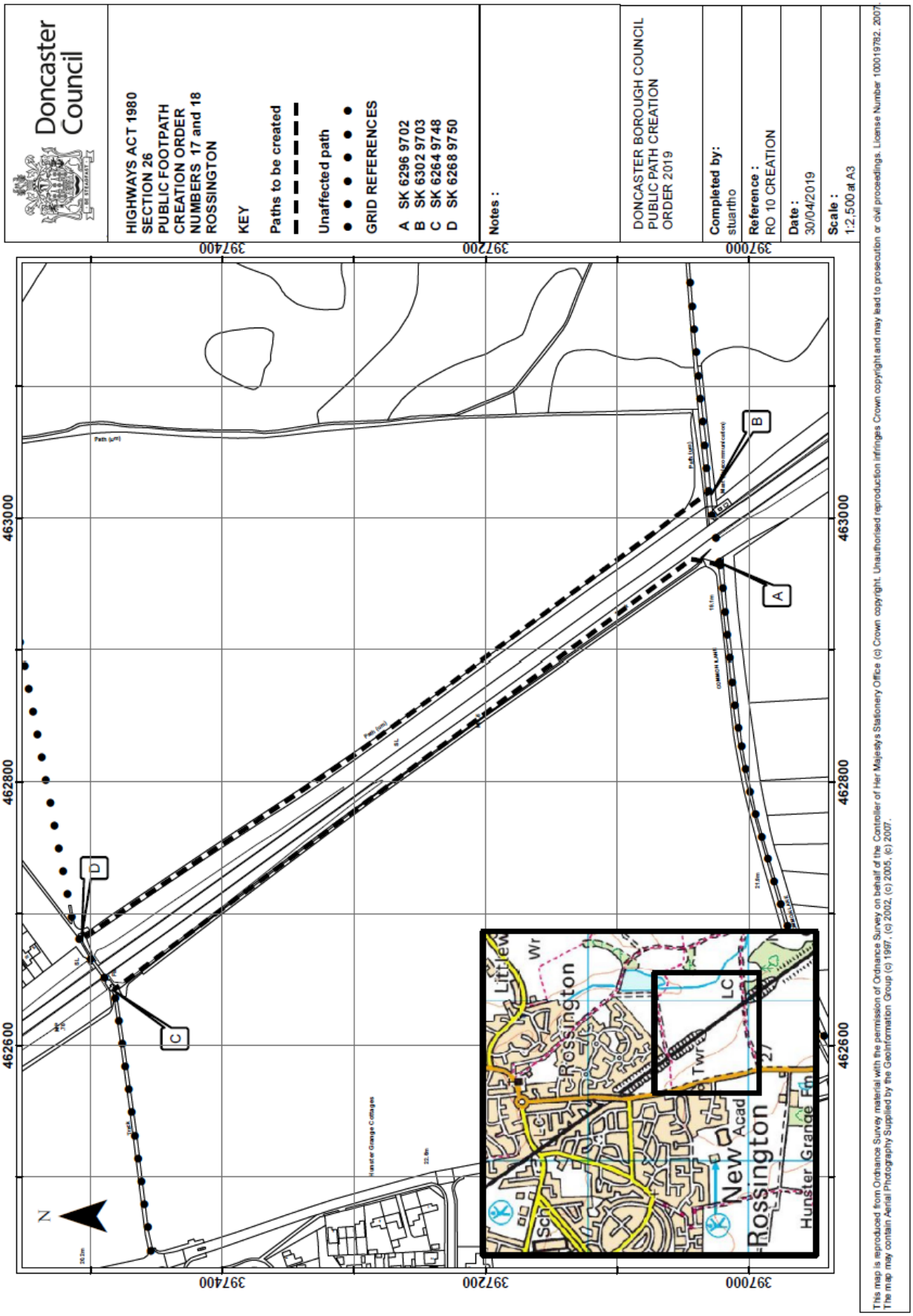
The Extinguishment Order

68. I confirm the Order.

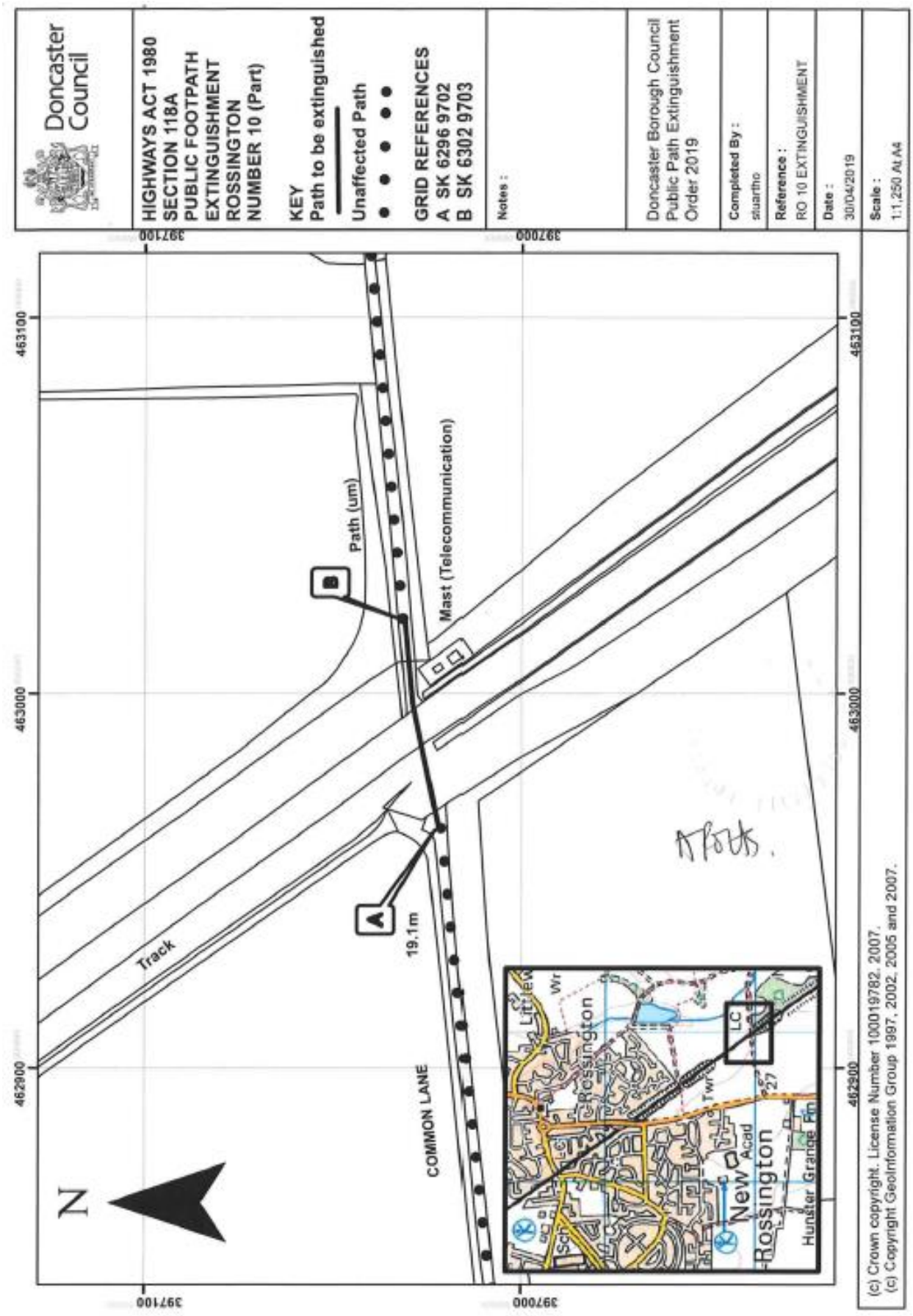
Claire Tregembo

INSPECTOR

Creation Order Plan



Extinguishment Order Plan



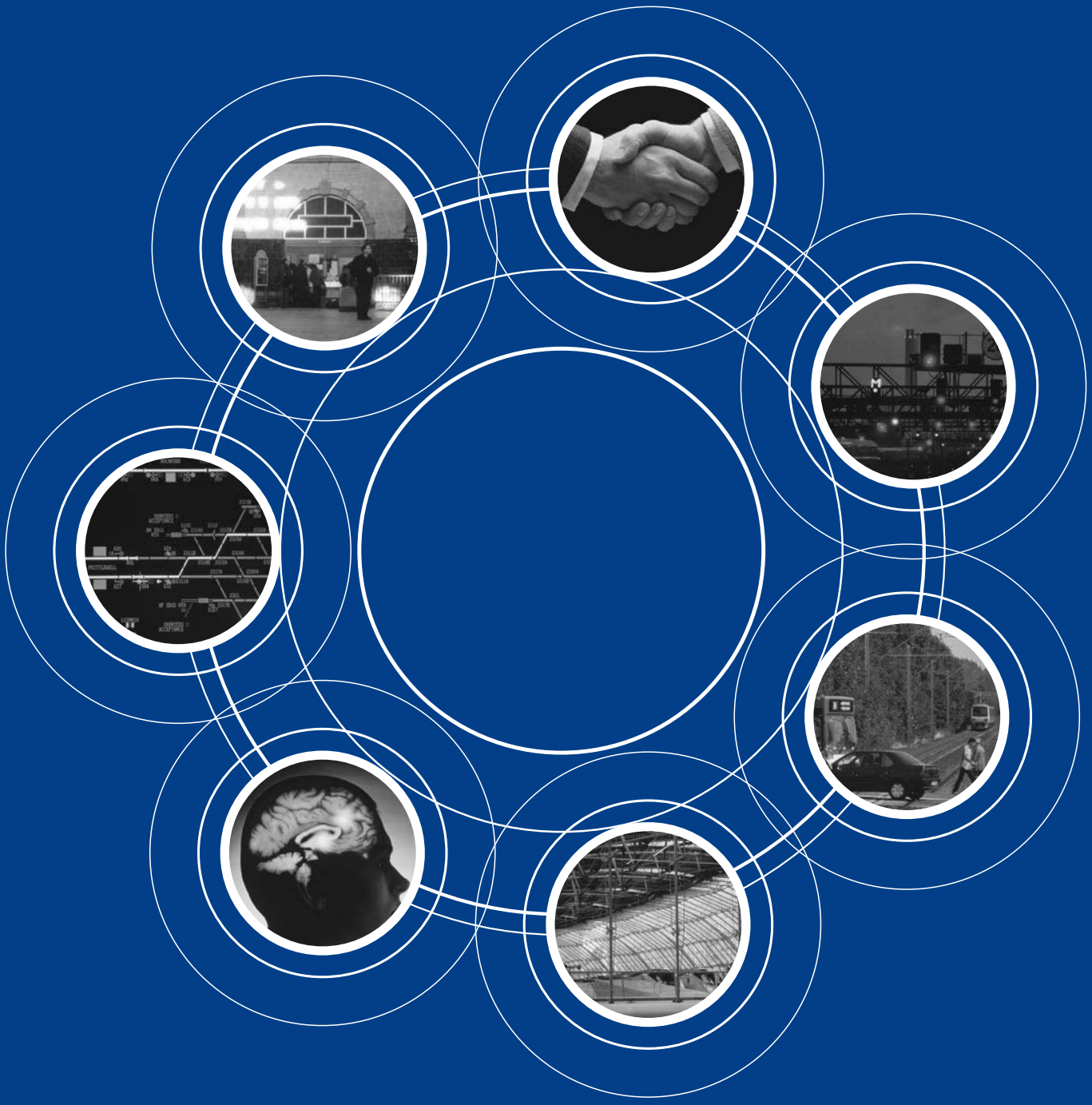
JG4

Rail Safety & Standards Board

Research Programme

Operations

Understanding human factors and developing risk reduction solutions for pedestrian crossings at railway stations



Arthur D Little

T730

Understanding human factors and developing risk reduction solutions for pedestrian crossings at railway stations

Final Report to
Rail Safety and Standards Board

January 2009

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Glossary

ALARP	As Low As Reasonably Practicable
ALCRM	The All Level Crossings Risk Model
ATC	Another Train Coming
DfT	Department for Transport
FP	Footpath
FWI	Fatalities and Weighted Injuries
HAZOP	Hazard and Operability
HMRI	Her Majesty's Railway Inspectorate
MSL	Miniature Stop Light
ORR	Office of Rail Regulation
RAIB	Rail Accident Investigation Branch
RSPG	Railway Safety Principles and Guidance
RSSB	Rail Safety and Standards Board
SFAIRP	So Far As Is Reasonably Practicable
SMIS	Safety Management Information System
SPC	Station Pedestrian Crossing (general term to encompass all sub-types of Station Pedestrian Crossing described below)
SPC-G	Station Pedestrian Crossing with Gates
SPC-GL	Station Pedestrian Crossing with Locked Gates
SPC-GMSL	Station Pedestrian Crossing with Gates and Miniature Stop Lights
SPC-MSL	Station Pedestrian Crossing with Miniature Stop Lights
SPC-Open	Station Pedestrian Crossing (Open)

Executive summary

Background

The Rail Accident Investigation Branch (RAIB) investigation into station pedestrian crossings, with reference to the fatal accident at Elsenham Station Crossing in December 2005 [28], placed recommendations on the industry to review aspects of station crossings. Recommendation 4 calls for the Office of Rail Regulation (ORR), in consultation with Network Rail and the Department for Transport (DfT), *"to undertake a comprehensive review of existing guidance relating to the design of station pedestrian crossings."* RSSB volunteered to lead the industry's response to this recommendation, and this [draft] report, based on work conducted over a six-month period from May to November 2008, is the outcome of the research to support this response.

To meet the requirements specified in Recommendation 4, this project involved:

- A comprehensive review of existing guidance relating to the design of station pedestrian crossings
- Consideration of the existing and potential roles of current technology
- Understanding of current good practice in relation to human factors, and the extent to which this is being delivered with current design
- Review of fencing to direct passengers to the route that gives optimum sighting of trains and signs
- Review of the potential benefits of providing additional stop lights on the far side of the crossing from an approaching user (so-called 'back-to-back' lights)
- Review of options for 'another train coming' warnings
- Identification and assessment of a number of other options to change design and enhance crossings

The broad aim was to identify good practice, leading to consideration of promulgation. A core part of the project was the identification of areas of risk not currently covered by suitable/appropriate mitigations with a view to identifying suitable mitigation measures.

It is important in reading this report to understand that Network Rail, and their predecessors, have been investing in risk management at level crossings, including those at stations, for many years. As such, the review is not starting from scratch, but considers the wide range of current controls that are in place, and looks at what could potentially improve them.

Key points relating to the approach include:

- The work was subject to close supervision and guidance from a project Steering Group, whose role it was to provide a review of task deliverables, provide technical advice, and to help obtain relevant data and documentation
- Senior oversight of the project was provided by representatives from ORR, DfT and Network Rail – the Senior Steering Committee
- The work included a review of available standards, guidance, research and literature to ensure that current practices were understood, and ideas for improvements used elsewhere were identified
- Two workshops were carried out with industry representatives, subject matter experts (railway operations, human factors, signalling, level crossings) as well as non-experts (to provide a fresh insight and to protect against relying on the long-held views of experts)
  - HAZOP: a systematic review of the tasks involved in using station pedestrian crossings, and identifying the hazards that can arise at each task considering the environmental, design and behavioural influencing factors. The output was a comprehensive record of hazards that can occur, and what factors can make these more or less likely to arise
  - A risk mitigation workshop to review hazards from the HAZOP against 24 options for mitigating risk
  - The outputs of both workshops were submitted to the Steering Group for review
- Consistent with latest good practice in risk evaluation and decision-taking [1], the approach has considered a wider range of issues than just risk and cost-benefit analysis. It has combined cost-benefit analysis, risk assessment, and a qualitative review of the wider implications of the various options to reduce risk, including impacts on railway operations, accessibility requirements, noise implications for railway neighbours, practicalities and a separate behaviour impact assessment

The authors of the report recognise that the most effective risk control at station pedestrian crossings, indeed any crossings, is to reduce the level of use, ideally removing the need for the crossing altogether. At station pedestrian crossings grade separation (footbridges or underpasses) can, if correctly implemented, remove the need for the crossing altogether and facilitate its closure. Reducing the level of use can be achieved through revising the layout of facilities such as ticket machines so that 'unnecessary' traverses over the crossing are avoided. Notwithstanding the above, the report does not consider these options in detail, since they are not related to the *design of the crossing* – which is the purpose of the review.

Context: current guidance, design and controls

There are 97 station pedestrian crossings on Network Rail managed infrastructure. Of these, 19 are fitted with MSLs, a further 13 have gates locked by railway staff and the remainder are open or have self-closing gates at which the user is responsible for making a decision on whether or not to cross.

Railway Safety Principles and Guidance (RSPG) [2] [1] provide general design principles for level crossings, but do not specifically cover station pedestrian crossings. For MSL crossings (by inference including those at stations), guidance is provided on positioning, equipment, associated signs, and the principles for control and signalling.

Guidance on stations is provided by RSPG Part 2 Section B [3] although this confusingly refers only to 'barrow crossings' and makes no mention of station pedestrian crossings[2]. The guidance within the section on 'barrow crossings' refers to crossings where *'…there is unescorted passenger or public use…'* noting that *'…miniature red/green lights should be provided.'*

The pending update to RSPG would seem a good opportunity to clarify the confusion over the relevance of guidance to station pedestrian crossings.

Overall, the review finds that there is little in the way of guidance, design principles and standards that are specific to station pedestrian crossings. What is available is limited to high-level basic principles for the provision of signs, and, optionally, audible and visual warnings.

This lack of guiding principles for station pedestrian crossings does not present a problem in terms of risk, but does potentially mean that station pedestrian crossing design aspects do not necessarily follow good practice in a consistent way.

Conclusions

The key conclusions of the work are presented below, followed by further supporting conclusions in three categories: 'risk', 'current design, guidance and controls', and 'options for further and enhanced risk control'.

[1] At the time of this study, currently being reviewed and redrafted by ORR

[2] 'Barrow' crossings are those crossings that are to be used only by railway staff, or by members of the public only when escorted by railway staff. Station Pedestrian Crossings (the subject of this report) provide access to platforms for passengers, who do not require escort by members of staff

It is important to note that these conclusions are based on the current population of station pedestrian crossings, and their associated collective risk. It is understood that Network Rail is seeking opportunities to close some of the highest risk crossings, which could have a significant impact on the overall risk profile. Should this be achieved then the residual risk at remaining crossings would be lower, and consequently some options become less viable due to the lower incremental safety benefits that could be achieved.

The review provides a response to Recommendation 4 of the RAIB report [28] and as such includes an up-to-date understanding of human factors, and potential use of new technology in developing effective solutions. It has specifically investigated the four options for risk control raised in Recommendation 4 (fencing, gates, back-to-back lights, and another train coming warnings), and gone considerably beyond this to consider a wide range of other options including several which would be novel to the rail industry in Britain.

Key conclusions

- Many options for improved risk controls would offer only a marginal impact on safety risk; the decision to cross still lies with the user and there remains the potential for error or deliberate misuse with a resultant risk. There is no 'silver bullet' that will significantly reduce the risk at all station pedestrian crossings that can be considered practical and affordable
- The review has identified and assessed 24 options for further risk reduction, considering their potential behaviour impact, cost, safety benefit, practicalities, and wider implications such as noise, accessibility and railway operations. Of these, 13 emerge as being *potentially* viable, although most would be subject to location specification assessment, and in some cases further clarification of safety benefits and behaviour impact:
  - Automatic-locking gates *(very specific cases only for example where closure of high risk crossings cannot be achieved)*
  - Fencing: platform ramp edges
  - Fencing: channel user to the decision point
  - Fencing: chicanes
  - Back-to-back lights
  - Side-to-back lights (the same as back-to-back lights with different orientation)
  - Providing MSLs
  - Additional audible warnings at MSLs triggered by user presence at the decision point
  - Station announcements giving warnings about crossing
  - Platform announcements giving warnings about crossing
  - 'Another train coming' combined active visual and audible warning
  - Providing audible warning at existing MSLs where there is currently none

  - Provide crossing surface as a single block of distinctive colour to mark the decision points and more clearly distinguish the crossing from platform areas

- If it were possible to close a small number of the highest risk crossings, the total overall risk at station pedestrian crossings could be reduced significantly (for example replacing the top five crossings with footbridges could in theory reduce total risk by around 50%). This is based on a coarse assessment using available data, and Network Rail will be better equipped to make such assessments using All Level Crossings Risk Model (ALCRM) once it has been fully populated

Supporting conclusions: risk

- The average annualised risk at station pedestrian crossings is around one fatality in three years. The low number of incidents makes quantified assessment of the risk subject to a large degree of uncertainty. To put this risk into context, station pedestrian crossings contribute about 3% to the total risk at all level crossings
- The risk to pedestrians at station pedestrian crossings is higher *per crossing* than at all other types of crossing, including footpaths. While station pedestrian crossings contribute to 3% of the risk (see above), they represent only 1.3% of the total number of crossings
- A preliminary assessment indicates that providing miniature stop lights (MSL) reduces risk, as expected but not previously demonstrated. Using user census counts provided by Network Rail for the ALCRM, it appears that the risk per traverse at station pedestrian crossings with MSLs is broadly similar to that at station pedestrian crossings with no MSL. However, the average number of trains passing over SPC-MSLs is higher, so per moment[3], the risk at SPC-MSLs appears to be approximately half, or less, than at crossings without MSLs
- Although the industry has moved away from individual risk as a measure on which to base an assessment of 'risk acceptability', it is interesting to note that the individual risk at station pedestrian crossings appears to be lower than the limit previously considered to be 'intolerable' by the UK Health and Safety Executive[4]

Supporting conclusions: current design, guidance and controls

- The guidance on level crossings provided in RSPG does not include station pedestrian crossings. The update to RPSG could usefully provide clarity on which elements of the guidance are appropriate for station pedestrian crossings. An

[3] Moment is a measures of exposure, defined as 'traverses per day x trains per day'

[4] Previously, an annual risk of fatality above 1 in 10,000 has been considered to be the limit of tolerability for members of the public

opportunity could also be taken to correct the terminology in Part 2 Section B, guidance on stations, referring only to barrow crossings which is misleading

- There are no guidance or standards specific to station pedestrian crossings which set out the principles for design to reduce risk, beyond the basic requirement to provide signs, and optionally visual and audible advance warnings of train approach. Providing such guidance or standards could help over time as station works are carried out, to improve consistency with design
- Signs and instructions provided at many station pedestrian crossings fall short of human factors good practice (clarity, positioning, conspicuity, conflicting messages, text rather than graphics). RSSB could consider further research into improving signs (although their actual influence on risk is not clear)

Supporting conclusions: options for further and improved risk controls

- Very few mitigation options address the user errors and violations that could have the most serious consequences. Automatic-locking gates (which would be new to the British railway, but have been used to a limited extent elsewhere) are the only option under consideration that targets user errors and violations, and could significantly reduce the likelihood of both
- Options with high costs are difficult to justify on the basis of cost-benefit analysis, at all but the highest risk station pedestrian crossings. This is because of the low average risk per crossing
- In general, and consistent with other level crossings, risk controls are best implemented on a risk basis, using the best available techniques for risk assessment that are available (i.e. ALCRM once this has been calibrated)
- Other options have been assessed and concluded as not viable, due to some combination of poor safety benefit, little or negative behaviour impact, excessive cost, significant practical difficulties, and wider implications including accessibility and railway operations
  - Providing more self-closing wicket gates
  - Replacing MSLs with an illuminated pictogram
  - Providing MSLs that are larger than the current design
  - Replacing MSLs with a ‘push-button and wait’ design similar to PUFFIN crossings on roads
  - Replacing MSLs with traffic light type lights
  - Active tactile warnings
  - Enhancing MSLs with lights in the floor at the decision point
  - Providing audible messages at self-closing gates without MSLs
  - Deliberate obscuration of the sight lines (to enhance risk perception)
  - Painted markings on the platform/crossing to direct users approach

  - Reconfiguring stations so that the crossing is in the middle, rather than t the end of, the platform

- Back-to-back lights appear to provide some benefit over and above MSLs located only on one side of the crossing. It is not clear what the extent of the safety benefits would be without further fundamental research (e.g. pilot testing 'before and after') but at this stage the best estimate is that justification in terms of cost-benefit would be marginal. One possibility would be to provide back-to-back lights at new installations, or where current installations are life expired
- Indications are that at the 20% highest risk station pedestrian crossings, MSLs would need to reduce risk by about 60% from the current level to be justified in terms of cost-safety benefit. As discussed in above, there is some evidence that MSLs do provide a reduction in risk although whether such a risk reduction is achievable is not clear without further fundamental research
- The current cost of providing MSLs is a barrier to their more widespread fitment and consequently a barrier to reducing the overall risk at station pedestrian crossings (and other passive crossings). Use of alternative technologies, such as predictors, to produce a lower cost active warning, could potentially overcome this barrier. Even in the event that such a design is shown to have a lower integrity than the current design of MSL, this need not necessarily be a barrier – a globally lower level of risk may be achievable as it would be cost-effective to install more active warnings owing to their lower cost
- Although outside the scope of this report, the assessment of options for risk control at station pedestrian crossings could be used to inform improvements at footpath crossings (i.e. those not at stations). Options that might have similar benefits at footpath crossings include:
  - Fencing: channel user to the decision point
  - Fencing: chicanes
  - Back-to-back lights / side-to-back lights
  - Providing MSLs
  - Additional audible warnings at MSLs triggered by user presence at the decision point
  - Providing audible warning at existing MSLs where there is currently none
  - Provide crossing surface as a single block of distinctive colour to mark the decision points and more clearly distinguish the crossing from platform areas

1. Introduction

1.1 Background

Level crossings have been, and continue to be, a focus of significant risk management effort by Network Rail and also a key component of the DfT funded research programme managed by Rail Safety and Standards Board (RSSB) on behalf of the rail industry. This considerable effort has paid off; not only is risk at level crossings lower than in previous years (for example, the early 1990s), but the management system for level crossings is now highly robust, with a risk model being used (the All Level Crossings Risk Model - ALCRM) and an organisation in place for delivery and design of improved crossings on a consistent national basis.

Nevertheless, accidents do continue to occur. Accidents such as the double fatality at Elsenham Station Crossing in December 2005 are a reminder that, despite risk controls being in place, interactions between members of the public and the crossing equipment, railway and surrounding environment are susceptible to human behavioural influences that can lead to errors and violations. The key is to understand these influences so that risk can be controlled to a level that is SFAIRP (So Far As Is Reasonably Practicable).

Station crossings are understood to have a unique set of hazards (as highlighted in previous industry research for RSSB on station and barrow crossings [21]). In particular these are associated with influencing factors such as:

- The *motivation* to cross (to catch trains) which can lead to deliberate violations such as crossing when it is not safe to do so, or errors in crossing such as failing to check for trains
- The *increased probability* that the train and user of the crossing will actually approach the crossing at the same time (i.e. arrival is not random but biased towards conflict)
- The chance that *two trains* might arrive at the crossing within short succession, so even if a pedestrian carefully avoids crossing before the first train, they are ‘caught out’ by a second
- *Obscuration* of a second train by the stationary or slowly moving first train
- *Distraction* of users from the tasks associated with crossing safely (crossing in groups, mobile phone usage etc.)

The Rail Accident Investigation Branch (RAIB) investigation into station pedestrian crossings, with reference to the fatal accident at Elsenham Station Crossing in December 2005 [28], placed recommendations on the industry to review aspects of station crossings. Recommendation 4 calls for the Office of Rail Regulation (ORR), in consultation with Network Rail and the Department for Transport (DfT), *"to undertake a comprehensive review of existing guidance relating to the design of station pedestrian crossings."* RSSB volunteered to lead the industry's response to this recommendation, and this report is the outcome of the research to support this response.

To meet the requirements specified in Recommendation 4, this project involved:

- A comprehensive review of existing guidance relating to the design of station pedestrian crossings
- Consideration of the existing and potential roles of current technology
- Understanding of current good practice in relation to human factors, and the extent to which this is being delivered with current design
- Review of fencing to direct passengers to the route that gives optimum sighting of trains and signs
- Review of the potential benefits of providing additional stop lights on the far side of the crossing from an approaching user (so-called 'back-to-back' lights)
- Review of options for 'another train coming' warnings

The remit of the project called for a comprehensive review of existing guidance relating to the design of station pedestrian crossings including a review of current technologies. The broad aim was to identify good practice, leading to consideration of promulgation. A core part of the project was the identification of areas of risk not currently covered by suitable/appropriate mitigations with a view to identifying suitable mitigation measures.

1.2 Scope and objectives

The objectives of the project were:

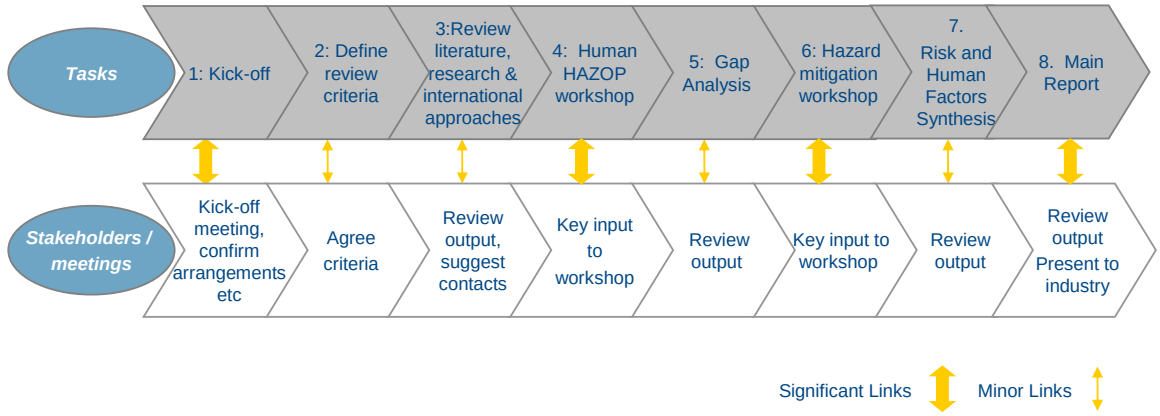
- To undertake a **comprehensive review of existing guidance** relating to the design of station pedestrian crossings (station pedestrian crossings). This included a review of current technologies and the modern understanding of human factors. This review had to include each of the following (to meet recommendation 4 of the RAIB Rail Accident Report [28]):
  - Use of fencing to direct passengers to approach the crossing by the route that best enables them to observe the approach of trains whilst drawing their attention to any associated signs or stop lights
  - An assessment of the safety benefits and disbenefits of providing pedestrian gates on the final approach to station pedestrian crossings
  - 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)
  - Research into the most effective means of providing users with an active warning to alert them of the approach of a second train. This should encompass research into the effectiveness of visual displays and/or voice messages as a means of alerting users
- **Compare the existing guidance within the industry with current good practice** in this area in the fields of human factors, engineering and risk assessment as found in the comprehensive review

The scope included desktop review of current risk and available literature, guidance, standards and relevant research, site visits, and a fresh review of the hazards that can occur, and what options might be available to mitigate them. Prior to this project there had already been research into risk at station and pedestrian crossings [21], and Miniature Stop Light crossings [7]. It is important to recognise that whilst this project acknowledges and makes reference to these previous items of work, it approached the project with no preconceptions that the risk was fully understood, or that all risk controls had been previously thought of.

1.3 Approach

The work described in this report has been carried out over a 6 month period from May to November 2008, following the approach outlined in Figure 1 below:

Figure 1: Overview of approach



Key points relating to the approach include:

- The work was subject to close supervision and guidance from a project Steering Group. Four formal meetings were held with the Steering Group throughout the project, and all key outputs were submitted to the Steering Group for review
- Senior oversight of the project was provided by representatives from ORR, DfT and Network Rail – the Senior Steering Committee
- Before conducting a review of available standards, guidance and literature, criteria were defined against which the contents of each document could be evaluated and codified (Task 2). This provided an additional degree of rigour to the review, and provided a means of classifying the outcome
- The work included two workshops with industry representatives, subject matter experts (railway operations, human factors, signalling, level crossings) as well as non-experts – the latter to provide a fresh insight and to protect against relying on the long-held views of experts:
  - The first workshop, a HAZOP (Task 4), involved conducting a systematic review of the tasks involved in using Station Pedestrian Crossings, and identifying the hazards that can arise at each task considering the environmental, design and behavioural influencing factors. The output was a comprehensive record of hazards that can occur, and what factors can make these more or less likely to arise

- The second workshop reviewed the main hazards emerging from the HAZOP, and evaluated various different options for mitigating risk against each of these
- The outputs of both workshops were submitted to the Steering Group for review

Consistent with latest good practice in risk evaluation and decision-taking (such as that in RSSB's own guide on taking safe decisions [1]), the approach has considered a wider range of issues than just risk and cost-benefit analysis. The high degree of uncertainty as to the risk associated with station pedestrian crossings means that quantified approaches alone are not adequate. The work has therefore combined cost-benefit analysis, risk assessment, qualitative review of the wider implications of the various options to reduce risk, practicalities and a separate behaviour impact assessment.

2. Current design and controls

This chapter provides an introduction to the design and controls provided at station pedestrian crossings in Great Britain, and summarises the standards and guidance that are available. It is structured as follows:

- Population of station pedestrian crossings
- Existing standards and guidance
- Signs
- Warning times
- Whistle boards
- Miniature stop lights
- Self-closing gates and other barriers
- Lockable gates

2.1 Population of station pedestrian crossings

Station pedestrian crossings provide access to platforms for passengers. They are commonly confused with 'barrow' crossings which are intended for use only by railway staff, or by passengers only if escorted by railway staff.

There are 97 station pedestrian crossings on Network Rail managed infrastructure. Just over half of these have no barriers or active protection systems. 19 have miniature stop lights (MSL) which provide active warning of an approaching train. 14 are fitted with self closing gates which are opened manually by the user, and 13 have gates that are locked by a member of railway staff when a train is approaching (Table 1).

Table 1: Station pedestrian crossings by sub-type

SPC sub-type		Number
SPC-MSL	Station pedestrian crossing with miniature stop lights	19*
SPC-GL	Station pedestrian crossing with locking gates	13
SPC-Open	Station pedestrian crossing with no barriers (open)	50
SPC-G	Station pedestrian crossing with self closing gates	15
TOTAL		97 **

Source: RAIB report [28]

*Note: Includes 1 SPC-MSL with gates

**Note: of the total, 11 are provided with whistle boards

2.2 Existing guidance and standards

The overarching guidance on design aspects of all types of level crossings is provided in the Railway Safety Principles and Guidance, Part 2 Section E [1] (hereafter for simplicity referred to as RSPG). Railway Group Standards provide the minimum safety requirements for the rail industry; those relevant to level crossings include GI/GN7612 [14] and GE/RT7012 [13]. There is relatively little in the way of guidance relating specifically to the design and risk management of station pedestrian crossings in either RSPG or Railway Group Standards.

A range of other documents (none of which are specific to station pedestrian crossings) provide standards and guidance relating to specific aspects of level crossings such as signage, and the design and functional requirements for Miniature Stop Lights (MSLs).

Key aspects relevant to station pedestrian crossings, or inferred as being relevant when it is not specifically stated, are provided in Table 2.

In summary, there is very little guidance that is specific to station pedestrian crossings in any of the documentation available. The guidance and standards are limited to high-level basic principles for the provision of signs, and, optionally, audible and visual warnings. Network Rail requires all level crossings to be risk assessed, using the ALCRM and supporting expert judgement. On this basis, decisions are made as to suitable levels of upgrade and improvements, such that risk is managed SFAIRP (So Far As Is Reasonably Practicable).

Table 2: Standards and guidance relating to station pedestrian crossings

Document	Reference	Aspects relevant to station pedestrian crossings
RSPG, Part 2 Section E, 1996	[1]	See text §2.1
RSPG, Part 2 Section B, 1996	[3]	See text §2.1
Specification: Provision, Risk Assessment and Review of Level Crossings, NR/SP/OPS/100, 2006	[50]	Sets out mandatory requirements relating to determining safety requirements for new level crossings, and risk assessment and management processes for new and existing level crossings. Requires risk assessments for all level crossings (including station pedestrian crossings) using ALCRM. Appendix A provides the "minimum combinations of control measures" for new crossings, including station and pedestrian crossings: • No barrier, signs or monitoring required • Signs required • Active visible warnings sometimes required (where insufficient warning times) • Audible warning for second trains considered where level of risk justifies it • Only permissible for trains speeds at or below 100mph
The Private Crossings (Signs and Barriers) Regulations, 1996	[46]	Specifies requirements for the signs (including MSLs) at 'private' crossings including footpaths (not specifically station pedestrian crossings • Minimum size of MSLs 60mm diameter • Specification for STOP, LOOK, LISTEN sign (black lettering on white background with red border) • MSL instructions signs (Red STOP Green CLEAR)
Railway Group Standard GI/RT7012, 2004	[13]	Outlines the mandatory requirements for the design, construction, inspection, maintenance, operation and decommissioning of crossings. Recommendations specific to station pedestrian crossings pertain to the positioning of pedestrian gates on footpath crossings (gates must open away from the railway and not be less than 1m wide), the design of signage (it should be of 'suitable' design). Signs at station foot crossings "explaining to the railway passenger how to proceed over the crossing shall be provided, sited to avoid conflict with other signs for the public'. Also describes the positioning of MSLs and the inclusion of whistle boards on approach to station pedestrian crossings

Document	Reference	Aspects relevant to station pedestrian crossings
Railway Group Guidance Note GI/GN7612 Miscellaneous Guidance on Level Crossings, 2005	[14]	Gives guidance on signs for level crossing users, with cross references to other documents. Mentions footpath crossings, but not specifically station pedestrian crossings. Gives design guidance on geometry and surfaces, but nothing specific to station pedestrian crossings
Railtrack Line COP: Technical Guidance, RT/E/C/11600, 2000	[45]	Large document with some references to SPC-MSLs • Audible warnings – minimum of two required. Directed to crossing area – accounting for local characteristics and noise etc • Audible warnings – where residential areas exist provide for volume control, day/night settings/directional adjustment • Two distinct tones required if two trains strike in - second tone activated when first train reaches the crossing • Bi-directional controls should be provided • Track circuits supplemented by a minimum of duplicated treadles • MSL - warning period at least 5 seconds greater than traverse time between decision points • Minimum 20sec warning
Railtrack Line Specification RT/E/S/10031 – MSL Unit, 1997	[43]	Gives detailed mandatory design details for the MSL unit as used on a level crossing. Key points: • Weather and corrosion resistant, protected reasonably against vandalism • Mounted on a post with adjustment to optimise sighting • 25 years service life expected • Enclosure surfaces matt black • Matt black hoods nominally 200mm length • Details on performance of lights themselves • Auxiliary lamps provided (in case of failure) • Reliability of equipment (not lamps) MTBF = 175,000 (20 years) • Gives detailed humidity, vibration, temperature resistance etc

Document	Reference	Aspects relevant to station pedestrian crossings
Network Rail Company Specification, RT/E/S/10039 Operation Requirements for MSL Crossings, 2003	[44]	Requirements for MSLs including at FP. Makes extensive reference to RSPG although the specification is defined as mandatory • At FP crossings "each MSL is located on the far side of the railway with lights facing across the railway towards the user" (referenced to RSPG Clause 248). Signal sighting committee have to ensure that lights can be seen by the user • Bi-directional controls provided unless authorised by Network Rail (RSPG Clause 257) • No fail "wrong side" • Audible warnings provided if local circumstances require (ref RSPG Clause 154) taking into account noise nuisance • Sequence: (1) green light extinguished (2a) audible warnings sounds (if provided) (2b) red light illuminated for 20sec (these are minimum times required). Warning must be at least 5sec longer than traverse time accounting for the mobility of users (RSPG clause 147) • Gives requirements for signalling arrangements – important ones include (1) special controls so that a train standing at a signal at danger does not call the warning sequence, (2) a train permitted to pass over the crossing if the signal clears after striking in cannot reach the level crossing in less than the minimum warning time(3) station MSL – special stopping/non-stopping controls may be required to ensure warning sequence is not initiated for excessively long periods (justified by risk assessment)
Railtrack Guidance Note RT/CE/C/008/230GN – Model Causes for Specifying Civil Engineering Works, 1997	[42]	Guidance for specifies to produce contract documentation. Most guidance is relevant for public vehicular crossings, with only two requirements for footpath (not specifically station) crossings (1) warning signs for users to stop, look, listen (2) MSLs may be provided (3) telephones with associated signs
Railtrack Line Specification RT/CE/S/040 – Level Crossing Surface Systems, 1997	[41]	Gives specifications for surfaces of level crossings including tread depth, life of 15 years, non slip performance etc. However – scope is for public vehicular crossings - it also says that for private or footpath crossings surfaces of lower specification are allowed. Therefore, doesn't provide specific restrictions or guidance for any new surfaces. For example, the sub system must be capable of tolerating rail gauge tolerance of +/- 6mm. Impedance of at least 2000 Ohms is also required. Crossings surfaces require type approval by Network Rail

RSPG [2] provides guidance on the design of level crossings. At the time of this report, an ORR review of the RSPG was under way but not completed. The purpose of this review was to update the guidance in line with developments such as improved risk assessment processes (ALCRM), to incorporate elements of good practice with design and risk management and to accommodate some innovations with level crossings which had been anticipated for some time.

The contents of RPSG, both in its current and future version, are not mandatory. However, many of the specific elements of RSPG are consistent with those in other Network Rail documentation, some of which are mandatory.

RSPG does not specifically include guidance on station pedestrian crossings. It is not clear whether or not the guidance on footpath crossings and crossings with MSLs is intended to be applied to station pedestrian crossings, although it may be interpreted as being the case, given that from a basic design perspective there are many similarities. For footpath crossings, guidance is provided on signage, the requirement for adequate warning times, and the provision of gates (see § 2.2 below). For MSL crossings, guidance is provided on positioning, equipment, associated signs, and the principles for control and signalling.

RSPG Part 2 Section B [3] provides guidance on stations. Unfortunately, this confusingly refers only to 'barrow crossings' and makes no mention of station pedestrian crossings[5]. The guidance within the section on 'barrow crossings' refers to crossings where *'…there is unescorted passenger or public use…'* noting that *'…miniature red/green lights should be provided.'* This highlights the concern raised in previous work carried out by Arthur D. Little for RSSB on the risk management of station and barrow crossings [21], which identified that there was significant confusion within the industry over the terms 'barrow' and 'station' crossing.

The pending update to RSPG would seem a good opportunity to clarify the confusion over the relevance of guidance to station pedestrian crossings (see Chapter 5).

[5] 'Barrow' crossings are those crossings that are to be used only by railway staff, or by members of the public only when escorted by railway staff. Station Pedestrian Crossings (the subject of this report) provide access to platforms for passengers, who do not require escort by members of staff

2.3 Signs

Over half (50/96) of station pedestrian crossings are equipped with signs only, and are designed such that the user is responsible for making a decision as to whether or not it is safe to cross. A further 14 are provided with self-closing gates, but also have similar signs giving instructions to the user.

Railway Group Standard, Requirements for Level Crossings, GI/RT7012 [13] states that for station foot crossings signs *'explaining to the railway passenger how to proceed over the crossing shall be provided, sited to avoid conflict with other signs for the public'*.

The key sign instructing on safe use of the crossing is the 'Stop, Look, Listen' sign as shown in Figure 2, and which is specified in The Private Crossings (Signs and Barriers) Regulations [45]. Such signs are also commonly used at crossings fitted with Miniature Stop Lights (see §2.6 below).

Figure 2: Stop Look Listen sign at Kennett station pedestrian crossing



Stop Look Listen sign at Kennett station pedestrian crossing (Anglia). At this location this standard sign is supplemented by a warning of second trains approaching.

Source: Arthur D. Little

In reality, the type and number of signs in use varies considerably by location and, at some locations, between different sides of the same crossing. The extent to which this adds to safety risk is questionable, but from a human factors perspective it is clear that some aspects of the current signage at station pedestrian crossings are not optimal.

- At some locations there is considerable visual clutter, either from the large number of signs or from other surrounding infrastructure, which can detract from the primary safety messages 'stop, look, listen'
- Safety-related signs are not always conspicuous due to their size, colour and position relative to other signs
- A mixture of safety instructions and other information could be seen as confusing or conflicting. An example are warnings not to trespass posted at the crossing

It could be argued that some signs that are provided are counter to the principle in GI/RT7012, to '*avoid conflict with other signs for the public'*. One example of this is the signs provided to discourage trespass, which are frequently located on the same post as the instructions for using the crossing (Figure 2).

2.4 Warning times

Where no MSLs are provided, the user is required to make a decision on whether or not it is safe to cross. This decision is made based on looking and listening for approaching trains. This requirement is articulated in RSPG (although it relates to footpath and bridleway crossings, since Station Pedestrian Crossings are not specifically covered by RSPG):

> 138 Users are expected to use reasonable vigilance to satisfy themselves that no trains are approaching the crossing before they start to cross the line, and to cross as quickly as possible

The railway therefore has to maintain warning times that make it possible for a user to make this decision safely; again this is articulated in RSPG:

> Users should have sufficient time from first seeing or being warned of an approaching train to cross safely

RSPG states that a crossing speed of 1.2 m/s should be used for pedestrians. Traverse time is increased to account for user mobility, prams and bicycles. This equates to a requirement to maintain warning times of up to at least 9.5 seconds at crossings on double tracks (distance 11.3m).

Where adequate sighting times cannot be maintained, then additional equipment may be provided, in the form of whistle boards (see §2.5 below) or MSLs (see §2.6).

2.5 Whistle boards

Safe use of station pedestrian crossings relies on the user making a decision about whether it is safe to cross, based on stopping, looking and listening for approaching trains. Where sight times are not sufficient to allow a user to traverse the tracks safely, whistle boards may be provided, which instruct train drivers approaching the crossing to sound the horn to give an audible warning of their approach. According to information available to us, 11 station pedestrian crossings are provided with whistle boards.

Previous research carried out by Arthur D. Little on behalf of the rail industry [10] indicated that compliance with whistle boards at footpath crossings (not station pedestrian crossings) varied by location, and was around 93% on average – with some evidence for significantly lower levels of compliance at night. Previous research led by RSSB [10] highlighted the significant ill effects suffered by railway neighbours, particularly since the introduction of rolling stock onto the network which had louder horns. To mitigate this, the industry took the decision to implement a night-time quiet period, effectively changing the Rule Book requirement for the horn to be sounded at whistle boards between 2330 and 0700. Although this was applied to all crossings with whistle boards and not specifically to station pedestrian crossings, clearly the 11 station pedestrian crossings with whistle boards were included in this change.

2.6 Miniature stop lights

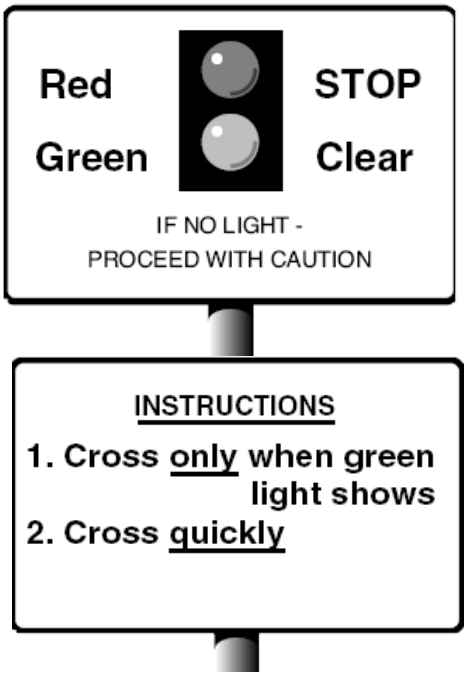
19 station pedestrian crossings on Network Rail managed infrastructure are provided with miniature stop lights (MSLs) that provide a visual warning that a train is approaching. RSPG gives the following general description of MSLs:

> 246 Miniature stop lights consist of red and green lights. They can be used at user-worked crossings, footpath crossings and bridleway crossings. The green light normally shows, but an approaching train automatically changes the lights to red. Signs instructing users to cross only when the green light shows should be provided

The lights and one example of the associated signs are shown in Figure 3. There are some variations in the wording on both the backplate of the lights and on the instructions sign. The lights show a green aspect which is extinguished when a train strikes in, at which time the red aspect is shown, no less than 20 seconds before the train arrives at the crossing.

Specific design requirements for the MSL unit and its operation are provided in Railtrack and Network Rail Line Specifications [43], [44] (see Table 2). In summary, there is a minimum light diameter specified, a general requirement for bi-directional control, a durability that gives 25 year life, hoods to prevent sun glare, and the provision of audible alarms in conjunction with the lights if local conditions allow.

Figure 3: MSL and associated instruction sign



Source: Railway Safety Principles and Guidance, Part 2 Section E, Guidance on Level Crossings, Health and Safety Executive

Of particular interest to this study (because of the need to examine the possible benefits of 'back-to-back' lights) is that at footpath crossings, RSPG suggests that MSLs are located on the far side of the railway and face inwards towards an approaching crossing user. Most of the 19 station pedestrian crossings with MSLs are configured this way, although there are exceptions such as Bolton-upon-Dearne (Figure 4) at which the MSL is on the nearside, and angled towards users as they approach from the platform.

There are advantages and disadvantages to each arrangement, and acknowledging this, HMRI's current position is understood to be that it does not take action to encourage the arrangement for the MSL on the far side as described in the current RSPG. The reason that RSPG currently favours the far side is that the user can check the status of the crossing when they are traversing.

Figure 4: MSL far-side versus nearside



Littleport SPC-MSL. Here the MSLs are in the most usual configuration – i.e. on the far side angled towards an approaching crossing user. Because of the lens hoods and fall-off of the intensity of the light at an angle, the aspects cannot be seen until the user is three or four metres from the crossing.



Bolton-upon-Dearne SPC-MSL. In an alternative configuration, the MSLs are positioned on the nearside facing towards users as they move down the platform towards the crossing. Consequently, the aspect can be clearly seen for a significant distance back along the platform – well before the user reaches the crossing, but the user cannot recheck the aspect when crossing. A potential hazard is that the user may check the aspect early, and then fail to recheck when they are nearer to the crossing, by which time the aspect may have changed to red.

Source: Arthur D. Little site visits

Figure 5: MSL instructions



Located in the usual place, instructions are hard to read due to the font size and distance across the tracks.



Some locations, such as the example here at Woodlesford SPC-MSL, have repeated instructions on the nearside.

Source: Arthur D. Little site visits

2.7 Self-closing gates and other barriers

Self-closing gates are provided at 15 station pedestrian crossings. The gates are designed with no latch (so as to not trap users) and swing closed after being opened. Many are located adjacent to road crossings, and provide a means of access over the crossing for pedestrians.

Because the gates are not locked, pedestrians are free to cross at any time so in this sense the protection offered by the gate is simply that it provides a barrier to slow down movement onto the crossing. The requirement to cross safely remains with the user, as at crossings with no gates (SPC-Open). As such, the associated signage is typically similar.

Normally, similar gates are provided on both sides of the railway, although there is at least one exception to this at Crowle SPC (Figure 6).

At SPC-Open, many crossings have no form of barriers. At some locations, however, chicanes are provided to give a partial barrier on approach to the crossing (for example Woodlesford Figure 6). These do not provide a significant redirection of pedestrians to look ‘up and down’ the tracks, but simply provide a partial barrier to accessing the crossing.

Figure 6: Gates and barriers



Crowle Station lies at the end of a cul-de-sac, and as such there is only one entrance and exit, which is provided with a self closing gate. Behind the gate to the left is a walkway leading to the nearside platform and straight ahead is the station pedestrian crossing leading to the far side platform. There is therefore no gate on the other side of the crossing (not shown on the picture).



Chicanes at Woodlesford. These do not direct the users approach to look 'up and down' the line, rather provide a partial barrier to slow access to the crossing.

Source: Arthur D. Little

2.8 Gates lockable by railway staff

Station pedestrian crossings fitted with lockable gates (SPC-GL) are provided with a locking mechanism that is operated by the signaller or crossing keeper such that the gates are locked when a train is approaching. The locked gates provide a physical barrier to pedestrian who might otherwise choose to ignore a warning or fail to look for a train.

These have been provided at 13 crossings where it has been practicable to do so, for example at Foxton where there is an adjacent full-barrier road crossing operated locally by the signaller. The principle is that when an approaching train is detected, for example by 'striking in', the operator checks that pedestrians are clear of the crossing, and then engages the lock. When the train has cleared the crossing, the gates are unlocked and pedestrians may proceed.

An important point to note is that the pedestrian gates are *not* interlocked with the signalling system (with one exception at Seamer), meaning that they can be locked and unlocked manually by the operator at any time. For example, at Foxton, because the closure time of the main full barrier road crossing can be several minutes when two trains pass through, the operator may unlock the pedestrian gates to allow them passage, even though the road crossing remains closed.

Essentially, at SPC-GL the decision to cross or not to cross is removed from the user, and transferred to the railway, although it is interesting to note that at some locations a 'Stop Look Listen' sign is also provided (see Figure 7).

Figure 7: Lockable gates at Foxton



Locking gates at Foxton, alongside the full barrier manually controlled road crossing. The gates are locked electro mechanically by the operator in a building adjacent to the crossing.

Source: Arthur D. Little

3. Risk profile

This chapter reviews the safety risk at station pedestrian crossings by considering:

- Accident history and overall risk
- Risk compared to other crossing types
- Risk variation by protection arrangements
- Risk factors

3.1 Accident history and overall risk

A review of available accident data shows that there have been five pedestrians struck at station pedestrian crossings in 14 ½ years, 1994 to mid 2008, (Table 3). All are reported to have resulted in fatality and so based on this historical data, the total annualised risk is 0.34 FWI/yr. RSSB report a risk of 0.44 FWI/yr in the Risk Profile Bulletin version 5.5, which compares closely; it is expected that the difference reflects the fact that this may include barrow crossings which are excluded from this project, and / or the number of years over which the risk is calculated. Indeed, it must be understood that risk calculated on this basis is subject to variation depending on the number of years over which incidents are considered, and the random nature of events. In particular, two out of the five reported fatalities were the result of the single incident at Elsenham in 2005 which has changed the risk, viewed from a historical perspective, quite significantly.

Of the accidents listed in Table 3, 3 out of 5 (60%) of the fatalities involved the arrival of a second train (the incidents at Gomshall and Elsenham).

Table 3: Station pedestrian crossing accidents 1994-2008

Location	Date	Fatality/ies and injuries	
Chorley SPC	23 July 1994	1 fatal	Adult male
Tywyn SPC	6 August 2002	1 fatal	Elderly male
Gomshall SPC-G	21 August 2004	1 fatal	Male, crossed behind stationary train – was in a group the rest of whom waited
Elsenham SPC-GMSL	3 December 2005	2 fatal	Two school girls

Source: data provided by Network Rail, compiled from Safety Management Information System (SMIS)

3.1.1 Sensitivity of risk estimate to period of data

We have gone back further in the accident record, by supplementing the data above with information on station pedestrian crossing accidents contained within the Annual Railway Safety Reports published by Her Majesty's Railway Inspectorate. Such an approach, however, gives less certainty that all events are captured. For example the narratives provided in the reports do not always cover all accidents in any given period, so there is a strong possibility that additional accidents may have occurred. Since 1982 there is known to have been a total of eight pedestrians struck (the five from 1994 to 2008, plus three earlier accidents), giving an average annual fatality rate of 0.27 FWI/yr. The additional three accidents were:

- 1989 a fatality at Elsenham (elderly lady). The crossing had MSLs
- 1991 a fatality at Wrabness (elderly man). Again the crossing had MSLs
- 1993 a serious injury at Farnborough North MSL. A teenager was seriously injured (resulting in an amputated foot) after alighting from one train, and following others over the line, crossing behind the stationary train, to be struck by a non-stop train on the other line

For the purposes of the analysis presented in this report, we will use the five incidents that are known to have occurred since 1994, as there is a higher degree of certainty over the annualised risk - 0.34 FWI/yr, and this is higher than the value derived from the extended period and as such is more cautious.

3.1.2 Uncertainty over number and outcome of accidents

With such a small number of incidents over several years, an estimate of risk derived from historical accident rates is subject to a large degree of uncertainty. It would have been quite possible that an additional accident could have occurred in addition to the four reported in Table 3, or for one of the accidents which resulted in a single fatality to have resulted in a double fatality (such as the one that occurred at Elsenham). Equally, fewer accidents could have occurred. For the purposes of sensitivity analysis, therefore, upper and lower cases on this basis are considered as follows:

- Mid-point: 0.34 FWI/yr
- Reasonable upper case: 0.41 FWI/yr (+20%) based on one more fatality having occurred in the period 1994 to mid 2008
- Reasonable lower case: 0.28 FWI/yr (-20% based on one fewer fatality having occurred in the period 1994 to mid 2008

Of course, it would not be unreasonable to extend the upper and lower sensitivity cases further (for example, two additional accidents in the upper case, or two fewer in the lower case). For the purposes of this report, those presented above are deemed to be appropriate in demonstrating a degree of uncertainty around the level of risk determined from the historical accident rate.

3.2 Risk at station pedestrian crossings compared to other crossing types

To put the total risk at station pedestrian crossings into context, a comparison to the risk at other types of crossing is shown in Figure 8 (taken from the Risk Profile Bulletin version 5.5).

- There is a total of 11.1 FWI/yr across all crossing types. The risk at station pedestrian crossings represents only 3% of this total
- The total annualised risk at other footpath crossings (i.e. those not at stations) is approximately 4 FWI/yr – almost 10 times greater than that at station pedestrian crossings (although of course there are a much larger number of these than SPCs – about 25 times more – see below)
- The risk to pedestrians at other crossings (neither station pedestrian crossings nor footpath crossings) is some 3.2 FWI/yr; about seven times higher than at station pedestrian crossings
- Turning to road vehicle accidents at level crossings, the risk is characterised by a relatively higher overall accident rate, but fewer fatalities per collision (owing to the protection provided by the vehicle)

It is useful to compare the annualised safety risk at station pedestrian crossings with other footpath crossings normalised by the number of crossings in each group. This shows station pedestrian crossings to have some two to three times the risk per crossing than other footpath crossings:

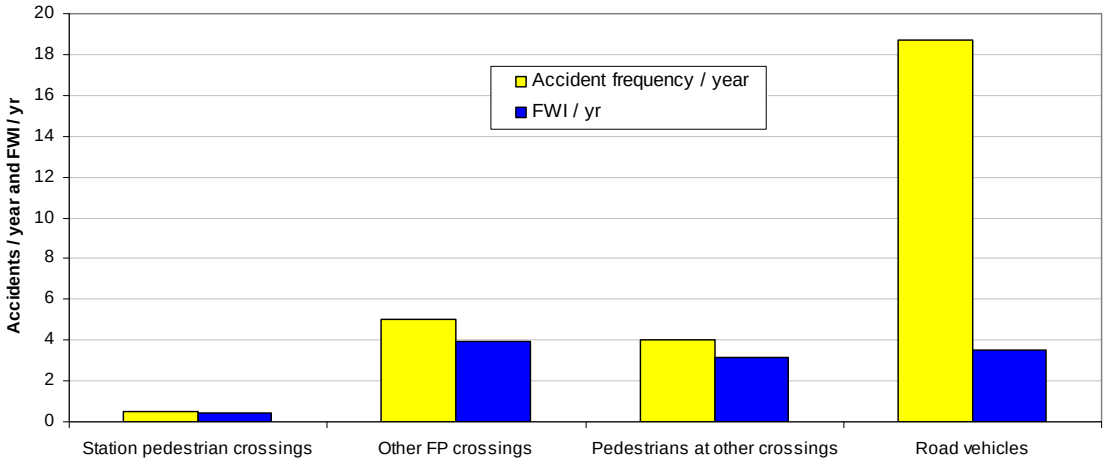
- For station pedestrian crossings, the average risk per crossing[6] is 0.0046 (0.44 FWI/yr ÷ 97)
- For other footpaths, the average risk per crossing is around 0.0017 (4 FWI/yr ÷ 2290)

[6] Based here on the figures from the Risk Profile Bulletin for ease of comparison with other crossing types

This is shown in Figure 9 which indicates the normalised pedestrian risk at other crossing types (footpaths and all other crossings), and also the normalised road vehicle risk at all crossings. Even considering the lower sensitivity case (described above in section 3.1.2 above), station pedestrian crossings would still show approximately double the risk of that at footpath crossings, and about four times the risk than that at other crossings. (Of course, there is also uncertainty over the level of reported risk at other crossings in Figure 9, although these are not examined in detail here. Also, the level of uncertainty is less significant than at station pedestrian crossings due to larger numbers of crossings, and larger number of accidents).

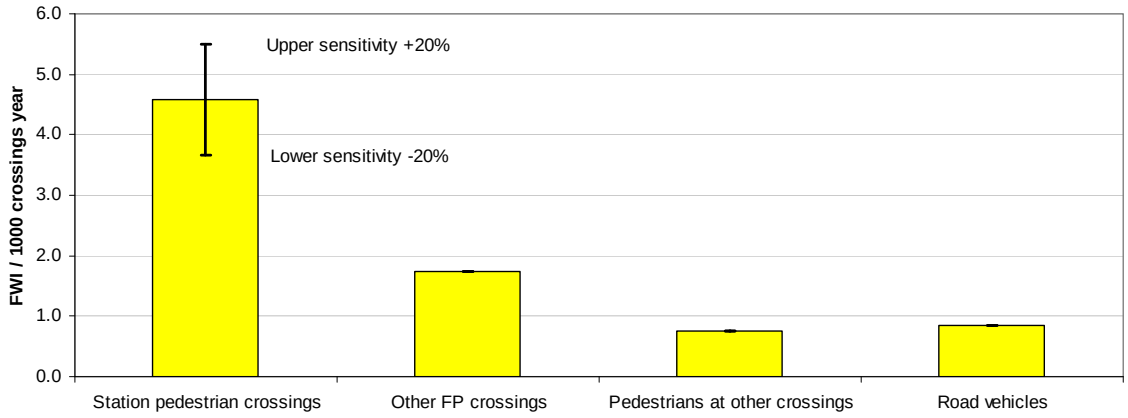
The higher risk per crossing at station pedestrian crossings is not unexpected and potentially arises from two sources. Firstly, the average level of use at station pedestrian crossings is likely to be much higher than the average use at other footpath crossings, many of which are rural and see only very light use. Secondly, it is known that there are risk factors present at station pedestrian crossings that are less of an issue at other footpath crossings (these are discussed in detail in §3.4).

Figure 8: Comparison of accidents and risk by crossing type



Source: Risk Profile Bulletin 5.5

Figure 9: Comparison of risk by crossing type – normalised by number of crossings



Source: Risk Profile Bulletin 5.5.

Upper sensitivity assumes 1 more fatality having occurred in 14.5 years of data, lower sensitivity considers 1 fewer fatal accident having occurred in 14.5 years of data – see section 3.1

3.3 Risk variation by protection arrangements

At the time of writing this report Network Rail had completed a large number of risk assessments at all crossing types, including station pedestrian crossings, using the ALCRM. However, the algorithms within the model were not yet calibrated meaning that risk results from the ALCRM were not available that would provide accurate levels of absolute risk, or that could be compared by individual crossing or types of crossing.

For this study, it has therefore been necessary to use the historic accident records (discussed in § 3.1.2) to investigate how risk could vary across the three main categories of station pedestrian crossing[7]:

- Station pedestrian crossings that have only self-closing gates or are open (SPC-G, SPC-open)
- Station pedestrian crossings provided with miniature stop lights (SPC-MSL)
- Station pedestrian crossings that have lockable gates (SPC-GL)

There have been no recorded accidents at SPC-GL crossings, so for the purposes of this comparison the risk is not explored further. It cannot be inferred that the risk is literally zero at these crossings, but given the historic record of no accidents combined with the significantly higher level of protection offered, it is reasonable to argue that risk is markedly less than at station pedestrian crossings without lockable gates.

[7] In carrying out this analysis we have retained data for Elsenham, although a footbridge has been provided. We consider this an appropriate approach since the accident data used includes the fatalities that occurred at Elsenham

The results comparing SPC-MSL and SPC-Open/G are shown in Table 4. Figure 10, shows graphically the risk per crossing, which is more than two times higher at SPC-MSLs than at SPC-Open/G.

However, for a fair comparison the risk needs to be normalised. Two of the key known risk factors at level crossings are the utilisation (pedestrians per day) and the number of trains, both of which were provided by Network Rail, from the inputs to the ALCRM risk assessments[8].

- The average level of *utilisation* of SPC-MSLs is 75% higher than at station pedestrian crossings with no active warning (218 versus 124 traverses per day). This is not surprising since Network Rail (and formerly Railtrack and British Rail) will have invested risk controls such as MSL at crossings which see a higher level of use
- The average *moment*, which factors in the number of trains *and* the utilisation, (moment = pedestrians x trains per day) is four times higher at SPC-MSL than at SPC-Open and SPC-G (19,414 versus 4,785 - Table 4). In other words, they are more heavily used by pedestrians, *and* have more trains passing over them
- So, when normalising *by moment*, the risk at SPC-MSLs is *44% lower* than at SPCs without MSLs (the first pair of bars "base case" in Figure 11). We consider that normalising the risk per moment provides the best means of comparison as it removes the effect of the relative number of pedestrians and trains between different crossing types

For the same reasons as explained in § 3.1.2, where a sensitivity analysis was applied to the total risk at SPCs, here it is helpful to apply a sensitivity analysis to the risk at SPC-Open / Gs compared to the risk at SPC-MSLs to check the robustness of the results. Five cases are presented in Figure 11 alongside the base case:

- A: the double fatality that occurred at Elsenham (SPC-MSL) could have occurred instead of one of the single fatality accidents at any of the other crossings (all SPC-Open/G). Therefore, the impact of the double fatality is transferred to the SPC-Open/G; correspondingly the risk per moment at SPC-MSLs would be comparatively even lower than the base case – the double fatality at the SPC-MSLs having become a single fatality

[8] Of the 97 SPCs on Network Rail infrastructure, pedestrian and train usage data was available for this study for 71 crossings

- B: one more fatality occurred at SPC-Open/G (no change at SPC-MSL). As discussed in § 3.1.2, with the overall low number of incidents across station pedestrian crossings, it would not have been at all remarkable had one more fatal accident occurred in the past 14 ½ years (from which the data is drawn). Had an additional accident occurred at an SPC-Open/G then of course by comparison SPC-MSLs would show an even lower relative risk per moment than the base case
- C: one more fatality occurred at SPC-MSLs (no change at SPC-Open/G). Had an additional fatal accident occurred at a SPC-MSL, then the relative risk per moment at SPC-MSLs would still be lower (albeit marginally) than that at SPC-Open/G
- D: one more fatality occurred at SPC-Open/G and one less at SPC-MSL. This shows the same result as Case A – i.e. the SPC-MSL appears to have significantly lower risk per moment
- E: one more fatality occurred at SPC-MSL and one less at SPC-Open/G. This is the only sensitivity case considered where, per moment, the risk at SPC-MSLs would be higher (marginally) than at non-MSL crossings

So in summary, a comparison of station pedestrian crossings with and without MSLs indicates that, per moment, risk is lower at SPC-MSLs in all but one sensitivity case (and here the risk is only marginally higher and requires one more accident to have occurred at SPC-MSLs *and* one fewer at other crossings). There is therefore reasonable confidence that MSLs do provide a tangible safety benefit at station pedestrian crossings. Even if one more accident had occurred at SPC-MSLs, by comparison they would still be lower risk per moment than other station pedestrian crossings.

The design purpose of MSLs is to provide warning of trains where there is insufficient sighting, but they may also have benefits even when sighting is adequate, as they provide an extra source of information on the crossing status. This level of redundancy provides extra protection to the user and is elevated further still where there is an associated audible alarm to alert even those who are not paying attention. To establish whether MSLs provide significant safety benefits at user worked crossings, fundamental research would be required (which is currently being planned by RSSB in a research project).

Table 4: Comparison of risk between SPCs with only gates or open and SPCs with

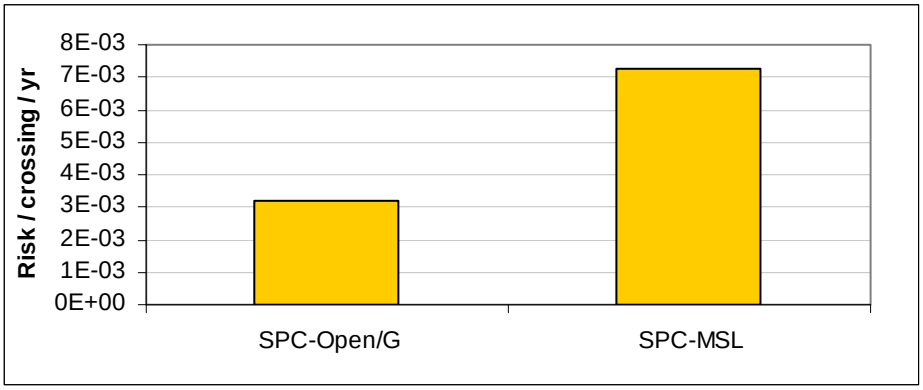
SPC type	No. crossings	FWI 1994-2008	FWI/ crossing/ yr	Average daily moment [9]	FWI/ moment/yr	Estimated individual risk/yr*
SPC-Open & SPC-G	65	3	0.003	19,414	1.8×10^{-9}	2.3×10^{-5}
SPC-MSL & SPC-GMSL	19	2	0.007	4,785	1.0×10^{-9}	1.8×10^{-5}

*The industry has moved away from individual risk as a measure for comparison against 'acceptability targets' and towards risk acceptability in terms of demonstration that risk is SFAIRP. Nevertheless, it is interesting to compare the levels of risk to those levels which have previously been used by the UK HSE in judging tolerability. This approach considered a risk above 1 in 10,000 per annum as 'unacceptable', meaning that the risk must be reduced to a lower value, regardless of cost. Below this level, the risk was only acceptable if it could be demonstrated that all measures to reduce the risk further were grossly disproportionate in terms of effort and cost, compared to the safety benefits (i.e. satisfaction of SFAIRP). The estimates of risk for both SPC-MSL and SPC-Open/G are both below this 1 in 10,000 threshold

Source: Arthur D. Little analysis, and Network Rail data on crossing use and trains per day. Individual risk estimate assumes 250 traverses per regular user per year as most crossings will not be traversed twice in a single day

[9] Total moment is taken by taking the sum of the total traverses per day at all crossings in the group, and multiplying by the average number of trains per day at crossings in that group

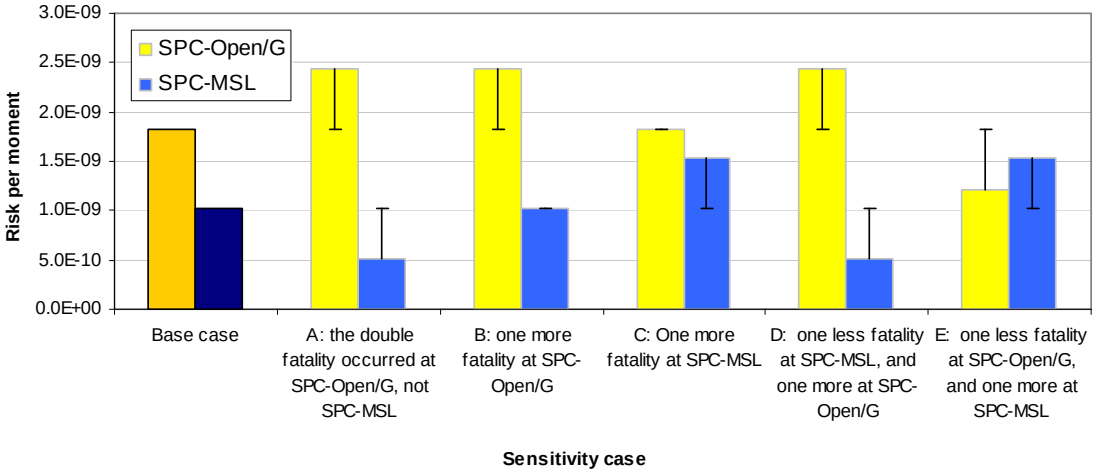
Figure 10: Risk per crossing: station pedestrian crossings with and without MSL



Using the estimates of risk from historical accident data, risk per crossing is more than twice as high at SPC-MSLs than at SPC-Open/G

Source: Arthur D Little analysis of accident data (see § 3.1, plus crossing utilisation data from Network Rail)

Figure 11: Risk per moment: station pedestrian crossings with and without MSL



In all sensitivity cases the SPC-MSL category shows a lower risk per moment than crossings with MSLs, with the exception of one case (Case E) where it is assumed that there was one less fatality at SPC-Open, and one more at SPC-MSL

Source: Arthur D Little analysis of accident data (see § 3.1, plus crossing utilisation data from Network Rail)

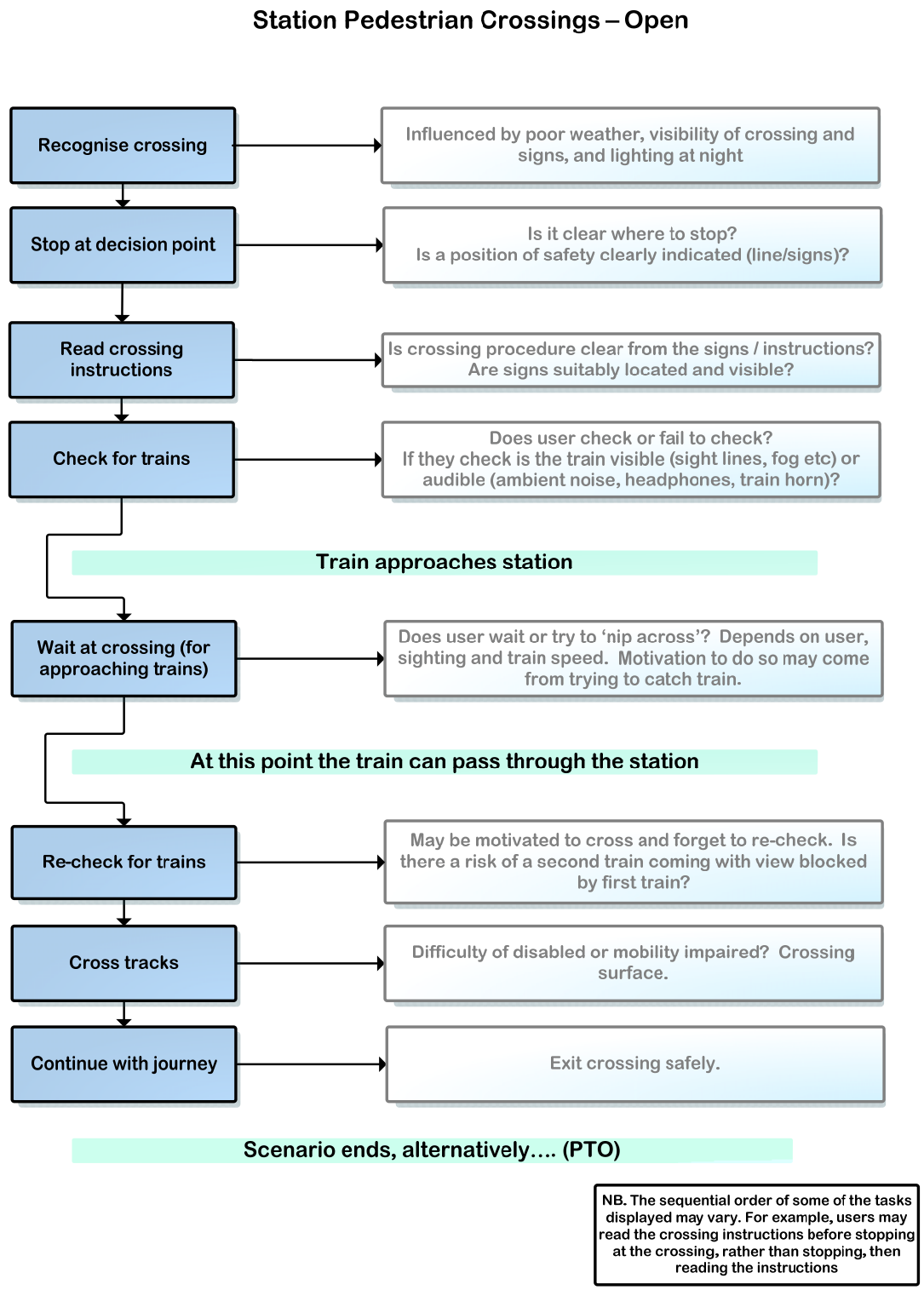
This section provides an overview of the key aspects of crossing, user, and rail characteristics that influence the risk at station pedestrian crossings. These have been developed from various sources:

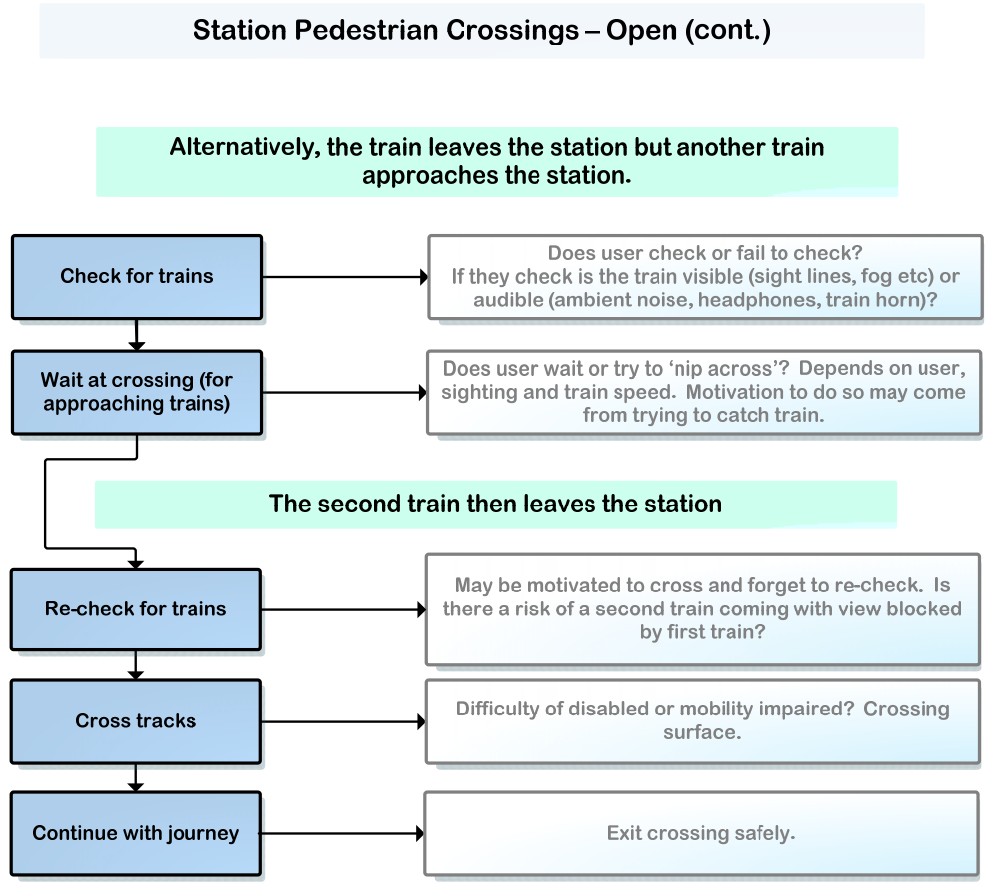
- A rigorous and systematic review of the hazards that can arise at station pedestrian crossings was carried out in a HAZOP session. Discussions were based around a detailed Task Analysis (TA) of station pedestrian crossing use for each of the different types (SPC-GL, SPC-GMSL, SPC-G, SPC-MSL, SPC-open), including single train and another train coming scenarios. (An example task analysis is shown in Figure 12). A series of guide words were applied to the tasks to identify the errors and violations that can occur. Any performance shaping factors were also considered, (i.e. individual and environmental influences upon behaviour, perception and risks associated with crossing use), for example:
  - Weather conditions, in particular visibility
  - The type of pedestrians crossing (i.e. school children, commuters, elderly, disabled etc)
  - Whether people are crossing individually, or within a group of known or unknown individuals
  - Time pressure
  - Familiarity with crossing procedure
  - Attitudes toward risk taking behaviour
  - The role of assumption and familiarity in crossing behaviour

  Consequences of errors and violations were considered in conjunction with the potential for error recovery, e.g. none, poor, marginal, good, complete.

  The HAZOP was attended by 13 industry representatives (from RSSB, Network Rail, DfT, Passenger Focus, National Express, Human Engineering Limited and Arthur D Little). Other organisations were invited but were unable to be represented on the relevant date. The outputs were recorded in a tabular format (provided in Appendix B).
- Site visits to a selection of crossings carried out specifically for this review. The site visits included observation of use by members of the public, and a general review and familiarisation prior to the HAZOP (see above)
- Previous experience of visits to footpath and station pedestrian crossings carried out by members of the case team (in particular previous research carried out in the rail industry [8], [10], [11], [12], [20], [21])

Figure 12: Example task analysis





Source: Human Engineering

3.4.1 Pedestrian moment

Traffic moment (the product of number of trains and number of traverses) is generally regarded as the single most effective indicator of level crossing risk. Common sense dictates that as the number of opportunities for a user and train to conflict increases, then so does the likelihood of an accident. This has been shown to be the case in previous research (for example [20]) and is accepted in the risk modelling approaches of a large number of railways overseas [9].

Likewise, pedestrian moment (product of number of pedestrians and number of trains per day) is a good indicator of risk at station pedestrian crossings. This is difficult to confirm, however, based on historic accidents at these crossings, because the number of accidents is so low. Of the five fatalities that have occurred (Table 3) certainly three have been at crossings with relatively high levels of use (the double fatality at Elsenham, and the fatality at Gomshall).

Among the highest pedestrian moments at remaining station pedestrian crossings are at Woodlesford, Moorthorpe, Normanton station pedestrian crossing and Bolton-upon-Dearne. All are provided with MSLs, in recognition of their relatively high use.

It should be noted that the average level of use at station pedestrian crossings is quite low; many crossings have very light use, either because alternative arrangements for access are provided, or because there is a low number of passengers using the station. Compared to the very busiest footpath crossings providing cross community links (i.e. not at stations) most station pedestrian crossings are comparatively lightly used.

Figure 13: Example of relatively heavily used station at Woodlesford



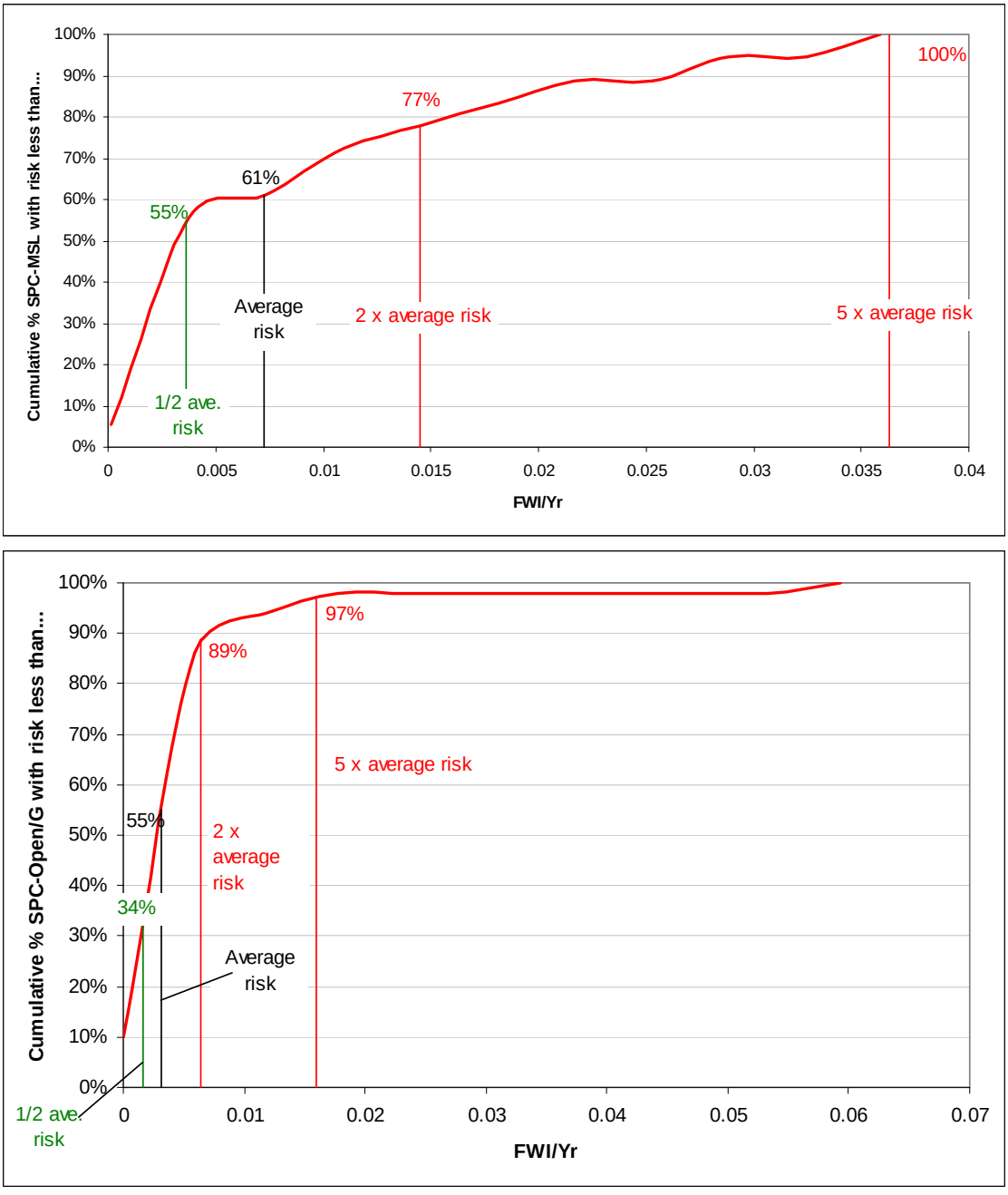
Source: Arthur D Little

ALCRM requires estimates of pedestrian use per day, and train frequency as inputs (amongst many others) for each crossing. Using moment alone as a coarse indicator of how the risk profile may vary over the crossing population gives the results shown in Figure 14. This shows the cumulative distribution of the risk at crossings (SPC-MSL and SPC-Open/G are done separately), and compares this to the 'average' risk. For example:

- 61% of SPC-MSL have less than the average risk, compared to 55% at SPC-Open/G
- Of SPC-MSL, 23% have more than two times the average risk, but none has more than five times the average risk
- Of SPC -Open/G, only 11% have more than two times the average risk. One or two crossings have very high moments relative to the group, and thus have risk more than five times the average

It must be understood that this risk profile is based only on distributing the average risk by pedestrian moment, and does not consider the many complex risk factors that are included in the ALCRM. Nevertheless, it indicates coarsely how the risk is distributed, which is useful in considering whether options for reducing risk further may be justified (Chapter 4).

Figure 14: Station pedestrian crossing risk profile variation by moment



Source: Arthur D. Little analysis based on Network Rail data on pedestrian moment

3.4.2 Decision points and position of safety

The 'decision point' is the location at which a user makes their judgement as to whether or not it is safe to cross. At crossings without MSLs this will depend on the sighting distance, and how this varies with distance from the line. The 'Stop Look Listen' sign is positioned on the near side of the crossing, but its proximity to the line will vary according to local layout. It is not, therefore, a reliable indicator of where the decision to cross should be made.

At crossings with MSLs, there is no requirement for users to check for trains, only to observe the MSL. Consequently, the location of the decision point is more complex, and will vary depending on:

- Whether the user decides to cross solely on the status MSL, or whether in addition the user stops to look for a train before crossing (previous research for RSSB [7] suggests that the majority of users do carry out an additional cursory check for trains, even if the MSL is green)
- At what point in the journey the user can see the lights and the point at which they decide to look. This can vary significantly depending on the location and position of the MSL. With the MSL positioned in the conventional location on the far side and facing across the tracks, the lights can only be seen when the user is fairly close to the crossing. Elsewhere, such as at Bolton-upon-Dearne (see Figure 4) the lights can be seen well before the user reaches the crossing

In summary, the decision point in reality is not a fixed place, but depends on local layout factors and the behaviour, risk perception and other wide ranging characteristics of the crossing user. From observation, there is variation in how and when users look for trains depending on the crossing infrastructure (signs, MSL, marks on the platform and crossing), and the individual. The HAZOP and site visits raised the following issues regarding decision points:

- At many crossings there is a lack of information provided to the crossing user as to where it is safe to make the decision to cross
- A decision point (and one that puts the user in a position of safety) is usually not demarcated, either with a white line or appropriate tactile paving. This can be because at many locations platform geometry makes this very difficult or impossible; often the platform is too narrow to place a mark sufficiently far back from the line
- There is potential for the user to assume that the edge of the crossing surface (or other location) demarcates the safe decision point; this is unlikely to be in a position of safety

- Individuals use different cues to identify decision points; therefore each user at a single crossing may use different decision points
- Where the decision to cross should be made is particularly problematic at open crossings (i.e. no gates) as there is no physical barrier between the crossing user and the railway. There are often no, or contradictory, visual cues indicating where decision points are located

Figure 15: Variation in decision point



Fairly typical crossing layout at Littleport SPC-MSL. No formal decision point is marked as painting a white line suitably far back from the tracks is not practical due to platform width. However, because the crossing surface contrasts with the platform surface this may be construed as the decision point which in this case puts the user too close to the line (not in a position of safety).



At Kennet SPC-Open, the non-slip surface appears to demark the decision point, although this is not intentional (it is too close to the line and as such not in a position of safety).



At Woodlesford SPC-MSL, a white line has been painted to mark the decision point. In practice this does little to influence behaviour of most crossing users.

Source: Arthur D. Little

3.4.3 Warning time

At user worked or footpath crossings without MSLs or telephones (including station pedestrian crossings) the user makes a decision to cross based on their checking for the

approach of a train. Clearly, the sight time that they have from the decision point (see §3.4.2) is a key factor in their ability to make this judgement safely. Conventional wisdom is that providing longer sight times is desirable as the person making the assessment of whether or not to cross is afforded more margin for error. However, previous research carried out for RSSB [20] challenged this conventional view and found that there is actually little evidence for a relationship between sight time and accident occurrence – at least for pedestrians. This was explained by *risk homeostasis* theory – essentially that when people perceive a greater risk (such as a short sight time) they compensate by taking more care to cross safely. Nevertheless, the railway considers a threshold acceptable sight time, below which other controls must be put in place to warn a user of train approach [1]. Two main methods are used at station pedestrian crossings:

- MSLs (provided at 19 station pedestrian crossings)
- Whistle boards (provided at 11 station pedestrian crossings)

3.4.4 Position of MSLs

As discussed in §2.6 there is variation in the location and position of MSLs. Most are provided on the far side, facing towards the approaching user, although there are exceptions such as Bolton-upon-Dearne where the MSLs are located on the nearside (Figure 4).

The location of MSLs has been the subject of discussion for a number of years (see §2.6), and this study confirms that their location does influence the tasks associated with using the crossing.

- Crossing layout, particularly with regard to the position of the lights, can have a large influence on when the user makes the decision to cross
  - Where MSLs are positioned on the far side (typical layout), the font size on the sign means that some users may have difficulty reading the instructions alongside the lights. This may be particularly problematic for vision-impaired and/or colour blind users
  - MSLs positioned on the nearside and angled towards the user's approach (less usual) may encourage a decision to cross to be made earlier than at crossings where the MWL cannot be seen until the user reaches (or is close to reaching) the crossing
- To mitigate the risk that users may not be able to read the instructions, some crossings have a 'repeater' instruction sign on the near side of the crossing (for example, Woodlesford, Figure 5)

- Users may apply an incorrect mental model at an MSL crossing - e.g. they perceive a level crossing to be similar to a road crossing where a red aspect can be shown even when there is no oncoming vehicles
- Drawing from experience of using road crossings, the user may perceive a red MSL as a cue to check for trains rather than a legal requirement to stop

3.4.4 Gates

14 station pedestrian crossings are provided with self-closing wicket gates. These have generally been installed for historical reasons usually associated with providing a boundary to the railway from public areas and not on the basis of safety. Indeed, the HAZOP conducted for this study highlighted doubts that self-closing gates provide overall *safety* benefit.

Gates, such as those at Foxton SPC-GL that are locked by the signaller provide a much higher degree of protection. The gates are closed by the signaller when a train is approaching, who only does so when he/she can visually confirm that no one is trapped on the railway. The gates are then unlocked once the crossing is clear.

The HAZOP conducted for this study identified the following main issues relating to gates:

- It is not clear that self-closing gates at station pedestrian crossings provide any safety benefit
- One benefit of gates is that they slow down certain user groups such as cyclists, or dogs or small children and as such could prevent them going onto the line at danger
- Locking gates can provide a very significant safety benefit as they can prevent many causes of error leading to a pedestrian being on the line when a train is approaching (for example failures to recognise the crossing, failures to stop and look, distraction etc)
- Operation of lockable gates is somewhat flexible, to allow passage over the railway even when the adjacent road crossing is still closed. For example, at Foxton during long road closure sequences due to the passing of two trains, the pedestrian gates may be unlocked for a short period between trains to allow pedestrians to pass over the crossing. Whilst this may be seen as compromising safety it could also be viewed as helping to prevent violation of the crossing (for example vaulting the gates, or jamming them open) due to frustration over long closures
- The user may perceive that the provision of locked gates abdicates their responsibility to check for trains when about to cross; the responsibility is effectively transferred to the signaller or level crossing keeper operating the gates

- The view of the tracks from behind the gate may determine whether users make the decision to cross before or after opening the gate
- The proximity of the gate to the tracks affects user safety if an insufficient refuge is provided inside the gate
- Operating gates can be time consuming, especially for those with encumbrances (or physical impairment). This can extend the traverse time and may increase risk especially if the user fails to recheck for trains once past the gate (This is actually more of an issue where a good view can be afforded behind the gates – i.e. the gate is the decision point)
- At station pedestrian crossings with MSLs and self-closing gates (SPC-GMSL) there is the potential for conflict between the two safety systems, e.g. an unlocked gate versus a red MSL. This could present a mixed message, especially for users who have experience of gated crossings that are locked when trains are approaching. There is potential for the user's attention to be diverted from the most important safety system (i.e. the MSLs) to the operation of the gates

There are no *automatic* locking gates at station pedestrian crossings on the British railway, owing to the concern that users could be trapped between the gates if a train struck in during the traverse. Such gates are, however, used in other countries such as the one that has been on trial at Bentleigh, Australia [38]. To counter the risk associated with being trapped, the configuration here includes an emergency escape route, with a gate that can be opened only from the crossing side via a push button.

3.4.5 Signs and crossing instructions

The HAZOP and site visits identified the following issues regarding signs and instructions provided at station pedestrian crossings:

- It was acknowledged that most people will not read signs (maybe on their first time ever using the crossing - but rarely, if at all, thereafter). This is supported by previous research conducted at user worked crossings [8]
- Signs are often inconsistent, with different signs being presented at station pedestrian crossings of the same type. Differences are thought to stem from several sources: historical regional preferences, signs being added in response to specific problems or perceived problems (e.g. 'cyclists dismount'), or actual differences in the layout of crossings which might mean additional or differently positioned signs are preferable

- The visual environment can be cluttered with redundant or conflicting signage making it harder for the user to pick out relevant instructional signs
- Key information/crossing instructions are sometimes not the most conspicuous signs at a crossing as a consequence of their colour, size, positioning and content

It is worth noting that in comparison to other sectors, such as highways, signs at level crossings (including station pedestrian crossings) are substantially text based with little or no use of modern graphics/symbols. The reasons behind this are believed to be historical. Research into the relative impact of text based and graphical signs has been conducted in other contexts. For example, research for RSSB [4] into anti-trespass signs indicated that a combination of images and text provides the highest impact message to members of the public. A wider review of the literature indicates that, from a visibility standpoint, symbols are superior to text. For road signs, icons permit better 'at a glance' recognition than text [52] and reduce the complexity of visual processing required; this is primarily due to the fact that they can successfully be used to communicate more informatively than other methods while using the same amount or, in some cases, less space [51].

However, symbols require a different kind of comprehension to words. Symbol meaning is either understood intuitively or learned. Sign experts and traffic engineers agree that comprehension is the most important factor in symbol design (ref Dewar, 1988). Ambiguity is more prevalent in images than in text – the picture that *'speaks a thousand words may say a thousand different words to different viewers'* [53].

It may therefore be beneficial for RSSB to conduct research into the most effective and impactful designs for user instruction signs at level crossings.

3.4.6 Non-design issues

There is a wide range of other key issues that affect the likelihood of errors at station pedestrian crossings that are not connected with the design of the crossing or protection arrangements:

- User distractions are myriad (Mp3 players, mobile phones, other crossing users, dogs, children). Previous research [20], [10] has suggested that such distractions are frequently cited in accident reports
- Pedestrians using crossings at stations have additional motivation to cross, even when the crossing is at danger, if they see that the train that they wish to catch is already at the station. A desire not to miss the train provides an additional incentive to take risks when crossing

- The very nature of station pedestrian crossings dictates that there is a greater likelihood than at other crossing types for trains and pedestrians to be in close proximity, since crossing users are usually train passengers

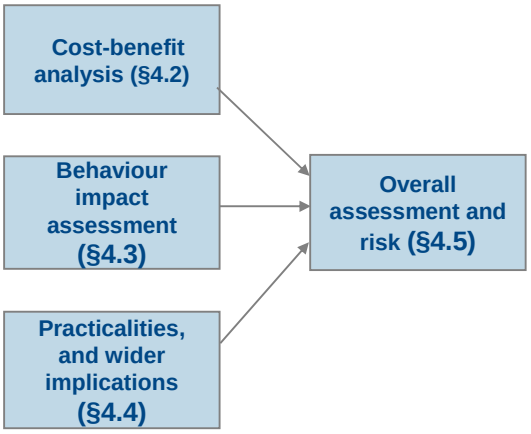
These factors need to be, and have been[10], considered in identifying effective solutions to reduce risk.

[10] A broad range of environmental and other influences were considered in HAZOP and risk mitigation workshop

4. Options for further risk control

This chapter describes the options that have been identified for providing additional risk control at station pedestrian crossings. It then assesses each option in detail using three key approaches:

- Cost-benefit analysis, to evaluate the % risk reduction that would need to be achieved for the cost of the measure to be justified by the improvement in risk
- Behaviour impact assessment, to evaluate in a semi-quantitative way the impact on behaviour at each point of the process of using the crossing
- Practicalities and wider implications
- Overall assessment – pulling together all aspects together with a ranking of risk to draw overall conclusions as to the viability of each option



This combination of approaches has been used since there is significant complexity and uncertainty as to the potential impact on user behaviour of these mitigation measures, many of which are novel or untested in the real world. This broad consideration of issues reflects good practice, going beyond merely attempting a quantitative comparison of safety benefits and costs.

4.1 Identification of options

The RAIB [28] report, recommendation 4, provides the scope of this research with respect to the options to be considered for mitigating risk:

> *...review should include each of the following:*
>
> a. *Use of **fencing** to direct passengers to approach the crossing by the route that best enables them to observe the approach of trains whilst drawing their attention to any associated signs or stop lights*
> b. *An assessment of the safety benefits and disbenefits of providing pedestrian **gates** on the final approach to station pedestrian crossings*
> c. *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**)*
> d. *Research into the most effective means of providing users with an active warning to alert them of the approach of a **second train**. This should encompass research into the effectiveness of visual displays and/or voice messages as a means of alerting users*

The research has expanded on the scope defined in the RAIB report Recommendation 4, and identified and assessed 24 options for mitigating risk in the categories of fencing, gates and back-to-back-lights, as well as a number of other options, including ones novel to the British railway context. With reference to item 'd' of the RAIB recommendation, detailed research [12] into providing 'another training coming warnings' to mitigate the risk of a 'second train' has recently been completed, the findings and conclusions of which are referenced in this report (see §4.5.2).

These 24 options to potentially reduce risk were identified from three main sources:

- Analysis of the 'gaps' between what is currently specified in standards and guidance, and good practice in human factors and hazards identified from the HAZOP session (Table 5)
- Review of literature (research, practice overseas, and from the highways sector). Six of the documents reviewed provided an idea relevant for consideration in this study (Table 6) including automatic locking pedestrian gates, clearer marking of the decision point, another train coming warnings and fencing/chicanes
- From ideas generated in an industry workshop conducted for this project, in which options were identified and systematically assessed for their impact. The workshop was attended by the same participants as the HAZOP session (see §3.4 for a list) with the exception of Passenger Focus who provided a substitute attendee.

Table 5: 'Gap analysis' of current practice versus good practice in human factors

Design aspect	Current practice	Shortfalls in good practice relating to human factors	See report section
Signs	Stop Look Listen signs Various other signs varying by location	Visual complexity Lack of symbols Conflicting messages Lack of information hierarchy/prioritisation	2.3
Decision point	Decision point not usually marked on platform/crossing surface (practicality of platform width) 'Stop Look Listen' sign is the more usual indicator	'Hazardous' area (on or near the line) is not very clearly marked User interprets decision point themselves	2.4
Whistle boards	Can be provided where sighting is limited and MSLs are not provided	Trains may not always sound the horn	2.5
MSL	Move to larger size (LED lights) Usually provided on far side facing railway	Text to be read in association with MSL can be hard to read on far side of tracks Not "graphical" in nature Many do not have associated audible warning (multi sensory warnings are better) Following instructions at MSL not be interpreted as being a legal requirement	2.6
Self-closing gates	Gates for historical reasons regarding boundaries	May not indicate decision point Operation may detract from more important safety checks (for trains, of MSLs)	2.7
Gates lockable by railway staff	Not interlocked with signalling Only used at locations with nearby operator	Reliant on crossing keeper or signaller to operate and therefore subject to inconsistent operation depending on operator's workload/other demands placed upon them Perceived transfer of responsibility to gate operator for crossing safely	2.8
Fencing	Use of fencing highly dependent on station layout Generally not used to direct user to decision point in optimal way	Often fails to guide crossing user to the decision point but is for railway boundary/anti trespass purposes	N/A

Table 6: Ideas for reducing risk identified from literature review

Idea	Title	Organisation/country
Automatic locking pedestrian gates Automatic locking pedestrian gates	The Installation of Pedestrian Gates in New Zealand [6]	Ministry of Transport, New Zealand
	Railway Pedestrian Crossings, Centre Road, Bentleigh [37] [38]	Department of Transport/Arup, Victoria, Australia
Automatic locking pedestrian gates Barriers to channel users Clearer marked decision point Active “look both ways” device	Effects of Pedestrian Treatments on Risky Pedestrian Behaviour [39]	Transport Research Board (TRIS) USA
Decision points more clearly marked	User Behaviour at User Worked Crossings stream A: Determining when the final decision to cross is made [7]	RSSB (Human Engineering), GB
Fences to channel users	Compilation of Pedestrian Safety Devices In Use at Grade Crossings [35]	Federal Railroad Administration, USA
Another Train Coming Warnings	Examining the benefits of 'another train coming' warnings at level crossings [12]	RSSB (Arthur D Little), GB

Table 7 and Table 8 describe each of the 24 options, and list the ‘target’ crossing types to which each option applies. Some options are considered to be appropriate only at crossings currently provided with MSLs, since they require detection of an approaching train.

It should be noted that no additional static signs have been considered as an option to improve station pedestrian crossings, because:

- The station pedestrian crossings visited as part of this research were noted to display a significant number of differing sign warnings, some considered to be confusing
- It would be sensible to review the current signs provided at station pedestrian crossings with a view to rationalisation and standardisation (outside the scope of this research) before any new signs are considered
- Without such a review, any additional sign could be lost in visual clutter, located in a sub-optimal position or potentially conflict with others (e.g. anti-trespass signs)
- A recent study on behalf of RSSB [12] completed a public survey which concluded that word changes to a static warning to inform users of ‘another train coming’ at MWL crossings, gave no benefit. This highlights that any new sign would have to be conspicuous, relevant and meaningful to provide any benefit

Table 7: Risk mitigation options – gates, fencing and back-to-back lights

	Option	Design intent	Target
G1	Self-closing gates	Provide crossings that are currently not provided with gates with a self-closing wicket gate (not lockable)	SPC-Open
G2	Auto-locking gates	Provide gates that automatically lock when a train is approaching	SPC-MSL
F1	Platform ramp edge	Prevent users from taking diagonal route over crossing – forcing them to design decision point	All
F2	Channel user to decision point	Use of fencing to channel users to the design decision point at right angles to railway	All
F3	Chicane	Chicane with barriers at right-angles to tracks to slow user on approach	All
B1	Back-to-back lights	Provide repeat MSL light on nearside and far-side of crossing in 'back-to-back' configuration	SPC-MSL
B2	Side-to-back lights	Same as B1 but with nearside lights angled to face users (i.e. at 90° to far-side lights)	SPC-MSL

Table 8: Mitigation options – novel and other

	Option	Design intent	Target
N1	MSL	Provide a standard MSL at a crossing that currently has no active protection	SPC-Open, SPC-G
N2	Replace MSL with illuminated pictogram	Change circular light to other shape (e.g. human) and remove need for MSL instructions	SPC-MSL
N3	Larger MSL	Increase conspicuity of MSL by increasing size	SPC-MSL
N4	Replace MSL with traffic light type lights	Replace MSL with three aspect (red / yellow / green) traffic light type lights intended to be more recognisable to users	SPC-MSL
N5	Replace MSL with push button	Replace MSL with PUFFIN-style crossing; user presses button. Normally 'red' only 'green' if user presses button an no train approaching	SPC-MSL
N6	Warning triggered by user	Similar to road PUFFIN crossing, in addition to normal MSL warning, an additional audible warning sounded when a user's presence is detected (e.g. by radar)	SPC-MSL
N7	Active tactile warning	Provide tactile warning at MSL for vision impaired users. Similar to that provided at some road crossings, could be a rotating disk located near to the MSLs	SPC-MSL
N8	Enhance MSL with lights in floor at decision point	Supplement conventional MSL with active lighting in ground at the decision point	SPC-MSL

	Option	Design intent	Target
N9	Station announcement	Provide general voice announcements warning of crossing use via station PA system	All
N10	On-train announcement	Provide general voice announcements warning of crossing use via train PA system	All
N11	Novel ATC warning	Provide advanced warning of the approach of another train to protect against hazard of users crossing after the first train has passed	SPC-MSL
N12	Audible message triggered by gate	Provide audible warning when user opens gate (i.e. activated by switch on gate). At non-MSL crossings there would be no capability to detect whether or not a train was approaching so the warning provided would not indicate whether it was safe to cross or not, but simply act as a reminder to stop, look and listen for trains	SPC-G
N13	Audible warning at MSL	Provide audible warnings at current MSL crossings that are not fitted with an audible warning	SPC-MSL
N14	Planned obscuration	Provide screening such that users can only get adequate sighting of approaching trains at the design decision point (increase risk perception)	All
N15	Crossing as block of colour	Mark crossing surface up to decision points as a single block of colour to denote area as 'hazard' and provide a means of marking decision point	All
N16	Painted markings to channel user	Paint markings on approach to crossing to direct users to decision point in optimum direction (similar to F2)	All
N17	Crossing in middle of platform	At parallel platforms, place SPC in centre of platforms to prevent users crossing being stationary train when another train is approaching	All

4.2 Cost-benefit analysis

Evaluating the safety benefits of particular mitigation options at station pedestrian crossings is difficult, due to a very low number of incidents on which to draw, and major gaps in research relating to the effectiveness of the measures on user behaviour.

Instead of estimating safety benefits, with the associated high levels of uncertainty, we have therefore considered the risk reduction required (in % terms) that would justify the cost of each measure[11]. If it is judged that the risk reduction is over this level, this would mean that the option could be 'justified' on the basis of cost/safety benefits.

[11] Latest guidance on cost-benefit analysis has been followed: discount rate is 1.5% and life of each option has been assumed to be 25 years

Note that this target risk reduction level can only be indicative for the groups of crossings targeted by each option, and like all other options for reducing risk would need to be assessed by Network Rail for individual crossings in their ongoing programmes of risk assessment and managing risk So Far As Is Reasonably Practicable (SFAIRP).

The cost-benefit analysis is provided in Table 9 and Table 10 below:

- The cost estimate is the best estimate of the total cost of the option, although this may not cover the full costs associated with approvals and research and development for the more novel options
- The average FWI/yr at target crossings represents the typical average risk at each crossing that needs to be mitigated. This varies according to whether the target crossing type is SPC-MSLs, SPC-Open or SPC-G, or whether it would apply to all types of station pedestrian crossings
- The 'risk reduction required' is then the % safety improvement that would match the estimated cost of the option
- The final two columns on the tables repeat the analysis but show the 'risk reduction required' if the measure were applied to the top 20% of highest risk crossings. This has been derived from using the user census data gathered for the ALCRM (see §3.4.1)

The results show that the required risk reduction varies considerably by option; clearly those with anticipated higher costs would need to deliver more substantial safety benefits to be justifiable on a cost/safety benefit basis. For example, providing a standard MSL (N1) at crossings that currently have no active protection is costly, and as such could not be justified at all crossings; in fact even eliminating the risk would not deliver enough benefit to justify the cost. Targeting MSLs to the highest risk crossings appears much more sensible – with a risk reduction of around 60% required to justify fitment.

Many options such as fencing, and some of the enhancements to existing crossings are relatively low cost and as such would require a small percentage in safety improvement to justify the investment. For these options, the practicalities of installation and the level of certainty that they would actually deliver any tangible improvement in user behaviour become the key factors in assessing their viability (see §4.3, 4.4).

As discussed in §3.1.2, the estimate of risk at station pedestrian crossings is sensitive to the low number of accidents that have occurred over the approximately 100 station pedestrian crossings. It would not have been at all surprising had there been one fewer or one more accident in the period of time used to in estimate the level of risk, which is used here in the cost benefit analysis (Tables 9 and 10 below). Had there been one fewer, or one more, fatal accident then the risks per crossing and 'risk reduction required' presented here (Tables 9 and 10) would be 20% lower and 20% higher respectively. There is, therefore, in effect a range of risk reduction around the figure presented – so these should be seen as a guide, in particular showing how the target risk reductions required compare for each mitigation measure.

Table 9: Cost-benefit analysis: gates and fencing

	Option	Cost Estimate (£K)	Average FWI/yr at target crossings	Risk reduction required	Average FWI/yr at top 20% target crossings	Risk reduction required
G1	More self-closing gates	10	0.0032	9%	0.014	2%
G2	Auto-locking gates	150	0.0073	59%	0.025	31%
F1	Platform ramp edge	10	0.0036	8%	0.019	2%
F2	Channel user to decision point	20	0.0036	16%	0.019	3%
F3	Chicane	10	0.0036	8%	0.019	2%
B1	Back-to-back lights	35	0.0073	14%	0.025	4%
B2	Side-to-back lights					

Table 10: Cost-benefit analysis: novel and other options

	Option	Cost Estimate (£K)	Average FWI/yr at target crossings	Risk reduction required	Average FWI/yr at top 20% target crossings	Risk reduction required
N1	MSL	300	0.0032	>100%	0.014	62%
N2	Replace MSL with illuminated pictogram	20	0.0073	8%	0.025	2%
N3	Larger MSL	25	0.0073	10%	0.025	3%
N4	Replace MSL with traffic light type lights	150	0.0073	59%	0.025	16%
N5	Replace MSL with push button	15	0.0073	6%	0.025	2%
N6	Warning triggered by user presence	15	0.0073	6%	0.025	2%
N7	Active tactile warning	10	0.0073	4%	0.025	1%
N8	Enhance MSL with lights in floor at decision point	100	0.0073	39%	0.025	12%
N9	Station announcement	0	0.0036	Negligible	0.019	Negligible
N10	On train announcements	0	0.0036	Negligible	0.019	Negligible

	Option	Cost Estimate (£K)	Average FWI/yr at target crossings	Risk reduction required	Average FWI/yr at top 20% target crossings	Risk reduction required
N11	Novel ATC warning		0.0073		0.025	
N12	Audible message triggered by gate	10	0.0032	9%	0.025	2%
N13	Audible warning at MSL	10	0.0073	4%	0.025	1%
N14	Planned obscuration	20	0.0036	16%	0.019	3%
N15	Crossing as block of colour	10	0.0036	8%	0.019	2%
N16	Painted markings to channel user	10	0.0036	8%	0.019	2%
N17	Crossing in middle of platform	300	0.0036	>100%	0.019	45%

4.3 Behaviour impact assessment of mitigation measures

This section presents the results of a behavioural impact assessment, conducted separately from the risk assessment and cost-benefit analysis. It examines the potential impact of each option on the hazards identified in the HAZOP, semi-quantitatively.

It considers deviations from intended crossing procedure, assessing how well each measure could address the behaviours that underlie user errors and violations. A four-point scale was used to score the options against each hazard (the left hand side box of Table 11).

For example, the likelihood that a user will fail to recognise a station pedestrian crossing may be reduced with the introduction of improved fencing that channels the user to the crossing decision point, but would not be affected by replacing an MSL with an active tactile warning.

The likelihood of a user being on the tracks at the same time as a train will vary depending on where in the crossing procedure an error/violation is made. For example, on the distant approach to the crossing, failures may be less likely to result in an accident that occurs at the crossing itself – therefore the chance of 'error recovery' will be greater. In contrast, errors made at the decision point are more likely to lead directly to potential accidents involving the train – i.e. there is less chance to recover from an error. Accordingly, a weighting was applied to each deviation to account for error recovery (right hand side box of Table 11).

Table 11: Behaviour impact assessment ranking method

Four-point scale for scoring

Impact on behaviour	Score
Eliminates error/violation	2
Reduces error/violation	1
No change	0
Increases error/violation	-1

Error recovery weighting

Error recovery	Weighting
Least opportunity for recover	1
Moderate opportunity for error recovery	2
Most opportunity for recovery	3

Source: Human Engineering

Nineteen different deviations from intended behaviour at station pedestrian crossings were identified at the HAZOP. A total score for each of the 24 mitigation measures under consideration was calculated and multiplied by the error recovery weighting factor. The list of measures in rank order of potential effectiveness in terms of addressing the user behaviours that lead to errors and violations is shown in Table 12 (top 10 ranked) and Table 13 (lower ranked options). A more detailed table showing the scores for each measure is provided in Appendix A.

An important result of the behaviour impact assessment is that very few mitigation options would effectively target the user errors and violations that could have the most serious consequences. Automatic-locking gates attain the highest score because they would virtually eliminate the possibility of a user crossing in error when a train is approaching. Automatic-locking gates would also significantly reduce the likelihood that a user will commit a crossing violation, since he/she would be required to vault or climb over the locked gate.

Train and station announcements are ranked highly because they would provide a timely reminder to the user to consider crossing risks. Options that aid the user in determining where and when it is safe to cross also rank highly, e.g. lights in the crossing floor and channelling the user to the decision point. Those options that provide additional sources of information about crossing status to the user also score well, such as providing MSLs where there are currently none, introducing a novel ATC warning, providing an audible warning at all MSL crossings and having a warning triggered by user presence.

Back-to-back and side-to-back lights rank reasonably highly (11th), as they provide some redundancy in the warning reducing the chance that a user fails to see the MSL, or fails to notice a change from green to red. However, they would not fundamentally change the warning given to a user, and would not reduce incidents of deliberate violation of the warning.

The lower ranking options would either fail to address any significant hazards in the crossing process, or would target a very small proportion of users (e.g. N7 active tactile warnings) and as such have a low overall impact.

Table 12: Behaviour impact assessments results – top 10 ranked options

Rank	Option	Key Impacts
1	G2 Auto-locking gates	Except for gate jumpers, eliminates risk of user crossing when a train is approaching (either in error or violation)
2=	N9 Station announcement	Reduces likelihood that user will fail to recognise the crossing or attend to any warning devices. Reduces likelihood that passengers will fail to wait at the crossing, unaware of an approaching train
2=	N10 On-train announcements	
4	N8 Enhance MSL with lights in floor at decision point	Reduces likelihood that user will fail to recognise the crossing or the decision point. Reduces likelihood that user will be unaware of an approaching train
5=	F2 Channel user to decision point	Reduces likelihood that user will fail to recognise the crossing or the decision point
5=	N1 MSL	Reduces the likelihood that user will fail to recognise the crossing or be unaware of an approaching train
5=	N11 Novel ATC warning	Reduces the likelihood that a user will assume that it is safe to cross once a train has passed
5=	N13 Audible warning at MSL	Reduces likelihood that user will be unaware of approaching train. Reduces risks associated with users observing the MSL too early and failing to recheck its status before crossing
5=	N15 Crossing as block of colour	Reduces likelihood that user will fail to recognise the crossing or the safe decision point
10	N6 Warning triggered by user presence	Reduces likelihood that user will fail to recognise the crossing or be unaware of an approaching train

Note: Low number/high ranking is better

Table 13: Behaviour impact assessments results – lower ranking options

Rank	Option	Key Impacts
11=	B1 Back-to-back lights	Reduces likelihood that user will fail to recognise the crossing or the decision point. Reduces likelihood that user will fail to read crossing instructions. Reduces likelihood that user will be unaware of an approaching train. Reduces risks associated with users observing the MSL too early and failing to recheck its status before crossing
11=	B2 Side-to-back lights	
11=	N3 Larger MSL	Reduces likelihood that user will fail to recognise the crossing. Reduces likelihood that user will be fail to observe MSL or a change in its status
11=	N16 Painted markings to channel user	Reduces likelihood that user will fail to recognise the crossing or the decision point
15	F3 Chicane	Reduces likelihood that user will fail to recognise the crossing or observe the MSL
16	N12 Audible message triggered by gate	Reduces likelihood that user will fail to recognise the crossing or to check for trains. However, may increase the likelihood of user hesitation while operating the gates
17=	F1 Platform ramp edge	Reduces likelihood that user will fail to recognise the crossing
17=	N14 Planned obscuration	Reduces the likelihood that a user will fail to observe the MSL or a change in its status. However, if intent on crossing on red, increases the likelihood that a user may be unaware of an approaching train
19=	G1 More self-closing gates	Reduces likelihood that user may fail to recognise crossing or stop before crossing. However, may increase the likelihood that a decision to cross is made too early (if sighting distance from gates sub optimal), or increase the risk of user hesitation when crossing due to difficulties in opening the gates
19=	N4 Traffic light type lights	Reduces likelihood that user will fail to observe warning light or a change in its status. However, may increase the risk of users ignoring the light, failing to understand it is applicable to them
19=	N7 Active tactile warning	Only targets behaviour of small minority of crossing users (sight-impaired). No impact on behaviour of majority of users
22	N17 Crossing in middle of platform	Increases the likelihood that a user will fail to recognise the crossing, or notice it too late
23	N2 Replace MSL with illuminated pictogram	Increases the likelihood that a user will fail to understand the meaning of the MSL
24	N5 Replace MSL with push button	Increases the likelihood that a user will fail to understand how to operate the MSL or its meaning

Note: low number/high ranking is better

4.4 Practicalities and wider implications

For an option to be considered viable it not only has to demonstrate reasonable cost-benefit, but also to be practical to implement. Wider implications such as impacts on railway operations, noise impacts to railway neighbours, and the extent to which guidance, standards and legislation changes also need to be factored into the assessment.

To a large extent, the practicality of a measure is related to the estimated cost; many practical difficulties can be overcome if higher costs are incurred. For example, the implementation of a new design of lights which require significant changes to the signalling and control system for existing MSLs may be considered as being impractical, but this could in theory be offset if higher costs were incurred. For the purposes of this assessment, we have therefore highlighted any practical difficulties that are foreseen, even if these could be overcome with a higher expenditure.

An assessment of the practicalities, wider implications, guidance and legislative issues is presented in Table 14. A blank cell in the table means that no issues are anticipated. Key points arising from the assessment are:

- ***Practicalities are largely location dependent:*** Many practical issues depend to a large extent on local factors at the crossing/station. For example, fencing to direct pedestrian to the decision point (F2) would be difficult to achieve at locations where the platform is narrow, or the crossing approaches could not accommodate the required fencing
- ***Noise:*** Additional noise would not be an issue for most options, other than those that provide an additional audible warning (G2, N1, N6, N9, N12, N13)
- ***Accessibility:*** Relatively few options would cause accessibility difficulties – exceptions being providing gates (G1), fencing (F1, F2, F3), and planned obscuration (N14). Moving the crossing to the middle of the platform, which is considered to be highly impracticable anyway, could also lead to difficulties with accessibility for some users
- ***Railway operations:*** Again, few options would increase instances of disruption to railway operations. MSLs are understood to have very low failure rates, so instances of having to caution trains owing to a failure are reportedly uncommon. Providing more MSLs (N1) would therefore be unlikely to have significant impact. The only other option with a potential impact on operations is the automatic locking gate. Although it is unlikely that it would be interlocked with the signalling (consistent with current railway staff locked gates), public reports of problems with the gates could mean that trains would have to be cautioned past the crossing

- ***Highly novel options are likely to require safety approval:*** Particular examples of options that would need approval include automatic locking gates (G2), MSLs replaced with illuminated pictograms (N2), traffic light style lights (N4), replacing MSLs with a ‘push button’ arrangement (N5), novel warnings for another train coming (N11), and additional warnings triggered by user presence (N6)

Table 14: Practicalities, wider implications and implementation issues

Option	Practical constraints	Wider implications			Implementation	
		Noise	Accessibility	Railway operations	Guidance change	Legislation/approval
G1 More self-closing gates	Limited by station and platform layout	-	Can make access more difficult for some users	-	-	-
G2 Auto-locking gates	Require associated fencing to prevent choosing another route Need to prevent trapping	Likely to require audible warning of train approach	-	Failures may require cautioning of trains	Require new suite of guidance for new technical and operating	New principles required as this type of crossing is not currently permitted due to concern over trapping users. Approval process likely to be difficult
F1 Platform ramp edge	Few difficulties: care to prevent blocking view from decision point	-	Might make access more difficult for some users (e.g. at narrow platforms)	-	May require some revision to guidance	-
F2 Channel user to decision point	Limited by platform width and layout	-		-	May require some revision to guidance	-
F3 Chicane	Limited by platform width and layout	-		-	May require some revision to guidance	-
B1 Back-to-back lights	Orientation of 'back-to-back' may not suit some approaches (B2 preferable)	-	-	-	Require change to RSPG and other documentation	-
B2 Side-to-back lights	-	-	-	-	Require change to RSPG and other documentation	-

Option	Practical constraints	Wider implications			Implementation	
		Noise	Accessibility	Railway operations	Guidance change	Legislation/approval
N1 MSL	Practical (existing technology) but require significant signalling work	If audible alarms provided adds to noise at station	-	Low chance of failure resulting in need to caution trains	-	-
N2 Replace MSL with illuminated pictogram	-	-	-	-	Require changes to guidance regarding size and design of MSL	Require change in legislation regarding MSL design and associated signs. Would require approval
N3 Larger MSL	No major difficulties but may require larger backboard/new posts etc	-	-	-	Require changes to guidance regarding size and design of MSL	Require some change in legislation regarding MSL design and associated signs. Would require approval
N4 Replace MSL with traffic light type lights	Require significant resignalling and design Traffic light not a recognised control for pedestrians – potential for confusion	-	-	-	Require significant changes to guidance and standards relating to MSLs	Would require legislative changes and significant approvals
N5 Replace MSL with push button	Likely that people will not use the push button. May require significant resignalling work	-	-	-	Require significant changes to guidance and standards relating to MSLs	Would require legislative changes and significant approvals

Option	Practical constraints	Wider implications			Implementation	
		Noise	Accessibility	Railway operations	Guidance change	Legislation/approval
N6 Warning triggered by user presence	Some concern over reliability of user detection and response when users cross in groups although in use at one location (Wareham)	Additional audible warning adds to noise	-		Would need changes to guidance and standards relating to MSLs	Unclear – may not require legislative changes/approval as already used at Wareham
N7 Active tactile warning	New infrastructure/layout at crossing and additional power requirement	-	-	-	Require some changes to guidance and standards relating to MSLs	May require legislative changes and approval, although similar to devices used on road crossings
N8 Enhance MSL with lights in floor at decision point	Maintenance difficulties, may require more power than MSL alone	-	-	-	Require changes to guidance and standards relating to MSLs	May require legislative changes and approval
N9 Station announcement	Should be practical although depends on location	Minor: voice adds to level of noise from station	-	-	-	-
N10 On train announcements	No practical difficulties foreseen, could be recorded announcement or driver	-	-	-	-	-
N11 Novel ATC warning	Difficult to apply at some locations due to existing signalling	-	-	-	Require changes to guidance and standards relating to MSLs	May require legislative changes and approval

Option	Practical constraints	Wider implications			Implementation	
		Noise	Accessibility	Railway operations	Guidance change	Legislation/approval
N12 Audible message triggered by gate	Reliability, susceptibility to vandalism and maintenance likely to be problematic	Minor: warning adds to level of noise from station	-	-	Would need changes to guidance and standards relating to MSLs	Unclear – may not require legislative changes or approval depending on whether it can be accepted that warning does not need to be high integrity
N13 Audible warning at MSL	Audible warning provided at some MSLs, although may not be straightforward to apply to all (circuitry for time of day and possession switches)	Additional audible warning adds to noise	-	-	-	-
N14 Planned obscuration	Not possible to obscure view in both directions owing to platform layout Not clear if safety benefit	-	Could cause access problems (e.g. wheelchair users)	-	Require fundamental change in guidance relating to sight times	Require fundamental acceptance of the principle of obscuration, and associated legislative changes
N15 Crossing as block of colour	-	-	-	-	-	-
N16 Painted markings to channel user	Paint will wear off and be blocked when station platform is busy Unlikely that people will follow markings on platform	-	-	-	-	-

Option	Practical constraints	Wider implications			Implementation	
		Noise	Accessibility	Railway operations	Guidance change	Legislation/approval
N17 Crossing in middle of platform	Massive civil engineering redesign	-	May have adverse impacts on those with mobility impairments	Impractical due to use of different door positions on rolling stock	Current guidance and design standards would not allow crossings in the middle of platforms	Require approval and legislation

Source: Arthur D Little analysis

4.5 Overall assessment

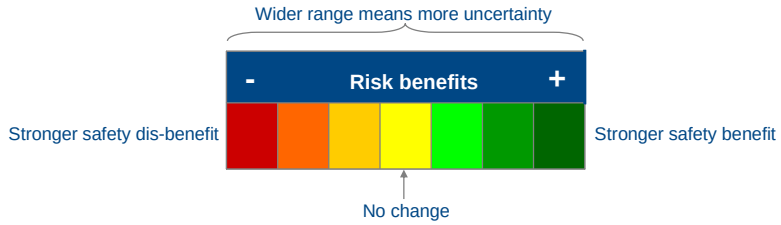
4.5.1 Introduction

An overall assessment of the options has been made, by considering the cost-benefit analysis, behaviour impact assessment, practicalities and wider implications.

Table 15 summarises the results:

- Behaviour impact (refer to §4.3)
- Practicalities (refer to §4.4)
- Wider implications (refer to §4.4)
- Risk benefits (see below for explanation)
- CBA: risk reduction required (refer to §4.2)

The 'risk benefits' assessment provides an overall estimate of safety benefits of the measure on a *relative* scale:



Where there is uncertainty over the level of safety benefit a wider range is used (for example an option being rated as the right hand three green cells has safety benefit, but it is uncertain whether this is minor, moderate or significant).

For behaviour impact, wider implications, and practicalities the following indicators are used:

☹ Significant issues

😐 Some issues

☺ No issues

Finally, the overall assessment places each option into one of three categories (for both the 'all crossings' case and the 'top 20%' highest risk crossings case):

✓✓ For further consideration

✓ For further consideration at some locations, or with further investigation

✖ Not for further consideration

The result of the overall assessment is that 13 options emerge as being potentially viable, however, only very few are assessed as being potentially viable without having some anticipated difficulties in widespread application, or requiring some further clarification of the practicalities or safety benefits.

The higher cost options, (G2, N1, N4, N8, N17) would need to deliver substantial levels of safety benefit for them to be justified in terms of cost-benefit. In some cases, the benefits exceed 100%, including providing MSLs (N1) at the 'average' crossing. In this particular case, the option only becomes potentially viable when the risk mitigation is focused at the higher risk crossings.

Table 15: Overall assessment of options

Option		Behaviour impact	Practicalities	Wider implications	Risk benefits							CBA: risk reduction required		Overall evaluation	
					- - -	- -	-	0	+	+ +	+ + +	All crossings	Top 20%	All crossings	Top 20%
G1	Wicket gates	☹	😐	😐								9%	2%	✘	✘
G2	Auto-locking gates	☺	☹	😐								59%	31%	✘	✓
F1	Platform ramp edge	😐	☺	😐								8%	2%	✓	✓
F2	Channel user	☺	😐	😐								16%	3%	✓	✓
F3	Chicane	😐	😐	😐								8%	2%	✓	✓
B1	Back-to-back lights	☺	😐	☺								14%	4%	✓	✓
B2	Side-to-back lights	☺	☺	☺								14%	4%	✓	✓

Option		Behaviour impact	Practicalities	Wider implications	Risk benefits							CBA: risk reduction required		Overall evaluation	
					- - -	- -	-	0	+	+ +	+ + +	All crossings	Top 20%	All crossings	Top 20%
N1	Provide MSL	☺	😐	😐								>100%	62%	✘	✓
N2	.. illuminated pictogram	☹	☺	☺								8%	2%	✘	✘
N3	Larger MSL	😐	😐	☺								10%	3%	✘	✘
N4	Traffic light type lights	☹	☹	☺								59%	16%	✘	✘
N5	… push button	☹	☹	☺								6%	2%	✘	✘
N6	Warning triggered by user	☺	😐	😐								6%	2%	✘	✓
N7	Active tactile warning	☹	😐	☺								4%	1%	✘	✘
N8	Lights in floor at dec. point	☺	☹	☺								39%	12%	✘	✘
N9	Station announcement	☺	😐	😐								Negligible	Negligible	✓✓	✓✓
N10	Train PA	☺	☺	☺								Negligible	Negligible	✓✓	✓✓
N11	Novel ATC warning	☺	☹	☺										✘	✓
N12	Audible message at gate	😐	☹	😐								9%	2%	✘	✘
N13	Audible warning at MSL	☺	😐	😐								4%	1%	✓	✓✓
N14	Planned obscuration	☹	☹	😐								16%	3%	✘	✘
N15	Crossing block of colour	☺	☺	☺								8%	2%	✓✓	✓✓
N16	Markings to channel user	😐	😐	☺								8%	2%	✘	✘
N17	Xing in middle of platform	☹	☹	☹								>100%	45%	✘	✘

Source: Arthur D Little analysis

4.5.2 Options for further consideration

Overall, 13 options are considered *potentially* viable when all aspects of the analysis are considered (see below for a detailed summary of each). Many of these are likely to be applicable only at specific locations where implementation is practical, or the risk actually warrants the level of expenditure. In other cases, there is significant uncertainty over the benefits, and further research would be needed to develop the option suitable for pilot testing.

It is important to note that in most cases a large proportion of the residual risk will remain; in other words, risk is to some extent mitigated although the decision to cross would still lie with the user so there will always be the potential for error or deliberate misuse. The three options that have the largest potential impact on risk are:

- N1 provide MSLs (where there are currently none)
- G2 Provide automatic-locking gates
- N13 Provide audible warning at MSL

Of these, automatic-locking gates, would be a new concept to British railways, although these have been applied in Australia and New Zealand (see Table 6 and references [38], [37] and [6]). Given the cost of developing, getting approval for, and installing such a scheme, crossing closure is likely to be a more attractive option. Significant uncertainties over the impact on risk (e.g. trapping, clarity of how to use the crossing correctly etc) mean that further research would be needed if it was decided that there were locations where automatic-locking gates were a possibility.

Providing MSLs is of course not novel but remains a viable option where its cost can be justified. There remains a degree of uncertainty over the safety benefits, and with current design principles and associated costs it would only be viable on economic grounds at the highest risk locations, based on an assessment of the risk.

Adding an audible warning to existing MSLs could provide additional safety benefit, although again, the actual level is unknown with any certainty. The behaviour impact assessment ranks it highly, mainly as the audible warning can be effective in alerting otherwise distracted users. Costs are generally not likely to be high (although would depend on the location and the circuitry currently provided) and as such it is expected that audible warnings could be justified. One issue is the consideration of noise to railway neighbours which means that night time deactivation of the audible warning may be required.

Back-to-back lights do emerge as *potentially* attractive, although the improvement in user behaviour and the resultant impact on risk is not certain. At this stage of evaluation the best estimate is that the benefits of providing the additional lights may exceed the costs, although it appears to be a marginal case.

All other options are relatively minor improvements to the infrastructure, layout and appearance of the crossing and the approach. These would correspondingly have a minor impact on risk but are relatively low cost so, where practical, could be considered.

Finally, the research has highlighted the variability in the consistency of signs and warnings at station pedestrian crossings, both between locations and at different sides of the same crossing (see §2.3). Signs fall short of good human factors practice in terms of their conspicuity relative to other (non-safety) related signs and their largely text-based style.

G2 Auto-locking gates

Not for further consideration (generally) but possible for very specific cases:
Providing automatic-locking gates is not a viable option at a large number of station pedestrian crossings. Experience in other countries has highlighted the practical difficulties and high costs. They may be a possibility at the highest risk locations where other measures to reduce risk or close the crossing are, for whatever reason, not viable

Automatic-locking gates have not been used in GB due to the concern that users could be trapped between the gates. Such crossings have, however, been used in New Zealand and Australia, with the problem of trapping is mitigated by providing emergency escape routes for users who might otherwise be trapped. One difficultly exposed in the trials is that providing an emergency escape route provides a channel for any users who wish to bypass the locked gate – so violation can still occur. Attempts have been implemented to get around this by providing the emergency exit gate with a push button escape which cannot be reached from the entry side. The design of the emergency exit button at Bentleigh in Australia was such that it could be activated (by pushing) by users in wheelchairs.

Practically, providing such crossings at typical GB platform layouts could be very difficult. For example, the fencing required to prevent users bypassing the gates would not be practical without significant changes to platform and station layouts. Cost would be another major consideration; although the option considered here is to provide the locking gates at a former MSL crossing (so there would be existing signalling/circuitry to detect the train) costs would still be high. As such, automatic-locking gates, even if the practical difficulties could be overcome, are considered to be an option only at the highest risk crossings where other measures to reduce risk (such as crossing closure) are not possible. It is understood that Network Rail are actively seeking closure options at the small number of highest risk station pedestrian crossings, so the feasibility of

achieving these closures (e.g. through grade separation) will dictate whether or not automatic-locking gates should be further researched.

F1 Platform ramp edge

For further consideration (limited number of locations):
Where practical to implement, platform ramp edges could deliver some minor safety benefit associated with improving the position at which the user decides to cross

The main potential risk mitigation of platform ramp edges is preventing users from entering onto the tracks before the desired decision point. Therefore, although the risk mitigation is not likely to be substantial, they may be appropriate at some locations where (a) they are compatible with the platform layout and don't restrict access due to limited width of the platform and (b) there is currently the potential for users to cut the corner off the crossing.

Various options would be available for how to implement platform ramp edges, including vertical fending, and low level trespass guards. Care should be taken prevent creating trip hazards and restricting sight lines.

See also F2 and F3 below for other fencing options.

F2 Channel user to decision point

For further consideration (limited number of locations):
The layout of many station pedestrian crossings means that providing fencing to channel users to the decision point is not likely to be an option that would apply to a wide range of crossings

Site visits conducted for this research and previous projects have shown that providing fencing to channel users to the decision point in an optimal way is not feasible at all crossings due to practical limits imposed by narrow platforms and the general layout of the station environment.

However, where it is practical to do so, more effective channelling of users could provide safety benefits in that the user would approach the crossing at right angles to the railway at the design decision point. Safety benefits may not be significant but implemented carefully would not introduce risk, so it is considered a potentially viable option at some locations.

See also F1 and F3 for other fencing options.

F3 Chicane

For further consideration (limited number of locations):
The layout of many station pedestrian crossings means that providing a chicane to channel users to the decision point is not likely to be a option that would apply to a wide range of crossings. Where possible, however, it could improve the users' approach to the crossing and reduce errors approaching and at the decision point

Some station pedestrian crossings are provided with a form of chicane as a partial barrier on approach to the crossing (see Figure 6 for an example). However, these do not serve to redirect the users' approach to look 'up and down' the tracks, rather just slow the approach to the crossing.

An alternative would be to provide a more staggered chicane with the barriers parallel to the tracks, such that an approaching user were forced around the barriers and in doing so look up and down the tracks before crossing. Space limitations due to narrow platforms would make this difficult at many locations, but where possible it could have positive behavioural impact and corresponding minor safety benefits.

Accessibility issues would have to be considered also, to ensure that the access to and from the station was not made difficult for particular user groups such as those in wheelchairs or with pushchairs.

See also F1 and F2 above for other fencing options.

B1 and B2 Back-to-back lights/Side-to-back lights

For further consideration (subject to further research):
Back-to-back lights would mitigate some of the shortfalls associated with providing MSLs only on one side of the crossing, and it is expected that they would provide an overall safety benefit. However, the extent of the safety benefit is not clear, and it is more likely that they could be justified in terms of cost-benefit, only at the higher risk MSL crossings

Conventionally, HMRI has recommended MSLs on the far-side only at footpath and station pedestrian crossings (where most are positioned) as the user can check the status of the light when crossing. The problems with this configuration are that the associated signs are more difficult to read, particularly for partially sighted people, the decision point is not clearly marked, and the lights might not be noticed as easily as nearside lights.

Providing 'back-to-back' lights would aim to improve the overall mitigation provided by MSLs, reducing the problems highlighted above. If the view of the nearside lights were blocked by users standing in front of them, then this would be mitigated by the lights on the far-side.

The work has found no disbenefits to providing back to back lights, and there are few practical difficulties are foreseen. It may be more straightforward to provide "side to back" lights (i.e. one MSL plate at 90 degrees to the other so not actually 'back to back') so as to face the approaching user, but this is a detail that could be considered in the final design.

Cost-benefit analysis shows that a risk reduction of 14% would be required to justify the costs of back-to-back lights, or 4% if provided only at the highest risk crossings. Fundamental research would be required to evaluate the safety benefit, and to determine whether this target improvement would be achievable. In our opinion at this stage, it seems likely that the costs could be justified at the highest risk crossings, but perhaps not at the wider population of MSLs. One option would be to provide back-to-back lights when replacing any existing MSL units, or if any new crossings are to be fitted with MSLs.

N1 Provide MSL

For further consideration (high-risk locations where closure not possible):
Due to high cost, MSLs are not a viable option at most station pedestrian crossings. Network Rail should therefore continue to apply risk based analysis as to their provision, informed by further research as to their safety benefits

MSLs have been provided at station pedestrian crossings (and other user-worked and footpath crossings) as a mitigation against short sighting distances, and often where pedestrian moment is relatively high. There is little evidence available as to the safety benefits provided by MSLs over and above no active protection, or other measures against short sighting distance such as whistle boards.

The work carried out for this study has indicated, however, that the risk at MSLs is *lower per moment* than at station pedestrian crossings without active warning (§3.3). However, this is subject to a high degree of uncertainty owing to a small data set, plus it is not clear what the benefit of providing MSLs at a specific location would be (since the comparison available shows the difference between two different populations of crossings).

What is clear is that MSLs could not be justified, using current technology and associated cost, at any but the highest risk station pedestrian crossings. This is not a surprise, and is the reason that they have not been provided more widely by Railtrack or Network Rail. The cost-benefit analysis suggests that even eliminating the risk at the 'average' station pedestrian crossing would not justify the cost of the MSL. At the top 20% highest risk station pedestrian crossings a risk reduction of 62% or greater would justify their cost.

So in summary, the currently high costs of providing MSLs limits the number of locations that they could be justified. Assuming that the MSL does provide a mitigation of the risk as indicated by this report, then potentially significant overall reductions in risk could be achieved if lower cost alternatives to current design were developed and implemented. To date, the industry has focused on very high levels of integrity (for example independent track circuit and treadle detection) which delivers very reliable crossings but at questionable incremental safety benefits. If, for example, a design using predictors could be provided at significantly lower cost, then even if its absolute reliability was slightly less than the current design, overall safety benefits could be significant because it could be justified at a larger number of crossings.

Should Network Rail decide, on the basis of risk assessment, to provide new MSLs, then it would be a good opportunity to provide back-to-back lights (see B1 and B2) as the incremental costs of doing so would be relatively minor in comparison to changing current installations which are not life expired.

N6 Additional warning triggered by user presence

For further consideration:
Providing at additional audible warning at existing MSL crossings when a user is detected

This research identified providing an additional audible warning as a novel idea for enhancing an MSL crossing, but during the latter stages of the project we have learnt that such a system has been provided at Wareham crossing. This particular installation, we understand also includes a camera as a deterrent to those who violate the red light and has been provided while Network Rail seek closure of the crossing with the local council.

Providing such an audible warning, in addition to the primary means of warning via the MSL, could be considered more widely. It could have a positive impact on user behaviour (warning at the key decision point), and may not be costly to install. As well as potentially reduced rates of unintentional error – for example users that are distracted – it could, if used in combination with camera recording, be used to deter intentional violations of the red MSL aspect. In this case, practical difficulties associated with taking necessary action against those caught by camera would need to be overcome.

One possible downside is that in the event of a failure, users who had become accustomed to the warning may have an incrementally higher risk of ignoring the primary (MSL) warning. The means of detecting users at the decision point (radar, infrared beams, etc) would need to be investigated further to balance cost and reliability/accuracy. Equally, the actual warning message would need to be designed.

N9 and N10 Station/on train announcements

For further consideration:
Providing warning/safety announcements on the train or station public address system is not likely to give significant safety benefits but, where practical to do, would have very low costs. On this basis, we consider that this should be considered further

Station and on-train announcements are used regularly to provide information on the journey, timetable and to provide safety and security messages. As such, such systems could be used to provide relevant safety messages about using station crossings – either on approach to the station (on the train) or at the station (before and after the train has arrived).

It is likely that the safety benefits of providing such announcements would be relatively low, but given the anticipated very low cost it is concluded that this should be taken forward for further consideration. This might be possible to do via pre-recorded announcements, or manually (for example) by the train driver as part of a general announcement about arrival to a station.

Logically, it would make sense to extend such a warning to other crossings which are located adjacent to stations, and provide a means of access such as Automatic Half-Barriers (AHBs).

N11 Novel ATC warning

For further consideration:
Other RSSB research recently completed has looked into detail at solutions for providing another train coming warnings including at station MSLs. This concludes that providing active visual/audible warning at SPC-MSLs is potentially viable on a cost-safety benefit basis

A separate study [12] has recently been completed and published on behalf of RSSB, researching the options for 'another train coming' (ATC) warnings at automatic crossings. This included crossings provided with MSLs. The following provides a summary of the key points.

ATC warnings could mitigate but not eliminate the risk associated with another train coming: The additional information provided by specific ATC warnings could help to raise awareness and therefore reduce user errors. However, such warnings are likely to be much less effective at reducing violations (intentional actions to ignore the warning provided). This is likely to be even more of a limitation at stations where a user is intending to catch an approaching train and as such has more motivation to cross.

Warning types available: The research identified three main types of warning:

- Static warning sign (e.g. as currently used in Great Britain at AHB, ABCL and AOCL crossings)
- Active warning sign (e.g. a graphic or text sign which only activates when a second train is approaching)
- Active audible warning (e.g. a tone or voice message which only activates when a second train is approaching)

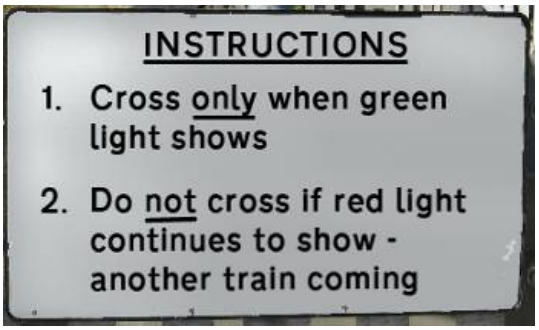
The warnings above could be used in isolation or in combination with each other.

The risk from ATC is recognised by other countries including USA, Australia, Japan, and France. These countries currently have ATC warnings in place or on trial. Most of the warnings identified were aimed at pedestrians with some intended for both pedestrian and vehicle users. Most were active or static visual warnings. At the time of the research no hard evidence was available as to the safety benefit from these warnings.

The arrival of more than one train is a difficult concept to convey simply, as it cannot be certain when the user will arrive at the crossing compared with the location of either or both trains, nor what the user can see and has (mis)understood of the situation. The challenge is to provide a warning that is perfectly clear, not ambiguous or open to interpretation in any way or it could result in an increase in risk.

The research included the development of 32 different options for ATC warnings covering static and both active audible and visual warnings. Three preferred options for crossings with MSLs were selected in a stakeholder workshop for testing with members of the public. The public testing took the form of 'mock-up' videos which were shown to the user with a strict protocol of questions to measure the opinions of the user.

Table 16: ATC warning options

Ref	Warning
1	Static warning: 
2	Static warning (as in '1') plus audible warning *"Do not cross! Another train coming"* overlaying intermittent yodel alarm. The audible warning would activate as soon as the front of the first train passed over the crossing.
3	Active visual warning:  plus audible warning *"Do not cross! Another train coming"* overlaying intermittent yodel alarm. The warnings would activate as soon as the front of the first train passed over the crossing.

Source: [12]

Risk reduction is greatest for audible or combined audible and visual warnings:
The public surveys showed:

- The most effective warnings were the audible and audible plus visual warning both reducing the chance of *error* by a maximum of 65% (note this is not the same as the reduction in risk since much of the risk is associated with intentional misuse)
- The new static warning resulted in no measurable impact on error rates

Station layout and signalling arrangements are a key factor in provision of ATC warnings: The research concluded that station layout coupled with signalling were influencing factors for the effectiveness of an active warning. Where stations have platforms staggered over the crossing (i.e. the platform lies after the crossing in each direction of train travel) the active warnings would work well. Where stations have both platforms on one side of the crossing trains striking-in on route to the platform before the crossing could be seen stopped while the crossing is closed. If another train approached from the other direction the ATC warning would not activate until one of the trains passed over the crossing. In the case of the train stopping in the platform, although it is the first train to be seen, it may not be the first train to pass the crossing, and as a consequence, users may think in the absence of an ATC warning it is safe to cross.

Providing ATC warnings at SPC-MSLs is supported by cost-benefit analysis: The research concluded that, based on the current population of SPC-MSLs, implementation of ATC audible plus visual warnings is supported by cost-benefit analysis. If, however, the highest risk crossings were closed (as we understand is being planned by Network Rail), then the cost-benefit argument could change significantly; a relatively large proportion of the risk could be eliminated, and the residual risk would be insufficient to justify expenditure on ATC warnings.

The research on another train coming warnings summarised above, and published by RSSB, provides the response to Recommendation 4 D of the RAIB report [28].

N13 Audible warning at all MSL

For further consideration (based on local risk assessment):
The multi-sensory warning provided by MSLs with audible alarms is potentially significantly more effective than the single sensory warning provided by MSLs alone. Costs of doing so at some locations, however, may be high and so implementation would need to be risk-based, taking into account local factors, including the 'noise impact' to railway neighbours

Audible warnings are provided at some, but not all, SPC-MSLs. From a human factors perspective, providing the audible warning in addition to the visual warning (the lights) has considerable benefits; so-called multi-sensory warning. Essentially, the audible warning can be a highly effective means of alerting users who are otherwise distracted when approaching the crossing.

It is understood that the reasons for not providing audible warnings are partially historic, as when some MSLs were provided, adding an audible alarm was not the default design.

The assessment shows that providing audible warnings at MSLs are the lowest cost means of potentially providing significant safety benefit, and as such it is concluded that more widespread fitment could be considered. Consistent with RSPG principles, potential noise nuisance affecting railway neighbours would need to be considered, so as not to offset any safety benefits.

N14 Crossing as block of colour

For further consideration:
Providing the crossing as a single block of colour could help to overcome the difficulties with providing a clearly marked decision point. Safety benefits are unknown but are likely to exceed the relatively low costs of such a measure. For this reason it is proposed for further consideration

The work has highlighted that there is commonly a lack of clarity as to the position of the decision point, often due to the limitations of platform width in marking a white line in the correct position.

The idea is therefore to provide the entire crossing surface, up to the decision point on both sides, as a single block of colour, which is distinct from the platform surface. This would aim to achieve two benefits: marking of the decision point, and a general indication that the crossing itself is a hazardous area distinct from the platforms.

For this to be a viable option, suitable material for the decking would need to be available which meets requirements for durability, non-slip characteristics, and ease of installation. Another key requirement would be the selection of a suitable colour that conveys the message of warning, whilst not having an adverse impact on train drivers response to railway signalling.

In summary, although safety benefits are anticipated to be relatively minor, the relatively low cost of providing coloured surfaces to indicate to the crossing and decision points more clearly means that this is a potentially viable option at all station pedestrian crossings.

4.5.3 Options not for further consideration

13 options are classified as not being candidates for further consideration, due broadly to the following:

- No evidence that safety would be improved, or concerns that risk would actually be introduced (§4.3)
- A high degree of confidence that the costs of options would significantly exceed the safety benefits (§4.2)
- Significant practical difficulties with implementation (§4.4), combined with doubtful benefits

These are discussed in more detail below.

G1 Self-closing gates

Not for further consideration: there is no evidence that providing self-closing wicket gates gives overall safety benefit

Gates have been provided at station pedestrian crossings largely for historical reasons and not on the grounds of safety. Whilst the presence of a barrier may benefit some users (such as errant toddlers), there are disbenefits to those that have mobility impairments, and the presence of the gate can be considered to be a distraction.

Providing gates at other locations may actually not be practical owing to the layout of the station and other boundaries.

In summary, there is no evidence that self-closing wicket gates provide an overall safety benefit, and as such are not considered an option for improving risk control.

N2 Replace MSL with illuminated pictogram

Not for further consideration: There is no evidence that replacing the conventional MSL and associated signs/instructions with a ‘shaped’ light would provide any safety benefit, and so this cannot be supported for further consideration

This study finds no evidence that replacing the standard MSL with an illuminated pictogram would offer any incremental safety benefits. Whilst it might be in concept desirable to provide a recognisable shape to crossing users in place of the MSL and associated instructions, the difficulty lies with providing a shape that conveys the right message clearly and unambiguously.

The ‘human’ shape used on road crossings is of course widely known and understood, but its transfer to the rail context could be highly problematic. The meaning of the warning, and the difference in the hazards between road vehicle and train approaches could mean that risk would increase if it were applied at rail crossings.

N3 Larger MSL

Not for further consideration:
Previous work recommended that the filament lamp MSL be replaced by a larger LED lights, which have now been implemented. There is no evidence that providing even larger MSLs would provide further incremental safety benefit

This study finds no evidence that further increases to the size of the MSL would provide any additional safety benefit. The standard size of the MSL has been increased in moving from filament lamps to LEDs – which have already been replaced at most MSL crossings. Previous research supports this conclusion; it found that the most significant problem with users not obeying the red light was not conspicuity or understanding, but in deliberate violation [8]. Making the lights larger still would therefore be unlikely to provide any improvement in error rates.

N4 Traffic light type lights

Not for further consideration:
Significant practical difficulties, high costs, and problems with users’ association with road traffic lights mean that traffic light type replacements for MSLs should not be considered further

There is some uncertainty as to the safety impact of replacing MSLs with traffic light style lights (e.g. larger diameter lamps than MSLs, configured to appear like traffic lights with an amber aspect). Although they would certainly be familiar to most users as a key control for road vehicle users, the context applied at a rail crossing would be very different. Pedestrians do not have to comply with traffic lights anywhere else so there is a risk that the transfer to the railway would introduce risk rather than mitigate it.

In addition, providing a three aspect traffic light would be very costly due to the signalling work required to provide three aspects.

In summary – traffic light type lights are not proposed for further consideration on the basis of potentially increased risk, and high cost.

N5 Replace MSL with push button

Not for further consideration:
Using the idea of a push-button system from PUFFIN crossings on roads would have significant practical difficulties for application on the railway, and there is concern that it would lead to an increase in risk. It is therefore not to be considered further

The DfT have provided us with details of the design and operation of PUFFIN crossings so that any ideas that might be useful for the rail context can be transferred. The concept of the 'push button and wait' arrangement used at PUFFIN crossings but applied to station pedestrian crossings has been reviewed and considered that the most likely impact would be an increase in risk. The road and rail environments are fundamentally different: at road, vehicles are usually approaching and the light will be red until the demand is registered. The pedestrian then gets given the right of way over vehicles which have to stop. At railways, most of the time, the crossing will be clear for the user to traverse, but when a train is approaching it always has the right of way. Conceptually, therefore, at a rail crossing the user will not be compelled to register a demand by pushing a button as they get no benefit from doing so. This is the primary concern raised in the behaviour impact assessment that the rate of compliance with pushing the button is anticipated to be very low.

The other key difference is that the PUFFIN crossing is designed such that the user wanting to cross pushes the button and in doing so faces the primary hazard (oncoming traffic), but in the rail context this would be less desirable as a train can approach on either line (or it may be a single line railway).

For these reasons, the push button and wait idea is proposed not to be considered further.

N7 Active tactile warning

Not for further consideration:
Providing active tactile warnings cannot be supported on the basis of cost-benefit analysis, owing to the very small target population

The safety benefits associated with providing active tactile warnings for vision impaired users are likely to be extremely small, owing to the target population of users who travel alone that would benefit from such a device.

There may be some practical difficulties also owing to the need to provide a separate panel with power required for the motor to drive the warning.

In summary, active tactile warnings cannot be proposed for further consideration on the basis of cost-safety benefit. However, it is understood that RSSB is planning a study, T650 'Improving safety and accessibility at level crossings for pedestrians with disabilities', which will look at the issue of safety for vision impaired users (and other disabled pedestrians) more generally.

N8 Lights in floor at decision point

Not for further consideration:
Providing additional lights in the floor at the decision point at MSL crossings would be costly and cause problems associated within maintenance, and be of questionable benefit where there are groups of users who would block the lights

The behaviour impact associated with providing lights in the floor at the decision point to replicate the MSL aspect is expected to be positive as it would provide another indication that a train was approaching, plus a demarcation of the crossing.

One of the major downsides would be associated with increased and more difficult maintenance and cleaning.

Overall, although he behaviour impact is estimated to be positive, the safety benefits are not anticipated to justify the level of cost required for implementation. Back-to-back lights would offer similar advantages, be lower cost, and not have the same problems with lights being blocked by users and is therefore the preferred option of the two (see B1 and B2).

N12 Audible message triggered by gate

Not for further consideration:
Foreseen problems with reliability and vandalism mean that providing audible warnings at the 15 SPC-G is not being proposed for further consideration

The idea of providing an audible warning at crossings with gates is to give a final warning or reminder to look for trains before starting the traverse. It is important to note that the system would not be capable of indicating whether or not there was a train approaching as the application is not for crossing with MSLs (see N6 for additional warnings at MSLs).

Although there is anticipated to be some positive behavioural impact, particularly relating to breaking a users distraction before crossing, there would also be some difficulties. Particular problems are anticipated with poor reliability and susceptibility to vandalism (e.g. it would only require the switch that activates the warning to be broken, or the gate to be jammed open for the device to fail). Current wicket gates are not high integrity mechanical devices – they are sprung but not latched – so a warning device triggered by the status of the gate would also not have high reliability.

Conceptually, providing a low integrity device at a passive crossing is also potentially problematic. It could be argued that in the event of an accident that an underlying or direct cause was the failure of the device, and gaining safety approval of anything other than very high integrity devices is unlikely.

Overall, providing audible warnings at wicket gate crossings is not proposed for further consideration.

N14 Planned obscuration

Not for further consideration:
Implementing deliberate obscuration at station crossings would very difficult to do given the need to preserve the open platform edge. Combined with the lack of evidence that risk would actually decrease this is not proposed for further consideration

Planned obscuration, for example by providing screens to block the view up and down the tracks, would aim to increase users' perception of risk and thus make them more likely to take care to cross safely having looked carefully for trains at the decision point. Whilst in theory this could be the case (and earlier research has indicated that increased risk perception can lead to safer behaviour [20]), there would be significant problems.

Firstly, actually achieving obscuration of both approaches would not be possible at most locations. Where users approach the crossing by walking along the platform it would be possible to screen the trains approaching from the direction in which they are facing, but not the other direction – due to the need for an open platform edge.

Secondly, although risk perception may increase, there is a possibility that other hazards would be introduced or increased. In short, there is no evidence that the overall risk to users would increase or decrease.

Thirdly, even if the appropriate screening could be provided, it could cause accessibility problems (e.g. for wheelchair users).

Overall – planned obscuration cannot be proposed for further consideration.

N16 Painted markings to channel user

Not for further consideration:
Safety benefits of painted markings on the platform surface to channel users are anticipated to be negligible, and it is therefore not proposed for further consideration

Painting markings on the platform in an attempt to channel users to the decision point is similar in concept to using fencing/barriers for a similar purpose (F2). However, the effectiveness of painted markings would be expected to be very low, and for this reason alone in cannot be proposed for further consideration.

N17 Crossing in middle of platform

Not for further consideration:
Moving the crossing position to the centre of parallel platforms would introduce significant operational problems, and may increase risk to crossing users. Not for further consideration

At some urban rail systems in the United States, the platform layout is such that the pedestrian crossing is in the centre, rather than the end of the platforms. Taking this idea to the railway in Britain would be highly problematic owing to a number of reasons:

- The massive extent of civil engineering required to make the change
- Mixed train services having doors in different locations meaning that operations and boarding and alighting would be severely adversely affected
- No real safety advantage over a crossing at the platform end. A user who wanted to cross the tracks but was blocked by the train would either have to wait for it to move, or be tempted to cross illegally at either end. In any event, the risk associated with a second train approaching would remain
- No apparent positive behavioural impact

Moving crossings to the middle of platform is therefore not proposed for further consideration.

5. Conclusions

The review provides a response to Recommendation 4 of the RAIB [28] and as such includes an up-to-date understanding of human factors, and potential use of new technology in developing effective solutions. It has specifically investigated the four options for risk control raised in Recommendation 4 (fencing, gates, back-to-back lights, and another train coming warnings), and gone considerably beyond this to consider a wide range of other options including several which would be novel to the rail industry in Britain.

The report reaches 18 conclusions, described below in the categories of 'risk', 'current design, guidance and controls' and 'options for further and improved risk controls'.

5.1 Risk

1. The average annualised risk at station pedestrian crossings is around one fatality in three years. The low number of incidents makes quantified assessment of the risk subject to a large degree of uncertainty. To put the risk into context station pedestrian crossings contribute about 3% to the overall risk at all level crossings

2. The risk to pedestrians at station pedestrian crossings is higher per crossing than at all other types of crossing, including footpaths. While station pedestrian crossings contribute to 3% of the risk (see above), they represent only 1.3% of the total number of crossings

3. A preliminary assessment indicates that providing miniature stop lights (MSL) reduces risk, as has been expected but not previously demonstrated. Using user census counts provided by Network Rail for the ALCRM, it appears that the risk per traverse at station pedestrian crossings with MSLs is broadly similar to that at station pedestrian crossings with no MSL. However, the average number of trains passing over SPC-MSLs is higher, so per moment, the risk at SPC-MSLs appears to be approximately half, or less, than at crossings without MSLs

4. Although the industry has moved away from individual risk as a measure on which to base an assessment of 'risk acceptability', it is interesting to note that the individual risk at station pedestrian crossings appears to be lower than the limit previously considered to be 'intolerable' by the UK Health and Safety Executive[12]

[12] Previously, an annual risk of fatality above 1 in 10,000 has been considered to be the limit of tolerability for members of the public

5.2 Current design, guidance and controls

5. The guidance on level crossings provided in RSPG does not include station pedestrian crossings. The update to RPSG could usefully provide clarity on which elements of the guidance are appropriate for station pedestrian crossings. An opportunity could also be taken to correct the terminology in Part 2 Section B, guidance on stations, referring only to barrow crossings which is misleading

6. There is no guidance or standards specific to station pedestrian crossings which set out the principles for design to reduce risk, beyond the basic requirement to provide signs, and, optionally, visual and audible advance warnings of train approach. Providing such guidance or standards could help, over time as station works are carried out, to improve consistency in design

7. Signs and instructions provided at many station pedestrian crossings fall short of human factors good practice (clarity, positioning, conspicuity, conflicting messages, text rather than graphics). RSSB could consider further research into improving signs (although their actual influence on risk is not clear)

5.3 Options for further and improved risk controls

8. Many options for improved risk controls would offer only a marginal impact on safety risk; the decision to cross still lies with the user and there remains the potential for error or deliberate misuse with a resultant risk. There is no ‘silver bullet’ that will significantly reduce the risk at all station pedestrian crossings that can be considered practical and affordable

9. Very few mitigation options address the user errors and violations that could have the most serious consequences. The use of automatic-locking gates (which would be new to the British railway, but have been used elsewhere) is the only option under consideration that targets user errors and violations, and would significantly reduce the likelihood of both

10. Options with high costs are difficult to justify on the basis of cost-benefit analysis, at all but the highest risk station pedestrian crossings. This is because of the low average risk per crossing

11. In general, and consistent with other level crossings, risk controls are best implemented on a risk basis, using the best available techniques for risk assessment that are available (i.e. ALCRM once this has been calibrated)

12. From identifying and assessing a large number of options for further risk reduction twelve emerge as being potentially viable, although most would be subject to location specification assessment, and in some cases further clarification of safety benefits and behaviour impact

13. Twelve other options have been assessed and concluded as not viable, due to some combination of poor safety benefit, little or negative behaviour impact, excessive cost, significant practical difficulties, and wider implications including accessibility and railway operations

14. Back-to-back lights appear to provide some benefits over and above MSLs located only on one side of the crossing. It is not clear what the extent of the safety benefits would be without further fundamental research (e.g. pilot testing 'before and after') but at this stage the best estimate is that justification in terms of cost-benefit would be marginal. One possibility would be to provide back-to-back lights at new installations, or where current installations are life expired

15. Indications are that at the 20% highest risk station pedestrian crossings, MSLs would need to reduce risk by about 60% from the current level to be justified in terms of cost-safety benefit. As discussed in above, there is some evidence that MSLs do provide a reduction in risk although whether such a risk reduction is achievable is not clear without further fundamental research

16. The current cost of installing MSLs is a barrier to their more widespread fitment and consequently a barrier to reducing the overall risk at station pedestrian crossings (and other passive crossings). Use of alternative technologies, such as predictors, to produce a lower cost active warning, could potentially overcome this barrier. Even in the event that such a design is shown to have a lower integrity than the current design of MSL, this need not necessarily be a barrier – a globally lower level of risk may be achievable as it would be cost-effective to install more active warnings owing to their lower cost

17. Based on apportioning the total risk according to pedestrian moment, it would appear that eliminating the highest risk crossings could reduce the overall total risk significantly (for example replacing the top five crossings with footbridges could in theory reduce total risk by around 50%). This is based on a coarse assessment and Network Rail will be better equipped to make such assessments using ALCRM when it has been calibrated

18. Although outside the scope of this report, the assessment of options for risk control at station pedestrian crossings could usefully be used to inform improvements at footpath crossings (i.e. those not at stations). Options that might have similar benefits at footpath crossings include:

- Fencing: channel user to the decision point
- Fencing: chicanes
- Back-to-back lights / side-to-back lights
- Providing MSLs
- Additional audible warnings at MSLs triggered by user presence at the decision point
- Providing audible warning at existing MSLs where there is currently none
- Provide crossing surface as a single block of distinctive colour to mark the decision points and more clearly distinguish the crossing from platform areas

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Appendix A: Behaviour impact assessment

The results of the behaviour impact assessment are as follows:

	Option	Impact Assessment Summary	Score	Rank
G1	More self-closing gates	No clear behavioural benefits other than (possibly) preventing children and dogs from accessing railway. May be disbenefits - distraction, vandalism	0	19
G2	Auto-locking gates	Except for gate jumpers, completely removes risk of user crossing when a train is approaching	38	1
F1	Platform ramp edge	Prevents crossing in incorrect location (cf Foxton incident) but unlikely to reduce other violations. Only addresses where crossing is made, not when	1	17
F2	Channel user to decision point	Maximises information provision to the user - ensures optimum sighting in both directions so aids decision on when to cross	8	5
F3	Chicane	Maximises info provision to the user - ensures optimum sighting in both directions so aids decision on when to cross. Would work only if a physical barrier were provided (i.e. not white lines on ground)	5	15
B1	Back-to-back lights	Provides redundancy. Increased information provision improves situational awareness and accuracy of decision to cross	6	11
B2	Side-to-back lights	Provides redundancy. Increased information provision improves situational awareness and accuracy of decision to cross	6	11
N1	Provide MSL	Some users may not be familiar with MSLs and fail to follow correct crossing procedure. However, MSLs do remove the need for users to rely on visual checks for trains before crossing. Further research required to determine quantitatively the benefits of MSLs at station pedestrian crossings	8	5
N2	Replace MSL with illuminated pictogram	Previous RSSB research e.g. T269 (RSSB, 2003) suggests that this will offer no significant benefits over standard lights. May import risk if users adopt incorrect mental model (i.e. road crossing)	-3	23
N3	Larger MSL	Larger and brighter lights are more conspicuous but further research would be required to determine threshold of added benefit (esp. over that already conferred by LED MSLs)	6	11
N4	Traffic light type lights	Risk may increase - traffic lights that apply to pedestrians are completely novel and would require mental model modification	0	19

	Option	Impact Assessment Summary	Score	Rank
N5	Replace MSL with push button	May increase risk, especially for users who are familiar with current MSL system who may fail to push button (perhaps assuming MSL is broken). Risk that user adopts incorrect mental model of a road crossing, choosing to cross even when a red light is displayed	-9	24
N6	Warning triggered by user	Further research would be required to determine effects on user behaviour, esp. group behaviour and the long term effectiveness of such a system	7	10
N7	Active tactile warning	Targets only a tiny proportion of users (sight impaired)	0	19
N8	Lights in floor at decision point	Provides redundancy if installed at MSL crossings. Increased information provision improves situational awareness and accuracy of decision to cross. Careful maintenance required to ensure visibility	11	4
N9	Station announcement	Potentially good, timely reminder to passengers about to use the crossing. Use in conjunction with train PA announcements to maximise effectiveness	16	2
N10	Train PA	Potentially good, timely reminder to passengers about to use the crossing. Only targets train passengers, not others waiting at the station	16	2
N11	Novel ATC warning	Behaviour impact may vary according to whether warning is audible or visual. Audible warnings tend to be more impactful	8	5
N12	Audible message triggered by gate	Further research would be required to determine effects on user behaviour, esp. group behaviour and the long term effectiveness of such a system	3	16
N13	Audible warning at all MSL	Extra source of information. HF research demonstrates high impact of audible warnings and benefits of multi-sensory feedback	8	5
N14	Planned obscuration	Potentially increases risk as impossible to obscure view in both directions and reduces information to user on which decision to cross is based	1	17
N15	Crossing as block of colour	Addresses 2 risks at SPCs: clearly demarcates decision point (intuitively, without requirement for additional signage) and highlights where users are 'at risk' and where extra care and attention is required. May be especially useful at crossings where large numbers of passengers disembark from trains and are required to use the crossing to reach the station exit/car park	8	5
N16	Painted markings to channel user	Clarifies decision point but may have no impact on risk as users can choose to ignore markings (and would if a more direct route to the crossing were available)	6	11
N17	Crossing in middle of platform	Increased risk of passenger confusion about direction of oncoming trains, violates existing mental model of passenger movements within stations	-2	22

Appendix B: HAZOP record

SPC with no gates or MSL									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Recognise crossing.		Action omitted	User fails to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Visibility of rail tracks and signage. Poor lighting conditions e.g. during night time.	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may be stood on crossing before they realise the error. User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present).	N/A	Potential for the worst case scenario consequence is minimal.
		Action too late	User is late to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User misinterprets level crossing sign. User's behaviour is impaired by drugs, alcohol or fatigue.					
		Wrong information obtained	User misinterprets warning sign on approach to level crossing.	User misinterprets level crossing sign. User is under time pressure. User is distracted. User is unfamiliar with crossing procedure. User's behaviour is impaired by drugs, alcohol or fatigue.					
Stop at decision point		Action omitted	User continues through crossing (user unaware of requirement to stop at decision point).	User is distracted. User follows errant dog or child onto the track. Users follows group onto crossing. User is under time pressure. User has low perception of risk. User is unfamiliar with crossing procedure. User misjudges location of decision point. User thinks he / she understands procedure without reading instructions. User's behaviour is impaired by drugs, alcohol or fatigue.	Ambient noise (e.g. road traffic, station announcements, passenger noise). No appropriate warning signs or indicators. Poor weather conditions. Sign obscured (e.g. by foliage or snow), or not clearly visible or legible. Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. Poor lighting conditions e.g. during night time. User is follows a dog or child into an unsafe position.	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present).	N/A	Decision point may be incompatible with any platform edge marking. Decision point may be not be in a safe position, this is dependant upon the sighting distance down the track, platform curvature, positioning of signage, and any other objects obscuring sighting. The user can make a false assumption as to where the appropriate decision point is based upon existing platform and station features. For example, assuming that changes in the crossing surface demarcate safe and non-safe areas to stand. Also the presence (or otherwise) of other vision or tactile cues. At pedestrian road crossings, tactile strips and other equipment are used to demarcate where it is safe to stand. This is particularly important for users with vision impairments.
		Action too late.	User stops at decision point too close to the line (not in a safe position).		No appropriate marking of safety position provided. Markings obscured (e.g. by leaf fall or foliage) or faded, or have an unclear meaning. Environmental conditions such as poor weather (e.g. snow, rain) and poor visibility.	User may position his/herself in an unsafe location before crossing. Potential collision between train and user. User may be unaware that they are positioned in an unsafe location.			

SPC with no gates or MSL									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
		Action too early	User stops at decision point too far away from the line (and so has insufficient sighting distance up and down the tracks).	User misjudges decision point. User is unfamiliar with crossing procedure. User may have an inadequate mental model of the crossing, therefore he / she may not locate or notice markings. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User's behaviour is impaired by drugs, alcohol or fatigue.	The markings for the position of safety may require the user to position his/herself well back, impairing his/her sighting of the track for trains.	User may decide to cross when it is unsafe to do so. Potential collision between train and user.			
Read crossing instructions.		Action omitted	User fails to read crossing instructions.	User is under time pressure. User has low perception of risk. User is distracted. User does not feel the need to read instructions before crossing. User thinks he / she understands procedure without reading instructions. User may be unfamiliar with level crossing protocols. User's ability to read may be impaired by poor sight/blindness, poor literacy, learning difficulties or language skills. User does not speak English, or English is not his/her first language. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Sign obscured (e.g. by foliage or other signage), or not clearly visible or legible. Crossing cluttered with numerous signs leads the user to be unsure which sign to read. Key signs may not be in optimal location for viewing. Prominance of sign (in comparison to other signs) does not reflect the importance of that sign. Crossing instructions poorly located, missing or unclear. Inconsistency of signage location and type between level crossings of the same type. Poor lighting conditions e.g. during night time.	User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present).		It is generally reported that individuals do not read signs, often because they do not believe it is important. The non-standard arrangement of lights and signage at LXs (such that the layout at each crossing is different) may be confusing to individuals who use multiple crossings. The positioning of signage should indicate the priority of information. High priority signage should be located within the primary vision field of the user and should be more prominent than less important signage. The user can derive contradictory messages from signage, for example signage indicating that users should not trespass around the crossing may also be interpreted as 'don't use the crossing'.
		Information not obtained.	User fails to understand crossing instructions.	User's ability to read may be impaired by poor literacy or language skills. User is under time pressure. User may be unfamiliar with level crossing protocols. User does not speak English, or English is not his/her first language. User may be unfamiliar with level crossing protocols. User's behaviour is impaired by drugs, alcohol or fatigue.	Sign obscured (e.g. by foliage), or not clearly visible or legible. Crossing instructions missing or unclear. Inconsistency of signage location and type between level crossings of the same type.			N/A	
		Wrong infromation obtained	User fails to realise instructions are appropriate to him / her.	User is unfamiliar with crossing procedure. User is under time pressure. User's ability to read may be impaired by poor literacy or language skills. User does not speak English, or English is not his/her first language. User has low perception of risk. User is distracted. User is following another user over crossing. User has succeeded in crossing in the same way previously. User's behaviour is impaired by drugs, alcohol or fatigue.	Crossing instructions missing or unclear. Positioning of signage fails to emphasise the importance of the instructions.				

SPC with no gates or MSL									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Check for trains	Listen for train	Action omitted	Failure to listen for train	User is over-reliant on seeing the train. User is under time pressure. User has low perception of risk. User is distracted (e.g. in a group or on a mobile phone). User is following another user over crossing. Familiar user applies prior knowledge of train times / frequencies. User's behaviour is impaired by drugs, alcohol or fatigue.	N/A	Lack of awareness of train approaching. May not be aware of a second train approaching. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present). LX users will receive multi-sensory feedback while waiting to traverse a crossing: -Tactile feedback from vibrations in the ground caused by the train approach. -Auditory feedback from train noise, the whistle of the rails, the train horn if sounded and station announcements. -vision feedback from the train approach.	N/A	Passengers will have a different mindset towards crossing depending on whether they are crossing to get on a train/get on the correct platform, using the crossing after getting off a train to leave the station, or getting off a train then using the crossing to get to another platform to make a connecting train.
		Information not obtained.	Failure to hear train	User has a hearing impairment. Sound of train is masked by other sound source (i.e. mp3 player, other people talking). User's hearing is impaired by clothing (e.g. a hood or hat). User's behaviour is impaired by drugs, alcohol or fatigue.	Environmental noise such as busy traffic, road works etc. Train driver fails to sound horn (if required at that crossing). Sound of a train is masked by other trains already within the station bounds. Sound of second train coming is masked by the sound of the first train leaving.				
	Look for train	Action omitted	Failure to look both ways for train.	User is over-reliant on hearing the train. User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. Familiar user applies prior knowledge of train times / frequencies. User's behaviour is impaired by drugs, alcohol or fatigue.	N/A				
		Information not obtained.	Failure to see train	User has a vision impairment. View of train is obscured by other people. User does not distinguish train from background.	User does not have a good viewpoint and cannot see the train. User does not distinguish train from background. View of train is obscured by features of the railway or surrounding environment (e.g. signage, foliage, gradient). On a multi-track section, a train travelling in one direction obstructs view of line in other direction. Poor lighting conditions e.g. during night time.				

SPC with no gates or MSL									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Train approaches station									
Wait at crossing (for an approaching train).		Deliberate violation.	User fails to wait, unaware of approaching train.	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. Use chooses to ignore instructions. User does not understand instructions. User believes he / she has enough time to beat the train. User has succeeded in crossing in the same way previously. User misjudges decision point. User frustrated, believing he / she is improperly prevented from proceeding. User's actions are influenced by peer pressure. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear.	Potential collision between train and user.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	N/A	Aside from deliberate violation of crossing protocols the key failures relate to the user misjudging, or assuming it is safe to traverse. A mid-point (safe haven) in a two line LX may encourage risk taking behaviour (especially for those in groups). Attendees noted that there were no known 4 line station pedestrian crossings where this may be a risk. visionly, the angle of the approach to the crossing influences the users perception of the distance to travel across the tracks. When the angle of approach is at 90° to the lines the perceived distance is shorter than if the tracks are not at right angles to the crossing approach.
		Action too little.	User misjudges the time available to traverse the crossing	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User misjudges the speed and distance of the train. User believes he / she has enough time to beat the train. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear.	Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present). LX users will receive multi-sensory feedback while waiting to traverse a crossing: -Tactile feedback from vibrations in the ground caused by the train approach. -Auditory feedback from train noise, the whistle of the rails, the train horn if sounded and station announcements. -vision feedback from the train approach.		
		Wrong information obtained.	User assumes it is clear to cross after the first train has passed.	User is under time pressure. User has low perception of risk. User is distracted. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User assumes mental model that it is safe to proceed after a train passes. User is following another user over crossing. User's behaviour is impaired by drugs, alcohol or fatigue.	Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. On a multi-track section, a train travelling in one direction obstructs view of line in other direction. User does not distinguish train from background. High activity area with many distractions (e.g. busy roads and platforms). User knows that he/she will have a long wait until his/her next train comes. The curvature of the track/platform blocks the users view of a second train coming.	Potential collision between user and train. Potential collision between user and second train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present.		It was noted that many incidents occur when individuals waiting to traverse the crossing stand in the nearside lines while waiting for the train in the farside line to pass.

SPC with no gates or MSL									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Train leaves station									
Re-check for trains.	See task 'Check for trains'								It was commented that the impact of time pressures upon user behaviour will be exacerbated by delay experienced by users in this step. Similarly, a re-check is likely to be less thorough than the initial check.
Cross tracks.	Cross tracks on foot.	Action too late.	User hesitates while crossing or decides to turn back (potentially choosing to remain on the crossing).	User is distracted. User has low perception of risk. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User believes he / she must turn back, e.g. he / she has forgotten something. User has mobility impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Poor or uneven crossing surface. Missing, partial, or damaged crossing deck causes confusion. User is encumbered, e.g. with luggage. Congestion on the crossing blocks the user's way.	Potential collision between user and train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	N/A	
		Deliberate violation.	User deliberately trespasses on the railway from the crossing.	User has low perception of risk. User is under time pressure. User's behaviour is impaired by drugs, alcohol or fatigue. User's actions are influenced by peer pressure.	N/A	Potential collision between user and train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.		
		Abnormal conditions / Right action on wrong object.	User slips, trips or falls when crossing.	User is under time pressure. User is distracted. User believes he / she must cross as quickly as possible. User has mobility impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Poor or uneven crossing surface. Missing, partial, or damaged crossing deck causes confusion. User is encumbered, e.g. with luggage. User trips or catches a foot in the gap between the rails and crossing walkway. Users encumbrance (e.g. suitcase with wheels, buggy, wheelchair) become caught in gap between the rails and crossing walkway. Poor lighting conditions e.g. during night time.	User may fall on or near the line. Potential collision between train and user.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present.		
Continue with journey.			N/A	N/A	N/A	N/A			

SPC-GL Station pedestrian crossings equipped with gates that are locked by the signaller or LX keeper on the approach of trains									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Recognise crossing.		Action omitted	User fails to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time.	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may not follow correct crossing procedure. Potential collision between train and user.	Good: The gates will only be unlocked when it is safe for the user to cross.	Gates form a physical barrier and indicate a safe position for the user to stand. As the responsibility for deciding when to cross is removed from the user and reallocated to the signaller or LX keeper the importance of sighting distances and decision points is also reduced.	Gates may be left open, or held open by crossing users, if the signaller locks them remotely. Gates may also be propped open, or wedged open by foliage etc. Lockable gates mitigate the risk associated with errant dogs or children straying onto the crossing when a train is approaching.
		Action too late	User is late to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User misinterprets level crossing sign. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time.				
		Wrong information obtained	User misinterprets warning sign on approach to level crossing.	User misinterprets level crossing sign. User is under time pressure. User is distracted. User is unfamiliar with crossing procedure. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time.		Good: The gates will only be unlocked when it is safe to cross. However, the user may not understand why they are unable to cross if signage is misinterpreted.		
Stop at decision point.	Stop at gate.	Deliberate violation.	User climbs over gate despite requirement to wait at the gate until safe to cross.	User is under time pressure. User has low perception of risk. User is unfamiliar with crossing procedure. User thinks he / she understands procedure without reading instructions. User believes he / she must cross as quickly as possible. User's behaviour is impaired by drugs, alcohol or fatigue. User's actions are influenced by peer pressure.	The LX keeper is delayed in opening gate. The LX keeper fails to, or is slow to, close gate. No appropriate warning signs or indicators. Poor weather conditions. Sign obscured (e.g. by foliage), or not clearly visible or legible. Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. Poor lighting conditions e.g. during night time.	User may not follow correct crossing procedure. Potential collision between train and user.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.		Locked gates effectively take the decision to cross away from the crossing user and transfer responsibility to the signaller. When the gate is in an unlocked state it is safe to cross, when locked it is not. However, the user is still required to make a decision when to cross in case of an error by the LX keeper or signaller. It was noted that signallers often struggle to remove vandals or trouble-makers from crossings when trains are approaching. As such, a high degree of stress is generally associated with the LX keeper job.

SPC-GL Station pedestrian crossings equipped with gates that are locked by the signaller or LX keeper on the approach of trains									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Read crossing instructions.		Action omitted.	User fails to read crossing instructions.	User is under time pressure. User has low perception of risk. User is distracted. User does not feel the need to read instructions before crossing. User thinks he / she understands procedure without reading instructions. User may be unfamiliar with level crossing protocols. User's ability to read may be impaired by poor sight/blindness, poor literacy, learning difficulties or language skills. User does not speak English, or English is not his/her first language. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Sign obscured (e.g. by foliage or other signage), or not clearly visible or legible. Crossing cluttered with numerous signs leads the user to be unsure which sign to read. Key signs may not be in optimal location for viewing. Prominence of sign (in comparison to other signs) does not reflect the importance of that sign. Crossing instructions poorly located, missing or unclear. Inconsistency of signage location and type between level crossings of the same type. Poor lighting conditions e.g. during night time.	User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present).	Lockable gates prevent the user from crossing when unsafe (aside from a deliberate violation of crossing procedure) mitigating much of the risk associated with not understanding/reading signage.	It is generally reported that individuals do not read signs, often because they do not believe it is important. The non-standard arrangement of lights and signage at LXs (such that the layout at each crossing is different) may be confusing to individuals who use multiple crossings. The positioning of signage should indicate the priority of information. High priority signage should be located within the primary vision field of the user and should be more prominent than less important signage. The user can derive contradictory messages from signage, for example signage indicating that users should not trespass around the crossing may also be interpreted as 'don't use the crossing'.
		Information not obtained.	User fails to understand crossing instructions.	User's ability to read may be impaired by poor literacy or language skills. User is under time pressure. User may be unfamiliar with level crossing protocols. User does not speak English, or English is not his/her first language. User may be unfamiliar with level crossing protocols. User's behaviour is impaired by drugs, alcohol or fatigue.	Sign obscured (e.g. by foliage), or not clearly visible or legible. Crossing instructions missing or unclear. Inconsistency of signage location and type between level crossings of the same type.	User may not follow correct crossing procedure. Potential collision between train and user.			
		Wrong information obtained.	User disregards instructions failing to realise that they are relevant to him / her.	User is unfamiliar with crossing procedure. User is under time pressure. User's ability to read may be impaired by poor literacy or language skills. User does not speak English, or English is not his/her first language. User has low perception of risk. User is distracted. User is following another user over crossing. User has succeeded in crossing in the same way previously. User's actions are influenced by peer pressure. User's behaviour is impaired by drugs, alcohol or fatigue. User's understanding of the crossing instructions does not fit with actual procedure (i.e. LX keeper does not open gate).	Crossing instructions missing or unclear. Crossing keeper fails to, or is slow to open the gate. Positioning of signage fails to emphasise the importance of the instructions.	User may not follow correct crossing procedure. Potential collision between train and user.			The non-standard arrangement of lights and signage at LXs (such that the layout at each crossing is different) may be confusing to individuals who use multiple crossings.

SPC-GL Station pedestrian crossings equipped with gates that are locked by the signaller or LX keeper on the approach of trains									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Check for trains	Listen for train	Action omitted	Failure to listen for train	User is over-reliant on seeing the train. User is under time pressure. User has low perception of risk. User is distracted (e.g. in a group or on a mobile phone). User is following another user over crossing. Familiar user applies prior knowledge of train times / frequencies. User's behaviour is impaired by drugs, alcohol or fatigue.	N/A	Lack of awareness of train approaching. May not be aware of a second train approaching.	Good: Lockable gates prevent the user from crossing unless deliberately violating LX procedure. Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present). LX users will receive multi-sensory feedback while waiting to traverse a crossing: -Tactile feedback from vibrations in the ground caused by the train approach. -Auditory feedback from train noise, the whistle of the rails, the train horn if sounded and station announcements. -Visual feedback from the train approach.	Lockable gates prevent the user from crossing when unsafe (aside from a deliberate violation of crossing procedure) mitigating much of the risk associated with not understanding/reading signage.	
		Information not obtained.	Failure to hear train	User has a hearing impairment. Sound of train is masked by other sound source (i.e. mp3 player, other people talking). User's hearing is impaired by clothing (e.g. a hood or hat). User's behaviour is impaired by drugs, alcohol or fatigue.	Environmental noise such as busy traffic, road works etc. Train driver fails to sound horn (if required at that crossing). Sound of a train is masked by other trains already within the station bounds. Sound of second train coming is masked by the sound of the first train leaving.				
	Look for train	Action omitted	Failure to look both ways for train.	User is over-reliant on hearing the train. User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. Familiar user applies prior knowledge of train times / frequencies. User's behaviour is impaired by drugs, alcohol or fatigue.	N/A				
		Information not obtained.	Failure to see train	User has a vision impairment. View of train is obscured by other people. User does not distinguish train from background.	User does not have a good viewpoint and cannot see the train. User does not distinguish train from background. View of train is obscured by features of the railway or surrounding environment (e.g. signage, foliage, gradient). On a multi-track section, a train travelling in one direction obstructs view of line in other direction. Poor lighting conditions e.g. during night time.				

SPC-GL Station pedestrian crossings equipped with gates that are locked by the signaller or LX keeper on the approach of trains									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Train approaches station									
Wait at crossing (for an approaching train).		Deliberate violation.	User fails to wait and climbs gate, unaware of approaching train.	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. Use chooses to ignore instructions. User does not understand instructions. User believes he / she has enough time to beat the train. User has succeeded in crossing in the same way previously. User frustrated, believing he / she is improperly prevented from proceeding. User's actions are influenced by peer pressure. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Gates left open or vandalised.	Potential collision between train and user. Potential collision between user and second train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	A locked gate forces the level crossing user to wait until it is safe to cross and the signaller/LX keeper has unlocked the gate. Only a deliberate violation of crossing procedure could result in a collision between train and crossing user.	
		Wrong information obtained.	Gate fails to lock properly. User tries the gate, finds it open and crosses.	User is following another user over crossing.	Gate has been left slightly ajar by another crossing user so bolts fail to activate properly. Gate has been vandalised or is not functioning as designed.	Potential collision between train and user. Potential collision between user and second train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	A locked gate forces the level crossing user to wait until it is safe to cross and the signaller/LX keeper has unlocked the gate. Only a deliberate violation of crossing procedure could result in a collision between train and crossing user.	

SPC-GL Station pedestrian crossings equipped with gates that are locked by the signaller or LX keeper on the approach of trains									
Task	**Sub Task**	**Guide words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Train leaves station									
LX keeper opens gate									
Re-check for trains.			See task 'Check for trains'						
Open gate		Action too long.	User hesitates while opening gate / is unable to open it in a timely manner.	User is distracted. User is unfamiliar with crossing procedure. User is unfamiliar with gate latching mechanism (if present). User has reduced mobility or is disabled. User's ability to open gates is impaired by encumbrance. User's behaviour is impaired by drugs, alcohol or fatigue.	Gate has been vandalised or is not functioning as designed. Movement of gate is impaired by an obstruction (e.g. snow, leaves or vegetation). Movement of gate may be impaired by crowds on the other side of the crossing or a user with an encumbrance or wheelchair.	No hazard - an open gate indicates that it is safe to cross at this type of crossing.			A further possibility is that the user could become trapped (e.g. clothes snagged) in the gate, especially if it is spring loaded. However, if the user were trapped, depending upon the distance between the gate and the lines, it is unlikely that the user would be in a dangerous position.
Cross tracks.	Cross tracks on foot.	Action too late.	User hesitates while crossing or decides to turn back (potentially choosing to remain on the crossing).	User is distracted. User has low perception of risk. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User believes he / she must turn back, e.g. he / she has forgotten something. User has mobility impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Poor or uneven crossing surface. Missing, partial, or damaged crossing deck causes confusion. User is encumbered, e.g. with luggage. Congestion on the crossing blocks the user's way.	No hazard - an open gate indicates that it is safe to cross at this type of crossing.		N/A	
		Deliberate violation.	User deliberately trespasses on the railway from the crossing.	User has low perception of risk. User is under time pressure. User's behaviour is impaired by drugs, alcohol or fatigue. User's actions are influenced by peer pressure.	N/A	Potential collision between user and train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.		
Open gate		Action too long.	User hesitates while opening gate / is unable to open it in a timely manner.	User is distracted. User is unfamiliar with crossing procedure. User is unfamiliar with gate latching mechanism (if present. User has reduced mobility or is disabled. User's ability to open gates is impaired by encumbrance. User's behaviour is impaired by drugs, alcohol or fatigue.	Gate has been vandalised or is not functioning as designed. Movement of gate is impaired by an obstruction (e.g. snow, leaves or vegetation). Movement of gate may be impaired by crowds on the other side of the crossing or a user with an encumbrance or wheelchair.	User's crossing could be delayed. User crossing time could be prolonged meaning that he / she is not in a safe position within sufficient time. Potential collision between train and user could occur.	Poor: Other crossing users. Station staff if present.		Completion of this task is contingent upon the signaller/LX keeper remembering to open both gates on the crossing. A user could become trapped on the crossing if only one gate is opened. This is dependant upon the type of locking mechanism used.
Continue with journey.			N/A	N/A	N/A	N/A			

SPC equipped with unlocked gates on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Recognise crossing.		Action omitted	User fails to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time. Gates left open by previous user and the user's attention is drawn to a feature beyond the other side of the crossing (e.g. a road junction, bright lights, train in platform).	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present).	Gates (although unlocked) form a physical barrier between the crossing user and the railway. The user has to actively open the gates to stand in an unsafe position at the crossing. Gates indicate a safe position for the user to stand.	Often gates may be left open, or held open by crossing users. As such, the benefit to risk reduction of unlocked gates may be limited. Gates may be propped open, or wedged open by foliage etc. Unlocked gates will mitigate some of the risk associated with errant dogs or children straying onto the crossing when a train is approaching.
		Action too late	User is late to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User misinterprets level crossing sign. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time.				
		Wrong information obtained	User misinterprets warning sign on approach to level crossing.	User misinterprets level crossing sign. User is under time pressure. User is distracted. User is unfamiliar with crossing procedure. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time.				

SPC equipped with unlocked gates on both sides of the track

Task	Sub Task	Guide Words	Deviation	Influencing factors - behavioural	Influencing factors - environmental / physical	Consequences	Potential for Error Recovery (None, Poor, Marginal, Good, Complete)	Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates	General Comments
Stop at decision point		Action omitted	User continues through crossing (user unaware of requirement to stop at decision point).	User is distracted. User follows errant dog or child onto the track. Users follows group onto crossing. User is under time pressure. User has low perception of risk. User is unfamiliar with crossing procedure. User misjudges location of decision point. User thinks he / she understands procedure without reading instructions. User's behaviour is impaired by drugs, alcohol or fatigue.	Gate has been left open by a previous user. Ambient noise (e.g. road traffic, station announcements, passenger noise). No appropriate warning signs or indicators. Poor weather conditions. Sign obscured (e.g. by foliage or snow), or not clearly visible or legible. Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. Poor lighting conditions e.g. during night time. User follows a dog or child into an unsafe position.	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present).	The provision of a gate, although unlocked, can reduce the risk associated with this error by providing a physical barrier at which the user conducts pre-crossing checks.	Decision point may be incompatible with any platform edge marking. Decision point may be not be in a safe position, this is dependant upon the sighting distance down the track, platform curvature, positioning of signage, and any other objects obscuring sighting. The user can make a false assumption as to where the appropriate decision point is based upon existing platform and station features. For example, assuming that changes in the crossing surface demarcate safe and non-safe areas to stand. Also the presence (or otherwise) of other visual or tactile cues. At pedestrian road crossings, tactile strips and other equipment are used to demarcate where it is safe to stand. This is particualrly important for users with visual impairments. Gates indicate a safe position for the user to stand. However, there may be a conflict between the gate and decision point if insufficient sighting up and down the tracks is available to the user. This could be highly problematic/confusing for the user if the decision point is beyond the gate. In this instance the following considerations were highlighted: - distance from the nearside line to the gate. - the size of the refuge between the gate and the line. - whether the individual/members of the group had any encumbrances. - length of time taken to open gate (for wheelchair users etc). - the gate closing mechanism: self-closing or manual close required.
		Action too late.	User stops at decision point too close to the line (not in a safe position).	The user's motivation to look up and down the track may mean that the user positions his/herself in an unsafe location. User is unfamiliar with crossing procedure. User may have an inadequate mental model of the crossing, therefore he / she may not locate or notice markings. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User has a low perception of risk. User thinks he / she understands procedure without reading instructions. The presence of wheelchairs, pushchairs and other encumbrances may cause the user to select a decision point too close to the line. User has a visual impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	Position of the gate in relation to the line means that the user must stand lineside of the gate to have a clear view up and down the tracks. No appropriate marking of safety position provided. Markings obscured (e.g. by leaf fall or foliage) or faded, or have an unclear meaning. Environmental conditions such as poor weather (e.g. snow, rain) and poor visibility.	User may position his/herself in an unsafe location before crossing. Potential collision between train and user. User may be unaware that they are positioned in an unsafe location.			
		Action too early	User stops at decision point too far away from the line (and so has insufficient sighting distance up and down the tracks).	User believes that the gate demarcates a decision point and is located to provide sufficient sighting distance up and down the tracks. User misjudges decision point. User is unfamiliar with crossing procedure. User may have an inadequate mental model of the crossing, therefore he / she may not locate or notice markings. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User's behaviour is impaired by drugs, alcohol or fatigue.	The positioning of the gate is too far away from the tracks. The markings for the position of safety may require the user to position his/herself well back, impairing his/her sighting of the track for trains.	User may decide to cross when it is unsafe to do so. Potential collision between train and user.			

SPC equipped with unlocked gates on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Read crossing instructions.		Action omitted	User fails to read crossing instructions.	User is under time pressure. User has low perception of risk. User is distracted. User does not feel the need to read instructions before crossing. User thinks he / she understands procedure without reading instructions. User may be unfamiliar with level crossing protocols. User's ability to read may be impaired by poor sight/blindness, poor literacy, learning difficulties or language skills. User does not speak English, or English is not his/her first language. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Sign obscured (e.g. by foliage or other signage), or not clearly visible or legible. Crossing cluttered with numerous signs leads the user to be unsure which sign to read. Key signs may not be in optimal location for viewing. Prominence of sign (in comparison to other signs) does not reflect the importance of that sign. Crossing instructions poorly located, missing or unclear. Inconsistency of signage location and type between level crossings of the same type. Poor lighting conditions e.g. during night time.	User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present).		
		Information not obtained.	User fails to understand crossing instructions.	User's ability to read may be impaired by poor literacy or language skills. User is under time pressure. User may be unfamiliar with level crossing protocols. User does not speak English, or English is not his/her first language. User may be unfamiliar with level crossing protocols. User's behaviour is impaired by drugs, alcohol or fatigue.	Sign obscured (e.g. by foliage), or not clearly visible or legible. Crossing instructions missing or unclear. Inconsistency of signage location and type between level crossings of the same type.				It is generally reported that individuals do not read signs, often because they do not believe it is important. The non-standard arrangement of lights and signage at LXs (such that the layout at each crossing is different) may be confusing to individuals who use multiple crossings. The positioning of signage should indicate the priority of information. High priority signage should be located within the primary visual field of the user and should be more prominent than less important signage. The user can derive contradictory messages from signage, for example signage indicating that users should not trespass around the crossing may also be interpreted as 'don't use the crossing'. It was noted that at some stations no instructions are provided to user's about the gates. Specifically, whether the gates are unlocked or locked, and if so whether the locking is done by a signaller, or is interlocked with the signalling. Without instructions to this effect user's who cross different crossing with gates may develop an incorrect mental model of gate operation at crossings.
		Wrong information obtained	User fails to realise instructions are appropriate to him / her.	User is unfamiliar with crossing procedure. User is under time pressure. User's ability to read may be impaired by poor literacy or language skills. User does not speak English, or English is not his/her first language. User has low perception of risk. User is distracted. User is following another user over crossing. User has succeeded in crossing in the same way previously. User's behaviour is impaired by drugs, alcohol or fatigue.	Crossing instructions missing or unclear. Positioning of signage fails to emphasise the importance of the instructions.				

SPC equipped with unlocked gates on both sides of the track

Task	Sub Task	Guide Words	Deviation	Influencing factors - behavioural	Influencing factors - environmental / physical	Consequences	Potential for Error Recovery (None, Poor, Marginal, Good, Complete)	Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates	General Comments
Check for trains	Listen for train	Action omitted	Failure to listen for train	User is over-reliant on seeing the train. User is under time pressure. User has low perception of risk. User is distracted (e.g. in a group or on a mobile phone). User is following another user over crossing. Familiar user applies prior knowledge of train times / frequencies. User's behaviour is impaired by drugs, alcohol or fatigue.	N/A	Lack of awareness of train approaching. May not be aware of a second train approaching. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present). LX users will receive multi-sensory feedback while waiting to traverse a crossing: -Tactile feedback from vibrations in the ground caused by the train approach. -Auditory feedback from train noise, the whistle of the rails, the train horn if sounded and station announcements. -Visual feedback from the train approach.	N/A	Passengers will have a different mindset towards crossing depending on whether they are crossing to get on a train/get on the correct platform, using the crossing after getting off a train to leave the station, or getting off a train then using the crossing to get to another platform to make a connecting train.
		Information not obtained.	Failure to hear train	User has a hearing impairment. Sound of train is masked by other sound source (i.e. mp3 player, other people talking). User's hearing is impaired by clothing (e.g. a hood or hat). User's behaviour is impaired by drugs, alcohol or fatigue.	Environmental noise such as busy traffic, road works etc. Train driver fails to sound horn (if required at that crossing). Sound of a train is masked by other trains already within the station bounds. Sound of second train coming is masked by the sound of the first train leaving.				
	Look for train	Action omitted	Failure to look both ways for train.	User is over-reliant on hearing the train. User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. Familiar user applies prior knowledge of train times / frequencies. User's behaviour is impaired by drugs, alcohol or fatigue.	N/A				
		Information not obtained.	Failure to see train	User has a visual impairment. View of train is obscured by other people. User does not distinguish train from background.	User does not have a good viewpoint and cannot see the train. User does not distinguish train from background. View of train is obscured by features of the railway or surrounding environment (e.g. signage, foliage, gradient). On a multi-track section, a train travelling in one direction obstructs view of line in other direction. Poor lighting conditions e.g. during night time.				

SPC equipped with unlocked gates on both sides of the track

Task	Sub Task	Guide Words	Deviation	Influencing factors - behavioural	Influencing factors - environmental / physical	Consequences	Potential for Error Recovery (None, Poor, Marginal, Good, Complete)	Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates	General Comments
Train approaches station									
Wait at crossing (for an approaching train).		Deliberate violation.	User fails to wait, unaware of approaching train.	User is under time pressure User has low perception of risk. User is distracted. User is following another user over crossing. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. Use chooses to ignore instructions. User does not understand instructions. User believes he / she has enough time to beat the train. User has succeeded in crossing in the same way previously. User misjudges decision point. User frustrated, believing he / she is improperly prevented from proceeding. User's actions are influenced by peer pressure.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear. Gates left open or vandalised.	Potential collision between user and train. Potential collision between user and second train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	A gate, although unlocked, provides a physical barrier behind which the user should stand whilst waiting to cross.	Aside from deliberate violation of crossing protocols the key failures relate to the user misjudging, or assuming it is safe to traverse. A mid-point (safe haven) in a two line LX may encourage risk taking behaviour (especially for those in groups). Attendees noted that there were no known 4 line station pedestrian crossings where this may be a risk. Visually, the angle of the approach to the crossing influences the users perception of the distance to travel across the tracks. When the angle of approach is at 90° to the lines the perceived distance is shorter than if the tracks iare not at right angles to the crossing approach. Opening and closing of the gates provides an additional task to the user when crossing. This may be particuarly problematic for users with encumberances or have reduced/limited strength. A gate will only provide a safe haven to stand behind when there is sufficient sighting distance up and down the lines from that position. Otherwise, the user will be forced to stand between the gate and lines.
		Action too little.	User misjudges the time available to traverse the crossing	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User misjudges the speed and distance of the train. User believes he / she has enough time to beat the train. User's behaviour is impaired by drugs, alcohol or fatigue. User is unable to open/close gate within time allowed for crossing by the sighting distance available. Users with encumbrances may not be able to open gates within a sufficient amount of time. User believes that if a gate is open it is safe to cross.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear. Gates vandalised or difficult to open/close. Gates may be held open or closed by crowds.				
		Wrong information obtained.	User assumes it is clear to cross after the first train has passed.	User is under time pressure. User has low perception of risk. User is distracted. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User assumes mental model that it is safe to proceed after a train passes. User is following another user over crossing. User's behaviour is impaired by drugs, alcohol or fatigue. User believes that if a gate is open it is safe to cross.	Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. On a multi-track section, a train travelling in one direction obstructs view of line in other direction. User does not distinguish train from background. High activity area with many distractions (e.g. busy roads and platforms). User knows that he/she will have a long wait until his/her next train comes. The curvature of the track/platform blocks the users view of a second train coming.				It was noted that many incidents occur when individuals waiting to traverse the crossing stand in the nearside line while waiting for the train in the far side line to pass.

SPC equipped with unlocked gates on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Train leaves station									
Re-check for trains.			See task 'Check for trains' in SPC-G.						
Open gate		Action too long.	User hesitates while opening gate / is unable to open it in a timely manner.	User is distracted. User is unfamiliar with crossing procedure. User is unfamiliar with gate latching mechanism (if present). User has reduced mobility or is disabled. User's ability to open gates is impaired by encumbrance. User's behaviour is impaired by drugs, alcohol or fatigue.	Gate has been vandalised or is not functioning as designed. Movement of gate is impaired by an obstruction (e.g. snow, leaves or vegetation). Movement of gate may be impaired by crowds on the other side of the crossing or a user with an encumbrance or wheelchair.	User's crossing could be delayed. User's crossing time could be prolonged meaning that he / she is not in a safe position within sufficient time. Potential collision between train and user.			A further possibility is that the user could become trapped (e.g. clothes snagged) in the gate, especially if it is spring loaded. However, if the user were trapped, depending upon the distance between the gate and the lines, it is unlikely that the user would be in a dangerous position.
Cross tracks.	Cross tracks on foot.	Action too late.	User hesitates while crossing or decides to turn back (potentially choosing to remain on the crossing).	User is distracted. User has low perception of risk. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User believes he / she must turn back, e.g. he / she has forgotten something. User has mobility impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Poor or uneven crossing surface. Missing, partial, or damaged crossing deck causes confusion. User is encumbered, e.g. with luggage. Congestion on the crossing blocks the user's way.	Potential collision between user and train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	N/A	
		Deliberate violation.	User deliberately trespasses on the railway from the crossing.	User has low perception of risk. User is under time pressure. User's behaviour is impaired by drugs, alcohol or fatigue. User's actions are influenced by peer pressure.	N/A	Potential collision between user and train.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.		
		Abnormal conditions / Right action on wrong object.	User slips, trips or falls when crossing.	User is under time pressure. User is distracted. User believes he / she must cross as quickly as possible. User has mobility impairment. User's behaviour is impaired by drugs, alcohol or fatigue. User may be hesitant about crossing if they have problems getting through the first gate.	Poor weather conditions. Poor or uneven crossing surface. Missing, partial, or damaged crossing deck causes confusion. User is encumbered, e.g. with luggage. User trips or catches a foot in the gap between the rails and crossing walkway. Users encumbrance (e.g. suitcase with wheels, buggy, wheelchair) become caught in gap between the rails and crossing walkway. Poor lighting conditions e.g. during night time.	User may fall on or near the line. Potential collision between train and user.	Poor: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.		
Open gate.			See task 'Open gate'						
Continue with journey.			N/A	N/A	N/A	N/A			

Ungated SPC equipped with MSL									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Recognise crossing.		Action omitted	User fails to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User's behaviour is impaired by drugs, alcohol or fatigue.	The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Poor weather conditions. Visibility of rail tracks and signage. Poor lighting conditions e.g. during night time.	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may be stood on crossing before they realise the error. User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present).	N/A	Potential for the worst case scenario consequence is minimal.
		Action too late	User is late to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User misinterprets level crossing sign. User's behaviour is impaired by drugs, alcohol or fatigue.					
		Wrong information obtained	User misinterprets warning sign on approach to level crossing.	User misinterprets level crossing sign. User is under time pressure. User is distracted. User is unfamiliar with crossing procedure. User's behaviour is impaired by drugs, alcohol or fatigue.					

Ungated SPC equipped with MSL									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Stop at decision point		Action omitted	User continues through crossing (user unaware of requirement to stop at decision point).	User is distracted. User follows errant dog or child onto the track. Users follows group onto crossing. User is under time pressure. User has low perception of risk. User is unfamiliar with crossing procedure. User misjudges location decision point. User thinks he / she understands procedure without reading instructions. User's behaviour is impaired by drugs, alcohol or fatigue.	The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. - the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Ambient noise (e.g. road traffic, station announcements, passenger noise). No appropriate warning signs or indicators. Poor weather conditions. Sign obscured (e.g. by foliage or snow), or not clearly visible or legible. Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. Poor lighting conditions e.g. during night time. User is follows a dog or child into an unsafe position.	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present).	Back to back lights	The group noted that the user does not always have to stop at the crossing before deciding whether it is safe to cross when the lights are green. However, it is likely that most users will check the MSL aspect, then scan up and down the tracks before crossing. With MSLs the user does not always have to stop at a decision point, but can make the decision to cross whilst approaching the crossing. They may check the MSLs on multiple occasions whilst approaching the crossing. The point at which the user decides that it is safe to cross is determined by the visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions.
		Action too late.	User stops at decision point too close to the line (not in a safe position).	The user's motivation to look up and down the track may mean that the user positions themself in an unsafe location. User is unfamiliar with crossing procedure. User may have an inadequate mental model of the crossing, therefore he / she may not locate or notice markings. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User has a low perception of risk. User thinks he / she understands procedure without reading instructions. The presence of wheelchairs, pushchairs and other encumbrances may cause the user to select a decision point too close to the line. User has a vision impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. No appropriate marking of safety position provided. Markings obscured (e.g. by leaf fall or foliage) or faded, or have an unclear meaning. Environmental conditions such as poor weather (e.g. snow, rain) and poor visibility.	User may position themselves in an unsafe location before crossing. Potential collision between train and user. User may be unaware that they are positioned in an unsafe location.			
		Action too early	User stops at decision point too far away from the line (and so has insufficient sighting distance up and down the tracks).	User misjudges decision point. User is unfamiliar with crossing procedure. User may have an inadequate mental model of the crossing, therefore he / she may not locate or notice markings. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User's behaviour is impaired by drugs, alcohol or fatigue.	The markings for the position of safety may require the user to position his/herself well back impairing his/herr sighting of the track for trains.	User may decide to cross when it unsafe to do so. Potential collision between train and user.			

Ungated SPC equipped with MSL									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Read crossing instructions.		Action omitted	User fails to read crossing instructions.	User is under time pressure. User has low perception of risk. User is distracted. User does not feel the need to read instructions before crossing. User thinks he / she understands procedure without reading instructions. User may be unfamiliar with level crossing protocols. User's ability to read may be impaired by poor sight/blindness, poor literacy, learning difficulties or language skills. User does not speak English, or English is not their first language. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Sign obscured (e.g. by foliage or other signage), or not clearly visible or legible. Crossing cluttered with numerous signs leads the user to be unsure which sign to read. Key signs may not be in optimal location for viewing. Prominence of sign (in comparison to other signs) does not reflect the importance of that sign. Crossing instructions poorly located, missing or unclear. Inconsistency of signage location and type between level crossings of the same type. Poor lighting conditions e.g. during night time. Signage positioned on the far side of the tracks may not be legible from that distance. Signage positioned on the nearside of the tracks will not be visible to the user facing the tracks.	User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present).	N/A	It is generally reported that individuals do not read signs, often because they do not believe it is important. The non-standard arrangement of lights and signage at LXs (such that the layout at each crossing is different) may be confusing to individuals who use multiple crossings. The positioning of signage should indicate the priority of information. High priority signage should be located within the primary visual field of the user and should be more prominent than less important signage. The user can derive contradictory messages from signage, for example signage indicating that users should not trespass around the crossing may also be interpreted as 'don't use the crossing'. The positioning of signage in relation to the MSLs and the position the user stands in when crossing should be considered. Furthermore, as the user does not necessarily have to stop before crossing when the MSL aspect is green, signage on the user's approach to the crossing should be provided. Signage on the far side of the tracks may not be visible from the near side. Furthermore, users may be unable to see near side signage if it is set some way back from the tracks. It was noted that 'Stop, Look, Listen' signs should not be present at crossings at MSLs because this gives a contradictory message to the user who is not required to stop at a crossing when the lights are green.
		Information not obtained.	User fails to understand crossing instructions.	User's ability to read may be impaired by poor literacy or language skills. User is under time pressure. User may be unfamiliar with level crossing protocols. User does not speak English, or English is not their first language. User may be unfamiliar with level crossing protocols. User's behaviour is impaired by drugs, alcohol or fatigue.	Sign obscured (e.g. by foliage), or not clearly visible or legible. Crossing instructions missing or unclear. Inconsistency of signage location and type between level crossings of the same type.			N/A	
		Wrong information obtained	User fails to realise instructions are appropriate to him / her.	User is unfamiliar with crossing procedure. User is under time pressure. User's ability to read may be impaired by poor literacy or language skills. User does not speak English, or English is not their first language. User has low perception of risk. User is distracted. User is following another user over crossing. User has succeeded in crossing in the same way previously. Users actions are influenced by peer pressure. Users behaviour is impaired by drugs, alcohol or fatigue.	Crossing instructions missing or unclear. Positioning of signage fails to emphasise the importance of the instructions.				

Ungated SPC equipped with MSL									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Train approaches the station.									
Observe crossing lights.	Observe MSL.	Action omitted	User fails to observe MSL.	User is under time pressure. User has low perception of risk. User is following another user over crossing. User is distracted on approach to the crossing (e.g. in group or on a mobile phone). User is positioned in a location that makes it difficult to notice the lights. User who is unfamiliar with this type of crossing may not expect lights to be present or think that they are located elsewhere. User has visual impairment. User's behaviour is influenced by drugs, alcohol or fatigue. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User misjudges the speed and distance of the train. User has succeeded in crossing in the same way previously.	Poor weather conditions. The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Light / glare obscures aspect. Warning lights obscured e.g. by foliage. Size of lights. View of MSLs on the far side of the track obscured (e.g. by umbrellas, people or items of clothing).	Lack of awareness of lights may render the user unaware of a train coming or second train coming. User does not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present).		The angle of the MSLs in relation to the track and platform is critical to this task. MSLs visible on approach to the crossing and at the crossing: - angled at 45 degrees provide the user with an earlier indication of when is safe to cross. - MSLs only on the far side can be obscured by trains or other obstructions. -MSLs only on the near side cannot be seen by the user when standing at the crossing.
		Deliberate violation	User chooses to ignore MSL.	User is under time pressure. User has low perception of risk. User is following another user over crossing. User is distracted on approach to the crossing (e.g. In a group or on a mobile phone). User's behaviour is influenced by drugs, alcohol or fatigue. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User misjudges the speed and distance of the train. User has succeeded in crossing in the same way previously. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Poor weather conditions. The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Light / glare obscures aspect. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of a perceived 'refuge' between double sets of train lines. Crossing instructions missing or unclear.				
		Information not obtained.	User fails to understand MSL.	User misinterprets warning lights. User is under time pressure. User is unfamiliar with crossing procedure. User is on crossing when lights / alarm activate. User is colour blind / short-sighted / illiterate. User's behaviour is influenced by drugs, alcohol or fatigue. User frustrated, believing he / she is improperly prevented from proceeding. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Crossing instructions missing or unclear. Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available.				

Ungated SPC equipped with MSL									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Wait at crossing (for an approaching train).		Deliberate violation.	User fails to wait, unaware of approaching train.	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. Use chooses to ignore instructions. User does not understand instructions. User believes he / she has enough time to beat the train. User has succeeded in crossing in the same way previously. User misjudges decision point. User frustrated, believing he / she is improperly prevented from proceeding. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear. Other warning lights in the area which can be seen from the platform provide confusing information.	Potential collision between train and user.	Poor: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	N/A	Aside from deliberate violation of crossing protocols the key failures relate to the user misjudging, or assuming it is safe to traverse. A mid-point (safe haven) in a two line LX may encourage risk taking behaviour (especially for those in groups). Attendees noted that there were no known 4 line station pedestrian crossings where this may be a risk. Visually, the angle of the approach to the crossing influences the users perception of the distance to travel across the tracks. When the angle of approach is at 90° to the lines the perceived distance is shorter than if the tracks is are not at right angles to the crossing approach. It was noted that many incidents occur when individuals waiting to traverse the crossing stand in the near side line while waiting for the train in the far side line to pass. Stations where trains have long or variable strike in times may provide a source of fustration to LX users as the MSLs will be red without any indication of a train approaching. This may encourage risk taking behaviour.
		Action too little.	User misjudges the time available to traverse the crossing	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User misjudges the speed and distance of the train. User believes he / she has enough time to beat the train. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear.	Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). The crossing user will receive multi-sensory feedback of the train's approach (i.e. tactile [vibrations], auditory and visual).	Back to back lights	
		Wrong information obtained.	User assumes it is clear to cross after the first train has passed.	User is under time pressure. User has low perception of risk. User is distracted (e.g. talking to another person, listening to mp3 player, on mobile phone). User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User assumes mental model that it is safe to proceed after a train passes. User is following another user over crossing. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. On a multi-track section, a train travelling in one direction obstructs view of line in other direction. User does not distinguish train from background. High activity area with many distractions (e.g. busy roads and platforms). User knows that he/she will have a long wait until their next train comes. The curvature of the track/platform blocks the users view of a second train coming.	Potential collision between user and train. Potential collision between user and second train.	Good: Change in tone of yodel alarm (if present). Other crossing users. Station staff if present. Customer information boards on platform (if present). The crossing user will receive multi-sensory feedback of the train's approach (i.e. tactile [vibrations], auditory and visual). Train driver on any line approaching the station sounds horn.		

Ungated SPC equipped with MSL									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Check for trains (nb. If the MSL aspect is green LX users will not necessarily stop and check for trains before crossing).	Listen for train	Action omitted	Failure to listen for train	User is over-reliant on seeing the train. User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. Familiar user applies prior knowledge of train times / frequencies. User's behaviour is impaired by drugs, alcohol or fatigue.	N/A	Lack of awareness of train approaching. May not be aware of a second train approaching.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. MSLs. Other crossing users. Station staff if present. Customer information boards on platform (if present). LX users will receive multi-sensory feedback while waiting to traverse a crossing: -Tactile feedback from vibrations in the ground caused by the train approach. -Auditory feedback from train noise, the whistle of the rails, the train horn if sounded and station announcements. -Visual feedback from the train approach.	Back to back lights	LX users do not necessarily have to check for trains when the MSL aspect is green, however, it was noted that even when the aspect is green a pre-crossing check would be good practice. Passengers will have a different mindset towards crossing depending on whether they are crossing to get on a train/get on the correct platform, using the crossing after getting off a train to leave the station, or getting off a train then using the crossing to get to another platform to make a connecting train.
		Information not obtained.	Failure to hear train	User has a hearing impairment. Sound of train is masked by other sound source (i.e. mp3 player, other people talking). User's hearing is impaired by clothing (e.g. a hood or hat). User's behaviour is impaired by drugs, alcohol or fatigue.	Environmental noise such as busy traffic, road works etc. Train driver fails to sound horn (if required at that crossing). Sound of a train is masked by other trains already within the station bounds. Sound of second train coming is masked by the sound of the first train leaving.				
	Look for train	Action omitted	Failure to look both ways for train.	User is over-reliant on hearing the train. User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. Familiar user applies prior knowledge of train times / frequencies. User's behaviour is impaired by drugs, alcohol or fatigue.	N/A				
		Information not obtained.	Failure to see train	User has a visual impairment. View of train is obscured by other people. User does not distinguish train from background. User's behaviour is impaired by drugs, alcohol or fatigue.	User does not have a good viewpoint and cannot see the train. User does not distinguish train from background. View of train is obscured by features of the railway or surrounding environment (e.g. signage, foliage, gradient). On a multi-track section, a train travelling in one direction obstructs view of line in other direction. Poor lighting conditions e.g. during night time.				

Ungated SPC equipped with MSL									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Train approaches the station.									
At this point the train can pass through the station and the MSL aspect will turn green…….									
Observe / hear warning signals stop.	Observe MSL turn to green.	Action omitted.	User fails to observe MSL turn to green.	User is under time pressure. User has low perception of risk. User is following another user over crossing. User is distracted. User is positioned in a location that makes it difficult to notice the lights. User who is unfamiliar with this type of crossing may not expect lights to be present or think that they are located elsewhere. User has visual impairment. User's behaviour is influenced by drugs, alcohol or fatigue. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User misjudges the speed and distance of the train. User has succeeded in crossing in the same way previously.	Poor weather conditions. The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Light / glare obscures aspect. Warning lights obscured e.g. by foliage. Size of lights. View of MSLs on the far side of the track obscured (e.g. by umbrellas, people or items of clothing).	User delayed because fails to proceed.	Good: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Audible alert. User can recheck for trains.		
Re-check for trains.			See task 'Check for trains'						

Ungated SPC equipped with MSL									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Cross tracks.	Cross tracks on foot.	Action too late.	User hesitates while crossing or decides to turn back (potentially choosing to remain on the crossing).	User is distracted. User has low perception of risk. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User believes he / she must turn back, e.g. he / she has forgotten something. User has mobility impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Poor or uneven crossing surface. Missing, partial, or damaged crossing deck causes confusion. User is encumbered, e.g. with luggage. Congestion on the crossing blocks the user's way.	Potential collision between user and train.	Poor: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	N/A	
		Deliberate violation.	User deliberately trespasses on the railway from the crossing.	User has low perception of risk. User is under time pressure. User's behaviour is impaired by drugs, alcohol or fatigue. User's actions are influenced by peer pressure.	N/A	Potential collision between user and train.	Poor: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.		
		Abnormal conditions / Right action on wrong object.	User slips, trips or falls when crossing.	User is under time pressure. User is distracted. User believes he / she must cross as quickly as possible. User has mobility impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Poor or uneven crossing surface. Missing, partial, or damaged crossing deck causes confusion. User is encumbered, e.g. with luggage. User trips or catches a foot in the gap between the rails and crossing walkway. Users encumbrance (e.g. suitcase with wheels, buggy, wheelchair) become caught in gap between the rails and crossing walkway. Poor lighting conditions e.g. during night time.	User may fall on or near the line. Potential collision between train and user.	Poor: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.		
Continue with journey.			N/A	N/A	N/A	N/A			
Scenario ends									

SPCs equipped with unlocked gates and MSLs on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Recognise crossing.		Action omitted	User fails to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User's behaviour is impaired by drugs, alcohol or fatigue.	The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time. Gates left open by previous user and the user's attention is drawn to a feature beyond the other side of the crossing (e.g. a road junction, bright lights, train in platform).	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present).	Gates (although unlocked) form a physical barrier between the crossing user and the railway. The user has to actively open the gates to stand in an unsafe position at the crossing. Gates indicate a safe position for the user to stand.	Often gates may be left open, or held open by crossing users. As such, the benefit to risk reduction of unlocked gates may be limited. Gates may be propped open, or wedged open by foliage etc. Unlocked gates will mitigate some of the risk associated with errant dogs or children straying onto the crossing when a train is approaching.
		Action too late	User is late to recognise crossing.	Speed of user's approach to the crossing. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User is unfamiliar with location. User has vision impairment. User follows group onto crossing upon egress from train. User misinterprets level crossing sign. User's behaviour is impaired by drugs, alcohol or fatigue.	The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time.				
		Wrong infromation obtained	User misinterprets warning sign on approach to level crossing.	User misinterprets level crossing sign. User is under time pressure. User is distracted. User is unfamiliar with crossing procedure. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Visibility of rail tracks, signage, gates. Poor lighting conditions e.g. during night time.				

SPCs equipped with unlocked gates and MSLs on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Stop at decision point		Action omitted	User continues through crossing (user unaware of requirement to stop at decision point).	User is distracted. User follows errant dog or child onto the track. Users follows group onto crossing. User is under time pressure. User has low perception of risk. User is unfamiliar with crossing procedure. User misjudges location of decision point. User does not feel the need to read instructions before crossing. User thinks he / she understands procedure without reading instructions. User's behaviour is impaired by drugs, alcohol or fatigue.	Gate has been left open by a previous user. Ambient noise (e.g. road traffic, station announcements, passenger noise). No appropriate warning signs or indicators. Poor weather conditions. Sign obscured (e.g. by foliage or snow), or not clearly visible or legible. Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. Poor lighting conditions e.g. during night time. User follows a dog or child into an unsafe position.	Failure to stop at the crossing. Failure to stop at the crossing in the appropriate location. Limited awareness of the crossing features to monitor. User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present).	The provision of a gate, although unlocked, can reduce the risk associated with this error by providing a physical barrier at which the user conducts pre-crossing checks.	The group noted that the user does not always have to stop at the crossing before deciding whether it is safe to cross when the lights are green. However, it is likely that most users will check the MSL aspect, then scan up and down the tracks before crossing. With MSLs the user does not always have to stop at a decision point, but can make the decision to cross whilst approaching the crossing. They may check the MSLs on multiple occasions whilst approaching the crossing. The point at which the user decides that it is safe to cross is determined by the visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions.
		Action too late.	User stops at decision point too close to the line (not in a safe position).	The user's motivation to look up and down the track may mean that the user positions his/herself in an unsafe location. User is unfamiliar with crossing procedure. User may have an inadequate mental model of the crossing, therefore he / she may not locate or notice markings. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User has a low perception of risk. User thinks he / she understands procedure without reading instructions. The presence of wheelchairs, pushchairs and other encumbrances may cause the user to select a decision point too close to the line. User has a vision impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. No appropriate marking of safety position provided. Markings obscured (e.g. by leaf fall or foliage) or faded, or have an unclear meaning. Environmental conditions such as poor weather (e.g. snow, rain) and poor visibility.	User may position his/herself in an unsafe location before crossing. Potential collision between train and user. User may be unaware that they are positioned in an unsafe location.			
		Action too early	User stops at decision point too far away from the line (and so has insufficient sighting distance up and down the tracks).	User believes that the gate demarcates a decision point and is located to provide sufficient sighting distance up and down the tracks. User misjudges decision point. User is unfamiliar with crossing procedure. User may have an inadequate mental model of the crossing, therefore he / she may not locate or notice markings. Distractions on approach (e.g. in a group, chatting, on mobile phone, listening to mp3 player). User's behaviour is impaired by drugs, alcohol or fatigue.	The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. The positioning of the gate is too far away from the tracks. The markings for the position of safety may require the user to position his/herself well back, impairing his/her sighting of the track for trains.	User may decide to cross when it is unsafe to do so. Potential collision between train and user.			

SPCs equipped with unlocked gates and MSLs on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Read crossing instructions.		Action omitted	User fails to read crossing instructions.	User is under time pressure. User has low perception of risk. User is distracted. User thinks he / she understands procedure without reading instructions. User may be unfamiliar with level crossing protocols. User's ability to read may be impaired by poor sight/blindness, poor literacy, learning difficulties or language skills. User does not speak English, or English is not their first language. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Sign obscured (e.g. by foliage or other signage), or not clearly visible or legible. Crossing cluttered with numerous signs leads the user to be unsure which sign to read. Key signs may not be in optimal location for viewing. Prominence of sign (in comparison to other signs) does not reflect the importance of that sign. Crossing instructions poorly located, missing or unclear. Inconsistency of signage location and type between level crossings of the same type. Poor lighting conditions e.g. during night time. Signage positioned on the far side of the tracks may not be legible from that distance. Signage positioned on the nearside of the tracks will not be visible to the user facing the tracks.	User may not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present).	N/A	It is generally reported that individuals do not read signs, often because they do not believe it is important. The non-standard arrangement of lights and signage at LXs (such that the layout at each crossing is different) may be confusing to individuals who use multiple crossings. The positioning of signage should indicate the priority of information. High priority signage should be located within the primary visual field of the user and should be more prominent than less important signage. The user can derive contradictory messages from signage, for example signage indicating that users should not trespass around the crossing may also be interpreted as 'don't use the crossing'. The positioning of signage in relation to the MSLs and the position the user stands in when crossing should be considered. Furthermore, as the user does not necessarily have to stop before crossing when the MSL aspect is green, signage on the user's approach to the crossing should be provided. Signage on the far side of the tracks may not be visible from the near side. Furthermore, users may be unable to see near side signage if it is set some way back from the tracks. It was noted that 'Stop, Look, Listen' signs should not be present at crossings at MSLs because this gives a contradictory message to the user who is not required to stop at a crossing when the lights are green.
		Information not obtained.	User fails to understand crossing instructions.	User's ability to read may be impaired by poor literacy or language skills. User is under time pressure. User may be unfamiliar with level crossing protocols. User does not speak English, or English is not their first language. User may be unfamiliar with level crossing protocols. User's behaviour is impaired by drugs, alcohol or fatigue.	Sign obscured (e.g. by foliage), or not clearly visible or legible. Crossing instructions missing or unclear. Inconsistency of signage location and type between level crossings of the same type.			N/A	
		Wrong information obtained	User fails to realise instructions are appropriate to him / her.	User is unfamiliar with crossing procedure. User is under time pressure. User's ability to read may be impaired by poor literacy or language skills. User does not speak English, or English is not their first language. User has low perception of risk. User is distracted. User is following another user over crossing. User has succeeded in crossing in the same way previously. Users actions are influenced by peer pressure. Users behaviour is impaired by drugs, alcohol or fatigue.	Crossing instructions missing or unclear. Positioning of signage fails to emphasise the importance of the instructions.				

SPCs equipped with unlocked gates and MSLs on both sides of the track

Task	Sub Task	Guide Words	Deviation	Influencing factors - behavioural	Influencing factors - environmental / physical	Consequences	Potential for Error Recovery (None, Poor, Marginal, Good, Complete)	Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates	General Comments
Train approaches station									
Observe crossing lights.	Observe MSL.	Action omitted	User fails to observe MSL.	User is under time pressure. User has low perception of risk. User is following another user over crossing. User is distracted on approach to the crossing (e.g. in group or on a mobile phone). User is positioned in a location that makes it difficult to notice the lights. User who is unfamiliar with this type of crossing may not expect lights to be present or think that they are located elsewhere. User has visual impairment. User's behaviour is influenced by drugs, alcohol or fatigue. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User misjudges the speed and distance of the train. User has succeeded in crossing in the same way previously.	Poor weather conditions. The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Light / glare obscures aspect. Warning lights obscured e.g. by foliage. Size of lights. View of MSLs on the far side of the track obscured (e.g. by umbrellas, people or items of clothing).	Lack of awareness of lights may render the user unaware of a train coming or second train coming. User does not follow correct crossing procedure. Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present).		The angle of the MSLs in relation to the track and platform is critical to this task. MSLs visible on approach to the crossing and at the crossing: - angled at 45 degrees provide the user with an earlier indication of when is safe to cross. - MSLs only on the far side can be obscured by trains or other obstructions. -MSLs only on the near side cannot be seen by the user when standing at the crossing.
		Deliberate violation	User chooses to ignore MSL.	User is under time pressure. User has low perception of risk. User is following another user over crossing. User is distracted on approach to the crossing (e.g. In a group or on a mobile phone). User's behaviour is influenced by drugs, alcohol or fatigue. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User misjudges the speed and distance of the train. User has succeeded in crossing in the same way previously. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Poor weather conditions. The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Light / glare obscures aspect. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of a perceived 'refuge' between double sets of train lines. Crossing instructions missing or unclear.				
		Information not obtained.	User fails to understand MSL.	User misinterprets warning lights. User is under time pressure. User is unfamiliar with crossing procedure. User is on crossing when lights / alarm activate. User is colour blind / short-sighted / illiterate. User's behaviour is influenced by drugs, alcohol or fatigue. User frustrated, believing he / she is improperly prevented from proceeding. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Crossing instructions missing or unclear. Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available.				

SPCs equipped with unlocked gates and MSLs on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Wait at crossing (for an approaching train).		Deliberate violation.	User fails to wait, unaware of approaching train.	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. Use chooses to ignore instructions. User does not understand instructions. User believes he / she has enough time to beat the train. User has succeeded in crossing in the same way previously. User misjudges decision point. User frustrated, believing he / she is improperly prevented from proceeding. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear. Other warning lights in the area which can be seen from the platform provide confusing information.	Potential collision between train and user.	Poor: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	N/A	Aside from deliberate violation of crossing protocols the key failures relate to the user misjudging, or assuming it is safe to traverse. A mid-point (safe haven) in a two line LX may encourage risk taking behaviour (especially for those in groups). Attendees noted that there were no known 4 line station pedestrian crossings where this may be a risk. Visually, the angle of the approach to the crossing influences the users perception of the distance to travel across the tracks. When the angle of approach is at 90° to the lines the perceived distance is shorter than if the tracks is are not at right angles to the crossing approach. It was noted that many incidents occur when individuals waiting to traverse the crossing stand in the near side line while waiting for the train in the far side line to pass. Stations where trains have long or variable strike in times may provide a source of fustration to LX users as the MSLs will be red without any indication of a train approaching. This may encourage risk taking behaviour.
		Action too little.	User misjudges the time available to traverse the crossing	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User misjudges the speed and distance of the train. User believes he / she has enough time to beat the train. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear.	Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Other crossing users. Station staff if present. Customer information boards on platform (if present). The crossing user will receive multi-sensory feedback of the train's approach (i.e. tactile [vibrations], auditory and visual).	Back to back lights	
		Wrong information obtained.	User assumes it is clear to cross after the first train has passed.	User is under time pressure. User has low perception of risk. User is distracted (e.g. talking to another person, listening to mp3 player, on mobile phone). User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User assumes mental model that it is safe to proceed after a train passes. User is following another user over crossing. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. On a multi-track section, a train travelling in one direction obstructs view of line in other direction. User does not distinguish train from background. High activity area with many distractions (e.g. busy roads and platforms). User knows that he/she will have a long wait until their next train comes. The curvature of the track/platform blocks the users view of a second train coming.	Potential collision between user and train. Potential collision between user and second train.	Good: Change in tone of yodel alarm (if present). Other crossing users. Station staff if present. Customer information boards on platform (if present). The crossing user will receive multi-sensory feedback of the train's approach (i.e. tactile [vibrations], auditory and visual). Train driver on any line approaching the station sounds horn.		

SPCs equipped with unlocked gates and MSLs on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Wait at crossing (for an approaching train).		Deliberate violation.	User fails to wait, unaware of approaching train.	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. Use chooses to ignore instructions. User does not understand instructions. User believes he / she has enough time to beat the train. User has succeeded in crossing in the same way previously. User misjudges decision point. User frustrated, believing he / she is improperly prevented from proceeding. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear. Other warning lights in the area which can be seen from the platform provide confusing information.	Potential collision between train and user.	Poor: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.	N/A	Aside from deliberate violation of crossing protocols the key failures relate to the user misjudging, or assuming it is safe to traverse. A mid-point (safe haven) in a two line LX may encourage risk taking behaviour (especially for those in groups). Attendees noted that there were no known 4 line station pedestrian crossings where this may be a risk. Visually, the angle of the approach to the crossing influences the users perception of the distance to travel across the tracks. When the angle of approach is at 90° to the lines the perceived distance is shorter than if the tracks is are not at right angles to the crossing approach. It was noted that many incidents occur when individuals waiting to traverse the crossing stand in the near side line while waiting for the train in the far side line to pass. Stations where trains have long or variable strike in times may provide a source of fustration to LX users as the MSLs will be red without any indication of a train approaching. This may encourage risk taking behaviour.
		Action too little.	User misjudges the time available to traverse the crossing	User is under time pressure. User has low perception of risk. User is distracted. User is following another user over crossing. User misjudges the speed and distance of the train. User believes he / she has enough time to beat the train. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Poor weather conditions. Angle of approach of the train affects the user's judgement of approach speed. Long sighting distance available. Presence of perceived 'refuge' between double sets of train lines. Safe decision point unmarked / unclear.	Potential collision between train and user.	Good: Crossing user may be alerted by: Train driver on any line approaching the station sounds horn. Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). The crossing user will receive multi-sensory feedback of the train's approach (i.e. tactile [vibrations], auditory and visual).	Back to back lights	
		Wrong information obtained.	User assumes it is clear to cross after the first train has passed.	User is under time pressure. User has low perception of risk. User is distracted (e.g. talking to another person, listening to mp3 player, on mobile phone). User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User assumes mental model that it is safe to proceed after a train passes. User is following another user over crossing. User's behaviour is impaired by drugs, alcohol or fatigue. User applies incorrect mental model - he/she may assume that a red light is displayed because there is a train in the platform and fails to consider the approach of other trains.	Crossing instructions missing or unclear. User does not have a good viewpoint and cannot see the train. On a multi-track section, a train travelling in one direction obstructs view of line in other direction. User does not distinguish train from background. High activity area with many distractions (e.g. busy roads and platforms). User knows that he/she will have a long wait until their next train comes. The curvature of the track/platform blocks the users view of a second train coming.	Potential collision between user and train. Potential collision between user and second train.	Good: Other crossing users. Station staff if present. Customer information boards on platform (if present). The crossing user will receive multi-sensory feedback of the train's approach (i.e. tactile [vibrations], auditory and visual). Train driver on any line approaching the station sounds horn.		

SPCs equipped with unlocked gates and MSLs on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
At this point the train can pass through the station and the MSL aspect will turn green……									
Observe / hear warning signals stop.	Observe MSL turn to green.	Action omitted.	User fails to observe MSL turn to green.	User is under time pressure. User has low perception of risk. User is following another user over crossing. User is distracted. User is positioned in a location that makes it difficult to notice the lights. User who is unfamiliar with this type of crossing may not expect lights to be present or think that they are located elsewhere. User has visual impairment. User's behaviour is influenced by drugs, alcohol or fatigue. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User misjudges the speed and distance of the train. User has succeeded in crossing in the same way previously.	Poor weather conditions. The visibility of the MSLs, specifically: - the angle of the lights in relation to the tracks and platform. - the sighting distance of the MSLs on the user's approach to the crossing. -the positioning of the MSLs on the crossing, i.e. on the near or far side of the tracks, or both. - the conspicuity of the MSLs under various environmental conditions. Light / glare obscures aspect. Warning lights obscured e.g. by foliage. Size of lights. View of MSLs on the far side of the track obscured (e.g. by umbrellas, people or items of clothing).	User delayed because fails to proceed.	Good: Crossing user may be alerted by: Other crossing users. Station staff if present. Customer information boards on platform (if present). User can recheck for trains.		
Re-check for trains.			See task 'Check for trains'						
Open gate		Action too long.	User hesitates while opening gate / is unable to open it in a timely manner.	User is distracted. User is unfamiliar with crossing procedure. User is unfamiliar with gate latching mechanism (if present). User has reduced mobility or is disabled. User's ability to open gates is impaired by encumbrance. User's behaviour is impaired by drugs, alcohol or fatigue.	Gate has been vandalised or is not functioning as designed. Movement of gate is impaired by an obstruction (e.g. snow, leaves or vegetation). Movement of gate may be impaired by crowds on the other side of the crossing or a user with an encumbrance or wheelchair.	User's crossing could be delayed. User's crossing time could be prolonged meaning that he / she is not in a safe position within sufficient time. Opening gates on both sides of the track increases the time taken to traverse. Accoridngly, this will increase the likelihood that MSL aspects will change while the user is crossing. Potential collision between train and user.			A further possibility is that the user could become trapped (e.g. clothes snagged) in the gate, especially if it is spring loaded. However, if the user were trapped, depending upon the distance between the gate and the lines, it is unlikely that the user would be in a dangerous position.

SPCs equipped with unlocked gates and MSLs on both sides of the track									
Task	**Sub Task**	**Guide Words**	**Deviation**	**Influencing factors - behavioural**	**Influencing factors - environmental / physical**	**Consequences**	**Potential for Error Recovery (None, Poor, Marginal, Good, Complete)**	**Risk Reduction - Fencing, Back to Back Lights, ATC Warning, Locked Gates**	**General Comments**
Cross tracks.	Cross tracks on foot.	Action too late.	User hesitates while crossing or decides to turn back (potentially choosing to remain on the crossing).	User is distracted. User has low perception of risk. User is unfamiliar with crossing procedure. Familiar user applies prior knowledge of train times / frequencies. User believes he / she has enough time to beat the train. User believes he / she must turn back, e.g. he / she has forgotten something. User has mobility impairment. User's behaviour is impaired by drugs, alcohol or fatigue.	Poor weather conditions. Poor or uneven crossing surface. Missing, partial, or damaged crossing deck causes confusion. User is encumbered, e.g. with luggage. Congestion on the crossing blocks the user's way.	Potential collision between user and train.	Poor: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the error.	N/A	
		Deliberate violation.	User deliberately trespasses on the railway from the crossing.	User has low perception of risk. User is under time pressure. User's behaviour is impaired by drugs, alcohol or fatigue. User's actions are influenced by peer pressure.	N/A	Potential collision between user and train.	Poor: Crossing user may be alerted by: Yodel alarm (if present) upon activation of lights. Other crossing users. Station staff if present. Customer information boards on platform (if present). BUT if a train is approaching the station there will be little time to recover from the violation.		
Open gate			See task 'Open gate'						
Continue with journey.		N/A	N/A	N/A	N/A	N/A			
Scenario ends									

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CENSUS GOOD PRACTICE

KNOW YOUR CROSSING, ITS USERS AND ITS ENVIRONMENT

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1 Purpose

This document provides guidance in the undertaking of census data collection as part of the risk assessment of level crossing safety.

2 Scope

It is intended for Level Crossing Managers and any other competent person responsible for the safe management and risk assessment of level crossings. It may also be used by other Network Rail personnel undertaking census data collection in support of level crossing risk assessments.

It should be applied to all risk assessments of level crossings and used to support decision making regarding the best means to obtain accurate census data, so far as is reasonably practicable.

3 The importance of accurate census

Census is one of the underpinning elements of a level crossing risk assessment. It is one of the most important influences on the level of risk. Therefore it is vital that a robust census is undertaken to achieve a meaningful and accurate risk assessment.

In general, the window of opportunity for an accident at a level crossing increases with a high level of crossing usage and a high number of train movements. Therefore, the number of level crossing users and the equivalent train moment, or trains per day, is a key influence of risk.

Census is also a key input of the All Level Crossing Risk Model [ALCRM] and forms a critical component in the calculated levels of risk. Underestimating or overestimating census can have a varying effect on the modelled output, which could influence decisions taken by the assessor or the business to manage safety. For example, crossings with a high individual risk and a low collective risk can be sensitive to changes in census data. In this circumstance, ALCRM might evaluate a crossing with weak census data to represent a slightly lower risk than that of the true risk profile. This could result in a lack of intelligence about the level of risk at an asset, leading to inaccuracies in strategic planning to manage safety.

In addition to the volume of use, it is also vital to understand the user demographic; i.e. the types of users who make up the census number, so as to identify hazards which may be prevalent to one or more user segments and to better target risk mitigation in these areas. Accurate census will therefore help us to better identify, and encapsulate within risk assessments, the types and vulnerabilities of users of our assets.

4 Census types, selection criteria and enhancing census accuracy

4.1 General

In general it may be considered that the greater the duration of census data collection activity, the greater the opportunity to improve the accuracy of the census.

This is an especially pertinent point in relation to determining pedestrian usage and in the undertaking of all census at footpath, bridleway and private user worked crossings.

In some cases due to seasonal fluctuations or peaks and troughs in use, it might be necessary to undertake more than one census data collection activity so as to broaden understanding regarding daily/annual usage. ALCRM can accommodate two censuses for this purpose.

In addition to physical on-site data collection techniques, an array of smart-sources of intelligence should also be used to support understanding; see 8. In determining robust knowledge of crossing usage, it might be necessary to use multiple combinations of on-site activities and other research based intelligence to accrue the complete picture.

4.2 Types of census and the preferred approach

Non-estimated census

The quick census is the least favoured of the non-estimate types due to its limited capacity to accurately reflect usage levels or identify all segments of users. A quick census can be susceptible to the time and date of the visit, omitting or overly including, peaks, troughs, seasonal activity and omitting weekend, evening and variances in use. It has, however, been independently endorsed as a broadly capable method for counting vehicles at public road crossings.

Where-ever possible, nine day census or greater (extended census) should be the census of choice for assessors. It offers strength in accuracy and endorses the company's approach to continuous improvement by enhancing the accuracy of risk assessments and improving level crossing safety.

Estimated census

Estimated census should ideally be a last resort unless using forecast figures to determine the impact of a proposed housing development for example.

If it is to be used as the primary source, every effort should be made to determine usage levels using actual census data collection activity and prior to adopting it as the chosen census gathering technique. As with all census gathering activity, but especially so when using estimated structured judgement, all available intelligent sources should be used to aid decision making; see 5.7 and 8.

Table 1 details the types of census which can be used within the risk assessment process. It also highlights some of the benefits and dis-benefits associated with each census type.

Type	When to use	When not to use	Strengths and weaknesses	Census owner
Nine day or extended duration	**In all cases where a census is required**. Applicable to all asset types and all assessments from steady-state to project work where it is a prerequisite; e.g. re-signalling schemes and level crossing (LC) renewals. Serves to enhance understanding of LC usage and user behaviour, e.g. identifying night time usage, confirming vulnerable or irregular users, identifying peaks and troughs etc.		**Strengths:** High level of accuracy leading to improved modelling of risk in ALCRM and informed decision making for the assessor and the business. **Weaknesses:** Internal resources needed to deploy equipment and analyse footage. Availability of mobile or fixed camera technology within the Route. Cost to employ external supplier to undertake census. Availability of external supplier to meet business timescales/deadlines. ***TIP:*** *Camera equipment should be directed away from train movements to prevent spurious activations and to improve analysis time and resource.*	Manager or External Supplier
24 hours	To support understanding of LC usage and where time-constraints prevent use of nine day or extended duration census. *NOTE: At lesser used crossings a longer census will be more appropriate to identify consistent usage and afford greater accuracy*.	Not appropriate for understanding weekend, consistent night time usage or where there are known or suspected peaks and troughs in usage which are likely to extend beyond 24 hours.	**Strengths:** A better level of accuracy than a quick census and might otherwise improve the accuracy of the risk assessment. Could be undertaken as a physical count by Network Rail staff in the absence of technology, for expediency or to facilitate engagement with users. **Weaknesses:** Does not provide the same level of accuracy as a nine day census. Resource implications for Network Rail staff to deploy technology or undertake a physical count. Cost and availability of external supplier to meet business timescales/deadlines.	Level Crossing Manager, Operations Staff or External Supplier

Type	When to use		When not to use	Strengths and weaknesses	Census owner
Quick 30 to 60 minutes, Mon to Fri between 9:30 - 16:30	Weakest of all non-estimated census types. Primarily best suited for vehicle count at public roads.		Not appropriate where pedestrian usage is inconsistent throughout the day or unlikely to be witnessed during the census, but is known or suspected, or where vehicle use at private crossings is subject to variation. Where an assessor is seeking to identify weekend use, night time usage or where there are known or suspected peaks and troughs in usage, including seasonal variations.	**Strengths:** Speed of data collection and assessor can observe and interact with users of the crossing. **Weaknesses:** Less accurate than a nine day, extended census or a 24 hour census. Only provides a snapshot of use observed during the site visit. Provides poor understanding of crossing user demographic.	Level Crossing Manager
Estimate at passive crossings including 24 hour usage	**No crossing usage witnessed**	Authorised user data available where: a). Authorised user provides written daily usage information; or b). Interview conducted with authorised user(s).	Not advisable if an authorised user is known or suspected to provide inaccurate information, e.g. over estimates usage due to fear of asset closure.	**Strengths:** Reasonable expectation of accuracy. **Weaknesses:** Reliability of data provided by user. Behavioural patterns not observed.	Level Crossing Manager
		Interview conducted with crossing user.	Not advisable if it is established or suspected that the user is unfamiliar with the crossing.	**Strengths:** Data potentially more accurate than relying on visual appearance of crossing. **Weaknesses:** Individual's opinion might not reflect accurate usage. User demographic might be misinformed.	
		Based on appearance of crossing.	Not advisable when trying to establish sleeping dog status, or where suspected or known high usage exists. Census needs to be supported with further evidence and is better suited to a nine day count.	**Strengths:** Allows use of structured expert judgement. **Weaknesses:** Relies on structured expert judgement being accurate. Unsupported by factual information. Behavioural patterns not observed.	

Type	When to use	When not to use	Strengths and weaknesses	Census owner
Estimate at protected crossings	For modelling the effect of changes in predicted traffic flows, e.g. impact of new developments on LC usage.	Not advisable where real time data is available.	**Strengths:** Allows forecast changes to be modelled in ALCRM enabling the impact to safety to be understood. This intelligence enables, for example, informed decision making in regard to planning application approvals or objections. **Weaknesses:** Relies on projected data to be accurate, as far as is reasonably practicable.	Level Crossing Manager

Table 1 Types of census

4.3 Selecting an appropriate census type

Although a nine day or extended census offers the greater opportunity for accuracy and is therefore the preferred choice, as detailed in 4.2, there are many factors that might ultimately influence the type of census chosen by an assessor.

Decisions that influence census selection might include matters such as the availability of source material; such as mobile camera technology, the readiness of resources required to undertake the census or deploy equipment, the confidence in existing intelligence or the financial outlay if using third party suppliers or procuring technology. In addition there are other considerations which can vary between assets and which will influence the requirement. For example:

- Reason for census – e.g. the census is required to support a risk assessment at which intelligence is already rich and relatively current, to verify and quantify vulnerable usage or to support a re-signalling or renewal project.
- Peaks and troughs – where usage can vary significantly during the hours of the day and days of the week, a nine day census or longer is more likely to provide a much better picture of crossing use than a quick 30-60 minute census.
- Seasonal variations – where usage varies significantly at different times of the year, e.g. due to holiday periods, leisure attractions or agricultural use, a second census is advised as this will provide better quality data relating to annual usage.
- Weekend peaks – where high weekend usage is suspected e.g. crossing is on a route to a tourist attraction or is used as a leisure walkway, a nine day census or longer will offer a much better picture of crossing use than a quick mid-week or 24 hour census.
- Logistics, practicalities and costs – e.g. an extended census might be needed for a duration of between nine days to several months to substantiate usage or the crossing might be in a remote location.

To illustrate this further, the table below offers examples of how factors may shape decision making. The content of Table 2 is not exhaustive.

Factor	Requirement	Census suitability
Uncertainty over night-time quiet period usage	Need to establish the level of use during the hours when whistle board protection is removed.	Quick census is unsuitable for this purpose as it will not offer a consistent picture or pattern. A nine day census or extended census is needed. Deployment of mobile camera technology or third party supplier required.
School in close proximity to level crossing	Need to better understand behavioural patterns and the volume of crossing usage by vulnerable users. *NOTE: Whilst it is essential to understand the effect the school has on crossing usage, it is also important that a quick census does not focus solely on school arrival and departure times or during a lull in activity during the day.*	A nine day census or extended census offers to the best opportunity to identify trending patterns of use. Deployment of mobile camera technology or third party supplier required. A 24 hour census is better suited for this purpose than a quick census, but is not as robust as a nine day or extended census.
24 hour operational business resides in close proximity to level crossing	Need to understand the impact that shift change or deliveries might have on level crossing safety, e.g. night time quiet period, darkness risk and peaks in usage.	Quick census is unsuitable for this purpose as it will not offer a consistent picture or pattern. A nine day census or extended census offers to the best opportunity to identify trending patterns of use. Deployment of mobile camera technology or third party supplier required. *NOTE: Speaking to local businesses for information on working hours can enhance understanding of business impact on level crossing safety.*

Table 2 Additional census selection factors

5 Good practice regarding census data collection activity

5.1 General

This section contains good practice guidance for assessors when undertaking quick or 24 hour census in-house, in addition it details items to consider when actively recruiting an external supplier to undertake a 24 hour, nine day or extended census.

Section 5 also features guidance on vulnerable users.

5.2 Quick and 24 hour 'manual count' census undertaken by Network Rail staff

If a nine day or extended census cannot be undertaken, it is important that assessors are confident that either a 24 hour or quick census is appropriate to reflect reasoned accuracy for the asset being assessed. Census selection is discussed in 4.

Preparation	**Quick & 24 hour census** Always review previous censuses to re-familiarise yourself with the user demographic recorded and take cognisance of observations relating to vulnerable users, irregular users, peaks, troughs and seasonal fluctuation. Also use this information to determine the appropriateness of using a 24 hour or quick census. **Quick census** Previous census might also offer intelligence to inform decision making when deciding on the best time of day or day of the week to undertake census data collection activity. Make sure that you source equipment, tools and other items in a timely manner. Such items might include: downloading of electronic forms, iPad (charged), paper collection forms (contingency), pens, compass, range finder, measuring wheel, camera (charged/memory card with capacity) and appropriate clothing aside of corporate PPE; e.g. taking forecast weather conditions into account, the crossing location and the need for personal comfort. Prepare and obtain necessary SSOWPs to assure your site safety during the visit. **24 hour census** Agreement with relevant operations staff will be needed if a 24 hour 'manual count' census is considered appropriate. Consideration will need to be given to staff welfare; the ability for this method to provide a robust count and take cognisance of resource implications, so as to justify why this approach is better suited than deploying technology or employing outside parties. If a 24 hour 'manual count' census is considered appropriate, a template for this purpose should be provided to staff undertaking the task.

On site behaviour	**Site safety and staff welfare is the first priority** Take the census from a position of safety where the crossing is fully visible. Do not obstruct user access or distract users during the traverse/within the confines of the crossing. Park road vehicles appropriately, e.g. do not obstruct signage, crossing equipment or impair safe use of the crossing. Do not stand where you might obstruct crossing signage or equipment. If engaging with users to determine a broader understanding of the risk profile: – be approachable, professional and prepared to listen; – be cognisant of the environment and the positions of safety; and – only engage in conversation when it is safe and appropriate to do so
Data collection	Note the start time, date and duration of the activity. Take cognisance of the type of crossing you are at and the level of concentration that is needed to conduct an accurate census, e.g. are you at a public highway crossing with high traffic moment or are you at a rural passive crossing that is lightly used? Observe usage: – is it in keeping with the calculated traverse time? – are users operating the crossing safely? – are there a high number of vulnerable and irregular users and how does this translate into applying the 50% safeguard? It is always useful to engage with users to obtain census information. It might lead to intelligence on risks and hazards that you might be unsighted to. It is often good practice to ask them about user demographics, if they have observed deliberate misuse or safety events and if they have any issues of concern with the asset, e.g. slippery surface, confusion with instructions on safe crossing protocol etc. Be aware of extreme weather conditions; this might influence the level of use witnessed during the census gathering activity. This can be particularly relevant at footpath or bridleway crossings. For example, very bad weather (gale-force winds, sleet, snow and very cold conditions) might lead to a reduction in the number of crossing users seen and conversely very good weather (heatwave) might result in slightly more users being out-and-about. Whilst both extremes are valid user moment experiences, in terms of quick census they could distort accuracy levels if significant. It is important therefore to consider if the weather conditions might have distorted the accuracy of the census. If appropriate, evaluate the need to revisit the crossing at another time.

Table 3 Quick and 24 hour ‘manual count’ census data gathering

5.3 Identifying vulnerable users

5.3.1 Vulnerable user definition

Vulnerable level crossing users can be defined as people who, when compared with typical users:

- are likely to take an extended time to traverse due to disability or distraction; and/or
- might be at greater risk of harm due to their perception of risk.

5.3.2 Defining vulnerability

There are a number of factors that can result in people being at greater risk when using level crossings. These can include but are not limited to:

- Limitations in mobility (take into account not only the ability to walk, but also the ability to turn their bodies or heads and look for oncoming trains)
- Visual or hearing impairment
- Cognitive ability, e.g. making safety related decisions (very young and elderly people are more likely to make poor decisions on the distance and speed of large moving objects such as trains)
- Being encumbered, e.g. crossing with bags, pushchairs, cycles or dogs (consider if dogs are on or off a lead (including the use of extendable versions), and if owners are in charge of more than one dog; it becomes increasingly harder to control multiple animals)
- Inability to comprehend English, i.e. to read signage and / or speak to Signallers

5.3.3 Types of vulnerable users

Vulnerable users can include, but are not limited to:

- People with physical and/or mental disabilities or other impairments; incl. those using mobility scooters
- Young children; unaccompanied or in groups
- Elderly people
- Dog walkers
- Cyclists, e.g. where known not to dismount and considered ‘at risk’
- People carrying heavy bags or large objects, with pushchairs etc.
- Non-English language speakers, e.g. migrant workers

5.3.4 Identifying vulnerable users by location

The likelihood of a level crossing being used by vulnerable users can be influenced by its proximity to:

- Sheltered housing or care homes; residential and nursing
- Schools
- Stations
- Residential thoroughfares
- Busy high streets
- Parks, play areas, known walking areas
- Fixed local attractions, e.g. beaches, caravan sites

5.3.5 Means of identifying vulnerable users

Crossings that might have vulnerable users can be identified by:

- Observation; census
- Research into the crossing environment using intelligent sources of information
- Interviewing users in nearby businesses, residential dwellings etc.
- Near miss or other reporting of precursor events

Other influencing factors can include:

- Location and/or crossing type, e.g. field to field crossings with stiles are less likely to have a high proportion of vulnerable users than a gated footpath crossing in an urban area
- Condition of the asset which might influence user traverse speed further, e.g. skewed crossing, stepped approaches etc.

5.3.6 Higher than average

5.3.6.1 What is higher than average?

NOTE: The below illustrative example does not offer a ratio of application, nor does it take precedence over structured expert judgement where for example, an assessor considers it an essential requirement to protect a minority user group or single person.

If there is ambiguity or uncertainty then, additional research and/or extended census might be necessary to inform decision making.

Deciding on whether higher than average vulnerable usage is prevalent should always be based on structured expert judgement and assessor's acquired knowledge. Decisions should be supported by all available evidence gathered as part of the risk assessment; taking cognisance of physical on-site observation and

intelligent sources of information. As an illustrative means only, it might be appropriate to consider, if for every five users:

- only one in five is made by a vulnerable user, the 50% safeguard might not typically be applied
- two in five is made by a vulnerable user, it is especially important that a risk based decision is made
- three to five are made by vulnerable users, the 50% safeguard would always be applied

The table below can be used to help decide which groups are considered vulnerable; however, it remains the LCMs final decision to add the 50% safeguard

	Vulnerabilities	When users are not normally considered vulnerable
Physical or mental disability	Users with known or suspected disabilities should always be considered as vulnerable; records should support this	N/A
Children	Easily distracted	Observed to be using the crossing correctly and safely as an individual user
	Subject to peer group pressures	Observed to be using the crossing correctly and safely as part of a group of users
	Low cognitive ability to interpret risk	Older children who may not be considered to be vulnerable users
	Observed to be unaware of or ignoring safe crossing protocols	Observed using the crossing correctly and safely whilst dismounted from a bicycle, scooter or similar
	Very young children most susceptible to all of the above vulnerabilities	
	Unaccompanied	
	Mounted or pushing a bicycle, scooter or similar	

	Vulnerabilities	When users are not normally considered vulnerable
Elderly *Judgement is needed as not all elderly people are slow or less able to use a crossing safely. The elderly are often in less of a hurry and can equally take greater time and care when crossing.*	Observed using walking aids or other obvious signs of mobility impairment	Observed to be using the crossing correctly and safely as an individual user
	Encumbered with shopping trolleys or large heavy bags	Observed to be using the crossing correctly and safely as part of a group of users
	Slower cognitive ability and/or reaction times	Observed to be compensating for sensory loss by checking carefully and moving as quickly as possible
	Using a mobility scooter; risks associated with negotiating decked surface (including width considerations) or getting stuck on the flange-way at skewed crossings	Persons who display physical fitness such as ramblers and leisure walkers
	Mounted or pushing a bicycle	
	Have become complacent and overly familiar with the train timetable and safe crossing protocol	
Dog walkers	Distracted due to: • dogs off leads • multiple dogs on leads • dogs on extendable leads	Observed to be using the crossing correctly and safely whilst keeping dogs on leads and under control
	Users who put themselves in danger to recover dogs off leads who are lineside	
	Type of access, stile/gate, and relative position of safety which may import risk to users who are unduly focusing on their dogs rather than making a safe crossing	
Cyclists	Failing to dismount and cycling across the crossing	Individuals observed dismounted and using the crossing correctly and safely
	Groups observed riding over the crossing together	Observed negotiating the crossing from a position of safety when manoeuvring their bicycle through the access and egress points
	Families on outings with small, young children on bicycles	
	Cyclists with trailers	
	Cycling event routes which attract and encourage crossing use by mounted riders	
	Type of access, stile/gate, and relative position of safety which may import risk to users who are unduly focusing on their bicycles	

5.4 Pedestrian usage at public highway crossings

If undertaking a quick census at public highway crossings, in the absence of the availability of a nine day or extended traffic census, it is good practice to sense-check pedestrian count. Whilst vehicular traffic flow remains 'broadly' consistent, pedestrian moment can be much more volatile and subject to environmental influences. These same environmental factors will also dictate the 'typical' volume of pedestrian use of level crossings; generating peaks and troughs which could be missed by a quick census. For example, if an asset is located in close proximity to residential dwellings and/or community links such as shops or schools, the chances are that the pedestrian footfall is notable; i.e. you would expect to see pedestrian users. If a 30 minute quick census was undertaken mid-morning and resulted in very nominal numbers observed or no pedestrian users witnessed, this might not represent 'typical' pedestrian moment, but could be a rare lull in use. In addition, where users are witnessed, this might not represent the complete user demographic; schoolchildren, students etc. If uncertainty exists, a nine day or extended census might be needed. Utilisation of other intelligent sources, see 7, would be advisable and might also serve to substantiate concerns.

5.5 Nine day, extended or 24 hour census undertaken by external suppliers

There are companies that can be appointed to undertake 24 hour, nine day or extended census gathering activities. Research might be necessary to identify local companies with the capability to do this type of work or if appropriate and economical, national organisations might also be available for this purpose.

Funding for census data collection activity undertaken by external suppliers will need to be considered. Sources of funding for such work might incorporate use of the Route Safety Fund or additionally project funding, for example if census relates to a renewal or enhancement activity, might be available for this purpose.

It might also be necessary to undertake a formal tender process if the cost of work necessitates this. If in doubt, please confirm business protocol requirements.

Instructions to companies undertaking census data collection activities should include requirements for:

a) when the census is to be undertaken and its duration;

b) data to be recorded, e.g. types of users (vulnerability of users: persons encumbered, disabled, unaccompanied children, elderly, dog walkers, headphone wearing, texting etc…), vehicle types (HGV, tractors, buses, cars, vans etc…), and the date/time they are observed;

c) how the data is to be presented, e.g. hourly, daily, mean average per user type and/or hazardous event (e.g. children, elderly, texting, using mobile phone, hood up); and

d) when the data is required by

GRD007 Level Crossing Census Requirements contains further details on this.

5.6 Modelling of nine day or extended census activity

It is recommended that daily usage is recorded by respective user groups so as to enable an average to be taken per group for the census duration. In this way, the 24 hour entry in ALCRM represents the average daily moment per user group as opposed to overestimating or underestimating usage patterns by taking the highest or lowest daily figure witnessed during the census data collection activity.

5.7 Estimated census

As discussed in 4.1, estimated census is likely to be the least accurate of all census types and is the non-preferred approach. In all cases, actual census activity should be undertaken whenever practicable.

Where estimate census is used, it should only be applied to very lightly used crossings, such as field to field crossings in rural areas or private vehicular crossings with evidence of limited usage e.g. rusty padlock, overgrown approaches.

To estimate the usage of the crossing:

a) use information supplied by the authorised user(s) if applicable/available;

b) If applicable, interview the landowner or neighbouring landowners and ask how often the crossing is used, by whom and if applicable, by what type of vehicles. Ask whether or not there are particular periods which might generate use or greater use e.g. harvesting, holidays etc;

c) speak to owners of nearby dwellings or facilities that might use or witness use of the crossing;

d) look for evidence of use such as tracks or trodden paths, litter or other signs, analyse the extent of vegetation growth around the access points, take account of rust on padlocks (where fitted); and

e) utilise intelligent sources of information to help in the application of structured judgement; see 7.

6 Influencing factors affecting crossing usage

There are many factors that can influence usage patterns over level crossings. These factors might impact census flow daily, weekly, monthly or even annually.

It is important that such intense changes are evaluated when undertaking census gathering activity so as to avoid over or under inflating calculated risk. Where such usage patterns are identified, steps should be taken to provide a balanced census count. This might involve re-commissioning census or an extended census to better reflect accuracy and/or involve adding a second census in addition to the first so as to afford a more accurate representation of user moment.

Intelligent sources of information in addition to on-site observations can help assessors identify influencing factors; see 7.

The table below details a selection of factors that might influence user moment. The content is non-exhaustive.

	Asset Type		
Influencing factor	Public road	Footpath or bridleway	User worked crossing
Road network: full or partial closures, minor road works, diversionary routes in utilisation, road traffic accidents, road layout alterations under construction			
Asset located near to attractions: funfairs, leisure retreats, historical or tourist matters of interest, beaches, race courses, motor racing circuits, theatres, concert halls, proximity to 'night-life' – e.g. clubs, bars, restaurants etc…			
Proximity of schools, hospitals, health clinics, community centres, shops etc…			
Proximity of businesses, types of businesses and hours of operation			
Type of private asset: field to field access for tending to crops or cattle, residential access, entrance to private facility or business use			
Harvest: types of crops, seasonal variance, hours of crop management			

Table 4 Influencing factors affecting user moment

NOTE: *For further information on census at private vehicle crossings, please also see guidance document LCG12 – Intensive use at UWCs.*

7 Using in-house technology to collect census information

In-house technology is widely used by assessors to help gather census intelligence. Available technologies adopted include use of mobile cameras, gate counters, pressure pads and SmartCam fixed equipment.

Camera equipment offers the best intelligence gathering capability as it can be used not only to count users, but to identify user demographics, including the presence of vulnerable users, and capture the behavioural attitude of users of level crossings. Naturally cameras are suited to 24 hour, nine day and extended censuses.

Gate counters and pressure pads, although suited to similar census conditions, have weaknesses which limit their successful deployment and effectiveness. The primary shortcomings with these census solutions is their inability to differentiate between user groups, provide capability for assessors to interrogate behaviour and the uncertainty of activation; e.g. a counter could be triggered by wind moving a gate or an animal standing on a pressure pad.

7.1 Use of fixed or mobile camera solutions

7.1.1 General and pre-planning activity

Deploying camera technology for nine days or more or using fixed equipment (where available) offers the greatest opportunity for accurate census.

It is important to pre-plan this activity well in advance so as to maximise the accuracy of the census gathering opportunity. You should take account of the date of the planned risk assessment and the duration of the census needed to provide a robust census, so that sufficient time is allocated to deploy camera technology. This applies where a single census is proposed to portray annual usage or where a second census is needed to support a more balanced annual picture.

When using camera equipment for the purpose of census gathering data collection, there are other important things to consider and procedures to follow. These are discussed below.

7.1.2 Knowing the law and complying with our legal obligations

Network Rail is subject to various acts of legislation and codes of practice. In particular, information security and data protection acts apply to the use of camera technology where it is used for the purpose of gathering census information at level crossings.

It is important that these instructions are adhered to so as to prevent legal or reputational risks to the company or individuals within the company. This includes regulatory or other operational threats and financial penalties which might ensue.

7.1.2.1 Notifying the general public/private land owners

Before camera equipment is switched on and during its operational use, it is essential that a conspicuous notice is provided on each side of the crossing informing users of its operational status and purpose.

The wording of notices shall be:

“A CCTV recording system is operated at this level crossing for the purposes of safety and the prevention of crime. The organisation responsible for the management of the system is Network Rail, which can be contacted on 03457 114141”.

These legal notices demonstrate that Network Rail is complying with the requirements of the Data Protection Act 1998. Specifically we must demonstrate that we are conforming to the following principles:

- Personal data shall be processed fairly and lawfully – *Organisations must be transparent about how they intend to use the data and give individuals appropriate privacy notices when collecting their personal data.*
- Personal data shall be obtained only for one or more specified and lawful purposes – *Organisations must be clear from the outset about why they are collecting personal data and what they intend to do with it.*

7.1.2.2 Data security

Data security is an important aspect of our company compliance with legislation and codes of practice. It is important that camera equipment is secured against vandalism or theft, and where equipment is mobile, that all practical steps are taken to reduce the temptation or likelihood of such acts.

The essential requirements that must be undertaken when deploying any camera technology are:

- Placing the camera equipment in a security box which is securely located and padlocked; and/or
- Encrypting the SD card prior to use.

In addition, locating equipment which will reduce attention, conspicuity or the likelihood of tampering is strongly advised.

7.1.2.3 Data retention/storage

Census data cannot be held indefinitely without good reason. A reason for retention of footage or an image might be necessary because it highlights a risk or bad practice that can be used to promote awareness and educate others. Before images are shared, whether externally or internally, it is essential that they are redacted so as to preserve a user's identity. Retention shall be by exception and a record should exist of any pictures held including where they are located.

In normal operation, data must be deleted once the census has been completed and intelligence analysed.

When making decisions about retention, consider the implications of the following principle of the Data Protection Act 1998:

- Personal data processed for any purpose or purposes shall not be kept longer than is necessary for that purpose or those purposes – *Organisations need to:*
  - *Review the length of time personal data is kept for;*
  - *Consider the purpose or purposes the information is held in deciding whether (and for how long) to retain it;*
  - *Securely delete information that is no longer needed for this purpose or these purposes; and*
  - *Update, archive or securely delete information if it goes out of date.*

7.1.2.4 Subject access requests (SARs)

So as to comply with SARs, a log of camera deployment, a record of data deletion and the location of any retained images or footage (as above 6.1.2.3) must be kept.

7.1.3 Positioning of mobile solutions

NOTE: *When deploying camera solutions always remember that your personal safety is essential – make sure you have arranged a safe system of work before you begin.*

It is important to position camera equipment so that it can record the very best footage and afford the very finest intelligence. In deciding on the location of equipment there are many things that need to be taken into consideration. These include, but are not limited to:

- The quality and capability of the technology; e.g. will the image quality be sufficiently robust to depict the user demographic and age profile if positioned remote from the asset.
- Optimal positioning so as to facilitate the identity of the user demographic, identify vulnerable, encumbered or obviously impaired users, whilst contextualising the user and the asset and helping to identify behaviours, hazards and risks.
- The likelihood that equipment may suffer from theft or vandalism.
- The possibility that the environment may trigger spurious activations where motion detection is in use due to vegetation, wildlife or passing trains.
- Battery life and data capacity; the greater the number of users/motion activated triggers, the greater the impact on battery drain and memory card capacity.
- The need to understand greater second train coming frequency.

There are a number of good practice indicators which have been identified within the Level Crossing Manager community in regard to camera deployment. Excerpts of these are shown below:

- When mounting census equipment within the railway boundary, ensure that it does not interfere with the safe operation of trains, crossing equipment or positioned so as to result in user distraction.
- Try to avoid installing equipment on the direct route a user will travel to minimise the likelihood that the camera might be subject to theft or tampering.
- Take cognisance of the trespass history of the crossing in determining the positioning or appropriateness of deploying camera technology.
- It is advisable to mount camera equipment at a height of between 2ft and 6ft from the ground to reduce the likelihood of spurious activations from vegetation or animals.
- Where camera equipment is located in close proximity to trees or other shrubbery, make sure that branches will not foul the field of vision during bouts of wind or rain.

- Be aware of positioning equipment in such a way that activity from roads or paths parallel to the railway might cause spurious activations and result in unanticipated battery drain and/or quickly fill capacity of memory cards.

7.2 Use of gate counters and pressure pads

Due to the limited capabilities of gate counters and pressure pads in comparison with camera technology, as discussed in 6, the value added ability of this equipment is to support census intelligence by validating user numbers. For example, the use of quick census combined with multiple intelligent sources might, in isolated cases, provide enough information on which to make a judgement regarding user demographic, vulnerable usage and user behaviour. Gate counter or pressure pad technologies, could therefore help assessors to determine usage numbers over a sustained period of time and in doing so validate the quantitative output of the quick census.

In addition and where equipment can record date and time of activations, gate counters or pressure pads might be used to provide intelligence relating to peaks and troughs and night-time quiet period usage for example.

In summary and as illustrative examples, these technologies can be used for confirming:

a) sleeping dog status;

b) night-time quiet period use or usage during darkness;

c) peaks and troughs: daily or weekly;

d) provide a numerical count to check the accuracy of a quick census or validate other intelligent sources of information; and

e) to gather generic data, i.e. not user type intelligence, in support of level crossing closures.

8 Identifying crossing use through intelligent sources of information

8.1 General

As discussed in 4.1, it is important in addition to on-site census activity, to make full use of all available intelligent sources when determining usage of level crossings.

The fatality at Frampton level crossing on 11th May 2014, involving unknown unauthorised use of the bridleway element of the crossing by trail bike riders, highlights the type of activity that takes place across our network. It is acknowledged even with extended census and the use of intelligent sources, that this type of event might still go undetected, but the broader the research and active data collection, the greater the opportunity to identify such practices.

It is therefore advocated that the combined use of census which is nine day or greater, with the proactive use of intelligent sources (internet searches, researching social media and local club sites), in addition to seeking visual cues when on-site

(tyre tread patterns or other clues); betters the opportunity for identifying the risk of unsafe or unauthorised activity than a quick, 24 hour or nine day census in isolation.

This is especially important so as to identify usage or patterns of use that might not be apparent even where nine day or extended census is undertaken. For example, organised groups promoting monthly or annual events which impact on the use of a level crossing could be missed from census activity alone, even where extended census is applied.

Utilisation of intelligent sources might also serve to identify vulnerable users or unauthorised use of level crossings. In this regard it can help assessors to identify organised groups so as to engage with them proactively and/or target risk mitigation appropriately.

8.2 Use of intelligent sources

Intelligent or smart-sources of information can take many forms. The information sources detailed below are not exhaustive, but they are a good source from which to build a portfolio of research material. Their sequence is also not representative of any hierarchical order of importance.

8.2.1 The internet

The world-wide web offers an abundance of opportunities to identify information to support census gathering intelligence. This rich smart-source may hold the key to significantly increasing assessor knowledge about the use of a level crossing and/or its users.

Detailed internet searches may yield information about the immediate environment, identify the promotion of rights of access or events and highlight use of level crossings by organisations or societies. When using the internet, consider:

- Local authority websites – might contain information on redevelopment proposals, road diversions, public attractions such as funfairs or other risk influencing intelligence.
- Rights of way maps and other mapping services – will highlight risk influencing factors within the immediate environment such as schools, businesses, public attractions, road layouts and afford understanding of how an asset serves the local community; e.g. provides a thoroughfare link, commuter route etc. The Definitive Map will help to identify if the route over a level crossing is publically promoted.
- Social media sites – intelligence relating to the use of level crossing might be available from social media channels such as: Facebook, YouTube, Twitter and Instagram. Individuals and organisations often promote activities via these network channels. Intelligence might include *posts* on forthcoming organised events within the locality, video footage or images of actual crossing use (including unauthorised or risk taking activity) and/or highlight

trends in use or frequencies of use including use by an unknown user demographic.

- Dedicated websites or chatroom forums – National groups such as the Ramblers or more localised groups such as off-road trail bike, 4x4 vehicle communities or regional scout groups often share or discuss experiences, social activity and promote events on their dedicated websites. A search for such communities and groups within the area of a level crossing may yield unknown intelligence about level crossing activity.

8.2.2 Highways authority traffic surveys

It is prudent to discuss with local authorities their programme of traffic surveys; both planned works and available footage or census data from completed activities. It might be possible to utilise this intelligence within risk assessments wholly or partially with agreement. Direct liaison with local authority contacts or through Road Rail Partnership Groups is advised.

8.2.3 Discuss the level crossing with the local experts

It might be that the best intelligence is accrued from the local community or those who interface with the asset directly. Often information may come to light through engaging with persons or groups that would otherwise reside unknown from census activity alone. Such intelligence might be obtained through discussion with people or groups such as:

- Local authority rights of way officers or community leads
- Council or Highways Agency officials
- Level crossing users
- Authorised users of private level crossings
- Local residents or businesses, schools or colleges
- Local user groups or clubs
- Signalling staff (Signallers or Crossing Keepers)
- Off-track, S&T, patrolling or other operational staff; e.g. MOMs
- Train operating companies (Drivers, Guards, station staff)
- British Transport Police

8.2.4 Operational records of crossing use

For private vehicle crossings equipped with telephones or automatic half barrier crossings (AHBs), record keeping in the form of occurrence books should exist to supplement intelligence for vehicle movements; albeit only for large or slow movements in the case of AHBs. In addition, in cases where the crossing provides

access to business premises, there might be separate registers or site visitor logs which could support intelligence regarding vehicle use.

Accuracy of records is unlikely to be such that numbers or intelligence can be considered to be 100% assured, but if information is combined with additional research, it might contribute toward a broader understanding of actual crossing usage.

8.2.5 Tagging

At very lightly used or perceived dormant crossings, tagging a gate can be a useful way to determine if the asset is actually used, by whom and at what frequency. There is no guarantee that a user will make contact if they break the tag to cross, but its presence might:

a) Promote contact, resulting in useful intelligence that would not otherwise be forthcoming; or

b) If removed to cross, but no contact is made, it will be apparent to the assessor during the next risk assessment or asset inspection; an obvious sign that the crossing has been used and that greater intelligence is needed.

If tagging a gate, the user instruction should be stored in a waterproof container with the tag in a conspicuous place. As a minimum its contents should include:

- Level crossing details; name, type, UID (ELR, miles, chains)
- Date tag was placed at the crossing and the reason for the tag
- Telephone number and/or email address of contact point (typically this might be a Control Centre to ensure a 24 hour response)

9 Intelligence driven response to census

9.1 General

The undertaking of active census in conjunction with the use of intelligent sources of information will often confirm ‘known’ or suspected patterns of use, substantiate risks or hazards and endorse the user demographic; including the presence of vulnerable users. In other cases it may highlight unknown threats, unauthorised use or unsafe practices which require immediate interim actions, in addition to long-term plans, to control.

As a prerequisite of risk management protocol, it is important that intelligence is acted upon to mitigate threats or hazards and manage safety. In no hierarchical order, actions or parallel actions might include:

- Redeploy camera equipment (if appropriate) to better identify usage, patterns of use, user groups or collate additional evidence to support intelligence.
- Work collaboratively with operations staff (OM, LOM, and MOM), BTP, train operators and other stakeholder partners. If regular patterns of use are identified and as appropriate, arrange for evening or weekend visits to the

crossing, so as to talk directly with users to re-educate them regarding unauthorised use and unsafe acts. A BTP presence might also serve to enforce key messages. Operations staff working on a shift basis, such as MOMs, may be best placed to support this approach, unless by agreement, a Level Crossing Manager volunteers to work 'out-of-hours'.

- Revisit the internet and make specific use of targeted user group searches; specifically this should include using social media and local community or club websites to identify groups or clubs that observed users may belong to.
- Make direct contact with relevant local organisations, such as trail bike, 4x4, equestrian or walking societies, so as to promote safe crossing protocols, highlighting the risks and hazards associated with level crossings and unauthorised use. Work collaboratively to address safety concerns.
- Make contact with any county or national organisations if it is possible that the group or organisation is broader than the immediacy of the parish. Contact the central level crossing team if there are national implications and transferrable risks. It is important and advantageous to engage with and promote safety within larger institutions.
- Work collaboratively with local authorities, highways agencies and rights of way officers to:
  - determine if public and private status is accurately represented in documentation such as the Definitive Map;
  - identify whether restrictions and prohibitions by vehicles or other groups is suitably recorded and visible in public documentation; and
  - understand what additional actions can be taken by local authority colleagues to support Network Rail in managing asset safety.
- Take practicable steps to improve safety through delivery of physical improvements and provision of mitigation:
  - Re-evaluate closure opportunities, diversionary access and downgrades in status (where applicable).
  - Evaluate the requirements to provide risk reducing mitigation such as MSL, POGO for example.
  - Signage: review optimal positioning and order of signs, clarity of instructions; are there too many leading to signage cluttering and ambiguity or confused information, is there unnecessary signage or duplication, if appropriate and safe to do so without resulting in distraction or dilution of safety critical information – is there scope to provide an additional safety information or trespass sign etc…
  - Take steps to improve the crossing layout and undertake general infrastructure improvements: channelling, user segregation, improving traverse, sighting etc…

10 Census protocol

10.1 General

Every effort should be made to undertake a new census when undertaking a new risk assessment. In this way data is kept current with latest intelligence and:

- recorded census is reflective of the most current position, taking account of environmental or other external influences and the user demographic;
- calculated risk is representative of the current threat; and
- it facilitates analysis of the trending risk profile of the asset.

Where a quick census is used, see 4.2, this should be undertaken at the time of the site visit. In exceptional circumstances, it might be necessary to undertake the census on a different day, for example, if weather conditions adversely affect the accuracy of census data on the planned day of collection. If the census needs to be taken on another day, it should be undertaken as close to the date of the original site visit as possible.

Where a 24 hour, nine day or extended census is used, pre-planning activity should facilitate a structured timeline to deploy census gathering equipment or arrange external support, so as to tie-in with the date of the risk assessment site visit.

Where additional census is needed, this should be undertaken during the most appropriate parameter; taking account of intelligence, the reason for the second census and all other pertinent factors.

10.2 Applying new census data to an existing risk assessment

10.2.1 Acceptable use

Sometimes, more recent census data than that used in the current risk assessment becomes available or a need for new census data is identified. For example:

- a Network Rail project might commission a nine day census as part of an asset renewal or re-signalling scheme;
- a developer might submit a current nine day census for comparison against projected usage;
- an authorised user might provide unsolicited census data;
- an additional census might have been undertaken to capture seasonal variations in use;
- a Highways Authority might undertake a traffic survey and share it directly with the Level Crossing Manager or through Road Rail Partnership Groups; or
- a third party report might be received which generates a requirement for a more recent census, for example, usage is identified during the night-time quiet period at a whistle board protected crossing.

The new census information can be applied to the existing risk assessment provided there is confidence that all other cumulative data remains fit for purpose. If there is any doubt or ambiguity over this or if an extended period has lapsed since this data was accrued, a complete new risk assessment might be necessary.

If there is a significant change in the ALCRM score as a result of using new census data:

a) evaluate the need to undertake a new risk assessment;

b) re-evaluate the need for new or additional risk control measures or the need to expedite planned mitigations or implement interim controls; and

c) review the impact of the change on the risk assessment frequency.

10.2.2 How to record this in ALCRM

When it has been established that it is appropriate to use new census data in an existing risk assessment (in place of existing data), this should be recorded in ALCRM as follows:

a) Create a new option below the current (LIVE) risk assessment and in the census tab enter the new census date;

b) Enter the name or source of the census taker/provider, duration and type for the census being used and the census data itself;

c) Add any pertinent information about the new census within the notes section and explain why the decision to use it has been made; and

d) Set the option to recommend, approved and implemented so that it becomes the LIVE risk assessment.

10.3 Using old census data in new risk assessments

10.3.1 Acceptable use

In exceptional circumstances it might be appropriate to use census data that pre-dates the risk assessment being undertaken. This is only appropriate where the census is believed to give greater accuracy than that completed during the site visit. Examples are shown in table 4.

Wherever possible, the old census data should be compared to the census completed during the site visit. This is important to establish if the old census continues to provide accurate data on crossing usage.

Old census	New census	Validation	Comments
Nine day or extended census or 24 hour census	Quick census	Compare the daily usage from the new quick census with the daily usage from the previous nine day, extended or 24 hour census.	If the data is broadly comparable, use the nine day, extended or 24 hour census. If there is significant variation, decide which census offers the greater accuracy using structured judgement and accounting for intelligent sources of information. If needed, undertake a new nine day, extended or 24 hour census.
Estimate provided by an authorised user	Quick or estimate census	Compare the daily usage from the new quick or estimate census with the data provided previously by the authorised user. *NOTE: A quick census might over or under estimate usage. The AU estimate might identify different patterns of use not identified by a quick or visual estimate.*	If the data is broadly comparable, use the estimate provided by the authorised user. If there is significant variation, decide which census offers the greater accuracy using structured judgement and accounting for intelligent sources of information.
Quick census, users witnessed	Quick census, no users witnessed and estimate made	Apply structured expert judgement to decide if either census is appropriate or if a new census is needed.	Use the old census data if it is believed to more closely reflect usage than the estimate made, making use of structured judgement and accounting for intelligent sources of information within decision making. If not satisfied that either census reflects crossing usage accurately, a new nine day or extended census should be undertaken.

Table 5 Examples of using old census data

10.3.2 How to record this in ALCRM

When it has been established that it is appropriate to use old census data in a new risk assessment, this should be recorded in ALCRM. The date of the old census should be recorded appropriately and any pertinent information about the old census, including the decisions taken to use it and any comparison or validation with new census data, should be documented within the notes section.

10.4 Comparing new census with historic census

10.4.1 General

It is good practice to compare new census information with historic census so as to:

a) identify when significant changes have taken place such as:
   - changes in user numbers;
   - changes in user demographic, e.g. increase in vulnerable and/or irregular users
   - changes in vehicle use or type, e.g. increase in or introduction of HGVs; and

b) take account of historic census activity so as to utilise all intelligence and remain consistent in the identification of vulnerable and irregular users or types of vehicles and patterns of use, SFAIRP;

c) consistently apply an appropriate traverse time applicable to the user demographic or vehicle moment;

d) apply the correct minimum sighting requirements appropriate to the user demographic or vehicle moment; and

e) reduce the likelihood of errors within census counts so as to increase the accuracy of modelled risk and the application of structured judgement within risk assessment.

A comparison of data between new and historic censuses can help to identify trends, highlight any potentially significant changes in risk or signpost errors in census data. It is good practice to make this comparison using more than the last census taken so as to comprehensively take account of all available information.

Changes to look for should include:

- significant movement in usage figures;
- alterations in use by vulnerable and irregular users; taking account of any broader demographic change; and
- peaks and troughs and seasonal variation.

Such transitions in use or by users can significantly impact on the risk controls in place, or those proposed. It might also serve to provide assessors with a true holistic understanding of the assets history and an insight into future risks.

10.4.2 Analysis and actions

Where significant changes are identified, it might be necessary to undertake further detailed analysis to validate new intelligence. This will enable assessors to determine the full impact on risk.

Examples of changes that might trigger further investigation include:

a) the new census does not identify vulnerable users when they have been identified previously;

b) previous census(es) indicate night-time quiet period use and the new census does not;

c) previous census(es) include vehicle types which import risk, e.g. tractors and trailers or HGVs, the new census does not;

d) there are significant changes in user numbers (vehicle and pedestrian);

e) previously identified irregular use is not recorded in the new census, e.g. irregular usage previously recorded due to: leisure attractions, seasonal variation (beach access, fruit farms) etc.

Where conflicting information between assessments exists, it is important to utilise intelligent sources of information, in addition to further census activity or site-visits, to determine the accurate position.

JG6

RAIB

Rail Accident Investigation Branch

Rail Accident Report



Pedestrian struck by a train at Lady Howard footpath and bridleway crossing, Surrey, 21 April 2022

Report 01/2023
v2 February 2024

This investigation was carried out in accordance with:

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

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This report is published by the Rail Accident Investigation Branch, Department for Transport.

Version	*Date*	*Location of change(s)*	*Description of change*
v1.0	14 February 2023	All	Initial issue
v2.0	6 February 2024	Summary 3rd para	Text added concerning the possibility of a derogation
		Summary 4th para	Text describing the learning point added
		Para 7	Description of signals and their position relative to the crossing
		Para 62	Description of strike in point added
		Para 63	Expansion of the description of different types of MSL
		Paras 64 to 68	New paragraphs on standards and derogations
		Para 69 onwards	Renumbered
		Para 72	Last sentence changed
		Para 73	New paragraph on option selection report
		Para 74	Re-phrased to reflect new evidence
		Para 75 to 79	New paragraphs to reflect new evidence
		Para 80	Tense change in first line
		Para 82	Changed to reflect new evidence
		Heading before Para 100	Heading changed
		Heading before Para 103	New heading
		Paras 103 to 105	New paragraphs for actions taken between publication of original and revised versions
		Heading before Para 107	New heading
		Para 107	New learning point
		Footnote 10	New footnote regarding learning point
		Throughout	Paragraph numbering and cross references updated to reflect extra paragraphs

Preface

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. 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.

RAIB's findings are based on its own evaluation of the evidence that was available at the time of the investigation and are intended to explain what happened, and why, in a fair and unbiased manner.

Where RAIB has described a factor as being linked to cause and the term is unqualified, this means that RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident or incident that is being investigated. However, where RAIB is less confident about the existence of a factor, or its role in the causation of the accident or incident, RAIB will qualify its findings by use of words such as 'probable' or 'possible', as appropriate. Where there is more than one potential explanation RAIB may describe one factor as being 'more' or 'less' likely than the other.

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident or incident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, words such as 'probable' or 'possible' can also be used to qualify 'underlying factor'.

Use of the word 'probable' means that, although it is considered highly likely that the factor applied, some small element of uncertainty remains. Use of the word 'possible' means that, although there is some evidence that supports this factor, there remains a more significant degree of uncertainty.

An 'observation' is a safety issue discovered as part of the investigation that is not considered to be causal or underlying to the accident or incident being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

The above terms are intended to assist readers' interpretation of the report, and to provide suitable explanations where uncertainty remains. The report should therefore be interpreted as the view of RAIB, expressed with the sole purpose of improving railway safety.

Any information about casualties is based on figures provided to RAIB from various sources. Considerations of personal privacy may mean that not all of the actual effects of the event are recorded in the report. RAIB recognises that sudden unexpected events can have both short- and long-term consequences for the physical and/or mental health of people who were involved, both directly and indirectly, in what happened.

RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of any inquest or fatal accident inquiry, and all other investigations, including those carried out by the safety authority, police or railway industry.

Pedestrian struck by a train at Lady Howard footpath and bridleway crossing, Surrey, 21 April 2022

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Summary

At about 14:49 hrs on Thursday 21 April 2022, a pedestrian was struck and fatally injured by an out-of-service passenger train at Lady Howard footpath and bridleway crossing, near Ashtead in Surrey. The pedestrian, who was walking on the crossing with a dog and pushing a wheeled trolley bag, started to cross the railway tracks shortly after a train had passed. She was struck by a second train, which was travelling in the opposite direction to the first. The driver of the train involved in the accident sounded the train's horn on seeing the pedestrian on the crossing. The pedestrian responded by hurrying forwards towards the exit of the crossing, but was unable to get clear of the path of the train in time to avoid being struck.

RAIB's investigation found that the pedestrian was apparently unaware that the second train was approaching when she made the decision to cross; there is no evidence that she was aware of it and/or had misjudged the time available to cross. This was because, although the pedestrian looked twice in the direction of the second train before starting to cross, the front of this second train was hidden behind the first train, which was moving away on the line nearest to her. RAIB also found it was possible that the pedestrian did not perceive the risk arising from the possibility that the first train was hiding another approaching train.

A probable underlying factor was that Network Rail had not provided any effective additional risk mitigation at the crossing, despite having previously deemed the risk to users to be unacceptable. Network Rail had planned and budgeted to install integrated miniature stop lights at the crossing, but a shortage of resource meant that delivery was delayed. There is little evidence that Network Rail considered effective options to mitigate the risk on an interim basis while this installation was pending, although it fitted additional warning signs for users and a camera to monitor crossing use. Network Rail had not considered applying for a derogation from an internal standard which would have allowed it to fit a simpler version of miniature stop lights at the crossing, although it is unlikely that this equipment would have been operational before the accident, had such a derogation been obtained.

As a result of this investigation, RAIB has made two recommendations, both to Network Rail. The first is intended to address the risk to pedestrians at crossings of this type arising from a second approaching train being hidden from view by another train. The second recommendation concerns the implementation of appropriate interim risk mitigations at level crossings that are awaiting long-term solutions. RAIB has also identified a learning point, addressing the need to consider whether a derogation from standards is justified or has been approved previously.

Introduction

Definitions

1 Metric units are used in this report, except when it is normal railway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.

2 The report contains abbreviations which are explained in appendix A. Sources of evidence used in the investigation are listed in appendix B.

The accident

Summary of the accident

3 At about 14:49 hrs on Thursday 21 April 2022, a pedestrian was struck and fatally injured by an out-of-service passenger train at Lady Howard footpath and bridleway crossing, near Ashtead in Surrey (figure 1). The train was recorded as travelling at about 62 mph (100 km/h) at the time of the accident.

4 The pedestrian, who was walking with a dog and a wheeled trolley bag, had started to cross the railway tracks shortly after a previous train had passed the crossing in the opposite direction to the train involved in the accident.

5 The driver of the train involved in the accident sounded the train's horn upon seeing the pedestrian on the crossing. The pedestrian responded to the warning by hurrying forwards towards the exit of the crossing, but did not reach a point that was clear of the train's path before it arrived at the crossing.

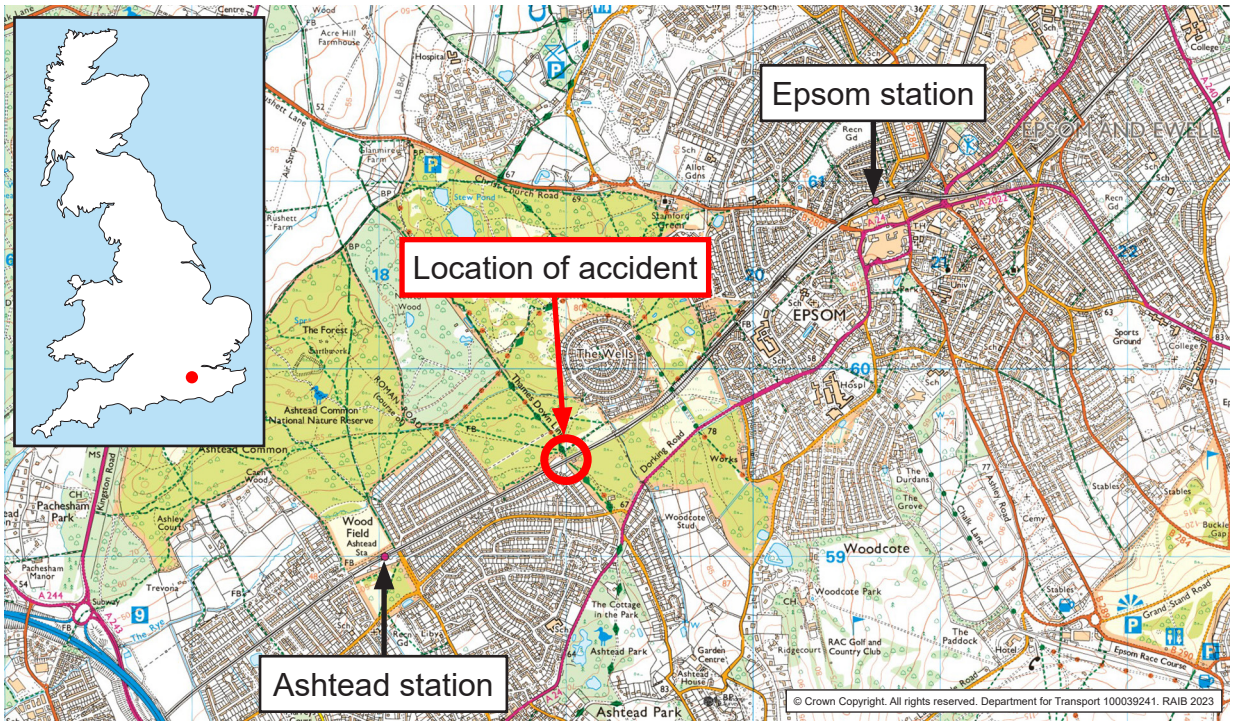


Figure 1: Extract from Ordnance Survey map showing location of accident at Lady Howard crossing.

Context

Location

6 Lady Howard crossing is situated in Surrey, between the stations at Epsom (1.3 miles (2.1 km) away) and Ashtead (0.7 miles (1.1 km) away). The line is used by South Western Railway trains running from London Waterloo to Guildford and Dorking, as well as Southern trains from London Victoria to Horsham. The crossing is 15 miles 43 chains[1] from a datum point at London Waterloo measured via Worcester Park.

[1] A unit of length equal to 66 feet or 22 yards (around 20 metres).

7 The railway at this location runs broadly north-east to south-west and comprises two tracks, known as the up and down Portsmouth lines (towards and away from London respectively; figure 2). An electrically live conductor rail, energised at 750 V DC, is located adjacent to each track to provide power to trains, although there is a gap in the conductor rail at the crossing, for a distance of about three metres either side of it. The maximum permitted speed for trains travelling in either direction over the crossing is 60 mph (97 km/h). Signalling in this area is by colour light signals, controlled from Wimbledon Area Signalling Centre. There is a signal on each approach to the crossing, around 80 metres away for trains approaching from Ashtead and 1200 metres away for trains approaching from Epsom.

8 The crossing itself is part of a footpath and bridleway linking Craddocks Avenue in Ashtead (around 350 metres to the south-east of the crossing) to Ashtead Common on the north-west side of the railway.



Figure 2: Google Earth view of the crossing.

Organisations involved

9 Network Rail is the owner and maintainer of the railway infrastructure at the location of the accident, which includes Lady Howard crossing and the land inside and including the boundary fences. It also employed the staff responsible for gathering data about the crossing and for assessing and managing its safe use (see paragraphs 27 and 28). Lady Howard crossing falls within Network Rail's Wessex route on its Southern region.

10 Govia Thameslink Railway, under its Southern brand, operated the train involved in the accident as well as the train that passed the crossing in the opposite direction just before the accident. It also employed the drivers of both trains.

11 Network Rail and Govia Thameslink Railway freely co-operated with the investigation.

The level crossing

12 In common with many footpath and bridleway crossings (see paragraph 13), Lady Howard crossing does not have any active protection, such as lights, to warn of approaching trains, or barriers to restrict access over the crossing. Crossing users on foot are expected to stop, look and listen for approaching trains, and to make their own decision about whether or not it is safe to cross. Telephones and instructions are provided for equestrian users to contact the signaller to ask permission before crossing. This is because the railway perceives that there is an additional risk involved in taking horses over a crossing of this type and the mitigation of this risk involves the signaller checking whether any trains are approaching the crossing before giving permission to cross.

13 Nationally, at the time of writing, there are 1336 crossings of the same type as Lady Howard (as described in paragraph 12) on Network Rail's infrastructure. On the Wessex route, there are 154 such crossings, out of a total of 315 level crossings.

14 On each side of Lady Howard crossing, users enter through a latched gate that opens towards the railway. The gate leads users through the railway boundary into a corridor laid with an asphalt surface. This corridor is enclosed with metal fencing, approximately 1.25 metres tall. Signs at each gate warn users of the following:

- to 'Stop, Look, Listen – Beware of trains'
- that cyclists should dismount
- that people in charge of animals should telephone the signaller before crossing
- that users should remove their headphones before crossing
- not to touch the live rail
- not to trespass on the railway
- that there have been several near fatalities at this crossing.

At the time of the accident, some of these signs had been painted with graffiti (figure 3).

15 RAIB measured the fenced corridor inside the gate on the Ashtead Common side of the crossing (the approach used by the pedestrian involved in the accident) to be 4.5 metres long. This ends with a white line painted on the asphalt surface 2 metres from the nearest rail of the up Portsmouth line (figure 4). This white line, known as the 'decision point', is the notional point at which users on foot are expected to make a decision as to whether or not it is safe to cross the railway. For crossing users with horses, Network Rail uses a decision point 3 metres from the nearest rail, although this point is not marked on the ground.

16 At the marked decision point, the metal fencing opens out in both directions along the railway. RAIB measured the sighting distances (the distances at which approaching trains can be seen by crossing users) in each direction at this point. On the Ashtead Common side, a user standing at the decision point can see for around 440 metres in the direction towards Epsom (the direction from which the train involved in the accident approached). Beyond this point the railway curves to the left from the observer's point of view (figure 5 and figure 6). In the other direction, the railway is straight and users can see for at least 1000 metres to Ashtead station.



Figure 3: The entrance to Lady Howard crossing, approaching from Ashtead Common (the direction of the pedestrian at the time of the accident).



Figure 4: Inside the gate at Lady Howard crossing showing the decision point, approaching from Ashtead Common.



Figure 5: View from the decision point on the Ashtead Common side of Lady Howard crossing, looking towards Epsom.

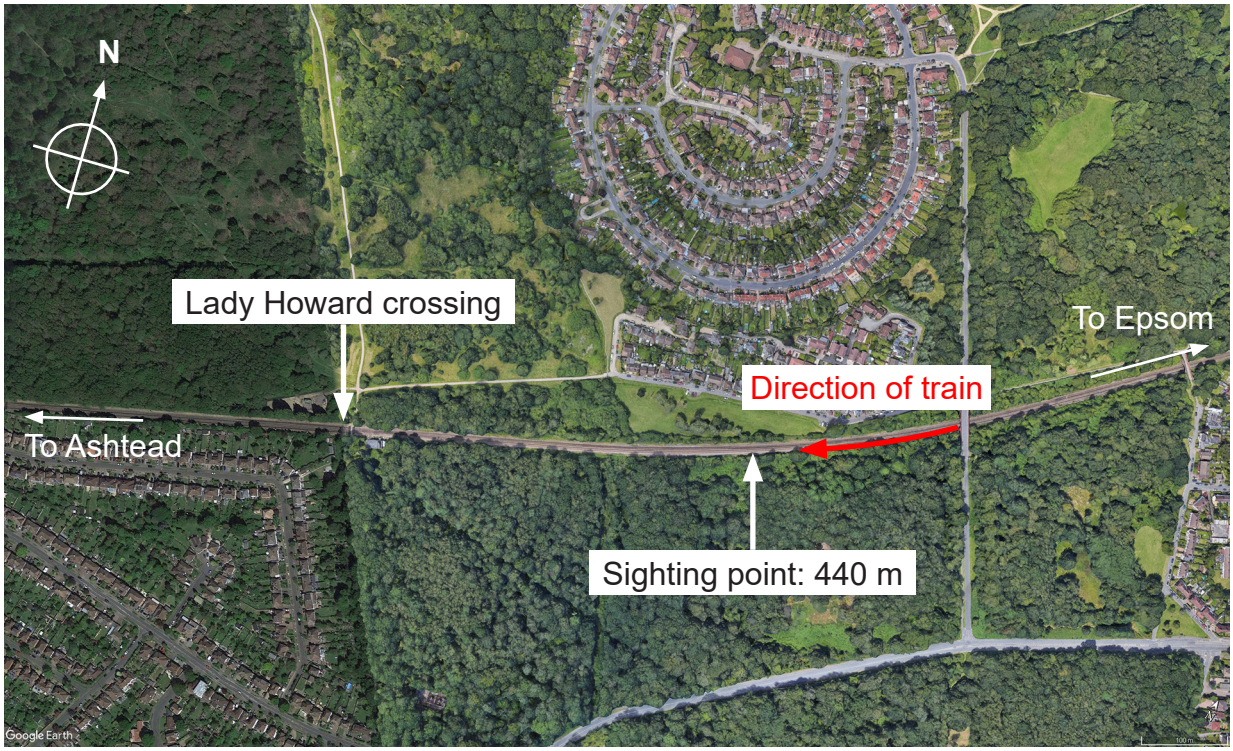


Figure 6: Google Earth view of the location, showing the crossing and the left-hand curve in the direction towards Epsom.

17 The distance between the two decision points (located 2 metres from the nearest rail on each side of the crossing) is known as the 'traverse distance'. RAIB measured this distance to be 9.3 metres. Because Lady Howard is also a bridleway crossing, Network Rail's measurement of the traverse distance starts at the decision point 3 metres from the nearest rail (paragraph 15) and ends 2 metres beyond the farthest rail. Network Rail measured the traverse distance to be 10.2 metres, which is comparable to RAIB's measurement (accounting for the additional metre).

18 Network Rail uses the traverse distance to calculate the amount of time it takes a user to cross. Network Rail uses a defined walking speed of 1.189 m/s for this calculation which, in some instances (including at Lady Howard crossing), is reduced by 50% to allow for vulnerable users (such as families with young children, dog walkers, or the elderly, who may walk slower). Including this 50% allowance results in a traverse time of 12.87 seconds. This is therefore the minimum required sighting time in each direction for trains approaching the crossing at the maximum permitted speed on the line (in this case, 60 mph or 97 km/h). A train at that speed will cover 345 metres in that time; hence, this is the minimum sighting distance that users require to decide if it is safe to cross.

19 Because the actual sighting distance exceeds the required sighting distance on both sides of Lady Howard crossing (440 metres towards Epsom and over 1000 metres towards Ashtead), there is no requirement for the crossing to be fitted with any type of additional protection that may be used for reduced sighting distances, such as a whistle board instructing train drivers to sound the train horn on the approach to the crossing.

20 Network Rail's most recent risk assessment (see paragraph 57) for Lady Howard crossing before the accident (dated October 2021) noted that an average of 201 users and 225 trains per day passed over the crossing. Users were identified as mainly being recreational, using the crossing to access Ashtead Common.

21 Network Rail assesses the risk of all its level crossings on two criteria. These are:

- the risk to an individual user of the crossing (rated from A to M, where A is the highest risk)
- the total, collective risk of harm to crossing users and those on board trains (rated from 1 to 13, where 1 is the highest risk).

The October 2021 risk assessment for Lady Howard crossing rated it as B2, ranking it the sixth highest risk footpath crossing on the Wessex route.

22 The October 2021 risk assessment documented six near misses at the crossing between 28 March 2019 and 29 March 2021 and one fatality on 9 August 2019, which Network Rail recorded as a deliberate act. The October 2021 risk assessment also recorded that Network Rail installed a motion-activated camera at the crossing, in response to a number of incidents that it classified as deliberate misuse.

Trains involved

23 The train involved in the accident, reporting number 5Z56, was the 14:05 hrs empty coaching stock movement (a train movement without passengers) from Selhurst depot to Dorking down sidings. It was a class 377 train formed of 10 coaches. The train was fitted with an on-train data recorder (OTDR) but not with forward-facing CCTV (FFCCTV) cameras.

24 The train which passed the crossing just before the accident, reporting number 1I37, was the 14:14 hrs passenger service from Horsham to London Victoria. It was also a class 377, formed of 8 coaches. This train was fitted with an OTDR as well as an FFCCTV camera, but not a camera looking behind the train. This means that there was no rearward-facing CCTV evidence available.

People involved

25 The pedestrian was an 85-year-old female from Hampton, south-west London. Her eyesight prescription showed that she had a mild astigmatism (a cause of blurred vision that can be corrected with glasses or contact lenses), but good distance vision. She also used a hearing aid and, while her mobility was good, the trolley she used was described to RAIB as also acting as an aid to standing. Although RAIB could not establish with certainty whether the pedestrian was familiar with the crossing, the circumstances suggest that, while she was unlikely to have used it regularly, it is possible that she had used it before.

26 The driver of train 5Z56 was based at Selhurst depot and had worked for Southern since November 2001. His competence assessments were up to date with positive feedback about his performance and no reported issues of concern.

27 The level crossing manager (LCM) with responsibility for Lady Howard crossing had worked for Network Rail since 2000, with the exception of one year working for a train operator. He had worked as an LCM in this area since 5 November 2018. Lady Howard was one of around 48 crossings that fell within his area of responsibility.

28 The route level crossing manager (RLCM) for Wessex route, to whom the LCM reported, joined Network Rail in 2003 and began managing level crossings about two years later. He had been RLCM for about 10 years and, at the time of the accident, managed a team of five LCMs. Since the accident (but not as a response to it), Network Rail's Wessex route has restructured the organisation of these roles, and the RLCM now works at a regional level.

External circumstances

29 The weather at the time of the accident was sunny and warm, about 18°C, with clear visibility. The sun was to the right of the pedestrian as she approached the crossing (in the direction towards Ashtead), the same direction from which the train that passed the crossing just before the accident approached. It is possible that the sunlight played a role in the accident (see paragraph 46).

The sequence of events

Events preceding the accident

30 At around 14:33 hrs on the day of the accident, Network Rail's camera at Lady Howard crossing recorded the pedestrian using the crossing for the first time that day. The pedestrian was walking towards Ashtead Common with a dog and a wheeled trolley bag.

31 At 14:49:06 hrs, the front of train 1I37 passed over Lady Howard crossing, travelling towards Epsom on the up Portsmouth line (from right to left when viewed from the Ashtead Common side of the crossing) at a speed of approximately 50 mph (80 km/h). As the train passed the crossing, its FFCCTV system recorded the pedestrian standing, stationary, waiting inside the boundary gate on the Ashtead Common side of the crossing, about 1.9 metres back from the white line marking the decision point and looking towards the oncoming train. The field of view of the camera at the crossing also showed the dog waiting stationary while train 1I37 passed the crossing.

32 Around one second after the front of train 1I37 passed the crossing, the front of train 5Z56 emerged round the curve on the down Portsmouth line. Train 5Z56 was about 440 metres from Lady Howard crossing at that time, travelling from the Epsom direction, and would have been visible from the crossing. After about 6 seconds, from the point of view of someone standing on the Ashtead Common side of the crossing, the front of the approaching train 5Z56 would have been obscured behind train 1I37 as it moved away.

33 Less than one second later, the rear of train 1I37 had cleared Lady Howard crossing, and the pedestrian started to move towards the decision point. The camera at the crossing showed that she briefly turned her head to the left as she started to move forwards and did so again as she crossed the decision point. During both of these glances, the front of train 5Z56 would have been hidden behind train 1I37. The pedestrian crossed the decision point about 4 seconds after train 1I37 had cleared the crossing.

Events during the accident

34 Around one second after the pedestrian crossed the decision point, the front of train 5Z56 emerged from behind train 1I37 and would have been visible from the crossing. The crossing would also now have been visible from the driving cab of the train. At this point, OTDR evidence shows that train 5Z56 was travelling at 62 mph (100 km/h) and that it was about 130 metres, or approximately 4.7 seconds, from the crossing. CCTV evidence from the crossing shows that the pedestrian was at that point moving across the up Portsmouth line, and that she was looking down and ahead.

35 Approximately 2.7 seconds later, the driver of train 5Z56 sounded the train's horn. The pedestrian, by now about to cross the down Portsmouth line, responded by looking to her left and starting to hurry across this line towards the exit of the crossing. The collision occurred at about 14:49:24 hrs.

Events following the accident

36 The pedestrian sustained injuries that were immediately fatal. The driver applied the emergency brake just over one second after the collision, and the train subsequently stopped about 315 metres beyond the crossing. The driver used the GSM-R (Global system for mobile communications – railway) train radio system to report the accident to the signaller and subsequently reported it to his employer.

37 Emergency services and Network Rail staff attended the scene from around 15:20 hrs. The driver was authorised to take the train on to Ashtead station where he was relieved, and another driver returned the train to Selhurst depot.

Analysis

Identification of the immediate cause

38 **The pedestrian crossed into the path of train 5Z56 as it approached.**

39 The FFCCTV footage from train 1I37 and images from the CCTV camera at the crossing (paragraph 22) showed that the pedestrian had waited for train 1I37 to pass the crossing, and that she then crossed behind it, having looked twice to her left before passing the decision point. The pedestrian did not look again to her left until she heard the horn of train 5Z56, after which she attempted to hurry to the other side of the crossing.

40 RAIB determined that the driver's reaction time in sounding the horn after seeing the pedestrian, which at most was about 2.7 seconds, was within the bounds of an appropriate response based on research[2] into car drivers' reaction times. Furthermore, if the driver had applied the train's emergency brake instead of (or as well as) the horn, it would have had no effect on the train's speed before the accident because the nature of the train's braking system means that there is a delay of about 3 seconds between applying the brakes and the beginning of deceleration. Finally, the apparent discrepancy between the train's speed of 62 mph (100 km/h) as recorded on the OTDR on approach to the crossing, and the maximum permitted speed on that line of 60 mph (97 km/h), is within the margin of tolerance allowed in rail industry standards.[3]

Identification of causal factors

41 The accident occurred due to a combination of the following causal factors:

a. The pedestrian was apparently unaware that train 5Z56 was approaching when she made the decision to cross (paragraph 42).

b. The pedestrian did not perceive the risk arising from the possibility that the passing train was hiding another train (paragraph 48). This is a possible causal factor.

Each of these factors is now considered in turn.

Awareness of the train

42 **The pedestrian was apparently unaware that train 5Z56 was approaching when she made the decision to cross.**

43 Based primarily on the CCTV evidence from the camera at Lady Howard crossing (paragraph 22), RAIB has concluded that the pedestrian had probably neither seen nor heard the approach of train 5Z56 when she started to cross. There is no evidence to suggest that she was aware of this second train when she made the decision to cross, or that she was aware of it but had misjudged the time available to cross safely.

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[2] Coley, G., Wesley, A., Reed, N. & Parry, I. (2009). Driver reaction times to familiar but unexpected events. TRL Report 313.

[3] RIS-2273-RST 'Post Incident and Post Accident Testing of Rail Vehicles', issue 2, December 2017.

44 RAIB created a computer model of the two trains passing at the crossing, to determine what may or may not have been visible to the pedestrian at the two points when she looked to the left, towards the approaching train 5Z56 (paragraph 35). The model was based on the OTDR evidence from both trains, FFCCTV footage from train 1I37, footage from the CCTV camera at the crossing, and RAIB's survey data for the crossing. Because the OTDR and CCTV data sources are not synchronised, and must be cross-referenced manually, there is a small level of inaccuracy (fractions of seconds) possible with this kind of analysis. However, RAIB has determined that the conclusions which follow reflect the best available evidence.

45 When the pedestrian looked twice to the left, the front end of train 5Z56 (which is the most conspicuous part of the train, being painted yellow and displaying headlights) was hidden behind train 1I37, which was receding from the crossing. The front end of train 5Z56 did not re-emerge from behind 1I37 until after the pedestrian had started to cross. Although it may have been possible for the pedestrian to have seen the side of train 5Z56 in the gap beyond train 1I37 and before the railway curved to the left out of view, it would have appeared very small at that distance and not particularly conspicuous (figure 7). This is in part because the green and white painted livery of the train would have provided relatively low contrast against the background of green vegetation.

46 The pedestrian was wearing prescription sunglasses and had been facing towards Ashtead just before crossing, in the direction of the approaching train 1I37. In that position and at that time of day, she was almost directly facing the sun. When she turned to look towards the left, there may have been some after-effects of facing the sun that could have reduced her sensitivity to contrast, and this may have been further attenuated by the sunglasses. However, the predominant factor affecting the pedestrian's ability to see the oncoming train 5Z56 was the presence of train 1I37 as it moved away from the crossing. This would have been much more conspicuous and largely hid the approaching train, 5Z56, from view.



Figure 7: Computer-generated reconstruction of the view from the pedestrian's perspective looking to her left as she started moving towards the crossing.

47 The driver of train 5Z56 did not, nor was he required to, sound the train's horn on the approach to the crossing, until a few seconds before the accident when he reacted to seeing the pedestrian ahead. In the absence of a train horn, the noise generated by an electric train at distance is relatively inconspicuous, and again would have been masked by the similar noise being produced by train 1I37, which was closer. The pedestrian also used a hearing aid, although her prompt response to the train's horn when it sounded just before the accident indicates that she was able to hear this warning.

Perception of risk

48 **The pedestrian did not perceive the risk arising from the possibility that the passing train was hiding another train. This is a possible causal factor.**

49 Among the signage at the crossing is an instruction for users to 'Stop, Look, Listen – Beware of trains'. The CCTV evidence shows that the pedestrian did stop for the first train passing the crossing (1I37) and then looked twice to the left before starting to cross.

50 When the pedestrian took the second glance, as she passed the decision point, RAIB calculated that the rear of train 1I37 was around 100 metres beyond the crossing. RAIB has also concluded that, at that point, it is more likely than not that the pedestrian would have been looking towards her left for oncoming trains on the down Portsmouth line to the right of, rather than beyond the front of train 1I37 and into the diminishing gap between it and the curve of the railway line.

51 Visibility past the trailing end of train 1I37 towards the down Portsmouth line would have been greater than 100 metres (figure 8). Given the extent of the visibility available to the pedestrian, it is possible that she decided that this was sufficient distance to be able to safely traverse the crossing, not realising that a train travelling at the maximum permitted speed of 60 mph (97 km/h or 27 m/s) could cover the visible distance in around 4 seconds. At the time of the accident, there were no warnings at the crossing to alert users to this risk.



Figure 8: Computer-generated reconstruction of the view from the pedestrian's perspective looking to her left as she crossed the decision point.

Identification of underlying factor

Risk management

52 **Network Rail had not provided any effective additional risk mitigation at the crossing despite having deemed the risk to be unacceptable. This is a probable underlying factor.**

Background information

53 The Office of Rail and Road (ORR), the safety authority and economic regulator for Britain's railways, has set out principles and guidance for managing level crossing safety in a document[4] published in June 2021. This document includes guidance that states 'It is essential that decisions and options for level crossing control measures are informed by a suitable and sufficient assessment of the risks'.

54 Under health and safety law, duty holders (in the case of this crossing, Network Rail) are required to reduce the level of risk so far as is reasonably practicable. Options for controlling the risk should be considered according to the hierarchy of prevention[5] Eliminating the risk (such as through closure of the level crossing) should be the first consideration, followed by engineering controls (for instance, technologies providing an active warning system), and finally administrative controls (such as signage and instructions).

55 Deciding what is reasonably practicable is a matter of judgement for each duty holder but, given the risks to railway staff, passengers and members of the public, the ORR guidance document states that risk control measures should be deemed reasonable unless the cost of the measure is grossly disproportionate to the risk. This can be determined by using a cost-benefit analysis as part of the risk management process.

56 The ORR guidance document also includes a principle which states:

> *'User Principle 6: Provide a suitable warning for users that a train is approaching to enable them to be in a safe place before a train passes. To help you achieve this, you should consider, at least, these factors:*
>
> *(a) an active warning system in preference to relying on the user to determine whether or not a train is approaching the level crossing;*
>
> *(b) user behaviours and actions in relation to the operation of the level crossing, e.g. to prevent them from being trapped within a closed crossing or starting to cross when it is unsafe to do so*
>
> *(c) foreseeable actions of different users in a 'another train coming' scenario, these trains may be coming in the same or different directions; one may be inaudible and hidden from view…'*

57 Network Rail's process for managing risk at level crossings begins with an assessment by an LCM of the crossing. This includes measuring sighting distances and the traverse length and conducting a census of both users and trains over the crossing. The results of this assessment are entered into Network Rail's computer-based all level crossing risk model (ALCRM), which calculates a quantitative risk score for the crossing (paragraph 21).

[4] https://www.orr.gov.uk/sites/default/files/2021-06/principles-for-managing-level-crossing-safety-june-2021_0.pdf.

[5] The Management of Health and Safety at Work Regulations 1999, schedule 1.

58 The LCM uses the information from the site visit and the output from ALCRM to produce a written narrative risk assessment (NRA). The NRA documents their findings and, if the risks are deemed not to be as low as reasonably practicable, proposes options to mitigate the risk. The quantitative risk score from ALCRM is used to calculate a cost-benefit ratio for each of the proposed risk mitigations. The cost-benefit ratio is a whole-life calculation of how much each proposed measure costs[6] and by how much it is expected to reduce the risk. The LCM then uses their experience and professional judgement to supplement this calculation and determine whether the options are reasonably practicable to implement, considering qualitative factors associated with risk at the crossing as well as the results of any cost-benefit analysis.

59 The LCM submits the NRA and their risk mitigation option proposals to the RLCM, who reviews and (as appropriate) countersigns them. In Network Rail's Wessex route, the RLCM takes these options, along with those for other level crossings, to a four-weekly 'tactical group' meeting, which also involves the route's asset managers for signalling and scheme renewals. This tactical group takes decisions about which options are progressed, based on the available funding and the route level crossing strategy.

60 The latest level crossing strategy for Network Rail's Wessex route before the accident (dated January 2019) covers the period from 2019/20 to 2023/24. While the previous route strategy focused on closing level crossings where possible, the emphasis of the strategy in force at the time of the accident was on reducing risk through engineering solutions as part of upgrades or renewals, where closure is difficult or impossible. The strategy is supported by its own, ring-fenced budget which can only be used for level crossing risk reduction in accordance with the strategy. The ORR has made additional funds available which are prioritised towards risk reduction at user worked crossings (a type of level crossing typically providing vehicular access to private land).

61 Closing a crossing outright (that is, closing it without providing alternative access over the railway at that location) is not always viable because it can involve issues such as extinguishing legal rights of way, or the consequent increased risk on diversionary routes. The main alternative options to outright closure are to install a footbridge (which, for a bridleway crossing, needs to include ramps to provide access for people with reduced mobility or horse riders) or to install miniature stop lights (MSLs).

62 MSLs consist of red and green lights. The green light is lit the majority of the time and indicates that no trains are approaching. When a train reaches the strike in point the light automatically changes to red, and an audible alarm sounds to indicate that users must not cross. The strike in point is set at a distance calculated to allow users a safe amount of time to cross when trains are travelling at the maximum speed permitted on the line. Network Rail told RAIB that the audible alarm also includes a spoken warning which is triggered if another train is approaching the crossing soon after the first one has passed. This message states 'Warning – another train may be approaching'.

[6] In May 2022, Network Rail issued new guidance on these cost-benefit analyses, raising the threshold for what is considered reasonably practicable by stating that mitigations should be considered for implementation unless the costs are 'grossly disproportionate' to the benefits. This change was not made in response to this accident.

63 There are different types of MSL system, each of which is appropriate for different level crossing configurations:

- 'Integrated MSL'. These were the original design of MSL and are built into the railway signalling system, which makes them costly and complex to install. However, as they form part of the signalling system, they are suitable for any location, including those where signals and stations lie between crossings and their strike in points. If a train is held at a signal or station, signalling controls are applied to prevent the red light from showing at the crossing until the train is about to start moving again. This avoids excessive warning times (see paragraph 66).
- 'Overlay MSL'. These were introduced from around 2012 and are separate from the railway signalling system. They can be installed at locations where the railway does not have complex features, such as nearby stop signals. These MSLs use a basic train detection system which detects trains a set distance along each railway approach to the crossing.
- 'Flex MSL'. These were approved for use by Network Rail in April 2021 and use the same technology as overlay systems but can receive inputs from a signal on each approach to a crossing. This allows them to be installed at locations where trains may be regularly stopped by a signal within the strike in area.

64 Section 5.1.3 of Network Rail standard NR/L2/SIG/11201/ModX39, published in June 2015, and later revisions of this standard, state that overlay MSL systems are not suitable for crossings which have signals within the strike in area, as well as other complicating features.

65 Section 5.2 of this standard requires that 50% of trains arrive at overlay MSL crossings within twice the normal warning time (the warning time is generally 20 to 40 seconds, depending on the crossing) and 95% of trains arrive within three times the normal warning time.

66 If the time between strike in and the train arriving at the crossing is longer than designed, it can result in red lights being displayed for prolonged periods and/or the overlay MSL system going into what is known as 'dark mode', where it turns off the lights at the crossing and waits for the passage of another train to reset itself. Frequent long warning times or occurrences of dark mode are unacceptable as they potentially diminish level crossing users' faith in, and compliance with, the red and green lights at the crossing. This means that, in principle, overlay MSLs are not suitable where there are signals which could regularly delay a train's arrival at the crossing.

67 In common with many other Network Rail standards, NR/L2/SIG/11201/ModX39 is colour coded with a Red-Amber-Green classification. Red boxed sections are mandatory, with no variations permitted, while sections with an amber colour coding may be varied if a risk assessment is submitted and approved following a national process. Green colour coded sections are guidance which should be used, unless a better alternative is available.

68 Sections 5.1.3 and 5.2 of NR/L2/SIG/11201/ModX39 have an amber colour coding. This means that designers could have applied for a derogation from the standard's requirement to not have any signals within the strike in area, provided a suitable risk assessment was prepared which demonstrated that the installation would provide an equivalent level of safety. This risk assessment would have to be approved by a national review panel before the derogation was granted. In the case of Lady Howard crossing, the designers would have needed to demonstrate that the signals on the approach to the crossing would delay the arrival of less than 5% of the trains approaching the crossing.

69 Another option for mitigating level crossing risk is to install supplementary audible warning devices (SAWDs). Using radar to detect an approaching train, these devices play a synthesised recording of a train horn through a speaker at the crossing itself. Because the reliability of SAWDs does not meet Network Rail's standards for safety-critical systems, Network Rail considers them to be supplementary to an actual train horn. As such, SAWDs are only installed at crossings where whistle boards are provided, requiring the train driver to sound the horn because sighting distances are insufficient to provide the necessary warning time. The synthesised recording is triggered at about the same time as the sounding of the actual train horn.

Risk management at Lady Howard crossing

70 The latest NRA for Lady Howard crossing undertaken before the accident, dated October 2021, expressed concerns about vulnerable users and frequent misuse. The installation of additional signage (see paragraph 83) and the crossing camera (paragraph 22) were intended as short-term mitigation measures for these concerns. In the medium term, the NRA stated that installing MSLs was being progressed and, in the longer term, that Network Rail's aspiration was to close the crossing. However, in the meantime, the NRA stated that the risk was not considered to be as low as reasonably practicable. Similarly, the previous NRA in 2020 referred to the risk being 'unacceptable'.

71 The 2021 NRA considered four options to mitigate the risk. These were closure, a ramped (accessible) footbridge, a stepped footbridge, or MSLs. Although the cost-benefit calculations for closure and a stepped footbridge were positive, the LCM concluded that these options were not viable. This was because, if Lady Howard crossing was closed, its risk would be transferred to the nearby Craddocks Lane footpath crossing, about 380 metres towards Ashtead station. The LCM also considered that gaining the necessary consent and approval for a ramped bridge would be unlikely, due to the size of such a bridge taking it outside of Network Rail's land, and that a stepped footbridge would neither be accessible nor suitable for equestrian users.

72 The LCM therefore recommended installing MSLs, even though the cost-benefit ratio for this option was marginal.[7] RAIB has reviewed NRAs for Lady Howard crossing going back to 2017, and on each occasion the recommendation made was to install MSLs. The evidence available to RAIB indicates that Network Rail had approved and allocated funds for installing MSLs at Lady Howard crossing every year since at least 2019, when budgets for Network Rail's control period 6 (a five-year financial allocation running from April 2019 to March 2024) had been allocated.

73 In 2020, Network Rail's Wessex route engaged its internal works delivery unit to produce an option selection report to determine the best type of MSL to be installed at Lady Howard level crossing. Network Rail has not been able to locate nor provide RAIB with a copy of the option selection report. However, internal meeting minutes from December 2020, after the report had been completed, recorded a decision to fit integrated MSLs to the crossing and gave financial approval for this.

74 RAIB considers that it is most likely that the option selection report concluded that integrated MSLs were the best option because there is a railway signal on each approach to Lady Howard crossing. This would have probably led those responsible for writing the report to conclude that the site was not compatible with the overlay MSL system. At the time the report was completed, there was no suitable alternative form of MSLs available for locations with this kind of more complex layout (paragraph 63).

75 Following the completion of the option selection report, its recommendations were reviewed by Network Rail's Wessex route's level crossing steering group, which consists of senior members of the level crossing and signalling teams. Financial approval was given for Lady Howard to be upgraded with integrated MSLs and this work was expected to be completed in the second half of control period 6. Once the budget had been allocated, Network Rail's Wessex route accepted the level of risk at Lady Howard until such time as integrated MSLs could be installed.

76 There is no conclusive evidence which shows if the authors of the option selection report were aware that it would have been possible to fit overlay MSLs to locations such as Lady Howard, rather than the proposed integrated MSLs, via a derogation from standard NR/L2/SIG/11201/ModX39 (paragraph 68). This approach had been used five times in 2017 by Network Rail's Sussex and Kent routes, and these previous derogations would have been visible to the authors of the option selection report if they had checked Network Rail's standards derogation tracker (which lists all approved derogations). As RAIB has not been provided with a copy of the options selections report, it is not possible to know for certain whether the tracker was checked as part of its preparation. However, RAIB considers that the decision to fit integrated MSLs means it is probable that the report's authors were not aware of these earlier derogations.

[7] RAIB reviewed the cost-benefit calculations and identified some inconsistencies in the analysis, which Network Rail was unable to resolve. Since these inconsistencies did not affect subsequent safety-related decision-making for Lady Howard crossing, RAIB determined that they were not causal to the accident. However, under different circumstances, these calculations may be pivotal to such decision-making.

77 In July 2021, Network Rail's Wessex route's level crossing steering group reported that it had a shortage of resource within its works delivery unit and that the delivery date for the integrated MSL at Lady Howard crossing was likely to be delayed. This meant that design work was not expected to start until the autumn of 2021.

78 In October 2021, around the revised time design work had been expected to start on the integrated system, the Flex MSL was identified as a viable option for Lady Howard crossing. This followed the trial installation and approval of this type of MSL at another Wessex route level crossing. The decision to install this type of system instead of an integrated MSL at Lady Howard was confirmed in January 2022 by the Wessex level crossing steering group.

79 In the time between the completion of the option selection report and the accident, of the twelve other level crossings selected for conversion to MSLs on the Wessex route, two were removed from the programme (due to one being closed and the other receiving other upgrades) and one overlay MSL was brought into use. This rate of completion meant that it was unlikely that Lady Howard would have been upgraded with overlay MSLs before the accident, even if it had been selected as part of the option selection process in 2020 and then been the subject of a successful derogation application.

80 Network Rail stated it had faced issues in delivering MSLs at a national level. This is because many of the level crossings that were feasible for closure have already been closed, meaning that LCMs were frequently relying on MSLs as a risk mitigation. (RAIB has seen several examples of other NRAs, similar to those undertaken for Lady Howard, in which the options of closure or a footbridge are not deemed to be viable, leaving MSLs as the recommended solution.) This has created high demand for both the equipment and the resources to install the MSL systems and reduced their availability, thereby slowing delivery programmes.

81 The 2021 NRA for Lady Howard crossing also identified the 'second train coming' risk (sometimes referred to as 'another train coming'), in which an approaching train can be hidden by a passing train on the nearest line, as occurred in this accident. This risk is present on any railway with two or more tracks and increases with the frequency of train traffic, but it is almost impossible to determine where trains will actually pass each other. As with other NRAs seen by RAIB, while the risk is identified, it is not specifically addressed or controlled in the conclusions and proposed options, partly because there are few options available to mitigate this risk. Although MSLs may be effective at addressing the second train coming risk, these warnings may not entirely eliminate it, because they are dependent on users recognising the warning, understanding its significance, and then acting upon it. Recognition may be affected if the user is hearing impaired or wearing headphones.

Interim risk mitigations

82 Although Network Rail had recognised that the risk at Lady Howard crossing was unacceptable, and that a suitable mitigation solution would not be installed for a minimum of three years, there is little evidence that alternative options were considered as an interim measure to reduce risk to crossing users.

83 Network Rail had implemented some mitigations at Lady Howard crossing, but these did not prevent the accident on 21 April 2022. Between August 2019 and July 2020, Network Rail installed additional signs at Lady Howard crossing, which were intended to raise awareness of the risks of near misses and to warn users to remove headphones before crossing (figure 3). The 2021 NRA also recorded the installation of the motion-activated camera, primarily to monitor misuse of the crossing. These signs and the camera were in place at the time of the accident.

84 Train drivers are not required to sound the horn at Lady Howard crossing because the sighting affords sufficient warning time to be able to cross safely (paragraph 19). There is no evidence that this was considered as an interim mitigation before the accident occurred. Network Rail is mindful of the noise pollution associated with train horns, particularly in residential neighbourhoods. In the absence of a requirement to sound the train horn, Network Rail also considers SAWDs to be unsuitable because they are only intended to be supplementary to the train horn (paragraph 69).

85 In other locations on Network Rail's infrastructure, temporary speed restrictions have been applied as an interim risk mitigation for level crossings, as slowing trains down increases the warning time for crossing users. These are usually used to mitigate the risk of insufficient sighting at the crossing, for example, due to foliage growth reducing a crossing user's view. Although it cannot be known for certain what effect a temporary speed restriction would have had on this particular accident, it is possible that it would reduce the likelihood of a user being struck.

86 There is no evidence that speed restrictions were considered as an interim mitigation for the risks at Lady Howard crossing despite the risk at the crossing being deemed unacceptable (paragraph 70). While it is not clear why speed restrictions were not considered as a mitigation measure, Network Rail stated to RAIB that the introduction of speed restrictions to address the second train coming risk could potentially extend to a large number of crossings and cause very significant disruption to railway operations.

Previous occurrence of a similar character

87 At about 08:24 hrs on 1 May 2019, the driver of the 07:25 hrs passenger service from London Victoria to Horsham reported a near miss with a pedestrian with a bicycle at Green Lane footpath crossing, about 0.5 miles (0.8 km) south-west of Ashtead. The latest NRA for Green Lane (dated April 2022 and carried out by the same LCM that undertook the assessment at Lady Howard crossing) recorded that the pedestrian walked out from behind another passing train.

88 The NRA recorded the risk rating for Green Lane as C2 and stated that this ranked it as the second highest risk of all footpath crossings on the Wessex route. The LCM concluded that the risk was not tolerable or as low as reasonably practicable. As with the NRA for Lady Howard, the NRA for Green Lane also identified the 'second train coming' risk, highlighting that this risk is exacerbated by the use of longer 10- and 12-coach trains on this line and the frequency of the train service. As with Lady Howard crossing, no specific mitigations to address this risk were identified or implemented, although the LCM recommended that Green Lane crossing should be closed because of different circumstances relating to access rights over the crossing.

Summary of conclusions

Immediate cause

89 The pedestrian crossed into the path of train 5Z56 as it approached (paragraph 38).

Causal factors

90 The causal factors were:

a. The pedestrian was apparently unaware that train 5Z56 was approaching when she made the decision to cross (paragraph 42, **Recommendation 1**).

b. The pedestrian did not perceive the risk arising from the possibility that the passing train was hiding another train (paragraph 48, paragraph 101 and **Recommendation 1**). This is a possible causal factor.

Underlying factor

91 Network Rail had not provided any effective additional risk mitigation at the crossing despite having deemed the risk to be unacceptable (paragraph 52, **Recommendations 1 and 2, Learning point 1**). This is a probable underlying factor.

Previous RAIB recommendations relevant to this investigation

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

Fatal accident at Gipsy Lane footpath crossing, Needham Market, Suffolk, 24 August 2011, RAIB report 15/2012, Recommendation 3

93 This recommendation read as follows:

Recommendation 3

The intent of this recommendation is for Network Rail to develop guidance for use by the level crossing teams on the circumstances under which short-term mitigation measures are to be implemented at level crossings that have insufficient sighting or warning of approaching trains.

Network Rail should develop its guidance for use by level crossing teams to include:

- *a clear definition of what constitutes a 'higher than usual' number of vulnerable users;*
- *implementing risk-reduction measures at crossings that have deficient sighting or warning times; and*
- *when speed restrictions must be imposed, what type of speed restriction is to be used (emergency, temporary or permanent) and the timescales for imposing speed restrictions.*

94 Network Rail's response to this recommendation focused largely on developing guidance to identify and calculate the proportion of vulnerable users of its level crossings and producing guidance on interim risk mitigation for level crossings with deficient mitigation. On 9 June 2014, ORR reported to RAIB that it considered the recommendation to be implemented.

95 The relevance of this recommendation to the current investigation lies in the short-term risk reduction measures for level crossings with insufficient warning of approaching trains. Although sighting at Lady Howard was sufficient under normal circumstances, the causal factors of the accident were associated with insufficient warning of the second train. Therefore, recommendation 2 of this report takes a broader approach to interim risk mitigations at high-risk level crossings.

Fatal accident at Tibberton No. 8 footpath crossing, 6 February 2019, RAIB report 13/2019, Recommendation 1

96 This recommendation read as follows:

Recommendation 1

The intent of this recommendation is for Network Rail to understand the risk to crossing users presented by fog at passive level crossings and to ensure that the risk to an individual using a passive level crossing in fog is acceptably low.

Network Rail should analyse and evaluate the risk of fog affecting the safe use of those passive level crossings where users are entirely reliant on the sighting of trains. This analysis should take into account regional and local variation of the likelihood of fog, its potential impact on visibility and the effectiveness of any existing mitigation measures. Network Rail should then use the output of this evaluation to develop and implement a strategy to adequately mitigate the effects of fog at passive level crossings.

97 Network Rail's response focused on developing a tool to identify passive level crossings that were historically vulnerable to fog, and on including that tool within the NRA process. The response included consideration of MSLs to mitigate sighting deficiencies but noted the problems in deployment of a wider solution. Network Rail also engaged with industry about the possibility of using whistle boards as a further means of reducing risk where reduced visibility is known to occur.

98 On 6 December 2021, ORR reported to RAIB that it considered the recommendation to be implemented.

99 Although the recommendation concerned a causal factor associated with foggy weather conditions, the factor is analogous to the restricted sighting associated with the second train coming risk which led to the accident at Lady Howard crossing on 21 April 2022.

Actions reported as already taken or in progress relevant to this report when originally published (v1.0)

100 From 25 May to 1 June 2022, Network Rail posted staff at Lady Howard crossing for 12 hours a day over a period of seven days to talk to users about how to use the crossing safely. On 26 October 2022, Network Rail delivered a presentation to Ashtead Residents' Association about level crossing safety.

101 On 11 October 2022, Network Rail erected a poster on the approaches to Lady Howard crossing warning users that a passing train can obstruct the view of a train coming on the other line (figure 9). Network Rail told RAIB that the poster would remain in place until MSLs are installed at the crossing.

102 Network Rail is progressing the implementation of Flex MSLs at Lady Howard crossing, with a view to completion in February 2024. In the meantime, it has considered alternative measures, such as convex mirrors or installing SAWDs, but has considered these to be unsuitable. Convex mirrors could cause glare or distraction for train drivers, while Network Rail considers that SAWDs are inappropriate at crossings where whistle boards are not fitted (paragraph 69).

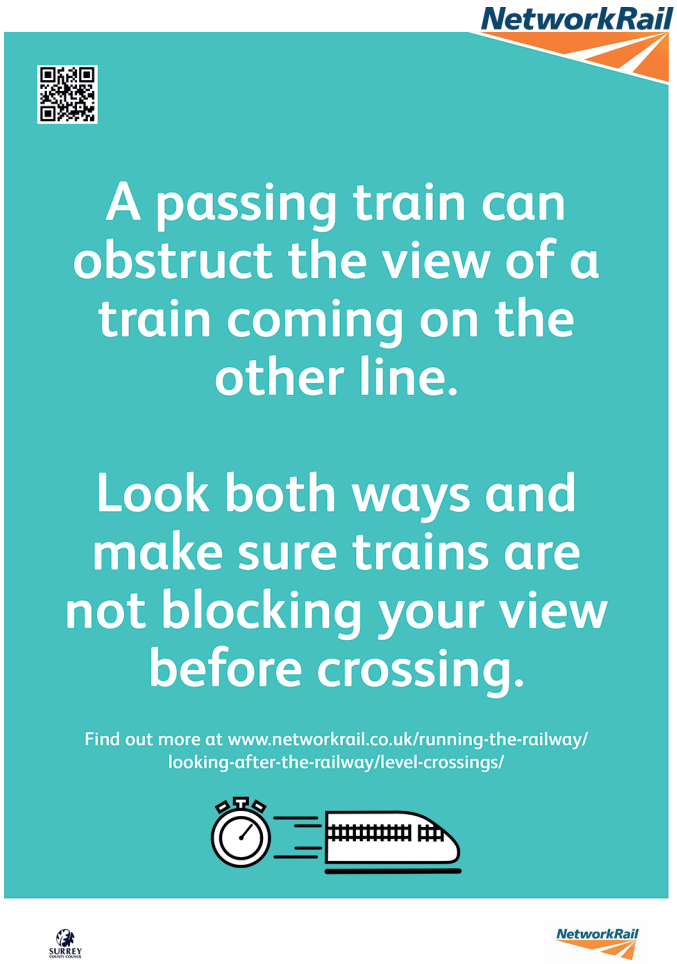


Figure 9: Design of the poster now in place at Lady Howard crossing (courtesy of Network Rail).

Actions reported as already taken or in progress relevant to this report when it was revised (v2.0)

103 In June 2023, Network Rail published a 'notice board'. This is the method used to provide guidance on the application of a standard, and the June 2023 notice board explained the method for applying for a derogation from Network Rail standard NR/L2/SIG/11201/ModX39, where the likelihood of trains being stopped at signals within the strike in area is low. This notice board is available to all signalling designers in the railway industry and is intended to be included in periodic briefings on standards.

104 A new sign, warning of the possibility of there being an oncoming train hidden by other trains was designed and included in the Private Crossings (Signs and Barriers) Regulations 2023.[8] This became law on 18 November 2023 (figure 10). While this law is not directly applicable to public footpath and bridleway crossings, like Lady Howard, Network Rail has updated its standard NR/L2/XNG/30020 Module A28 'Signage for level crossings' and its internal guidance to level crossing managers to require these signs be fitted to such crossings as well. At the time of publication this sign had been fitted to all footpath level crossings which have two railway lines or more and do not have any other method of warning.



Figure 10: Design of sign to diagram 157 in the Private Crossings (Signs and Barriers) regulations 2023 (courtesy of HMSO).

105 Network Rail's Wessex route applied for and received a derogation from the standard which has allowed it to fit overlay MSLs at Lady Howard crossing. MSL equipment was brought into use at the crossing in January 2024 (figure 11).

[8] Statutory Instrument 2023 No. 1112 Railways - The Private Crossings (Signs and Barriers) Regulations 2023 https://www.legislation.gov.uk/uksi/2023/1112/made.

Actions reported as already taken or in progress relevant to this report when it was revised (v2.0)



Figure 11: Lady Howard crossing, fitted with overlay MSLs (courtesy of Network Rail).

Recommendations and learning point

Recommendations

106 The following recommendations are made:[9]

1 *The intent of this recommendation is to reduce the risk at footpath and bridleway level crossings of a second train approaching being hidden from the view of crossing users by a previously passing train.*

Network Rail should:

- use its existing risk assessment data to identify those footpath and bridleway crossings that present the highest risk to users of a second train approaching being potentially hidden by another train
- at those crossings identified as presenting the highest risk, implement appropriate measures to control the risk to users of a second train approaching
- in deciding what measures to implement, specifically consider technological solutions, as well as user awareness campaigns. It should also consider good practice elsewhere in the rail industry (including internationally) and the predictable limitations of human performance (paragraphs 90a, 90b and 91).

2 *The intent of this recommendation is to ensure that appropriate interim shorter-term risk mitigations are identified and implemented in a timely manner at level crossings that are awaiting long-term solutions to reduce the risk.*

Network Rail should review its existing processes for level crossing risk management and include:

- explicit provision for considering a wider range of short- and medium-term risk mitigation options than is currently the case

[9] 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 and Road 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.

- steps to ensure that those responsible for implementing risk controls are aware of all the options available, including those that might offer only incremental reductions in risk or interim mitigation pending implementation of preferred long-term solutions
- documented details of short- and medium-term risk controls, including both technical and non-technical options (paragraph 91).

Learning point

107 RAIB has identified the following important learning point:[10]

1 Signalling designers and other staff responsible for specifying solutions are reminded to check whether a derogation from a relevant standard is possible or whether there are any existing relevant derogations. While derogations must be used appropriately, particularly where solutions exist that comply with standards, their use may be justified where they provide an opportunity to reduce risk in a more timely and cost-effective manner (paragraph 91).

[10] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where RAIB has not identified management issues that justify a recommendation) and the consequences of failing to do so. They also record good practice and actions already taken by industry bodies that may have a wider application.

Appendices

Appendix A - Glossary of abbreviations and acronyms

ALCRM	All level crossing risk model
FFCCTV	Forward-facing closed-circuit television
GSM-R	Global system for mobile communications - railway
LCM	Level crossing manager
MSL	Miniature stop light
NRA	Narrative risk assessment
ORR	Office of Rail and Road
OTDR	On-train data recorder
RLCM	Route level crossing manager
SAWD	Supplementary audible warning device

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from both trains' on-train data recorders (OTDRs)
- video footage taken from the FFCCTV of train 1I37 and from a camera at the crossing
- signalling data
- voice communications
- railway incident control logs
- documentary evidence associated with risk management for Lady Howard and other crossings on Wessex route
- site photographs and measurements
- weather reports and observations at the site
- a review of previous RAIB investigations that had relevance to this accident.

This report is published by the Rail Accident Investigation Branch,
Department for Transport.

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JG7

Research in Brief

Enhancing the accuracy and functionality of the All Level Crossing Risk Model T936





For more information contact:
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RESEARCH AND DEVELOPMENT

June 2017

Enhanced modelling of level crossing risk includes new technologies and algorithms

Aims

The aims of the project were to:

- Enhance the All Level Crossing Risk Model (ALCRM) to take full advantage of suggestions made by industry bodies and others.
- Deliver an Excel-based tool which will not only demonstrate that the enhanced ALCRM is a working stable tool but also will show how the new algorithms change the risk at level crossings.

Key enhancements

- Data provided by the Safety Risk Model (SRM) has facilitated greatly improved modelling of risk at the different 'core' level crossing types, compared to the best available data available during the original (2007) implementation of ALCRM.
- Normalised predicted risk per crossing type has not varied significantly since ALCRM's inception, but improved business intelligence on the impact of different level crossing features now shows greater differentiation in the level of predicted site-specific risk.
- Several new technologies (including obstacle detection, itself a product of an RSSB-managed research project T729 Further work on obstacle detectors at level crossings) are now incorporated into ALCRM's prediction of risk.

Impacts and benefits

Completion of T936 provides the industry with a comprehensively updated quantitative prediction of risk at each of its level crossings, supporting better safety-decision making in selecting crossings for upgrade and closure. In particular:

- The ALCRM Update supports the risk assessment of all of Network Rail's major level crossing types including recently introduced types such as automatic open crossings with barrier overlay.
- A method of calibrating the ALCRM Update has been developed that greatly simplifies future alignment of ALCRM and SRM risk levels.
- The predicted levels of risk provide better granularity than previous versions of ALCRM, now differentiating between important site-specific features including whistle boards, audible alarms, power operated gate openers (POGO) and pedestrian footbridges.
- Successful application of the ALCRM Update will lead to improved safety-decision making and will assist with the reduction in the overall level of risk across Network Rail's portfolio of level crossings and with targeted investment decisions.

Background

Network Rail has responsibility for some 6,000 level crossings on Great Britain's railways varying from small quiet rural footpath crossings to large busy public road crossings with barriers and warning lights. It is a legal requirement that the risk at these level crossings should be kept as low as reasonably practicable. The key tool to monitor and analyse this risk for all crossings is the All Level Crossings Risk Model (ALCRM) developed by RSSB and Network Rail and first rolled out in 2007. Suggestions for improving the tool have been made by such bodies as the ORR, within recommendations from reports published by the Rail Accident Investigation Branch, and by Network Rail level crossing practitioners. This project set out to update and upgrade the tool in the light of these suggestions so that it can maintain and enhance its essential role in the risk assessment process.

Some of the suggestions picked the fruits of earlier RSSB research work, such as the findings on risk levels at crossings protected by automatic detection of obstacles on the crossing (T729), and ensured that the findings are embedded in the risk assessment process. Other suggestions upgraded the ALCRM by addressing known issues such as the fact that where there are very large numbers of pedestrians using a few busy crossings at places like city centres the risk is not proportional to the numbers using the crossing but should be subject to a cap.

Method

The research began with discussions on the proposed criteria for the appraisal. A scorecard template was developed early within the research for appraisal of each suggestion prior to incorporation/rejection. Suggestions were screened to identify those where it was immediately obvious that further detailed research was not required. The more promising suggestions were subject to a probing analysis supported by the steering group before implementation/rejection. Of the original 57 suggestions, 29 were approved for implementation and carried forward to the project's second phase.

All suggestions were codified in a revised version of the Enhanced Specification, which included a complete record of all changes. An Excel tool, providing both an interface for entry of test level crossing data and a fully functional method of predicting the level of risk, was designed in parallel with the Enhanced Specification and tested with the release of each version.

Network Rail is planning the implementation of the algorithms drawn up in the project and will, with RSSB transferring its ownership of the tool to it, be directly responsible for future updates.

‘The project has enabled Network Rail to start the upgrade of ALCRM, which supports better decision making and underpins its efforts on level crossing safety.

Cajetan Chukwulozie, Head of Risk Management (Safety, Technical & Engineering Directorate)

Where to find out more

Industry bodies and other administrations which would like further information on ALCRM should contact enquirydesk@rssb.co.uk

JG8

Department for Transport

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Our Ref: TWA/17/APP/07
Your Ref: JEW/18136/655/PFI

27 March 2018

Winckworth Sherwood LLP
Minerva House
5 Montague Close
London
SE1 9BB

Dear Sirs,

TRANSPORT AND WORKS ACT 1992: APPLICATION FOR THE NETWORK RAIL (KINGS MILL NO. 1 LEVEL CROSSING) (LAND ACQUISITION AND CLOSURE) ORDER

1. I am directed by the Secretary of State for Transport ("the Secretary of State") to say that consideration has been given to the application made on 15 September 2017 by your client, Network Rail Infrastructure Limited ("NR"), for the Network Rail (Kings Mill No. 1 Level Crossing) (Land Acquisition and Closure) Order ("the Order"), to be made under sections 1 and 5 of the Transport and Works Act 1992 ("TWA").

2. The Order, if made, would confer powers on NR to: compulsorily acquire land and rights over land required in connection with the construction and maintenance of a new, ramped bridleway bridge over the Nottingham to Worksop line (the Robin Hood line) at Mansfield (which development has been separately authorised by the grant of planning permission under Part III of the Town and Country Planning Act 1990 ("the 1990 Act") by Ashfield District Council) in the county of Nottinghamshire; to stop up the level crossing at Kings Mill Lane, Grange Farm, Nottinghamshire; to extinguish the existing bridleway over the crossing and to create an alternative bridleway in substitution which will cross the railway on a new, ramped bridge. The Order also confers powers of temporary use of land in connection with that development and the right to oversail certain land with cranes.

3. As the proposed Order does not contain any works powers, NR has not submitted an environmental statement with the Order application. Further, as planning permission has already been granted by Ashfield District Council in relation to the new bridleway bridge, NR have not sought a direction for deemed planning permission from the Secretary of State under section 90(2A) of the Town and Country Planning Act 1990.

Summary of Secretary of State's decision

4. For the reasons given in this letter**, the Secretary of State has decided to make the Order with modifications.**

The Order application

5. In making this application, NR has complied with the publicity requirements of the Transport and Works (Applications and Objections Procedure) (England and Wales) Rules 2006 ("the 2006 Rules"). This included serving copies of the application and the accompanying documents on the persons specified in those Rules and making the documents available for public inspection. As also required by the 2006 Rules, NR displayed and published notices giving information about the application and how to make representations and served notice on those whose rights over land would be extinguished under the Order.

6. In response to the application the Secretary of State received no objections to the application nor any other representations. The application is, accordingly, unopposed.

Purposes of the Order

7. NR set out in their Statement of Aims, which accompanied the Order application, that the purpose of the Order is to provide NR with powers to close Kings Mill No. 1 level crossing and provide a suitable and convenient alternative means of crossing the railway for existing users. The main reason NR state for closure of Kings Mill No. 1 level crossing is safety. Following a fatality in 2012, NR state that despite improvements to the infrastructure at the crossing, it is regarded as a high risk.

The Secretary of State's consideration and decision

9. The Secretary of State notes that the Order will facilitate the closing of Kings Mill No. 1 level crossing, extinguish the existing bridleway over the crossing and create an alternative bridleway in substitution which will cross the railway on a new, ramped bridleway bridge. The Secretary of State also notes that the development comprising the bridge was granted planning permission by Ashfield District Council in the County of Nottinghamshire on 18 December 2017 under the 1990 Act. The Secretary of State also notes that the scheme is part of the National Level Crossing Risk Reduction Programme which aims to close, re-designate or upgrade crossings across the network to help to improve safety for everyone, reduce the risk that level crossings present to the national rail network and reduce maintenance costs.

8. The Secretary of State notes that NR did apply to Nottingham County Council for a rail crossing diversion order under section 119A of the Highways Act 1980 to create the new bridleway and extinguish the public right of way over the railway and that no objections were received to that application. NR subsequently agreed with the County Council to withdraw the Highways Act Order application and to instead pursue the level crossing closure and bridleway diversion by means of a Transport and Works Act Order.

10. The Secretary of State is satisfied that the statutory procedures in connection with the application for the Order have been followed. The Secretary of State notes that the Order would confer powers on NR for the compulsory acquisition of land and to use land temporarily in connection with the proposals. The Secretary of State is satisfied that the powers granted by the Order for rights to acquire land compulsorily and to use land temporarily are legitimate and that there is a compelling case in the public interest for granting these powers and notes that there are no objections to those powers. The Secretary of State also notes from the funding statement which accompanied NR's application that the scheme is fully funded and is therefore content that there is unlikely to be any financial or other impediment to implementing the scheme. The Secretary of State is therefore satisfied that, having regard to the Ministry of Housing, Communities and Local Government's (formerly the Department for Communities and Local Government) Guidance on the Compulsory purchase process and the Crichel Down Rules (October 2015), the compulsory acquisition powers applied for are justified.

11. For the purposes of section 5(6) of the TWA, the Secretary of State is satisfied that, in relation to the public rights of way that would be extinguished, an alternative right of way will be provided. He notes further that, as regards the extinguishment of any private right of way over the level crossings, compensation would be payable if any person suffered loss as a result.

12. In light of this, the Secretary of State has decided to make the Order, subject to a number of minor drafting amendments which do not make a substantial change in the proposals such as would require notification to affected persons under section 13(4) of the TWA.

Notice of determination

13. This letter constitutes the Secretary of State's notice of his determination to make the Order for the purposes of section 14(1)(a) and section 14(2) of the TWA. Your clients are required to publish a notice of the Secretary of State's determination in accordance with section 14(4) of the TWA.

Challenge to decision

14. The circumstances in which the Secretary of State's decision may be challenged are set out in the note attached to the Annex to this letter.

Yours faithfully,

Natasha Kopala

Annex

RIGHT TO CHALLENGE ORDERS MADE UNDER THE TWA

Any person who is aggrieved by the making of the Order may challenge its validity, or the validity of any provision in it, on the grounds that —

- it is not within the powers of the TWA; or
- any requirement imposed by or under the TWA has not been complied with.

Any such challenge may be made, by application to the High Court, within the period of 42 days beginning with the day on which notice of this determination is published in the London Gazette as required by section 14(1)(b) of the TWA. This notice is expected to be published within 3 working days of the date of this decision letter.

A person who thinks they may have grounds for challenging the decision to make the Order is advised to seek legal advice before taking any action.

JG9

The Planning Inspectorate

Order Decision

Site visit made on 6 September 2022

by Mrs A Behn Dip MS MIPROW

An Inspector appointed by the Secretary of State for Environment, Food and Rural Affairs

Decision date: 28 October 2022

Order Ref: ROW/3285310

- This Order is made under Section 257 of the Town and Country Planning Act 1990 and is known as The Buckinghamshire Council (Public Footpath No 70 (part) Parish of Great Missenden) Public Path Diversion Order 2021.
- The Order is dated 5 March 2021 and proposes to divert part of the public right of way as shown on the Order plan and described in the Order Schedule.
- There was 1 objection outstanding when Buckinghamshire Council (BC) submitted the Order to the Secretary of State for Environment, Food and Rural Affairs for confirmation.

Summary of Decision: The Order is confirmed subject to the modifications set out below in the Formal Decision.

Procedural matters

1. I made an unaccompanied site visit on 6 September when I was able to walk Public Footpath No 70 (FP No 70) on its current line and the Order route on its proposed diversion.

2. In writing this decision I have found it convenient to refer to points marked on the Order Map.

3. BC have requested if the Order is confirmed that Part 2 of the Order Schedule (Description of Site of Alternative Highway) is amended to include the proposed width of the route, which is 3 metres throughout.

The Main Issues

The statutory test

4. Section 257 of the Town and Country Planning Act 1990 (the 1990 Act) provides for an Order to be made authorising the stopping up or diversion of a footpath if it is necessary to do so in order to enable development to be carried out in accordance with a valid planning permission already granted under Part III of the same Act.

Other material considerations

5. In considering whether or not to confirm an Order, the disadvantages or loss likely to arise as a result of the diversion of the way to members of the public generally, or to persons whose properties adjoin or are near the existing highway, should be weighed against the advantages of the proposed Order.

6. The requirements of the Equality Act 2010 should also be considered where appropriate.

Reasoning

Background

7. Sustrans have received funding from the Department for Transport which will enable them to create a Greenway stretching from Uxbridge to Buckingham and Milton Keynes. The Misbourne Greenway between Wendover and Great Missenden will form part of this project and has the aim of setting out a safe and attractive multi-user route away from the busy A413, to encourage walking and cycling, both for leisure and for access to work, school, and amenities. The proposed diversion of FP No 70 would form the southern end of the Misbourne Greenway.

8. Although much of the Misbourne Greenway is a permissive path with agreement of the landowners, the proposed diversion in question here, would retain its status as a public right of way, as agreed by the owner of the land, Road Farm.

9. FP No 70 does not materially affect the creation of the southern section of the Misbourne Greenway but the planning consents granted, require, as part of the conditions for development, that the part of the footpath that crosses the mainline railway via an unmanned level crossing, be stopped up and the crossing removed.

Whether the diversion of the path is necessary to allow development to be carried out in accordance with a valid planning permission

10. I am satisfied that the planning permissions PL/19/4427/FA and 19/04476/APP are extant, albeit PL/19/4427/FA is the permission that directly relates to land upon which the diverted route will sit.

11. The relevant condition in both planning consents states the following:

    - Prior to the approved development being brought into use the following shall be implemented:

        a. The public right of way (GMI/70/4) over Great Missenden level crossing(Great Missenden No.70 Level crossing, Network Rail ref: MCJ2 30m, 3ch) shall be permanently stopped up.

        b. Great Missenden No.70 Level Crossing (Network Rail ref: MCJ2 30m, 3ch) shall be closed; and

        c. Any necessary diversional route shall be completed and operational.

12. In a physical context, there is no need to make any changes to FP No 70 for development to take place. However, for the development to proceed it must comply with the valid planning permissions above and the conditions thereby imposed. Both permissions contain conditions that require that Footpath No 70 is stopped up over the railway crossing, in order that the Level Crossing can be closed. As there are two extant planning permissions presented in support but only one of these is included in the Order, as both are deemed relevant and if the Order should be confirmed, it would be appropriate to modify the Order to record both permissions.

13. The reasons given for this requirement are to ensure the proposed development does not increase footfall across the level crossing, so as to minimise risk to users of the footway and the railway infrastructure and to ensure the safe operation of the

railway. The reasons comply with the National Planning Policy Framework and the Local Plans for the area.

14. The current route of FP No 70 travels east to west across the railway line in a rural location. The line is active and there are currently 79 trains that traverse the crossing in a 24-hour period. Evidence provided suggests that the crossing has been little used in recent years and accordingly the risk posed by the crossing is fairly low.

15. Although likely future use cannot realistically be determined, I do accept Network Rail's view that the new Misbourne Greenway of which this proposed diversion is part, would likely attract a much larger number of users than currently use FP No 70. This would change the dynamic of the use of the area from an infrequently used rural footpath to that of an open and easily accessible surfaced route attractive to walkers, cyclists, families, and those who have mobility restrictions. With a potential increase in use and change in user profile, there would likely be a fundamental rise in the risk of public safety should that part of FP No 70 that crosses the railway line remain open.

16. Whilst ensuring safety of the public is a priority to Network Rail, the operational efficiency that would be affected if there were an incident, near miss, or trespass is also a material factor in their rationale for closing the crossing.

17. The imposition of the planning conditions that require the diversion of the path, in turn determines that the diversion of the path is necessary to enable development to take place, in accordance with planning permission granted under Part III of the 1990 Act. The development is essentially frustrated unless the path is diverted, thus justifying the statutory test.

18. I now move on to consider the advantages and disadvantages of the proposed Order.

Disadvantages v advantages of the proposed Order

19. Confirmation of the proposed Order would result in the loss of that part of FP No 70 that crosses the railway line and heads in a south westerly direction uphill, to meet with GMI/1 on the western side of the railway line. The replacement path would not terminate at a similar point, west of the railway line, but instead would run parallel to the railway line on its eastern side, in a south easterly direction before turning east to connect to the Aylesbury Road. A short walk is then required to reach the underpass that leads across to GMI/1 as well as to other connecting footpaths that are west of the railway line.

20. The objector pointed out that the proposed route was longer, entailing 'a walk alongside the railway line for approximately 0.5 kilometre, a short walk along the Aylesbury Road and then a walk under the railway before walking up GMI/1'. Certainly, if the intention is to reach the GMI/1 at Point A on the map from Leather Lane or the A413, then the proposed route is considerably longer than that of FP No 70. It should be noted however, that users wishing to utilise FP No 70 in this way would likely be recreational walkers as FP No 70 connects to further rural public rights of way to the west of the railway line. With this in mind, the longer distance of the proposed diverted route would be diminutive compared to the total distance generally being travelled in a recreational capacity.

21. The offered diversion, in comparison, does provide a safe shorter route to Great Missenden, avoiding the busy A413 and does not have the limitations of the two sets of stiles and steps of the current footpath, thus being a better suited route for those users with protected characteristics under The Equality Act 2010.

22. The objector stated that the current route of FP No 70 is very pleasant and the alternative route is a much less pleasant walk. It is true that the current footpath offers commanding views and an enjoyable walk across open fields and that the alternative is less pleasing. The diverted route would run alongside the railway track, across an open field, away from the busy A413. This route although not as enjoyable, does however provide a safe green route for users to easily access Great Missenden as well as the GMI/1 via an underpass close to the termination point at E.

23. BC suggested that the Misbourne Greenway, which would be created as a result of this proposed diversion, will result in much higher usage than that observed on the current route of FP No 70, the Greenway benefitting health and exercise and boosting leisure spend and enjoyment of the area. It would also provide a safe off-road route for walkers and cyclists, between Wendover and Great Missenden as there is currently no footway or cycleway on the corresponding section of the A413.

24. BC also advised that the proposed diversion of FP No 70 and the ensuing Misbourne Greenway would provide for long circular walks that are currently not available.

25. Limited weight can be given to the benefits of the Misbourne Greenway as the majority of this route has not yet been realised and consequently the larger picture of this multi-use route has little current relevance to the proposed diversion.

26. The objector noted that the current route of FP No 70 provides a point of crossing to Leather Lane. The section of FP No 70 from the A413 to Point C on the map would be retained, still giving access to Leather Lane. From Point C, the diversion route running south would still provide access to Great Missenden as well as the GMI/1 to the west of the railway line, via the underpass to the south.

27. The objector also considered that the replacement footpath was totally different and unsuitable, although this comment was not expanded upon. I agree that the proposed path is quite different from the current footpath but in many ways its suitability could be found to benefit a large proportion of the public, wanting to head north or south in a safe environment. For those people wanting to travel east or west, the proposed route whilst much longer, is not substantially unsuitable for the type of recreational walk being undertaken.

28. When looking at the overall network in the immediate vicinity, the majority of public rights of way lie to the west of the railway line with very little in the way of connectivity to the east of the railway line. It follows then, that use from east to west of the FP No 70 is likely to be sparse, in correlation with the evidence of use provided. The type of use is also likely to be recreational and part of a longer walk. Thus, the extra length of the proposed diversion, when travelling east or west is not substantially inconvenient or more of a disadvantage than the ability to travel safely.

29. It is acknowledged that the proposed diversion route would be 3 metres wide and surfaced appropriately for multi-use, providing better access opportunities for

families and users with mobility restrictions. The proposed Order route would also negate the need to cross stiles, a railway line, and negotiate steps or an unmade surface in inclement weather. These advantages hold significant weight.

30. There are no properties adjoining or immediately close by the proposed route, so there would be no disadvantages to local residents in this respect.

31. The proposed diversion and to a larger degree, the Greenway as a whole, does support the Buckinghamshire Council Rights of Way Improvement Plan objectives for better connecting the rights of way network, specifically sections EN1 and EN3 ensuring access improvements are strategically planned to meet needs and evolving the network to meet needs and improve connectivity.

Conclusions

32. It is clear that the Grampian conditions imposed in the planning consents for the Misbourne Greenway necessitate that the FP No 70 is diverted in order for the development of the Greenway to take place, or otherwise be frustrated due to non-confirmation of the Order.

33. Both public safety and operational efficiency of the railway are issues that are in the public interest and hold some weight when considering the rationale and merit of the Order.

34. The quite apparent disadvantage of the diversional route is that it is significantly longer. However, the rural nature of the current line of FP No 70 with its limitations of stiles, steps and railway line suggests recreational use by a finite audience. In this context, the additional time and distance would likely represent a proportionally small increase in overall journey time.

35. Whilst the more convenient route across the railway line to join the rural paths on the west of the railway from the A413 would be lost for the small number of people using it, the proposed diversion does offer a route to reach the western side of the railway, albeit longer. There is comparatively greater public benefit in enabling the development to take place, providing a safe, easily accessible route by foot and on bicycle without the need to negotiate the limitations of the current footpath.

36. Having regard to these and all other matters raised in the written representations I conclude that the Order should be confirmed with modifications.

Formal Decision

37. I confirm the Order subject to the following modifications :

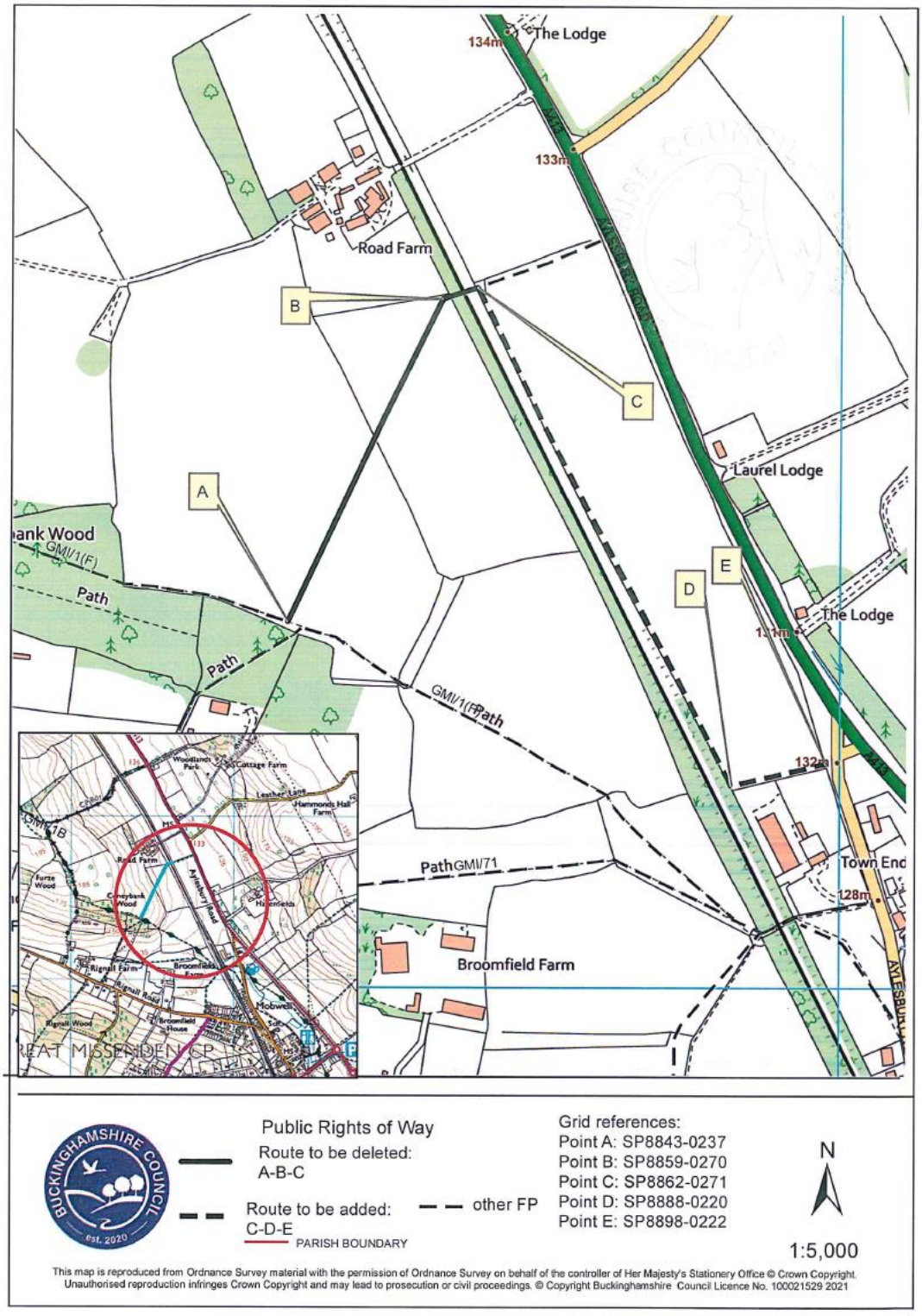
    On the Order, at the end of the first paragraph, delete (Planning Application Reference 19/04476/APP) and insert (Planning Application References 19/04476/APP and PL/19/4427/FA).

    On Part 2 of the Order Schedule, at the end of the description for C-D-E, remove the full stop after the word ‘dashes’ and insert the words ‘with a width of 3 metres throughout’.

Mrs A Behn

Inspector

Town and Country Planning Act 1990
Section 257 Diversion of Public Footpath No 70 (part)
Parish of Great Missenden



JG10

The Planning Inspectorate

Order Decision

Inquiry opened on 4 June 2019

by Mark Yates BA(Hons) MIPROW

an Inspector appointed by the Secretary of State for Environment, Food and Rural Affairs

Decision date: 27 August 2019

Order Ref: ROW/3209333

- This Order is made under Section 118A of the Highways Act 1980 ("the 1980 Act") and is known as the Leicestershire County Council Public Bridleway I20 (Part) Parish of Barrow Upon Soar Rail Crossing Extinguishment Order 2017.
- The Order was made by Leicestershire County Council ("the Council") on 4 December 2017 and proposes to extinguish a section of Bridleway I20 in the parish of Barrow upon Soar, as detailed in the Order Map and Schedule.
- There were ten objections outstanding at the commencement of the inquiry.

Summary of Decision: The Order is confirmed subject to modifications set out below in the Formal Decision.

PROCEDURAL MATTERS

1. I held a public inquiry into the Order on 4-6 June 2019 and undertook both unaccompanied and accompanied visits to the site and the surrounding area.

2. The Council adopted a neutral stance at the inquiry and the case in support of the confirmation of the Order was made by Network Rail Infrastructure Limited ("NR").

3. There are two errors on the additional map within the Order[1], which proposes to show the alternative route available to the public. Firstly, the route is shown through properties and not along the highways concerned. Secondly, the one-way system within the village means that it is not possible for horse riders or cyclists to travel northwards along the carriageway of Grove Lane[2]. There is nothing to suggest that anyone was prejudiced by these matters.

4. I take the view that it is not appropriate to insert a new map into an Order to remedy errors with the original version. It is nonetheless open to me to modify this map. The options are that the alternative route and the map key are modified, or the map is struck out. Bearing in mind that there is no requirement for this additional map and the difficulty of showing the different options on it, I consider it appropriate for the context plan to be struck out.

5. It became apparent that the Planning Inspectorate had not forwarded the proof of evidence for one of NRs witnesses (Mr Greenwood) to the other parties. Arrangements were put in place for this to be circulated a few days before the inquiry opened and I gave some additional time on the opening day of the inquiry for people to read it.

[1] Known as the 'context plan' and having the reference number '2340C'
[2] It may be permissible for a person to push a cycle along the footway

MAIN ISSUES

6. The Order was made as it appeared to the Council expedient that a section of bridleway should be stopped up in the interests of the safety of members of the public using it or likely to use it. If I am to confirm the Order, I will need to be satisfied that it is expedient to do so having regard to all the circumstances, and in particular to:

   (a) whether it is reasonably practicable to make the crossing safe for use by the public, and
   (b) what arrangements have been made for ensuring that, if the Order is confirmed, any appropriate barriers and signs are erected and maintained.

7. Whilst particular regard should be given to those matters set out above, other factors may be relevant when determining whether it is expedient to extinguish the section of bridleway included in the Order. Paragraph 5.49 of Defra Circular 1/09 ("the Circular") outlines that these may include "*the use currently made of the existing path, the risk to the public of continuing such use, the effect that the loss of the path would have on users of the public rights of way network as a whole, the opportunity for taking alternative measures to deal with the problem, such as a diversion order or a bridge or tunnel and the relative cost of such alternative measures*".

REASONS

8. The Order proposes to permanently stop up a section of Bridleway I20, where it passes over the Mountsorrel level crossing ("the crossing"), between its junctions with Sileby Road (point A) and Footpath I24 (point B). Further to the north, I20 links with Footpath I23 and continues north westwards to Melton Road/Paudy Lane and beyond. Point A is located towards the eastern extent of the village of Barrow upon Soar. To the south of Sileby Road in this locality is the River Soar.

9. Work has commenced on land to the north of the crossing in relation to the Poppyfields development, which will comprise of 291 dwellings. To the east of the crossing there are industrial units and the Lafarge works on the southern of the railway lines and British Gypsum works on the northern side of the lines.

10. The crossing passes over the Midland Main Line, which comprises of four lines for passenger and freight trains. There are two additional railway lines under the control of Lafarge Aggregates, and these are located nearest to Sileby Road.

Public Use of the Crossing

11. As outlined below, the crossing has been closed on a temporary basis since 2008. The only available information regarding the extent of the use of the crossing arises from a census undertaken over a period of nine days commencing on 25 March 2006. It is noted that nine hours of data was lost due to a person tampering with the camera. Subject to this issue, the camera recorded 358 people using the crossing during the nine-day period, which equates to an average of around 40 users per day. It is stated[3] that ten cyclists and two horse riders used the crossing during this period with the remainder of the users being pedestrians.

[3] At paragraph 2.7.3 of NRs 2019 risk assessment

12. NR relies on statistical data regarding the average figures for the occupancy of houses in the UK, the number of dependent children within households and the percentage of homes having a dog in support of its view that the Poppyfields development would give rise to a significant increase in use of the crossing and that some of this use will involve vulnerable users. Following the completion of the development it is believed that use could rise to over 80 users a day. Reference is also made to visitors to properties on the development. NR says that even without the Poppyfields development there has been natural growth in the village population and estimate that the number of users could have risen to 50-60 people a day if the crossing had been open.

13. Any increase in the number of users gives rise to a greater risk that an accident will occur, but it could also be supportive of the need for a means of crossing the railway in this locality. I accept that the development will lead to an expectation that there will be an increase in use of the crossing. However, I am reluctant to place too much reliance on the average figures involving households in the UK. The nature of the crossing and the locations of facilities within the village may serve to influence use to some extent. It is nonetheless the case that the figures put forward by NR are stated to be on the conservative side.

The Safety of Members of the Public Using the Crossing

14. The Midland Main Line comprises of two fast lines with trains travelling at speeds of up to 110 mph and two slow lines allowing for speeds of up to 65 mph. During operational hours, eight trains per hour pass over the fast lines (four in each direction) and two pass over the slow lines (one in each direction). There are additionally between twenty and fifty freight trains a day.

15. Two additional lines are used by Lafarge and are outside of the control of NR. They consist of a reception line and a loading line. Trains travel at speeds of up to 15 mph on these lines and on average there are between eight and ten arrivals and departures per day. In addition, there are shunting movements during the day which lead to trains moving over the crossing and sometimes stopping on the crossing.

16. An investigation was undertaken following a near miss on the crossing involving a pedestrian in 2008. The recommendation of the Railways Inspector (Mr Tilly) who investigated the matter was that the crossing should be closed. It has subsequently been the subject of temporary closures under the Road Traffic Regulation Act 1984. Some weight should be attached to the findings of Mr Tilly following his investigation of the crossing. However, the same cannot be said to apply to the temporary closures. The extension of the temporary closure was requested by the Council in order to find a solution and this was granted by the Secretary of State for Transport without comment on the merits of the permanent closure of the crossing.

17. Self-closing gates and signage informing people to 'stop, look and listen' were in place prior to the closure of the crossing. The main witness called by NR to speak on safety was Mr Briggs. He outlines that this type of signage is usually placed at decision points. A decision point is where it is reasonable to expect a user of the crossing to make the decision to cross. These signs place reliance on users deciding whether it is safe to cross and heeding the warnings whilst continuing to look and listen when crossing. NR draws attention to research and incidents showing that people do not always look at signage or crossing

equipment and can fail to look for trains when crossing. There may also be instances when people are unwilling to wait to cross for various reasons.

18. Attention is drawn to the risks associated with vulnerable users of level crossings. Vulnerable users are classed as those people who are unable to use a level crossing quickly and effectively and are not fully aware of the dangers at crossings. These include people with impaired mobility, unaccompanied young children, people with ear phones, dog walkers, people with a pushchair, cycle or leading a horse. The near miss incident of 2008 is stated to have involved an elderly person walking a dog.

19. The total distance of the crossing is stated to be 29 metres. Taking 1.2 metres per second as an average speed of a walker[4], the time taken to traverse the crossing would be 24 seconds. Mr Briggs outlines that at this speed a user requires 1,200 metres of sighting of a train approaching to cross safely. In the case of the average speed of a vulnerable user[5], allowing for a crossing time of 36 seconds, 1,800 metres of sighting is stated to be required.

20. Details have been provided of the sighting distances available at this crossing in each direction. In terms of vegetation, this can be removed to some extent in order to improve the sighting of trains. A reasonable user may also be expected to take into account adverse weather conditions, such as fog, when deciding whether to use the crossing. However, the curvature of the railway reduces the visibility of trains from both sides of the crossing to varying degrees in normal weather conditions. Visibility to the west from the northern side of the crossing is further affected by the Grove Lane overbridge. On the south side there will be occasions when visibility is obscured by trains using the sidings. NR also draws attention to trains obscuring the view on the different lines and the potential for people to assume that there is no risk if a train on one of the lines has passed over the crossing.

21. The evidence of NR is that the best available sighting is obtained by looking to the west from the northern side of the crossing and this allows a person to see as far as 660 metres. Therefore, even where visibility is at its greatest, there would be insufficient notice of an approaching train and not enough time to cross the lines in certain circumstances. It is clear the available sighting distances pose a greater risk to vulnerable users. I find this to be a matter of significant concern. NR also points to the diverse speeds of trains leading to problems in a user appreciating how far an approaching train is away.

22. Mr Greenwood highlights patterns of behaviour of people on level crossings. Of particular note are the examples of misuse and trespass at level crossings. He has provided photographs showing youths standing on level crossings, sitting on the decks, walking up or down the rails, chasing each other and playing 'chicken' on the lines. Whilst there is clearly the risk that such behaviour could happen at the crossing, no evidence of misuse has been provided at this location.

23. The 'All Level Crossing Risk Model ("ALCRM") is a computer-based application used by NR to assist in directing risk management at level crossings. This provides a risk result consisting of a letter (A-M for individual risk) and number (1-13 for collective risk). The risk is deemed to be higher towards A and 1. Mr

[4] As recommended by the Office of Road and Rail
[5] Mr Briggs says the current view is that the time for a vulnerable user to traverse a crossing should be increased by 50%.

Briggs outlines the problems with the ALCRM system at the time of an assessment carried out in 2007, which was the last risk assessment undertaken prior to the closure of the crossing. This is stated to have not accurately reflected the nature and use of the crossing for a number of reasons.

24. In order to measure the risk a further risk assessment was undertaken in 2019 on the basis that the crossing is still open. This assessment recorded an ALCRM score of B2 based on the 40 daily users recorded in the 2006 census. Use of the crossing by the 80 projected people (see paragraph 12 above) would give an ALCRM score of B1. I consider there to be some uncertainty in projecting the level of use when the crossing has been closed for many years. Nonetheless, even using the 2006 figures, the risk assessment categorises the crossing as being of a very high risk.

25. It is clear that the crossing poses a substantial risk to members of the public using it. This is borne out by the findings of Mr Tilly and the evidence of the witnesses for NR. It is apparent from the ALCRM score that the crossing continues to pose a high risk to the public. Further the objectors at the inquiry all accepted that the level crossing is unsafe.

Whether it is Reasonably Practicable to Make the Crossing Safe

26. Mr Briggs says that there is a need for a refuge to demark the different sets of lines, but it is not possible to make provision for one of the required dimensions for bridleway users in this location. Although a telephone system was previously in place, it is stated that this could not advise people of trains using the sidings. The Council also outlines that records of phone calls during the period covered by the census revealed that only 1 in 5 people contacted the signaller via the telephone as requested to do so before crossing. I accept that the provision of a NR employee at the crossing 24 hours a day is not a viable option.

27. Miniature stop lights can be employed at level crossings that are linked to the signalling system. These lights are triggered by approaching trains and there may also be an audible warning. They give a warning time of around 40 seconds. However, such a system is considered by NR to be impracticable in this location given the different line speeds and the absence of a decision point between the slow and fast lines. In terms of the use of whistle boards to warn users of an approaching train, these are subject to a maximum position of 400 metres from the crossing. After this distance they serve no useful purpose. They are also not recommended on lines with speeds of over 100 mph or where there are more than two tracks.

28. Mr Greenwood points to the use of a speed restriction in this locality being contrary to the requirement in NR's licence for operational efficiency. The slowing of trains can have a knock-on effect for the network causing congestion and delays. Compensation is paid by NR for delays experienced by train operators. It is also felt that speed restrictions may encourage users to believe they have more time to cross the railway lines.

29. The evidence of NR is that none of these measures could be employed in this location to make the crossing safe. This view is not challenged by the objectors. Instead the objectors consider that an alternative means of crossing the railway lines, as addressed in paragraphs 47-53 below, should be put in place.

Fencing and Signage

30. Following the temporary closure of the crossing people have been prevented from using it by palisade fencing. Ms Bedford of NR is not aware of any incidents of vandalism with this fence. The evidence of NR is that fencing is maintained at least every 12 months. If there is an incident it will be reviewed more regularly. Should there be no further issues within the next 12 months, it will revert to being examined annually. It is not felt that any additional signs would be required if the Order is confirmed.

31. I have no reason to doubt that the fencing would continue to be maintained in order to physically prevent access to the crossing should the section of bridleway be permanently extinguished. If it is considered appropriate to do so the Council could erect suitably worded signage informing the public of the closure of the crossing and the alternative route available.

Other Expediency Issues

Safety and operational efficiency

32. NR has a statutory duty to ensure safety on the railway. The duty of care extends to trespassers as well as lawful users of the crossing. Additionally, it has a duty in its network licence to improve operational performance and efficiency. This will include ensuring that trains run on time and compensation is payable if trains are delayed for whatever reason.

33. It is apparent that the primary concern of NR is safety. Nonetheless, an accident on a crossing is likely to impact on operational efficiency. NR outlines how an accident not only disrupts trains on the Midland Main Line, but it also potentially impacts on the wider train network.

The impact of the loss of the section of bridleway

34. A range of potential reasons for people wishing to use the bridleway have been put forward by the parties. However, there is little evidence regarding the purpose behind the previous use of the crossing. The 2006 census only provides information regarding the number of people using the crossing at that time.

35. The longstanding temporary closure of the crossing has meant that people have had to make use of alternative options. It is apparent from the photographic evidence that the section of I20 to the north of the railway remains well used in conjunction with the existing footpaths. Nonetheless, it seems to me that consideration needs to be given to the likely use that would occur if the crossing were open. The nature of I20 to the north of the railway lends itself more to use by off-road cycles. Clearly, the census information recorded that the equestrian use was limited.

Distance

36. The shortest distance in order to travel between the north and south sides of the crossing by an alternative route is around a mile. In terms of pedestrians this is via the footways of Sileby Road, Grove Lane and Melton Road to ultimately join Footpaths I23 or I24. Cyclists and equestrians travelling northwards have to ride along Sileby Road, South Street and Melton Road before joining I20. When travelling southwards cyclists and horse riders would travel a similar route but this would incorporate Grove Lane.

37. In terms of access to local amenities, most of those mentioned lie to the west of the crossing in or near to the centre of the village. There is no apparent benefit of using I20 as a quicker route to reach a range of destinations such as local schools and shops. The main bus service[6] through the village has stops positioned both to the north and south of the railway. There would nevertheless be some disadvantage for someone wishing to walk or cycle southwards over the crossing to access any of the industrial sites located on Sileby Road.

38. I find it likely that a significant proportion of the use of the rights of way network to the north and south of the crossing is for recreational purposes, such as dog walking. In that sense people would have to take a detour to connect with rights of way on the other side of the railway. However, it is apparent that for walkers at least there is a high concentration of public rights of way to use on each side of the railway. In terms of the network to the north, the existing rights of way will be retained within the Poppyfields development with additional routes provided.

39. To the south of Sileby Road there are paths in the locality of the River Soar. I note that there was opposition to the closure of the crossing from some residents of Sileby Road at the consultation stage. Looking at the network of rights of way in the area, there is the potential for the closure to have a greater impact on residents of properties to the south of the crossing. It is also apparent that there may be times when the flooding stated to occur on occasions restricts use of the ways near to the River Soar. However, there is a lack of evidence from local residents to indicate that the permanent closure of the crossing will have a significant impact on their use of the rights of way network.

40. I consider the issue with horse riders and cyclists to be less about the extra distance required to connect with the bridleway network and more to do with the need to ride for a greater distance on public roads, which I address below. Whilst Ms Bedford has provided details of the locations of the nearest riding schools, it is unlikely that this provides the complete picture on equestrian use. As is the case for Mrs Allen, there may be people whose horses are stabled at other locations within riding distance of I20.

Safety and enjoyment

41. There are footways located on both sides of Sileby Road. A 30 mph speed limit is in place in the locality of point A, which changes further to the east to a 40 mph limit. I also noted the existence of speed humps in places. Reference has been made to the presence of parked cars on the footway. Although not a matter within the control of NR, if parked cars are parked in such a manner as to force people to deviate onto the road, it would potentially impact on the safety of pedestrians. Nonetheless, the northern footway of Sileby Road is generally wide, and I did not encounter any problems with access during my visits to the area.

42. I did not find Sileby Road to be heavily trafficked during my visits to the site, but I accept that the position may be different at certain peak times. No details have been provided of any accidents involving pedestrians, cyclists or horse riders in respect of the alternative routes. Mrs Allen gave evidence regarding the attitude of some motorists when held up by horse riders but

[6] The No. 2 service between Loughborough and Leicester

raised no significant safety concerns. Such conduct may impact more on the enjoyment aspect than on safety. Whilst riders will have to ride on roads elsewhere as part of a riding circuit, the closure of the crossing would lead to horse riders and cyclists having to ride a greater distance on roads. The section of I20 to the north of the crossing is likely to provide a more enjoyable experience to riding on the village roads.

43. The issue of cyclists and horse riders using the local roads needs to be compared with the alternative of traversing the crossing. As outlined above, the present crossing poses a significant risk to the public, and this particularly applies to vulnerable users such as cyclists and horse riders. It is apparent from the census material that there was little use of the crossing at the time by horse riders. Whilst some people such as Mrs Allen may be prepared to use the crossing with a horse, other people were for the most part deterred from doing so.

Cul de Sac

44. Paragraph 5.48 of the Circular advises care should be taken to avoid the creation of a cul de-sac that encourages trespass onto the railway. The closure of the crossing would lead to the creation of a cul de sac bridleway. However, this only materially impacts on horse riders and cyclists as pedestrians can use I20 in conjunction with the existing footpaths. There have been no reported incidents involving people gaining access to the crossing since the erection of the palisade fencing and there is nothing to suggest that the situation will change in the future.

45. Whilst Ms Bedford draws attention to a conservation area being a point of interest served by I20, I consider this to be mainly applicable to pedestrians. I do not see it being a reason for recreational horse riders or cyclists choosing to travel down I20 towards point B. In terms of the concerns of Mrs Allen in relation to Ordnance Survey maps, these will be updated at some stage if the Order is confirmed. I would expect map users to be able to determine where the bridleway terminates once the maps are updated.

46. The creation of a cul de sac section of bridleway is an unsatisfactory outcome for cyclists and horse riders. However, this has to be weighed against the safety of these users and the previous use of the crossing. I address below the potential alternative options previously considered to maintain a link.

Alternative Options

47. NR have had meetings with the Council, landowners and user groups and public engagement events were held to discuss various options should the crossing be permanently stopped up. Details have been provided of fourteen options that have been considered. I have addressed miniature warning lights, the manning of the crossing and speed restrictions in paragraphs 26-28 above. A number of the other proposals involve the provision of a foot or bridleway bridge at the existing crossing point or at the private road known as Pingle Nook. The latter is located near to an industrial estate on Sileby Road. Some of the proposed footbridge options were considered in conjunction with the provision of a link for equestrians and cyclists on the northern side of the railway between Bridleways I20 and I4.

48. The least favourable options appear to be those that proposed to place a bridge at the existing crossing point. NR also draws attention to practical problems

regarding the acquisition of land and obtaining planning permission. A bridge would either block a private access road or need to be built in a garden. These matters are stated to be applicable to a footbridge and it is apparent that the impact would be greater in terms of a bridleway bridge. One of the options for a bridleway bridge would necessitate the purchase of two properties.

49. There is some support for the provision of a footbridge at Pingle Nook. The main issues appear to be the difficulty in tracing ownership of some of the land and the refusal by others to sell land to accommodate the bridge. In my view, this is the most viable option for the provision of a crossing of the railway. However, a footbridge by itself does not take account of the needs of cyclists or horse riders. The impact of a bridleway bridge in this location would again be greater and require the need to remove garages or provide a ramp near to the industrial units. It is also telling that there is no support for the provision of a bridleway bridge from equestrians.

50. Additional concerns are stated to have been raised by the Council regarding the narrow entrance to Pingle Nook given the private vehicular use of it and reference is made to incidents involving vehicles. Ms Bedford also points to the problems that would be encountered in getting machinery such as cranes on site and the need to close the railway lines for a period whilst any bridge is put in place. However, the difficulties in arranging for the works to be undertaken in relation to the construction of a bridge are not insurmountable.

51. In terms of proposals to create a replacement bridleway link, the British Horse Society favoured a new route parallel to the northern side of the railway on land outside of the control of NR. Mrs Allen spoke in favour of a bridleway link between I20 and I4 at the inquiry. However, Ms Bedford outlines that other horse riders disagreed with this option on safety grounds and it is opposed by the owners of the land in question. She says that British Gypsum raised serious health and safety concerns about a route along their western boundary. It would also impact on their ongoing aspiration to construct sidings to the north of the railway. The enhancement of alternative bridle routes and creation of new routes is also stated to have been rejected by affected landowners.

52. Mr Billson, on behalf of Barrow upon Soar Parish Council, considers the restoration of a private underbridge at the site of Hayhill Lane to be the most appropriate option. From my observations of the site there would appear to be significant difficulties in providing a route from Sileby Road given that it would pass through part of the Lafarge site. There would also need to be a lengthy creation on land to the north of the railway to provide a bridleway connection. The information supplied by NR is supportive of the bridge being partly infilled in 1979 and two pipes being taken through the underbridge in 1987. There is also a conveyor belt in this location that would possibly need to be relocated. NR says that the costs of removing the surrounding material, relocating the pipes, bringing the bridge up to a suitable standard and providing appropriate drainage would be considerable and cost more than a bridleway bridge.

53. NR has provided reasons why each alternative proposal is not a viable option. Some of these points are accepted by the objectors. It seems to me that a footbridge would be the most achievable option, but this would not assist with horse riders or cyclists. A bridleway bridge would be more problematic given the size and design required for such a structure within the potential locations.

Further, a bridleway bridge is not favoured by users, including horse riders. Nor is any single proposal favoured by the objectors. I consider there to be nothing to show that a bridleway link on the northern side of the railway or the restoration of the Hayhill Lane underbridge could be a realistic option at the present time.

Bridge or tunnel Order

54. If a crossing is deemed unsafe, a recommendation can be made to the Secretary of State that a bridge or tunnel Order is made. Such an Order would not apply to the alternative link on the northern side of the railway lines, between I20 and I4, favoured by some. As can be seen from the example of a recent decision of the Secretary of State for Transport presented to the inquiry, the costs of implementing a bridge or tunnel needs to be considered against the benefits for the public. If an Order is made, NR has to use its best endeavours to comply with the Order. NR asserts that it could not comply with any Order made within the required timeframe for a variety of reasons.

55. In addition to the budgetary constraints highlighted by Mr Greenwood, there are significant problems that would need to be overcome to provide an alternative crossing of the railway for all users. On the basis of the information provided to me, I find that there is no reasonably practical alternative means of crossing the railway in this locality to warrant the recommendation that a bridge or tunnel Order should be made.

Whether it is expedient to confirm the Order

56. I have concluded that the crossing poses a significant risk to the safety of the public and the evidence of NR is supportive of there no practical means of making the crossing safe. The alternative route available will be less convenient to the public than proceeding directly across the railway lines but this has to be balanced against the safety of the crossing. Further, I am not satisfied that there is a reasonably practical alternative means of crossing the railway lines that would make provision for all types of users.

57. Having regard to my various conclusions, I find that the evidence weighs more heavily in favour of it being expedient to confirm the Order. It follows that I conclude that the Order should be confirmed. I have reached my view on the circumstances in this case and my decision should not be taken to set a precedent for other cases involving an alternative route of a similar distance.

OTHER MATTERS

58. Mr Billson suggested at the inquiry that a permissive bridleway could be created along a fenced corridor over land owned predominately by British Gypsum to provide a link between I20 and I4. This arrangement could cease should British Gypsum wish to do so for operational reasons. It would not create a public right of way in perpetuity but would provide a valuable bridleway link. Whether it is viable option would be a matter for any interested parties to pursue.

59. I note from a consultation response to the planning application for the Poppyfields development that Mrs Allen requested that the footpaths through the site are upgraded to bridleway status. This appears to be consistent with the aim of condition 5 in the planning permission regarding support for the use of non-car use. The Council confirms that the paths through the site are to be improved. Whilst not a matter for me to determine, the upgrading of I24 to

bridleway status would remove the cul de sac element of I20. This is a matter again that any interested parties could pursue.

CONCLUSION

60. Having regard to these and all other matters raised at the inquiry and in the written representations I conclude that the Order should be confirmed with modifications.

FORMAL DECISION

61. I confirm the Order subject to the following modifications:

- Delete the final paragraph of the preamble to the Order, namely "*Plan No. 2340C attached to this Order shows alternative highways available to the public*".
- Strike out Plan No. 2340C in the Order.

Mark Yates

Inspector

APPEARANCES

For NR:

Mr J. Lopez	Counsel instructed by NR

He called:

Mr V. Briggs	Route Level Crossings Manager
Ms S. Bedford	Liability Negotiations Manager
Mr J. Greenwood	Head of Liability Negotiation

Objectors:

Mr J. Howells	Chairman of the Leicestershire Local Access Forum
Mr M. James	Chairman of Leicestershire and Rutland Ramblers
Mr R. Billson	For Barrow upon Soar Parish Council
Mrs V. Allen	President and Networks Officer of Leicestershire & Rutland Bridleways Association and District Access & Bridleways Officer for the British Horse Society

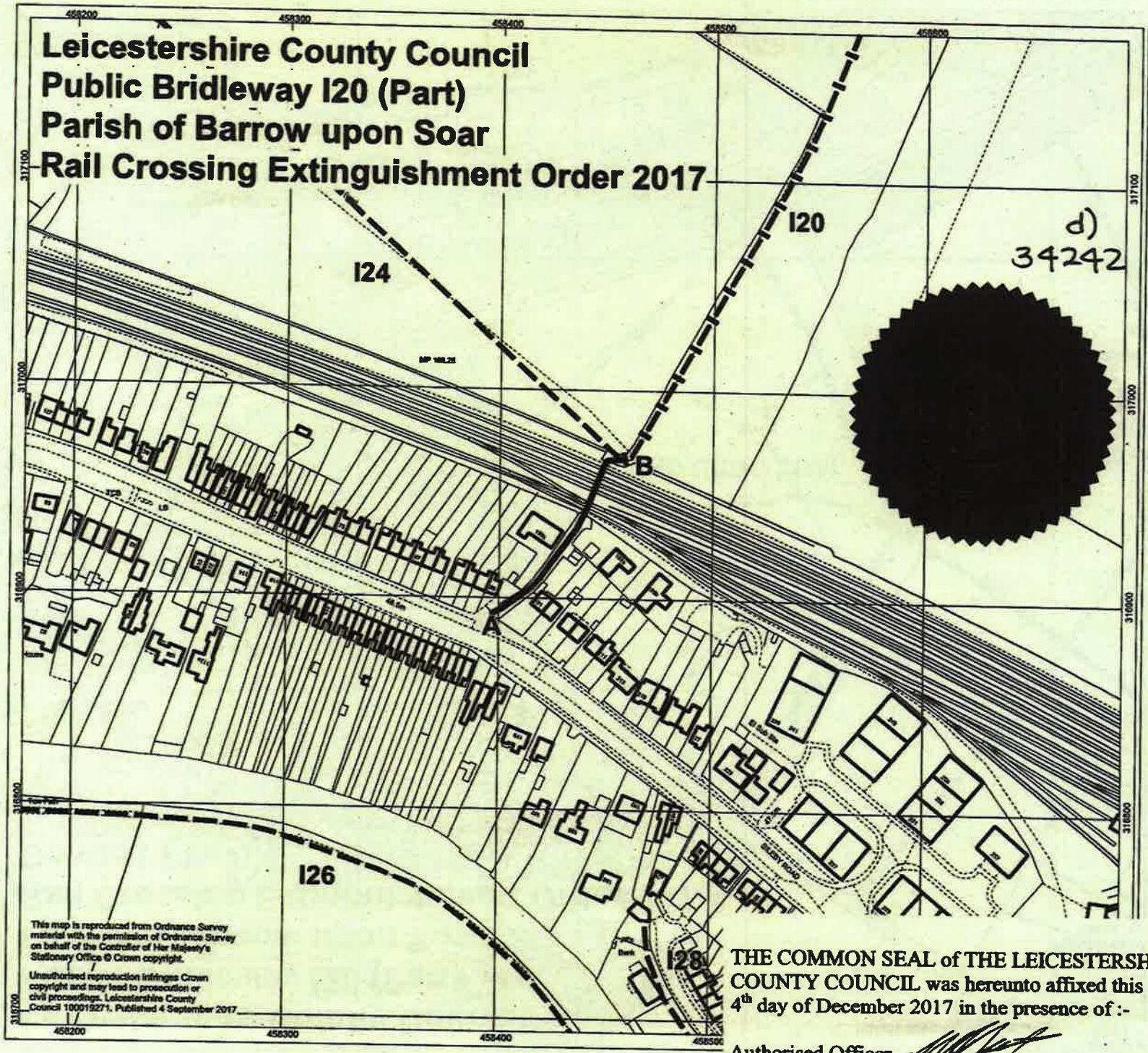
For the Council:

Ms N. Varia	Solicitor employed by the Council
Mr E. McWilliam	Rights of Way Access Manager

DOCUMENTS

1. Opening statement on behalf of the Council
2. Alternative routes map
3. Legislation extracts
4. Extract from 'Managing Public Money'
5. Extract from 'Network Rail's Licence on Operational Efficiency and Safety'
6. Case of Ramblers Association v Kent County Council [1990]
7. Submission from Mr Billson
8. Extracts of plan and photograph for culvert 54
9. Details of routes in the locality
10. Photographs in relation to Grove Lane
11. Options plan
12. Plans for the Poppyfields development
13. Plans of suggested modifications
14. Temporary Traffic Regulation Order correspondence
15. Closing submissions of the objectors
16. Closing submissions on behalf of NR

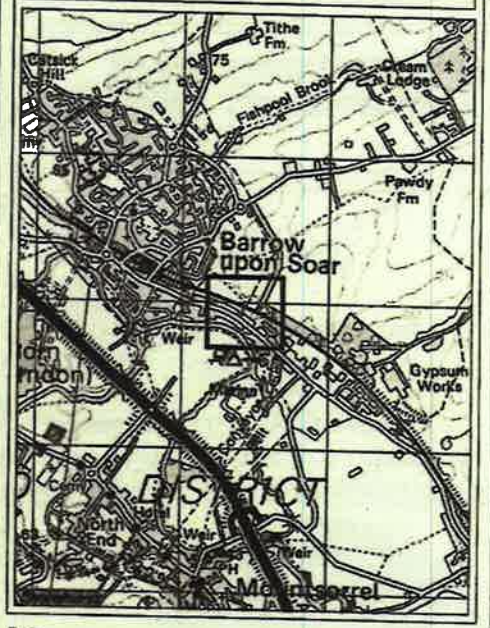
Leicestershire County Council
Public Bridleway I20 (Part)
Parish of Barrow upon Soar
Rail Crossing Extinguishment Order 2017



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Location Plan



Key

- Public Bridleway Proposed to be Extinguished (A-B)
- Unaffected Public Bridleway
- Unaffected Public Footpaths

Environment & Transport Department,
County Hall, Glenfield,
Leicestershire LE3 8RJ
email footpaths@leics.gov.uk
Phil Crossland, Director

Leicestershire County Council

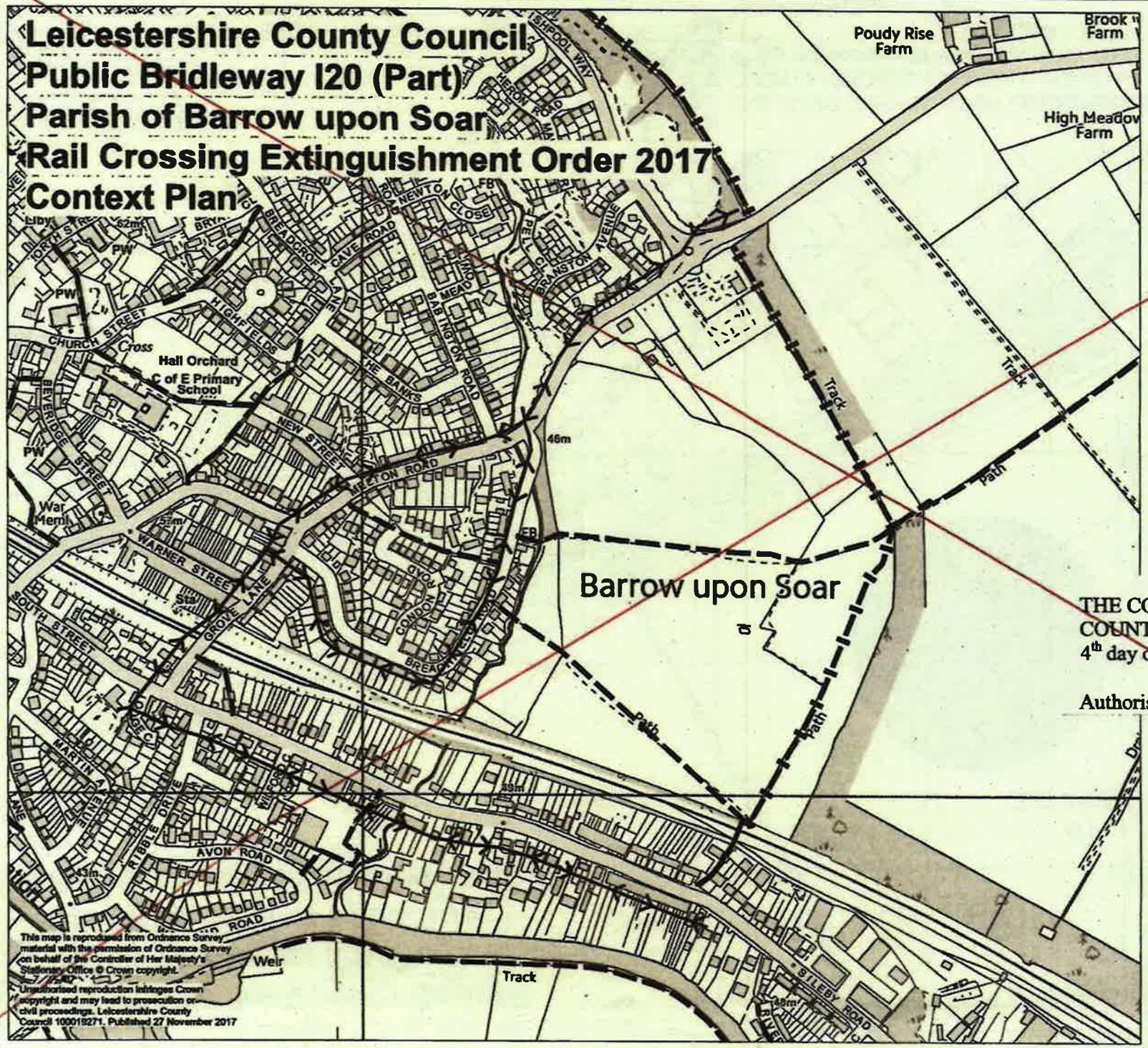
THE COMMON SEAL of THE LEICESTERSHIRE COUNTY COUNCIL was hereunto affixed this 4th day of December 2017 in the presence of :-

Authorised Officer

Plan No.2340

Scale 1:2500

Leicestershire County Council
Public Bridleway I20 (Part)
Parish of Barrow upon Soar
Rail Crossing Extinguishment Order 2017
Context Plan



Key

- Existing Public Footpaths
- Existing Public Bridleways
- Bridleway to be Extinguished
- Alernative Routes via Existing Highways for Equestrians, Cyclists and Pedestrians

e) 34242

THE COMMON SEAL of THE LEICESTERSHIRE COUNTY COUNCIL was hereunto affixed this 4th day of December 2017 in the presence of :-

Authorised Officer

Environment & Transport Department,
County Hall, Glenfield,
Leicestershire LE3 8RJ
email footpaths@leics.gov.uk
Director Phil Crossland

Leicestershire County Council

Plan No.2340C

Scale 1:6000

JG11

RAIB
Rail Accident Investigation Branch

Rail Accident Report



Fatal accident at Tackley station level crossing, Oxfordshire
31 March 2008

Department for Transport

Report 09/2009
March 2009

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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This report is published by the Rail Accident Investigation Branch, Department for Transport.

Fatal accident at Tackley station level crossing, Oxfordshire, 31 March 2008

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Introduction

Preface

1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.

2 The RAIB does not establish blame, liability or carry out prosecutions.

Definitions

3 Mileages are measured from London Paddington via Didcot.

4 The *up line* is used by trains heading south towards Oxford; the *down line* for trains heading north towards Banbury. The down line and down side of the crossing are closest to Tackley village.

5 Left and right are defined from the point of view of a train approaching the crossing on the up line.

6 Appendices at the rear of this report contain the following glossaries:

- acronyms and abbreviations are explained in Appendix A; and
- technical terms (shown in *italics* the first time they appear in the report) are explained in Appendix B.

Summary of the report

Key facts about the accident

7 At about 15:16 hrs on 31 March 2008, a train travelling from Dundee to Bournemouth struck and fatally injured a female pedestrian at Tackley station level crossing in Oxfordshire.

8 There was no damage to the train or the railway infrastructure.

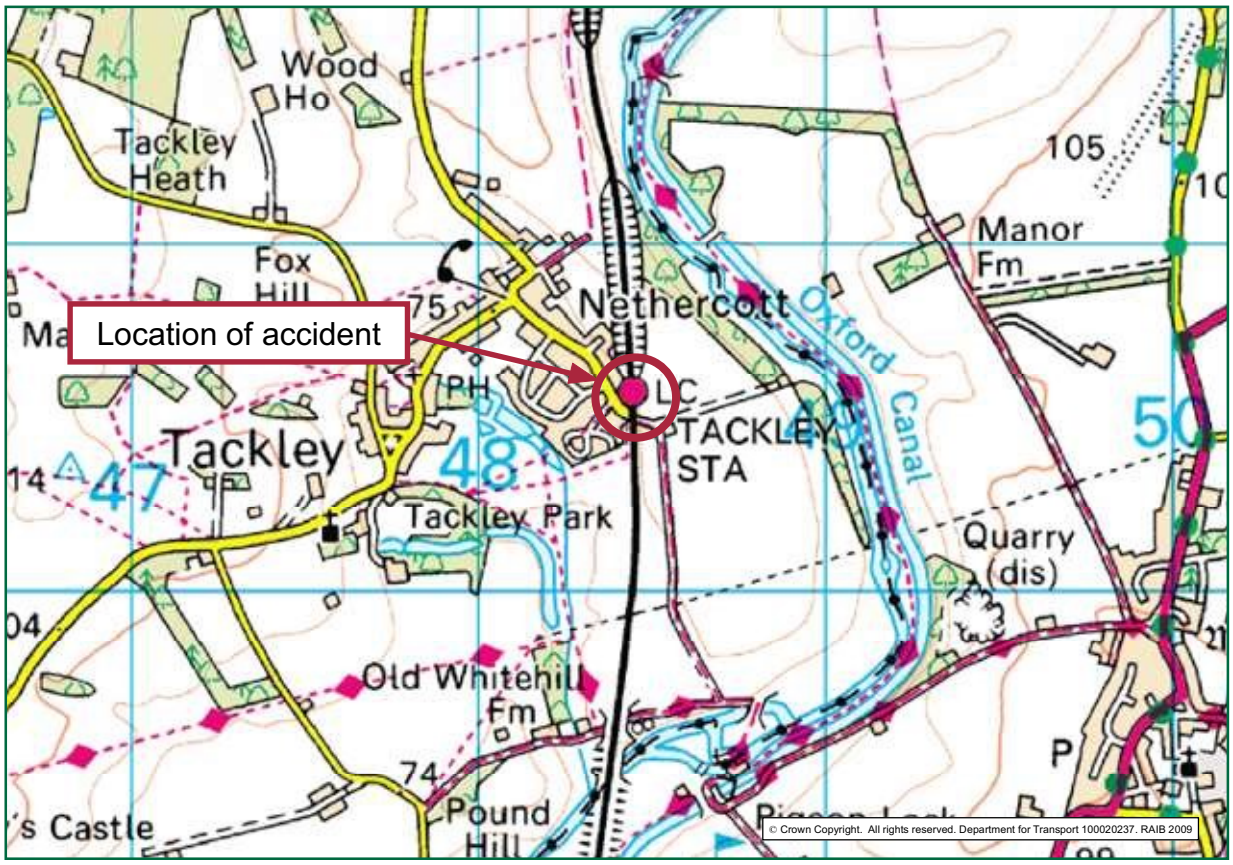


Figure 1: Extract from Ordnance Survey map showing location of the accident

Immediate cause, causal, contributory and underlying factors

9 The immediate cause of the accident was that the pedestrian stepped onto the crossing and into the path of an approaching train.

10 Causal factors were:

a. Either the deceased mistaking a late running through train for the stopping service, which was due at about the same time, and which she had intended to catch (incorrect use); or

the deceased being unaware of the approaching train until after she had committed herself to using the crossing, possibly by being unable to hear its approach; and

b. The restricted sighting of trains from outside the railway boundary, from the down (ie village) side of the crossing, due to a poorly sited palisade fence.

11 The following factor was considered to be possibly contributory:

- The use of a *decision point*, which was not required to be marked, within the wicket gate for assessment and inspection purposes. This did not accurately reflect the behaviour of crossing users, but allowed the crossing to pass its assessment and inspections and meant that the need to improve sighting was not recognised.

12 An underlying factor was:

- The local authorities' rejection of proposals to replace the crossing at a time when it was cost effective to take action, which meant that this opportunity was lost. As a consequence, no reasonably practicable measures could be taken, and this was an underlying factor in the crossing remaining in use.

Recommendations

13 Recommendations can be found in paragraph 158. They relate to the following areas:

- safety improvements associated with Tackley level crossing;
- the control of fencing at crossings; and
- the marking of decision points and required sighting distances at crossings.

The Accident

Summary of the accident

14 At 15:16 hrs on Monday 31 March 2008, train 9O18, the 07:03 hrs Dundee to Bournemouth CrossCountry service, struck and fatally injured an 82 year-old female pedestrian at Tackley station level crossing (Tackley crossing) in Oxfordshire. The deceased person was a local resident who was using the crossing to access the station.

15 At the time of the accident, train 9O18 was running approximately nine minutes late, and travelling at 90 mph (145 km/h).

The organisatons involved

16 The level crossing is on the railway between Oxford and Banbury, which is owned, operated and maintained by Network Rail (Thames Valley area).

17 The train was operated by CrossCountry Trains Ltd and the train crew (driver and guard) were CrossCountry employees.

18 Tackley station was operated by First Great Western Ltd, trading as First Great Western Trains.

19 The above parties freely cooperated with the investigation.

Location

20 Tackley station is located at 72 miles 50 chains on the Didcot to Chester line, between Oxford and Heyford. Tackley crossing is situated 35 metres (38 yards) south of the station (Figure 4).

21 The railway is double track with a 90 mph (145 km/h) line speed, increasing to 110 mph (177 km/h) for high speed trains south of Tackley crossing.

22 The railway is used by a mix of through-passenger and freight services, and local trains serving Tackley station.

23 The weekday timetable at the time of the accident listed 12 departures from Tackley in the up direction, and 10 departures in the down direction. The daytime passenger stopping service was infrequent, with three trains departing in the up direction between 10:00 hrs and 19:00 hrs.

External circumstances

24 The weather on 31 March was dry with normal visibility and a 5 mph south-easterly wind.

Train(s)/rail equipment

25 Train 9O18 was formed of a five-car 'Voyager' *diesel multiple unit*, 221 117, with a maximum speed of 125 mph (201 km/h).

26 Tackley crossing is *user-worked* with separate vehicular and wicket gates, the vehicular gates normally being kept locked (Figure 2). The crossing provides three types of access:

a. it is an *accommodation crossing* giving access for Tackley Estate, who are the only *authorised users*, and can use the crossing for farm vehicles in connection with managing and using the Estate;

b. it allows a footpath and bridleway to cross the railway, and forms part of an on-road cycle route promoted by the National Cycle Network; and

c. it is the only means of access to the up (London bound) platform of Tackley station from the village.



Figure 2: Approach to Tackley crossing from the down (ie village) side

27 Tackley crossing is defined as an *unprotected crossing* in accordance with Network Rail's operations manual procedure 5-23 'level crossing risk assessment – site visits & censuses' (procedure 5-23), as it is neither manned nor an *automatic level crossing*. It is equipped with *whistle boards* for trains approaching in both up and down directions, and there are telephones fitted at the crossing for use by level crossing users with vehicles or animals.

28 The crossing deck is constructed from rubber panels providing a surface level with the rails. At the time of the accident, the deck was in good condition

29 North of Tackley station, an emergency crossover provides a facility for crossing trains between the up and down lines. This crossover is operated at low speed and was not in use on 31 March 2008.

30 The railway is equipped with colour-light signals controlled from Oxford power signal box. The lines are fitted with a mix of DC and U-type Aster *track circuits*.

31 For trains approaching Tackley in the down direction, visibility of the crossing is restricted by a long left-hand bend. The approach in the up direction is straight for 600 metres (Figure 4).

Events preceding the accident

32 Train 9O18, operated by CrossCountry, was scheduled to run non-stop between Banbury and Oxford at a maximum speed of 110 mph (177 km/h) where permitted.

33 The train forming the 15:20 hrs First Great Western service from Tackley to Oxford was delayed by approximately four minutes at Banbury in order to allow the late running CrossCountry service to run ahead of it.

Events during the accident

34 Train 9O18 approached Tackley station at 15:16 hrs on the up line and at a speed of 90 mph (145 km/h). The driver sounded the horn as he approached a whistle board located 365 metres before the crossing and observed that the crossing was clear. At this time, the train was nine seconds from the crossing and would have been clearly visible to a crossing user.

35 As the train ran through the station, the driver states he observed a child with two adults standing behind the yellow line on the up platform. The driver then checked his speedometer before he looked ahead again.

36 The driver observed a female pedestrian on the crossing ahead of him, walking from right to left (ie towards the up platform) and looking ahead. The person on the crossing appeared to run in an attempt to get clear when she became aware of the train, but was unable to avoid being struck.

37 The driver applied the emergency brake nine seconds after sounding the horn, during which time the train travelled 355 metres.

Consequences of the accident

38 The level crossing user was fatally injured as a result of being struck by the train.

Events following the accident

39 The driver applied the emergency brake and brought the train to a halt. He switched on flashing lights to warn any trains approaching in the opposite direction and made an emergency call to Network Rail's Operations control, using an emergency button on the train's National Radio Network (NRN) radio. He informed the controller of the accident and requested the attendance of the emergency services.

40 The driver contacted the Oxford signaller using his mobile telephone, as the NRN radio had stopped working, to inform him of the accident. The driver was told that all other trains in the vicinity would be stopped and that his train was now protected. The driver then spoke to a British Transport Police incident room on the instructions of the signaller.

41 The driver informed the on-board train manager of the accident. The train manager walked back towards the level crossing to try and ascertain the location of the deceased. Members of the public waiting at the station were unaware of the accident until being informed by the train manager.

42 The emergency services arrived at approximately 15:25 hrs.

43 The driver was relieved of duty on site and was breathalysed as a routine precaution. This gave a negative result. The train was taken forward to Oxford before being taken out of service.

The Investigation

Investigation process and sources of evidence

44 The investigation focused on the following aspects:

a. actions of the driver;
b. the actions of the deceased;
c. crossing layout and conditions at the time of the accident;
d. visibility of approaching trains; and
e. crossing assessment and maintenance activity.

45 Evidence has included:

f. examination of the site;
g. witness statements;
h. on-train data recorder records;
i. level crossing records; and
j. planning records relating to the proposed replacement of Tackley crossing.

Key facts about the accident

Train 9O18

46 Train 9O18 had been delayed by a signal failure in the Wakefield area (Yorkshire) earlier in its journey, and was running late on arrival in Birmingham. It was due to depart from Birmingham New Street at 14:03 hrs, but eventually left 13 minutes late. The delay had reduced to nine minutes on departure from Banbury.

47 The *on-train data recorder* confirms that the train did not exceed the 90 mph (145 km/h) speed limit as it approached Tackley station, and that the driver sounded the horn as he passed the whistle board on the approach to the crossing. It also confirms that the driver applied the emergency brake nine seconds later and that the train travelled for 704 metres (771 yards) with the emergency brake applied before coming to a complete halt.

The deceased person

48 The deceased person was 82 years-old, and a longstanding resident of Tackley village. She was an occasional user of the level crossing, and was active and able to walk without aid. She had been intending to travel by train to Oxford on 31 March 2008 and was wearing appropriate shoes for walking. She had experienced some loss of hearing.

Tackley crossing

49 The village of Tackley is situated entirely on the west side of the railway, which was opened between Oxford and Banbury in 1850. A level crossing was required to allow the railway to cross an existing local road between Tackley and the nearby village of Kirtlington. In 1931, a halt (station) was opened adjacent to the crossing to serve Tackley village. At that time, a crossing keeper was provided on a 24-hour basis and the crossing gates were interlocked with the signalling system. With the closure of the crossing as a through route and withdrawal of the crossing keeper, the crossing subsequently became user-worked, and is now unmanned.

50 Network Rail own over 7600 level crossings, including 165 unprotected *station-related crossings*. Twenty six of these are defined as ‘user-worked’ or ‘footpath crossings’, as opposed to those provided for the operation of the station. Tackley is the only location identified by the RAIB where an unprotected level crossing combines station access with a public bridleway.

51 A local access road runs adjacent to the railway from the south-west corner of the crossing. The crossing’s vehicular and wicket gates are positioned approximately 2.3 metres from the nearest track, and in line with the railway boundary fence to the south. Crossing signage and a telephone are positioned on this fence line (Figure 2). As the crossing is defined as a road to which the public have access, all signs are required to comply with the traffic signs regulations.

52 The Office of Rail Regulation (ORR) is the safety authority for the national rail network. ORR's Her Majesty's Railway Inspectorate (HMRI), formerly part of the Health and Safety Executive, provide guidance for use by railway infrastructure owners. The document 'Railway Safety Principles and Guidance' Section 2E 'Guidance on Level Crossings' (RSPG Section 2E) relates to level crossings, and was published by the Health and Safety Executive in 1996.

53 RSPG Section 2E establishes the principle of a 'decision point' as being a point where guidance on crossing safely is visible and at which a decision to cross or wait can be made in safety. In addition, RSPG Section 2E stipulates that 'a sign explaining to the user how to proceed safely over the crossing eg 'Stop, Look, Listen' or 'Cross only if green light shows' or 'Stop, always telephone before crossing' should be provided facing the user at the decision point.'

54 In paragraph 138, the guidance states 'Users are expected to use reasonable vigilance to satisfy themselves that no trains are approaching the crossing before they start to cross the line, and to cross as quickly as possible. Users should have sufficient time from first seeing or being warned of an approaching train to cross safely.'

55 In paragraphs 147 and 148, the guidance recommends that 'in assessing the speed at which users will traverse the crossing, allowance should be made for the mobility of the likely users and the type of crossing surface'. For the purpose of calculating crossing times, 'a speed of 1.2 metres per second (m/s) should be used where the surface is at or near to rail level' and that 'the calculated time in traversing the crossing should be increased to take account of foreseeable circumstances such as impaired mobility of users, numbers of prams and bicycles or where there is a slope or step up from the decision point'. Network Rail standard RT/LS/S/012 'Specification for assessment of user worked and bridleway level crossings' (now superseded) recommended that the crossing time be increased by 50 % in urban areas.

56 The guidance also stipulates in paragraph 213, that at a user-worked crossing, gates should not to be closer to the track than the decision point.

57 RSPG Section 2E further stipulates additional protective equipment that may be provided at user worked crossings. These include audible warnings from trains where speeds are low and the service infrequent, with whistle boards positioned not more than 400 m from the crossing; and telephones where the minimum *warning time* cannot be obtained (ie where the crossing time exceeds the sighting time of approaching trains). For footpath and bridleway crossings, the same mitigation measures apply with the proviso that telephones are only applicable at bridleway crossings.

58 Tackley crossing is 9.5 metres long between wicket gates. The decision points are at the same level as the crossing, but the road slopes downwards towards the village once outside of the railway boundary fence.

59 There have been no accidents or significant incidents recorded at this location on the Rail Safety and Standards Board's safety management information system (SMIS) database, which includes information dating back to 1990.

Whistle boards

60 At Tackley, whistle boards are positioned on both the up and down lines to increase the warning time available for crossing users. The position of the whistle board on the up line, 365 metres from the crossing, gives a crossing user approximately 7.9 seconds warning of an approaching train.

Crossing telephones

61 Signs adjacent to the telephones instruct users with vehicles or animals to contact the signaller before crossing to check whether there is sufficient time to cross. The telephones are not intended for use by pedestrians in normal circumstances as this would place an excessive demand on the signaller. Pedestrians are expected to rely on the visual sighting and audible warning of approaching trains.

Crossing assessment

62 Tackley crossing is located within Network Rail's Thames Valley area. The area's Level Crossing Risk Control Co-ordinator is responsible for overseeing and reviewing risk assessments for the 228 level crossings in this area.

The All Level Crossing Risk Model

63 In January 2007, Network Rail launched an 'all level crossing risk model' (ALCRM), a computer modelling tool. This tool was designed to standardise the assessment of risks for all types of crossings across the network and its purpose is to support and inform decision making on level crossings in accordance with standard NR/SP/OPS/100 'Provision, Risk Assessment and Review of Level Crossings'.

64 The relevant section of the Network Rail operations manual, procedure 5-24 'Use of the all level crossings risk model', requires that each level crossing shall be subject to a risk assessment at not more than three-yearly intervals. Additional assessments are required following changes in traffic patterns or after an accident or serious incident. The assessment regime is supplemented by six-monthly inspections by Network Rail maintenance staff (paragraph 83).

65 The ALCRM requires the type of crossing to be identified and data from a site survey to be input. This includes sighting distances, line speeds and a census of crossing users. Procedure 5-23 lists three types of census: a 'full census' covering a 24 hour period, for which special arrangements need to be made; a 'quick' census covering a 30 minute period between 09:30 hrs and 16:30 hrs on a weekday, for which the results are multiplied by 27 to give a total estimated usage per day; and an estimate. Procedure 5-23 states that a quick census is the standard requirement for public vehicular crossings and the first preference for other crossings unless use is very light.

66 The risks associated with a particular crossing are divided into collective and *individual risk* categories. A *collective risk* is defined as the risk posed to groups, such as on-board staff, train passengers, tractor or vehicle occupants, whereas an individual risk is that posed to a regular crossing user.

67 The model gives the crossing a risk score for each risk category, and identifies the factors contributing to this. It is intended to support and inform an assessor, but the output does not highlight unacceptably short sighting times or take account of the provision of whistle boards. The user is required to exercise judgement in assessing the output.

68 The Level Crossing Risk Control Co-ordinator is required to visit the site and consider risk mitigation if a crossing is assessed as having a collective risk score of 1 to 3 on a range of 1 to 13, where 13 represents the lowest risk, at sites where the contribution of the train accident risk comprises more than 50 % of the total risk at the level crossing. A site visit has to be considered for those crossings with a collective risk score of A to C on a range of A to M, where M represents the lowest risk.

69 The model calculates an *equivalent fatalities* value, which is a statistical measure, before and after any mitigation is applied. The result is a numeric value which can be used for the purposes of cost-benefit analysis. Network Rail have developed a risk mitigation 'toolkit' to assist Level Crossing Risk Control Co-ordinators in identifying appropriate risk mitigation measures.

70 The initial programme of ALCRM assessments was required to include public vehicular crossings and *station foot crossings* within the first 12-month cycle commencing in January 2007, with all crossings being incorporated into a 3-year rolling programme. Assessments are normally undertaken by the Level Crossing Risk Control Co-ordinator or by a local mobile operations manager on his behalf.

ALCRM survey and assessment for Tackley crossing

71 Tackley crossing was assessed in April 2007 as a 'user worked crossing with telephone' rather than as a footpath crossing despite the majority of users being pedestrians. This was because the risk to a train was considered greater if it encountered a horse or vehicle on the crossing (ie collective risk) rather than a pedestrian (ie individual risk). The assessment was undertaken by the Level Crossing Risk Control Co-ordinator, who had been trained to use the tool and was an experienced level crossing assessor. The assessment policy was subsequently modified to require separate assessments for each element of a multiple-use crossing such as Tackley.

72 A 30 minute census was undertaken at the same time, and this was timed to include the departure of an up train. The census recorded five crossing users during this period and was not required to distinguish between station users and walkers heading for the nearby river and canal. Vehicular use of the crossing is rare.

73 Sighting distances from the crossing were measured by the Level Crossing Risk Control Co-ordinator using optical distance measurement (range-finder) equipment. Procedure 5-23 states 'measure the distance at which the train comes into sight'. He recorded sighting distances from the down side of the crossing as:

a. for trains approaching from the down direction: 420 metres with the file note 'sighted to trees'; and

b. for trains approaching from the up direction: 624 metres, sighted to a signal post.

74 Sighting distances from the up side of the crossing are greater due to the curvature of the track.

75 He assessed the crossing length as being 9.0 metres between decision points. As this was an early application of the ALCRM, he calculated the sighting requirements independently based on train speed and the required crossing time, using a crossing speed of 1.189 m/sec in accordance with procedure 5-23. This was slightly more conservative than the 1.2 m/sec recommended by RSPG Section 2E, giving a crossing time of 7.6 seconds. His assessment indicated that a minimum sighting distance of 324 metres was required, or 486 metres if an allowance, in this case 50 %, were made for users with impaired mobility (paragraph 55). He concluded that sighting was acceptable for normal users but deficient if the longer crossing time was considered.

76 The Level Crossing Risk Control Co-ordinator did not consider that a 1.8 metre high palisade fence, located on the down side at the north-west corner of the crossing, affected sighting. This was on the basis that the decision point was on the track side of the wicket gate where the sighting was not obscured (Figures 3 and 4).

77 The assessment record included the note: 'vegetation must be under control to maximise sighting, particularly down side approach to the south'. He did not consider that immediate action was necessary, which would have required him to log it as a defect with Network Rail control, or inform the local maintenance organisation who had responsibility for vegetation control (paragraph 84).

78 The ALCRM model was run using information obtained during the site survey and census, with 50 % additional time allowance for impaired mobility users.

79 The model gave the crossing a 'C2' risk score which indicates that both the collective and individual risks were relatively high, and this required Network Rail to consider mitigation measures. The model identified the following factors as contributing to this risk:

a. crossing is near a station;

b. train frequency; and

c. low sighting time.

80 The associated cost-benefit analysis suggested a figure of £600,000 to mitigate this risk. This value was derived by multiplying the annual *fatalities and weighted injuries* (FWI) value by the lifecycle of the proposed mitigation with relevant discount factors applied.

81 The Level Crossing Risk Control Co-ordinator judged this to be insufficient for a subway or footbridge suitable for use by horses, and he was aware of various schemes which had been proposed and not gained planning approval at this site. A *miniature stop light* scheme, displaying red or green lights to indicate the approach or absence of a train, was also considered, but the ALCRM did not indicate that this would be cost-effective due to the limited safety benefits associated with this type of crossing when located close to a station, due to the risk of misuse when passengers are rushing to catch a train.

82 At the time of the accident, the Level Crossing Risk Control Co-ordinator was waiting for further advice on footbridge costs for various sites including Tackley. However, the lack of any acceptable alternative to the crossing meant that the issue was otherwise in abeyance.

Crossing maintenance

83 Network Rail carried out crossing inspections at six month intervals in accordance with standard NR/SP/SIG/19608 Issue 2, 'Level Crossing Infrastructure (Inspection and Maintenance) Handbook'. The purpose of these inspections is to ensure that 'level crossing systems are safe, reliable and legally compliant'.

84 Network Rail's local maintenance organisation, led by the Area Services Manager, provided crossing inspectors for this purpose. The inspectors worked in pairs to allow minor maintenance tasks to be completed during the inspection visit, and were able to generate work orders if the need for more significant work was identified. NR/SP/SIG/19608 states 'the inspector must have access to relevant information to assess the level crossing, including as appropriate layout of signs and sighting distances. The Level Crossing Risk Control Co-ordinators shall maintain the sighting distance requirement for each crossing where this applicable, [sic] and shall make this information available to the Area Services Manager'.

85 Tackley crossing was visited by crossing inspectors in July 2007, and the same team revisited in December 2007. The inspectors identified minor defects on both occasions. The report form required the inspectors to compare the *required sighting distance* from each side of the crossing and compare this with the actual sighting distances, recommending that vegetation clearance be considered if the outcome was borderline. Specifically:

a. The July 2007 report identified a required sighting distance of 878 metres, but noted that this was not achieved on either side of the crossing. The whistle boards and crossing telephones were cited as mitigation; and

b. The December 2007 report identified a required sighting distance of 800 metres, noting that this could not be achieved from the down side of the crossing. However, on the up side the report stated that sighting exceeded 800 metres. On this occasion, the crossing telephones were cited as mitigation.

86 No action was taken to improve sighting as the provision of whistle boards meant that the crossing was compliant.

RAIB assessment of sighting distances

87 The RAIB assessed sighting distances and timings at the crossing using range-finder equipment and, where possible, a stop-watch on the day following the accident, with corroboration provided by a member of Network Rail's operations staff. For consistency, a train was deemed to be visible when its headlight could be seen although in the case of trains approaching on the down line (ie from the south), the roof was visible earlier.

88 From the down side of the crossing, observing trains travelling on the up line (ie approaching from the north):

a. Just outside of the railway boundary (ie wicket gate): 120 metres, equivalent to 3 seconds at 90 mph (145 km/h). The palisade fence at the north-west corner of the crossing obstructed visibility from this position (Figure 3).

b. Inside of wicket gate and approximately 2.2 metres from the running rail: 600 metres, equivalent to 15 seconds at 90 mph (145 km/h). This is the maximum possible distance due to curvature of the track and applies to sighting from both sides of the crossing (Figure 4).



Figure 3: Visibility from the down side of the crossing to the north, photographed from outside of the railway boundary



Figure 4: Visibility from the down side of the crossing to the north from within the wicket gate

89 From the down side of the crossing observing trains approaching on the down line:

a. Just outside of wicket gate: 925 metres, equivalent to 23 seconds at 90 mph (145 km/h). Approaching trains were visible across a field due to the curvature of the track.

b. Inside of wicket gate: 300 metres, equivalent to 7.6 seconds at 90 mph (145 km/h). Visibility from this position was restricted by vegetation on the inside of the curve growing on raised ballast, and by signs at the crossing. The roof of an approaching train was just visible above the vegetation as it passed the whistle board, 350 metres from the crossing (Figure 5) but this may not be apparent to all crossing users.





Figures 5 & 6: Train approaching on the down line, viewed from the down side of crossing outside of the wicket gate. The train is visible in the distance (Figure 5), but becomes hidden by vegetation as it approaches the crossing (Figure 6)

90 During the RAIB's daylight visit, several trains failed to sound their horns as they approached the crossing. This issue was reported at the time, and the RAIB raised an urgent safety advice notice which it issued to Network Rail and all train operating companies using this route. A copy is included as Appendix D.

The Cross Country Route Modernisation project

91 In 1999, Railtrack plc, as the then infrastructure owner, commenced a project to upgrade the line through Tackley as part of the Reading-Birmingham Cross Country Route Modernisation project. The project was designed to achieve line speed improvements in preparation for a new timetable to be introduced in September 2002 to complement the introduction of high speed class 220 and class 221 trains.

92 In order to achieve an increase in the line speed through Tackley from 90 mph (145 km/h) to 110 mph (177 km/h), it was considered necessary to close the crossing and provide alternative means for crossing the line. A higher approach speed means that crossing users need to be able to see an approaching train at a greater distance in order to use the crossing safely. The speed of trains is therefore directly related to the sighting distance required, assuming that the time to use the crossing remains constant.

Proposed footbridge

93 On 19 December 2000, Railtrack made a planning application for a footbridge to the local planning authority, West Oxfordshire District Council. The footbridge was to be sited immediately north of the existing level crossing, and was intended for pedestrians only, supplementing rather than replacing the crossing (Figure 7).

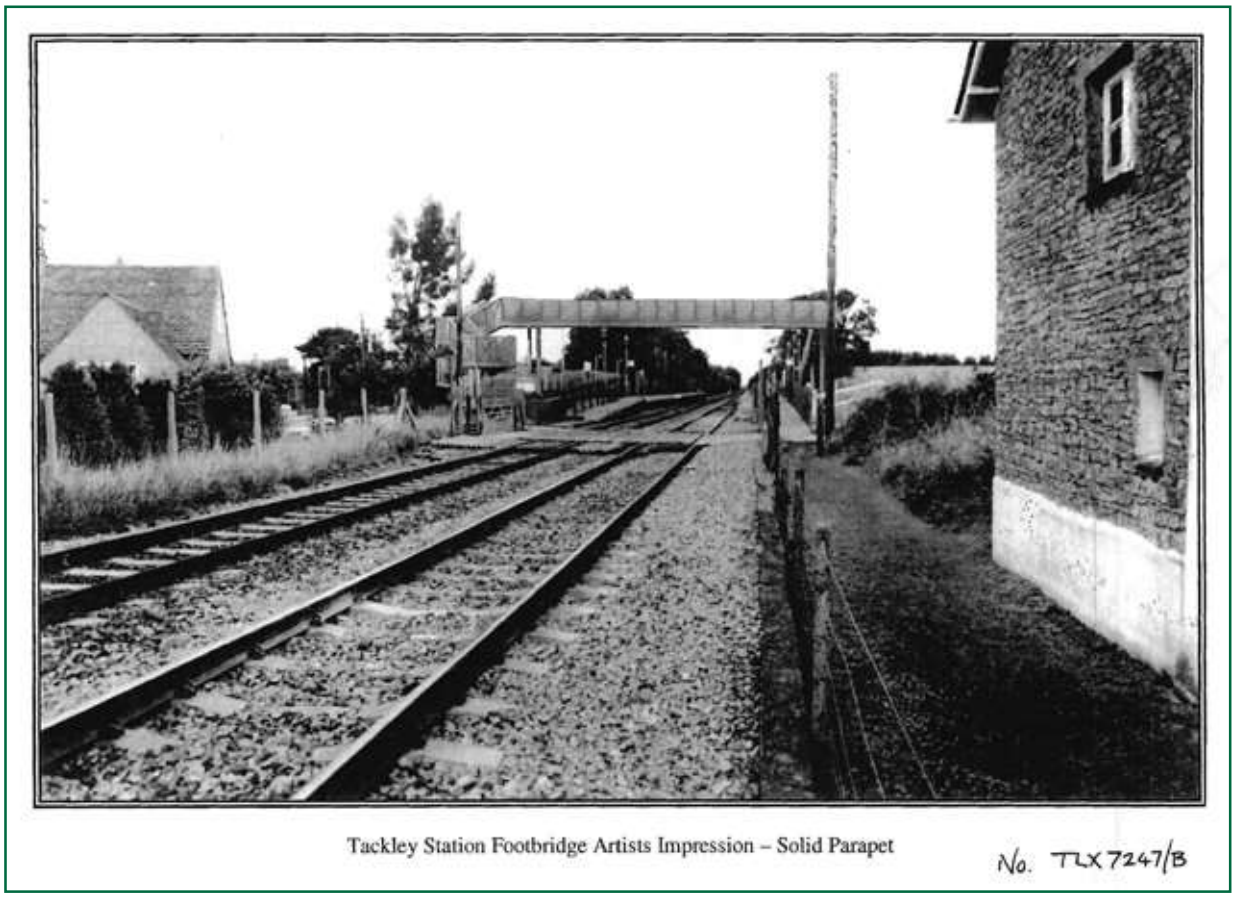


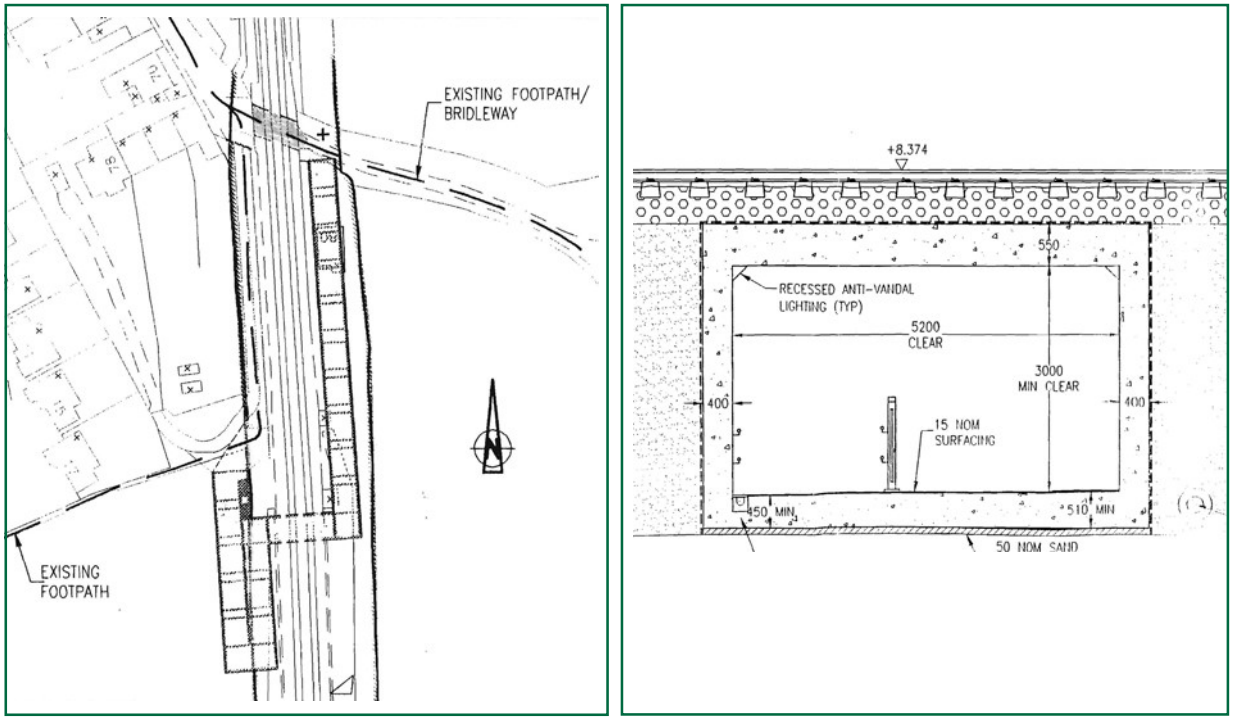
Figure 7: Artist's impression of proposed footbridge (Network Rail)

94 On 6 March 2001, this planning application was refused by the local planning authority, citing 'that the proposed footbridge will, by reason of its size, design and use of materials represent an alien, incongruous and overtly urban feature in this rural location'.

Proposed subway

95 On 15 July 2002, Railtrack submitted an alternative planning application, this time for a subway located south of the crossing. This scheme was intended to accommodate the bridleway and footpath, and together with a permanent diversion of vehicular traffic via a different route by agreement with Tackley Estate, would allow the complete closure of Tackley crossing.

96 Due to the existing access road at the south-west corner of the crossing, the subway was to be sited approximately 90 metres to the south on agricultural land. Drainage concerns dictated that the structure be kept as shallow as possible; the design drawings showing a structure passing beneath the railway at the minimum depth, and with insufficient headroom for horse riders to remain mounted. To minimise the amount of land required, the approach ramps were to be situated close to the railway fence, with steps and a ramp provided on the west approach and a shared ramp on the east side. A dividing barrier was proposed between bridleway and pedestrian sections (Figures 8 and 9).



Figures 8 & 9: Proposed subway showing location and cross-section (Network Rail)

97 On 10 October 2002, the planning application was refused by West Oxfordshire District Council, on the basis of "the design's failure to make safe and convenient provision for horses, their riders, pedestrians, cyclists, the elderly and disabled people; and that the subway would appear as an unduly prominent and intrusive feature in the rural scene". This decision was supported by Oxfordshire County Council.

98 Network Rail, which replaced Railtrack in October 2002, responded by lodging an appeal with the Planning Inspectorate on 24 October 2002 and made minor amendments to the scheme including proposing an alternative bridleway diversion via the bridge to the south and moving the subway ramps further from the railway.

99 A planning inspector appointed by the Secretary of State visited the crossing on 21 March 2003. The inspector was not qualified to assess the level crossing risk, but stated "I saw that trains run fairly frequently along this line, and that sight lines are not particularly good. It is my view that using the existing crossing would be a very hazardous event for anyone with any significant visual impairment or mobility difficulties". The inspector also noted that "whilst negotiating the subway would mean a longer route, some of it at the maximum recommended gradient, it would in my view be likely to make the station more accessible for some disabled users than the present situation".

100 On 8 July 2003, the Planning Inspectorate allowed the appeal, noting the inspector's comments on safety and convenience, and concluding that the proposed subway "would not cause unacceptable harm to the character and appearance of the landscape". Network Rail were granted planning permission and given five years in which to construct the works.

101 By mid-2003, Network Rail had substantially completed the Cross Country Route Modernisation project and project resources were being wound down. The company determined that the line speed increase proposed through Tackley was no longer cost effective and a decision was made not to progress the scheme. The planning approval finally lapsed in July 2008.

Miniature stop lights

102 The use of miniature stop lights was considered by the project, but was not pursued due to the belief that the HMRI would object to such a proposal. The project's view was that there were factors at the crossing which made it extremely unlikely that the HMRI would not object to proposals to install miniature stop lights here. This was due to the risk:

a. that late passengers could rush across for their train, such users being easily confused or tempted into taking risks and disobeying any coloured light warning system;

b. that passengers would be looking out for their Oxford bound train approaching on the far tracks, and that this could distract them from looking in the opposite direction towards trains approaching from Oxford on the near track with a sighting time of approximately six seconds at the new line speed; and

c. that late commuters face a lengthy wait for the next train, providing a strong incentive to run in front of approaching trains.

103 Railtrack did not pursue the miniature stop light option on this basis, citing another station with much lower line speeds where similar arrangements were prone to abuse, and the intended replacement of a similar crossing at Kings Sutton station with a footbridge.

104 HMRI have confirmed that miniature stop light installations at other stations are routinely disregarded if a crossing user is unable to see an approaching train. At Tackley, the bridleway would require a user to be given 40 seconds warning of an approaching train, as opposed to 20 seconds warning for a footpath crossing further increasing the risk of misuse. Level crossings in close proximity to stations pose a much higher level of risk, due to both the higher usage, and passenger violation to catch trains.

Analysis

Identification of the immediate cause[1]

105 The accident was caused by a person stepping onto the crossing and into the path of an approaching train.

Identification of causal[2] and contributory[3] factors

Train 9O18

106 Train 9O18 had been delayed, and approached Tackley station at about the time that a passenger intending to catch the 15:20 hrs stopping service might expect to first see their train approaching.

107 Both fast and stopping trains are required to sound their horns on the approach to Tackley crossing, so this would not allow a crossing user to distinguish between them. A person crossing in front of a train travelling at 90 mph (145 km/h) would be unable to cross safely if the train was closer than 305 metres when they stepped out from the decision point, based on a 7.6 second crossing time (paragraph 75). For a train approaching on the up line, this is beyond the north end of the station platforms, and after it has passed the whistle board and sounded its horn.

108 The driver of train 9O18 sounded the horn nine seconds before he applied the emergency brake. The horn was witnessed by passengers on the station platform, and the train would therefore have been audible to a crossing user, and clearly visible from within the wicket gate. The deceased had either committed herself to crossing the track before she became aware of the train, or was aware of it and mistook it for the stopping service, assuming that she would have time to reach the up platform before it arrived. A passenger missing this train would have to wait over two hours for the next service giving a strong incentive to try and catch the train.

109 The mistaking of a late-running through train for the stopping train, or a lack of awareness of the approaching train, which might be exacerbated by loss of hearing, are both possible causal factors in this accident.

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

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

[3] Any condition, event or behaviour that affected or sustained the occurrence, or exacerbated the outcome. Eliminating one or more of these factors would not have prevented the occurrence but their presence made it more likely, or changed the outcome.

Actions by the driver

110 As train 9O18 approached Tackley station, the driver observed members of the public on the up platform and was satisfied that a young child was under adult supervision. He also checked his speedometer having had to reduce speed to pass through Tackley. These actions, which are part of the normal activities of a driver, meant that he could not continuously observe the approaching level crossing at the far end of the station and it was not an absolute requirement for him to do so. When he looked up, he observed a person already on the crossing and was unable to take any avoiding action other than to immediately apply the emergency brake.

111 The driver brought his train to a halt and instigated the emergency procedure which included informing Network Rail and requesting the attendance of the emergency services.

112 The driver acted appropriately and his actions did not contribute to the accident.

Public use of pedestrian level crossings

113 Level crossings which provide public access across the railway have no restrictions on the age or mobility of those who wish to use them. RSPG Section 2E requires crossing assessments to consider and make allowance for the mobility of likely users. Tackley crossing is adjacent to the village and persons of reduced mobility are potential users of the crossing.

Tackley crossing

114 Tackley crossing has a good safety record (paragraph 59). The crossing deck is level and was in good condition, with gates arranged to give a near-minimum crossing distance. Once on the crossing, sighting is good in both directions. However, local residents have expressed concern about its safety and Tackley Parish Council made a representation to Network Rail on this issue in 2003.

115 This accident involved a pedestrian crossing from the down side (ie west to east), and a train approaching on the up line (ie from the north). From the down side of the crossing, the visibility of trains approaching on the up line was restricted by a palisade fence at the north-west corner of the crossing until the user had passed through the wicket gate (Figures 3 and 4). The height of the fence served no meaningful security purpose as it was not continuous and the rear of the enclosed area, adjacent to the down platform access, was protected by a lower wooden fence.

116 The palisade fence reduced the visibility of trains approaching on the up line to 120 metres from outside of the wicket gate. This represents three seconds travelling time for a train travelling at 90 mph (145 km/h) and was inadequate to assess whether it was safe to cross. Adequate sighting could be obtained from within the wicket gate (paragraph 88b).

117 The palisade fence at the north-west corner of the crossing created an unnecessary obstruction and its effect on sighting of the train by the deceased, and of a pedestrian beside the crossing by the train driver, until she was inside the wicket gate was a causal factor in the accident.

Decision point

118 The ALCRM assessment, and subsequent crossing inspections, were based on the assumption that the decision point for pedestrian users on the down side was at a location inside the wicket gate (ie approximately 2 metres from the closest track). The decision point is not marked, or required to be, but while this arrangement gave an acceptable view of trains approaching on the up line (Figure 4), it necessitated a crossing user looking round the 'Stop, Look, Listen' warning signs to sight trains approaching on the down line (Figures 5 and 6).

119 This dimension was compliant with the minimum given RSPG Section 2E (paragraph 53), although the crossing user was required to look round the warning signs, but the resultant arrangement did not accurately reflect the behaviour of crossing users, as the various sighting obstructions present on 31 March meant that there was no single clear point for pedestrians to decide whether it was safe to cross the line or not. In theory, the decision point for trains approaching on the down line was outside the railway boundary, but inside it for trains approaching on the up line. Standing inside the gate before making a decision on whether to cross the railway may have been counter-intuitive for crossing users, and there was no signage to suggest this might be required.

120 The use of a decision point, which allowed the crossing to pass its inspections, but did not accurately reflect the behaviour of crossing users, meant that the need to improve sighting was not recognised, and was a contributory factor.

Identification of underlying[4] factors

Crossing replacement proposals

121 The Cross Country Route Modernisation project made various attempts to modernise or replace Tackley crossing to allow the line speed to be increased to 110 mph (177 km/h).

122 Mixed-use crossings of this type are rare on the national rail network, and the conflicting needs of the various user types made an acceptable solution difficult to find. Tackley crossing has three modes of use (paragraph 26), and alternative facilities for each type of user needed to be provided to allow the crossing to be closed.

123 The project was unable to find a scheme which satisfied the requirements of all users and the local planning authority. The local authorities' rejection of alternative proposals at a time when it was cost effective to take action meant that this opportunity was lost.

124 Network Rail ultimately obtained planning consent for a subway following an appeal to the Planning Inspectorate. The closure of the crossing had been sought to allow an increase in line speeds, but with the new timetable already in operation by this time, the reason for replacing the crossing had gone. The closure of the crossing was never intended as a safety improvement in its own right, and despite the later ALCRM assessment requiring action to be taken, no suitable solution could be found in light of the earlier planning decisions. The crossing, although assessed as being a higher risk than others on the network, was compliant at the time of the accident.

[4] Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

125 As a consequence of delays caused by the planning process, no reasonably practicable measures to replace the crossing could be taken, and this was an underlying factor in it remaining in use.

Other factors for consideration

Network Rail's local organisation

126 A lack of regular communication between the operations and maintenance departments prevented Network Rail from forming a coordinated view of the condition and maintenance requirements of the crossing. Information contained on the ALCRM assessment record, for example 'vegetation must be controlled to maximise sighting, particularly from the south' was not communicated to the maintenance organisation, and the Level Crossing Risk Control Co-ordinator was not aware that the crossing inspectors were incorrectly relying on crossing telephones as mitigation for reduced sighting (paragraph 85).

Assessment and measurement of sighting distances

127 The level crossing inspectors did not have access to information on the required sighting distance (paragraph 85) and there is no evidence that they requested it. This may explain why the required sighting values differed between the July and December inspections of the crossing, but there was no reason why the value should change and this inconsistency was not identified by the inspectors themselves, or those responsible for reviewing their reports.

128 Network Rail provides training for staff responsible for inspecting level crossings and collecting data for ALCRM assessments. The training material identifies that both track curvature and vegetation can affect the sighting distance, but does not highlight the risk of error occurring if measuring to a non-specific point, or the effect of measuring to the outside of a curve (Figure 10). Range-finder equipment works by reflecting an infra-red beam off an object in its sightline. If there is no feature to reflect the beam at the required distance, the measurement will be incorrect.

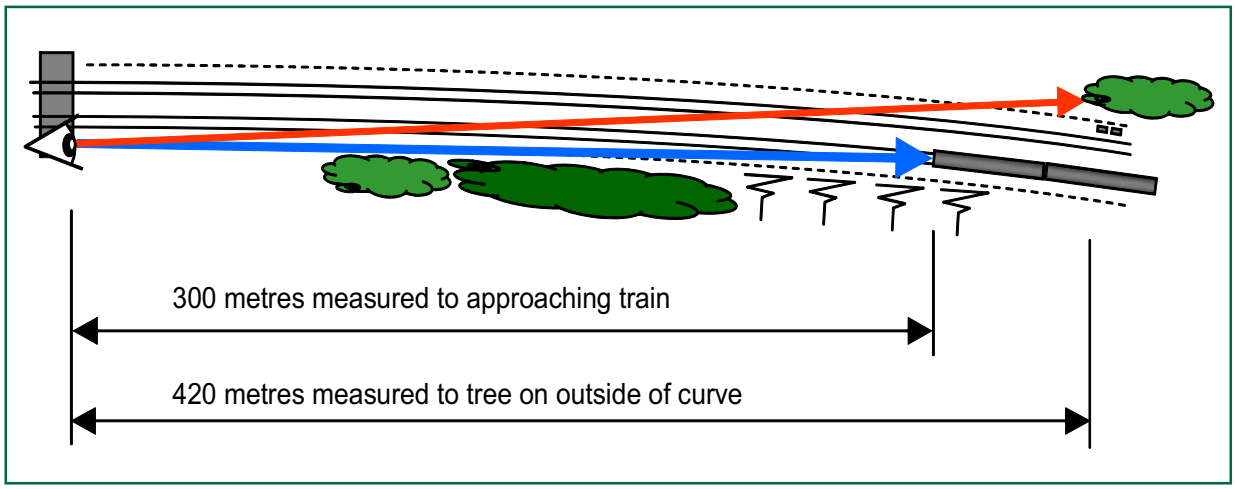


Figure 10: Schematic diagram showing over-measurement of sighting distance on a curve

129 The difficulty in accurately assessing distances using range-finder equipment is evidenced by the April 2007 ALCRM assessment and December 2007 crossing inspection reports. Specifically, the ALCRM assessment used the distance to the outside of the curve, giving a sighting distance of 420 metres, 40 % greater than that calculated by the RAIB by observing approaching trains and using a stop-watch (paragraph 89b). The December 2007 level crossing inspection report gave a sighting distance from the up side of the crossing of over 800 metres, which is 30 % greater than that which is possible for trains approaching on the up line due to a curve in the track. The methods currently in use result in unacceptable variations in the measurement of sighting distances which could compromise the safety of crossing users.

Whistle boards

130 The restricted sighting for crossing users was mitigated by whistle boards positioned at each approach, and these were within the 400 metre maximum distance permitted by RSPG Section 2E. A train approaching on the up line sounding its horn as it passed the whistle board would provide a crossing user with a minimum 7.9 seconds warning of its approach, which exceeds the calculated safe crossing time of 7.6 seconds (paragraph 75). If these boards were positioned at the maximum 400 metres from the crossing, the warning time would increase to 8.7 seconds.

Observations

Night time quiet period

131 Since June 2007, trains have no longer been required to sound their horns at whistle boards following an amendment to the section of the railway rule book relating to train working (GE/RT8000/TW1) unless in emergency or if a person is seen on the track. This rule change established the principle of the night-time quiet period (NTQP), and resulted from research by the Rail Safety and Standards Board (RSSB) into the safety benefits provided by train horns at level crossings (Report T668). The report found that, while the risks to users were higher at night, the level of night time use by trains and users was relatively low at most locations. This was off-set by the societal benefits of reducing noise at night.

132 The introduction of the NTQP removes the protection provided by whistle boards at Tackley crossing during the night. Three of the twelve daily services in the up direction call at Tackley during this period, including the only two morning commuter trains timed to arrive in London before 09:00 hrs. Although this matter is not of direct relevance to this accident, a significant proportion of the regular crossing users have to rely solely on the visual sighting of approaching trains at a time of day when reduced sighting due to poor visibility is more likely.

Effect of a stationary train in the down platform

133 The visibility and audibility of trains approaching on the up line from the down side of the crossing is reduced when a train is stationary at the down platform. The respective layout of the station platforms and crossing means that a train travelling at 90 mph (145 km/h) becomes fully visible less than three seconds before it reaches the crossing. Network Rail refers to this phenomenon as a ‘hidden train factor’ (Figure 11).



Figure 11: Photograph of train in down platform, in August 2008, illustrating the 'hidden train factor'. Note that the green palisade fence has now been removed, but that sighting is still affected by fencing on the platform

134 This risk to crossing users is not identified by warning signs as the crossing is defined as a road to which the public have access, and all signs are required to comply with the traffic signs regulations. In these circumstances, the whistle board performs a vital function.

Conclusions

Immediate cause

135 The immediate cause of the accident was the deceased stepping onto the crossing and into the path of an oncoming train.

Causal factors

136 Causal factors were:

a. Either the deceased mistaking a late-running through train for the stopping service, which was due at about the same time, and which she had intended to catch (incorrect use) (paragraph 109); or

   the deceased being unaware of the approaching train until after she had committed herself to using the crossing, possibly by being unable to hear its approach (paragraph 109, **Recommendation 1**); and

b. The restricted sighting of trains from outside the railway boundary at the down side of the crossing, due to a poorly sited palisade fence (paragraph 117, **Recommendation 2**)

Contributory factor

137 The following factor was considered to be possibly contributory:

- The use of a decision point, which was not required to be marked, within the wicket gate for assessment and inspection purposes. This did not accurately reflect the behaviour of crossing users, but allowed the crossing to pass its assessment and inspections and meant that the need to improve sighting was not recognised (paragraph 120, **Recommendation 3**).

Underlying factors

138 An underlying factor was:

- The local authorities' rejection of proposals to replace the crossing at a time when it was cost effective to take action, which meant that this opportunity was lost. As a consequence, no reasonably practicable measures could be taken (paragraph 125).

Additional observations[5]

139 A lack of communication between operations and maintenance departments led to a lack of shared knowledge concerning the condition of the crossing, and an incorrect assumption about the purpose of the crossing telephones going unchallenged (paragraph 126, **Recommendation 4**).

140 Assessment of the required sighting distances was inconsistent and, although conservative, inaccurate. There was no reason why this figure should have varied between inspections or could not have been established in advance as required by standard 19608 (paragraph 84). The anomalies were not identified by those responsible for reviewing the completed reports (paragraph 127, **Recommendations 4b and 5**).

141 Assessments of the actual sighting distances available were of variable accuracy and in some cases misleading (paragraph 129, **Recommendation 5**).

142 Sighting of trains approaching on the down line from the down side of the crossing was restricted by vegetation, some of which was growing on mounds of ballast deposited beside the track (paragraph 89, **Recommendation 6**).

143 The whistle boards are compliant, but closer than the 400 metres maximum allowed by RSPG Section 2E. This reduces the maximum warning time available to crossing users (paragraph 130).

144 Fast trains approaching on the up line are visible for less than three seconds before they reach the crossing when a second train is stationary in the down platform. This risk is not identified to crossing users (paragraph 134, **Recommendation 1**).

145 The driver of 9O18 was unable to use his NRN radio to report the accident to the Oxford signaller as this stopped working after the initial emergency call.

146 On 16 February 2009, the driver of train 1M54, the 13:45 hrs Bournemouth to Manchester Piccadilly CrossCountry service, reported having a near-miss at Tackley level crossing with an elderly person who did not seem to react to the noise of the train horn. The driver made an emergency brake application.

147 Although not the case in this accident, drivers did not always sound their horns when approaching Tackley crossing in daylight (paragraph 90).

[5] 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.

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

148 The RAIB issued an urgent safety advice Network Rail and all train operators using this route on 8 April 2008 to highlight the following issues:

a. Obstructions to visibility from the down side of crossing;

b. The lack of signage to advise crossing users that sighting of up through trains is impaired by any stationary train in the down platform; and

c. Inconsistent observation of the whistle board by approaching trains.

149 Network Rail responded to the urgent safety advice by removing part of the palisade fence.

150 The crossing was reassessed following the accident as both a user-worked crossing with telephone and as a bridleway crossing. Its 'C2' risk score was confirmed.

151 Network Rail report that they have since made further improvements to sighting at Tackley crossing by a reduction in the height of fence lines, and removal of vegetation and rubble. The signage at the crossing has been de-cluttered, and unnecessary parking notices have been removed. The crossing was assessed again following these works in November 2008, and the ALCRM risk profile has improved, giving a 'C4' risk score for the footpath and bridleway elements and a 'D4' risk score as a station foot crossing, this having not previously been assessed (paragraph 71). As a consequence, the whistle boards are no longer part of the primary means of protection at the crossing for foot users. However, the near-miss which occurred on 16 February 2009 (paragraph 146) suggests that there are still issues with sighting at the crossing.

152 The benefits of Network Rail's embankment clearance work were compromised by a local resident fly-tipping a substantial volume of garden waste onto Network Rail land. This matter was brought to the attention of the British Transport Police who took appropriate action.

153 Network Rail report that they are reviewing the station fencing with First Great Western Ltd to see if further improvements in sighting can be made although minimum standards are already met. The fencing on the platform ramp falls within the First Great Western station lease estate (Figure 11).

154 Network Rail report that they have recommenced reviewing possible options for a bridge at this location to accommodate all elements of the crossing, accompanied by the permanent diversion of vehicles via an alternative route. The introduction of new technology has reduced the cost of this type of structure, and has made this option potentially viable for the first time.

155 Network Rail has established a National Level Crossing Programme team to develop improved level crossing control systems. As part of this programme, a miniature stop light system has been fitted to a user-worked crossing with footpath at Healing station in Lincolnshire during 2008. This system is understood to be capable of predicting the speed of approaching trains and giving an 'another train coming' indication.

156 RSSB are undertaking a research project in response to a recommendation made in the RAIB's report into the fatal accident at Elsenham station in December 2005 (report 23/2006). The project, entitled 'understanding human factors and developing risk reduction solutions for pedestrian crossings at railway stations' (reference T730), is expected to be published during 2009.

Actions reported as already taken which address factors in the report so that the RAIB does not issue a recommendation

157 Network Rail have repositioned the whistle boards at 400 metres on each approach to the crossing. In the light of this action which mitigates the risk identified in paragraph 143, the RAIB has decided not to issue a recommendation covering this risk.

Recommendations

158 The following safety recommendations are made[6]:

Recommendations to address causal and contributory factors

1 Network Rail should investigate whether it is reasonably practicable to install a predictor miniature stop light warning system, capable of warning users of the approach of fast trains and if a second train is coming, at this location, and whether safety benefits would be gained from such an installation (paragraphs 136 and 144).

2 Network Rail should issue an updated policy or standard to improve the control of fencing at unprotected crossings, such that decision points are not forced to the minimum dimension or sighting distances unnecessarily compromised (paragraph 136b).

3 Network Rail should, at unprotected crossings where the location of the decision point is between the instruction sign and the track and therefore potentially counter-intuitive, propose measures to clearly mark the point at which the final decision to cross should be made for acceptance by the ORR. This is for the benefit of crossing users and for the guidance of persons making inspections of the crossing (paragraph 137).

Recommendations to address other matters observed during the investigation

4 Network Rail should incorporate in their procedures:

a. arrangements to routinely pass the findings of level crossing assessments and inspections between operations and maintenance departments, so that the organisation achieves a co-ordinated view of the condition of those assets (paragraph 139); and

b. an audit process to identify errors, inconsistencies or the application of inappropriate mitigation measures in crossing inspection reports (paragraph 140).

continued

[6] 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 167 to 171) can be found on RAIB's web site at www.RAIB.gov.uk.

5 Network Rail should review their methods for assessing warning times, as the current arrangements which rely on calculations and the measurement of distances using optical equipment have been shown to be unreliable, particularly on curved track. This should include consideration of permanently identifying the sighting distances to be achieved, so that visibility can be positively verified from each decision point when crossings are inspected to improve the objectivity of these assessments (paragraph 141).

6 Network Rail should consider providing a permanent solution to the restricted visibility from the down side of Tackley crossing by profiling the embankment to the south-west of the crossing and removing surplus material (paragraph 142).

Appendices

Appendix A - Glossary of abbreviations and acronyms

ALCRM	All Level Crossing Risk Model
HMRI	Her Majesty's Railway Inspectorate
MSL	Miniature Stop Lights
NTQP	Night time quiet period
ORR	Office of Rail Regulation
RSPG	Railway Safety Principles and Guidance
RSSB	Rail Safety and Standards Board
SMIS	Safety Management Information System

Appendix B - Glossary of terms

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

Accommodation crossing	A level crossing provided for the sole use of a landowner whose property was divided when the railway was built.*
Authorised user	Denoting a person or body registered with the Infrastructure Controller as a user of an Accommodation Crossing or Occupation Crossing.
Automatic level crossing	Any level crossing where the warning to highway users is given automatically, triggered by the approach of a train.*
Collective risk	The average number of fatalities, or fatalities and weighted injuries per year that would be expected to occur from a hazardous event, or group of hazardous events.
Decision point	A point where guidance on crossing safely is visible and at which a decision to cross or wait can be made in safety. For footpath crossings this should be not less than 2 m from the nearest running rails or 3 m where the line speeds are higher than 160 km/h (100 mph). For bridleway crossings and user worked crossings this should not be less than 3 m from the nearest running rail.
Diesel multiple unit	A multiple unit train whose source of power is a diesel engine. The transmission of this power to the driving wheels can be achieved electrically, hydraulically or mechanically.*
Down line / down direction	A track on which the normal passage of trains is in the down direction ie away from London, the capital, or towards the highest mileage.*
Equivalent fatalities	A way of expressing injuries in terms of fatalities for the purposes of risk assessment. Ten major injuries or 200 minor injuries are equated to one fatality.*
Fatalities and weighted injuries	A way of combining fatalities and injuries into a single number, used by RSSB and Network Rail to measure risk.
Individual risk	The probability of fatality per year to which an individual is exposed from the operation of the railway.
Miniature stop lights	Miniature lights, most often red and green, used as the warning at certain types of automatic level crossing. Previously miniature warning lights (MWL).*
On-train data recorder	A data recorder fitted to traction units collecting information about the performance of the train. Including: ● speed; ● regulator and brake control positions; ● activations of horn, DSD and AWS cancel button, etc.*

Required sighting distance	The distance from which trains must be visible in order to provide the required warning time.*
Station foot crossing	(see '*Station-related level crossing'*)
Station-related level crossing	The level crossing forms a means for accompanied or non-accompanied passengers (or members of public) to cross between platforms or to access the platform from the road (or car park) or vice versa. Crossing may be of any type. Staff only crossings excluded.
Track circuit	An electrical or electronic device used to detect the absence of a train on a defined section of track using the running rails in an electric circuit.*
User worked crossing	A level crossing where the barriers or gates are operated by the user. There is generally no indication of the approach of trains, but a telephone may be provided to contact the signaller.
Unprotected crossing	A crossing which is not manned or automatic. Types of unprotected crossing include: footpath and bridleway crossings; open crossings; station foot and barrow crossings; and user worked crossings.
Up line / up direction	A track on which the normal direction of trains is in the up direction, ie towards London, the capital or lowest mileage. The opposite is down line.*
Warning time	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.
Whistle board	A white circular sign with a grey edge and black 'W' in the centre that indicates to a driver that they must sound the horn or whistle. This is often used to provide a warning to users of accommodation crossings, footpath crossings and occupation crossings.*

Appendix C - Key standards current at the time

GE/RT8000	Railway rule book
NR/SP/OPS/100	Provision, Risk Assessment and Review of Level Crossings
5-23	Network Rail operations manual: Level Crossing Risk Assessments – Site Visits and Census
5-24	Network Rail operations manual: Use of the All Level Crossing Risk Model
5-25	Network Rail operations manual: Determining the Reasonable Practicability of Level Crossing Risk Reduction and Mitigation measures
NR/SP/SIG/19608 Issue 2	Level Crossing Infrastructure (Inspection and Maintenance) Handbook

Appendix D - Urgent Safety Advice

1. Incident Description			
Incident Report No	**0277**	Date of Incident	31 March 2008
Incident Name	Pedestrian fatality at Tackley station level crossing		
Type of Incident	Level crossing fatality		
Incident Description	At 15:16 hrs on 31 March 2008, an 82 year old female was struck by Arriva Cross-Country 9O18 Dundee to Bournemouth service at Tackley station user worked crossing. The crossing forms the only access between the up and down platforms at Tackley station and the above person was using the crossing to access the up platform. Tackley village is situated on the down side of the line.		
Supporting References	ELR: DCL Location: 72 miles 47 chains		

2. Urgent Safety Advice	
USA Date:	08/04/2008
Title:	Safety of footpath crossings
System / Equipment:	User worked crossing (used as a footpath crossing)
Safety Issue Description:	1. Visibility of approaching trains from the down side: The crossing gates are set 9.5 metres apart. Assuming a crossing speed of 1.2 metres per second [a] this equates to a crossing time of 8.3 seconds between wicket gates, or 12.5 seconds if a 50% allowance is made for use by impaired users. A person approaching the crossing on foot from the down side does not have adequate sighting of trains approaching from the north until they have passed through the pedestrian wicket gate and are within 2.5 metres of the track. From outside the gate, visibility is restricted to 120 metres (3 seconds warning time) by a palisade fence situated on the railway boundary. Trains approaching from the south are visible at a distance of 925 metres (23 seconds) across a low lying field due to a right hand curve in the track from outside the wicket gate. However, an approaching train is then hidden by vegetation on the railway embankment which forms a blind spot until it is 300 metres (8 seconds) from the crossing. **Network Rail to improve visibility of approaching trains from down side wicket gate.** 2. Crossing signage Sighting of up through trains is impaired by any stationary train in the down platform. Audible warnings from trains will not be given between the hours of 11pm and 7am following recent changes to rule book section TW1. Passengers using the crossing to access the up platform at night (eg for four daily timetabled services serving Tackley between these hours) will be at particular risk. The crossing signage does not alert users to these risks. **Network Rail to improve crossing signage.** 3. Observance of whistle boards Whistle boards are provided between 350 and 365 metres from the crossing in both approach directions. Drivers do not consistently observe the requirement to sound a warning. Whistle board positions are not compliant with sighting distance requirements at line speed [a]. **Train operating companies to remind drivers to observe all whistle boards in accordance with section TW1 of the railway rule book.** **Network Rail to review use of whistle boards to protect crossing.** [a] Railway Safety Principles and Guidance, Part 2 Section E: Guidance on Level Crossings
Circumstances:	Safety of public when using crossing
Consequences	Risk of being struck by a train
Reasons For Issue:	Fatal accident to member of public

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Department for Transport.

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JG12

Research Programme

Operations and Management

Research into the causes of pedestrian accidents at level crossings and potential solutions

Revision 1



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Published:
June 2015

Executive summary

Introduction

This report, *T984 Research into the causes of pedestrian accidents at level crossings and potential solutions*, has been commissioned by RSSB to document a wide-ranging review of the causes of pedestrian accidents at level crossings. It provides a statement of the importance that the rail industry places on level crossing risk in general, and specifically with the aim to reduce harm to pedestrians using level crossings. There are around eight pedestrians struck by trains at level crossings annually. Whilst there have been significant improvements made to the safety of level crossings in recent years, the residual pedestrian risk has become very diffuse over the several thousand lightly-used pedestrian crossings that include footpaths and bridleways – alongside more heavily used road crossings protected by barriers. The business case for crossing closure is often therefore very hard to make, despite this being the clear highest priority risk control. Therefore, this research explores those measures that are demonstrably cost-effective in specific situations (for example for particular user types and specific level crossing configurations) to form a credible basis for improving safety.

Objectives and scope

The objectives of this research were to:

- Establish the causes of pedestrian accidents at level crossings
- Improve or promote any existing, and identify any new mitigations that offer cost-effective solutions to reduce pedestrian risk

To meet these objectives the industry required this research to consider all possible causes of accidents such as distraction (from portable music players, mobile phones, groups, dogs) and all possible mitigation measures. However, mitigation measures that involve closure or upgrades to different types of crossing were outside the scope of this research.

The scope of work also included consideration of decision points. RAIB recommendations from recent (at the time of the research) fatal accidents at passive crossings (at Tackley, Oxfordshire and Fairfield, Berkshire) generated four separate objectives for this research:

- Examine the case for having decision points at footpath and user worked crossings used by pedestrians.
- Explain clearly under what circumstances, if any, decision points should be used at footpath and user worked crossings used by pedestrians.
- Describe how the optimum decision point should be identified.
- Describe the method(s) in which the decision point should be marked. If more than one method is identified, advise under which circumstances each method should be used.

In recognition that no single approach could provide a robust response to the project objectives, a number of complementary methods were applied during the research. These methods comprised literature review; quantitative analysis of safety data; site visits; eye tracking studies and human error analysis of plausible user errors and violations. The research started in

August 2012, with the interim reports completed some 11 months later and the final report drafted for industry review some 18 months after the research first commenced.

Conclusions

The research reached the following general conclusions about pedestrian risk at level crossings:

- There is a strong link between the occurrence of pedestrian accidents and pedestrian moment. Whilst this is not a new conclusion (it has been demonstrated in several previous research studies) this research reconfirms this strong relationship.
- Accidents are also more common at station crossings and for male users, and increase with age above 30.
- There is poor or no evidence that overall, other user, crossing and environment factors can be associated with higher rates of accidents. This lack of evidence is a useful conclusion as it suggests that there should not be a strategic focus on such factors.
- Therefore, the current risk assessment approach (ALCRM), which is focused primarily on pedestrian moment, is robust.
- However, at specific locations, combinations of characteristics of users, trains, the crossing layout and equipment, and other factors may 'add up' to cause users to have particular difficulties in crossing safely. This supports the idea that an improved site specific hazard assessment should be carried out alongside the quantitative risk assessment. Such ideas are currently being discussed with industry at the time of the research (T936 *and* related discussions). Inclusion of such improved hazard identification would also help to satisfy requirements for a 'suitable and sufficient' risk assessment.

This research has identified and ranked a number of mitigation options which are either new, or have already been considered to some degree but are not currently standard solutions. Many of these would not be applicable to a wide range of crossings, due to practical difficulties in installation, or because they would be of benefit to address specific hazards that do not exist at all crossings. Indicative cost benefit analysis has been used to highlight in broad terms whether each candidate option is likely to be affordable at all crossings, or the top 10 / 20% of highest risk.

Amongst the most promising options assessed for this research are:

- 'Danger zone' demarcated with a single block of yellow colour (passive crossings).
- MWLs – back to back lights, or repeater LED lights on gates.
- Improved auditory alarms at active crossings.
- Anti-climbing rollers at full barrier crossings.
- Improved crossing surfaces (at all crossings – particularly passive crossings) - in combination with demarcation of the 'danger zone' as noted above.

Overall, we conclude that the greatest gains in reducing accidents are likely to come from a focus on fewer specific actions:

- Establishing reliable, low cost active warnings to upgrade passive crossings – where existing methods for warning cannot be justified because of high cost. The research has reviewed three alternative means of providing such lower cost active warnings, but notes that in all cases a final conclusion on their adoption has not been reached. We consider that establishing workable designs for low cost active warnings solutions is a high priority given the potential benefits to be gained by increasing the number of passive crossings that could be upgraded.
- Providing good surfaces at all crossings (non-slip, demarcated zones of colour at FP and UWC). This should not be constrained by having to seek 'business cases' for improving crossing surfaces, but prioritise improvements based on the current level of risk - from highest to lowest or whenever existing surfaces are due for renewal.
- Busy station crossings should be specifically prioritised for risk reduction due to evidence of higher accident rates than crossings located away from stations.
- At passive crossings, 'design principles' should be followed when upgrades / maintenance work is carried out – documented by Turner et al (2013).

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Glossary of terms

AHB	Automatic half barrier crossing
ALCRM	All Level Crossing Risk Model
BCR	Benefit to cost ratio
BTP	British Transport Police
CCTV	Closed-circuit television
CCTV	Closed circuit television
FP	Footpath crossing
FWI/yr	Fatalities and Weighted injuries per year
HEA	Human error analysis/analyses
HFI	Human factors issue
LXRMTK	Level Crossing Risk Management Toolkit
MCBCCTV	Manual crossing with barriers and closed circuit television
MCX	Manually controlled crossing with either barriers, gates or CCTV
MWL	Miniature stop lights
NR	Network Rail
ORR	Office of Rail Regulation
POGO	Power operated gate opener
POS	Position of safety
RAIB	Rail Accident Investigation Branch
SHERPA	Systematic Human Error Reduction and Prediction Approach
SIDB	Safety Management Incident Intelligence Database
SLL	Stop, look and listen sign
SMIS	Safety Management Information System
SRM	Safety Risk Model
T000	Research project: User worked footpath level crossing research
T524	Research project: Use of risk models and risk assessments for level crossings by other railways
T668	Research into the safety benefits of train horn use at level crossings
T730	Research project: Understanding human factors and developing risk reduction solutions for pedestrian crossings at railway stations
T936	Research project: Enhancing the accuracy and functionality of the All Level Crossing Risk Model (ALCRM)
T9835	Research project: Research into signs at private level crossings
T984	This research project: Research into the causes of pedestrian accidents at level crossings and potential solutions
UWC	User worked crossing
UWCT	User worked crossing with telephone
VUPM	Vehicle user in pedestrian mode
WP	Work package

1. Introduction

Background

Level crossings have been, and continue to be, a key component of the research programme run by RSSB. Many topics within the level crossing area have been covered by research since RSSB's very first project T000, and this has added to the understanding of risk and human factors at level crossings, and to the development of a number of improvements in management – including most notably the Level Crossing Risk Management Toolkit (LXRMTK) and the All Level Crossings Risk Model (ALCRM). In the absence of such risk management activity the annual trend in pedestrian fatality and injury rates would be at best flat and at worst increase, for example due to increasing rail traffic and the emergence of new risk factors (such as potential distraction caused by the prevalence of smart phones).

This report documents a wide-ranging review of the causes of pedestrian accidents at level crossings commissioned by RSSB: T984 *Research into the causes of pedestrian accidents at level crossings and potential solutions* (herein just referred to as T984). It provides a statement of the industry's appreciation of the importance of pedestrian risk and the criticality of addressing these issues systematically. The overriding purpose of T984 is to identify cost-effective mitigations that could be used by industry to reduce pedestrian risk at level crossings. RSSB (2013) calculates that there are around eight pedestrian/train strikes that occur each year. Whilst there have been significant improvements made to the safety of level crossings in recent decades, residual risk has become very diffuse over the several thousand lightly-used pedestrian crossings that include footpaths and bridleways – alongside more heavily used road crossings protected by barriers and audible warnings. The business case for crossing closure is therefore often very hard to make. Therefore from the outset T984 has considered measures that are demonstrably cost-effective in specific situations (for example for particular user types and specific level crossing configurations).

A key aspect of the approach for T984 has been considering both behaviour of pedestrian users (human factors) and the evidence linking that behaviour to historical trends in safety risk. Historically, few level crossing accidents are attributed to technical failure of either the train or line side equipment; the immediate cause of such accidents is usually clear. This leaves the majority of accidents where the user believes their specific behaviours are 'safe', but where ultimately they have been struck by a train. The industry's duty of care to the user is to mitigate unsafe behaviours that may lead to accidents; the better the understanding of evidence for these behaviours the greater the opportunity for effective mitigation.

The causes of certain types of behaviour and the consequences of that behaviour can be linked to determine the value of a given risk mitigation. This is important given that the underlying factors – or root causes – of pedestrian accidents are often unclear. Analysis of data within the Safety Risk Model (SRM) by RSSB (2013) included later in this report shows the prominence of 'cause unclear' compared to other (known) causes. Better understanding of the related human factors shows which behaviours are leading to collisions and therefore precisely how an installed mitigation should be designed to protect the level crossing.

Research objectives

The objectives of this research were to:

- Establish the causes of pedestrian accidents at level crossings.
- Improve or promote any existing, and identify any new mitigations that offer cost-effective solutions to reduce pedestrian risk.

In order to meet these objectives the industry required T984 to consider all possible causes of accidents such as distraction (from portable music players, mobile phones, groups, dogs) and all possible mitigation measures. However, mitigation measures that involve closure or upgrades to different types of crossing were outside the scope of T984.

Decision points

The scope of work also included explicit consideration of decision points. Already an *implicit* aspect of understanding level crossing risk (*at which point should the user decide it is safe to cross?*), RAIB recommendations from recent fatal accidents at passive crossings (at Tackley, Oxfordshire and Fairfield, Berkshire) generated four separate objectives for T984:

- Examine the case for having decision points at footpath and user worked crossings used by pedestrians.
- Explain clearly under what circumstances, if any, decision points should be used at footpath and user worked crossings used by pedestrians.
- Describe how the optimum decision point should be identified.
- Describe the method(s) in which the decision point should be marked. If more than one method is identified, advise under which circumstances each method should be used.

The industry requested an early report against these objectives. This was delivered mid-way through the research (see Chapter 2. Approach) and has been published by RSSB. All findings from this separate report of relevance to the wider T984 research project are reported in the chapters that follow.

Pedestrian user types

For the purposes of this research, the term ‘pedestrian’ encompasses a broad range of user types (and not just limited to users on foot). These are:

- User type, such as dog walker or horse rider.
- Age group, such as elderly or adult.
- Grouping, such as alone or accompanied.

Outputs

The research has outputs informing existing level crossing risk management tools (notably ALCRM and the LXRMTK); on-going research streams (eg T983, T936-01) and Network Rail policy and procedure.

2. Approach

Introduction

In recognition that no single approach could provide a robust response to the project objectives, a number of complementary methods were applied during the research. These methods comprised:

- Literature review to establish the known causes of pedestrian risk.
- Quantitative analysis of safety data to establish the historical evidence for patterns of risk.
- Site visits to understand how user behaviour translates into level crossing risk.
- User observations and interviews, to record how users interact with level crossings.
- Cognitive walk-throughs for a wide range of users including adults, children, horse riders, wheelchair users and animal herders to support human error analysis (HEA).
- Eye tracking studies to identify exactly what users are looking at as they cross.
- HEA review of plausible user errors and violations.

These methods are described in more detail in Appendix I. Research methods.

Research plan and schedule

T984 was completed over nine work packages (WPs), illustrated in the figure overleaf. **WP 1-3** concerned the review of the available literature and data on pedestrian train collisions. This review was used to inform a site visit programme (**WP 4**) using both conventional tools (eg user observation and interview) and an eye tracker; a novel technique for recording eye movement and relating this movement to observable features at the level crossing that may influence user behaviour. The eye tracker was deployed principally to explore the issues around decision points at passive crossings (published as a separate report – see Appendix C. Project documents). Eye tracker findings applicable to the wider T984 research are reported where relevant in this current report.

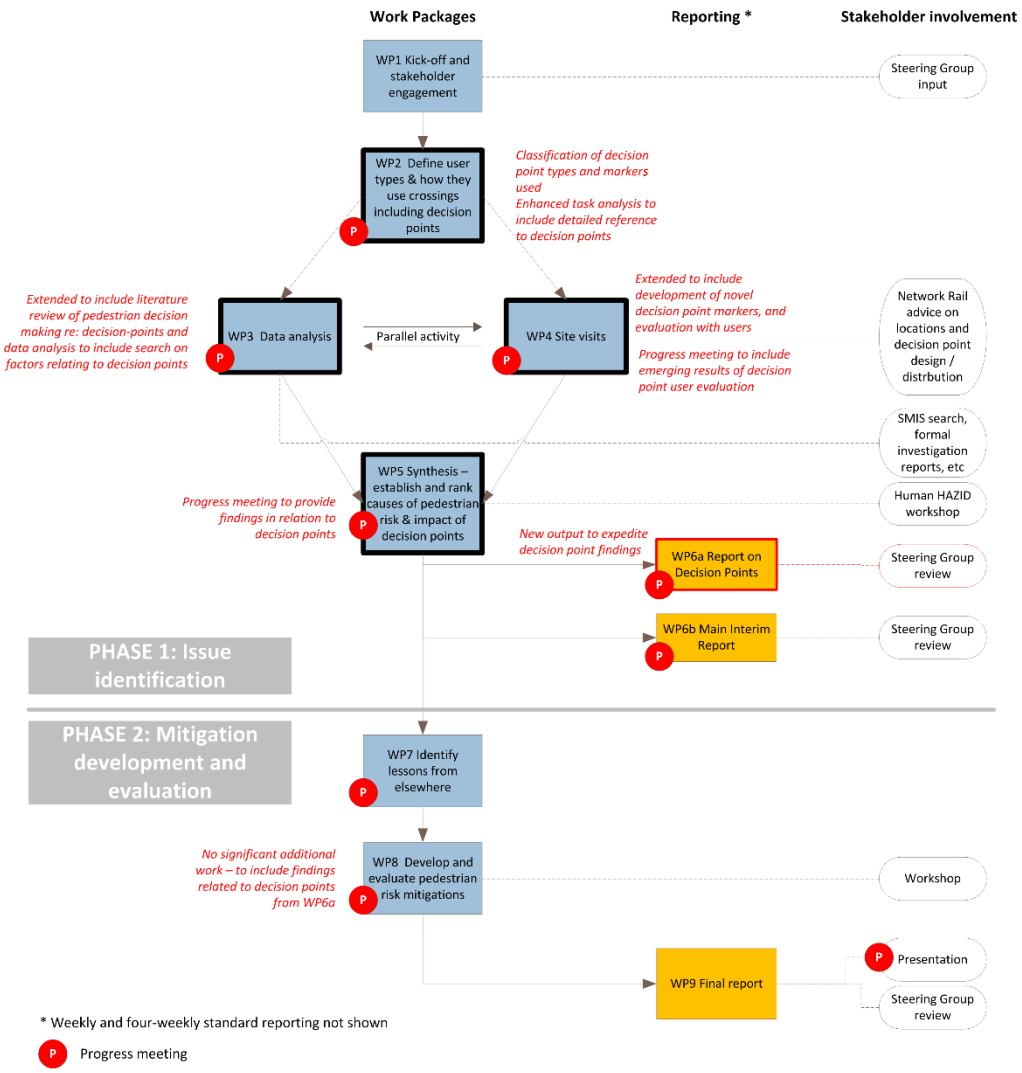
The synthesis of conclusions from **WP 1-4** were completed in **WP 5**, which established the known causes of pedestrian accidents at level crossings, and identified the most prominent factors considered to influence that risk.

The industry had requested that decision points be given early consideration within the scope of T984. **WP 6** therefore included the separate report on decision points, as well as a main interim report providing a summary of progress from the first 12 months and five completed work packages.

WP 7 began with a review of known risk mitigations in order to identify the lessons learnt elsewhere. Risk mitigations selected from the review were scored and presented at a workshop to which an external audience was invited to review the completed scores – the purpose of **WP 8**. All of this work was written up in a research report (**WP 9**) – this document.

An overview of the approach taken is illustrated in Figure 1.

Figure 1 – Approach overview



Source: Arthur D. Little / ERM

The research started in August 2012, with the interim reports for **WP 6** completed some 11 months later and the final report drafted for industry review some 18 months after the research first commenced – illustrated in Table 1 overleaf.

Table 1 – Project schedule

Work Package	Description	Q2-2012	Q3-2012	Q1-2013	Q2-2013	Q3-2013	Q4-2013	Q1-2014
WP 1	Project kick-off	■						
WP 2	Define user types	■						
WP 3	Data analysis	■						
WP 4	Site visit programme		■	■	■			
WP 5	Project synthesis				■			
WP 6	Interim reporting				■			
WP 7	Identify lessons from elsewhere					■		
WP 8	Developing risk mitigations						■	
WP 9	Project reporting						■	■

Regular contact was retained throughout the research with a steering group that included representatives from the Office of Rail Regulation (ORR), Network Rail and RSSB. **WP 6** was also presented to the Rail Accident Investigation Branch (RAIB).

The remainder of this report is divided into the following sections:

- **Chapter 3. Factors influencing risk** at level crossings discusses the evidence from both the analysis of historical risk and human behaviour that influences risk.
- **Chapter 4. Options for further risk control** describes the risk mitigations that appear best placed to mitigate the risk of pedestrian-train strikes from occurring.
- **Chapter 5. Overall assessment of mitigation options** reports the results of the overall assessment of options taking into account user behaviour, cost benefit, wider implications and safety.
- **Chapter 6.** Conclusions present the overall conclusions from the study.

Given the duration and scope of this study there have been several separate documents and reports produced to support the research. These have not been included in this report for brevity, but are referenced where applicable in the text.

3. Factors influencing risk at level crossings

Introduction

This research has reviewed a significant body of evidence documented in Appendix A. Causes of pedestrian accidents at level crossings and Appendix B. Identification of user errors and violations. This report aims to bring the various areas of research together, to confirm whether there appears to be positive influenced for a given factor or, equally importantly, a lack of evidence for the same factor.

It is the absence of compelling evidence for a particular risk factor that is most revealing within the profiles of recorded train strikes and near misses; whilst site-specific factors may play a significant role in the hazards present at a given crossing, there appear to be few factors systemic to all crossings beyond those already identified by quantified risk assessment (ALCRM) and qualitative local assessment. In particular:

- No additional compelling evidence has emerged that short sighting is a dominant risk factor at passive crossings; analysis of sighting time for FP crossings (where short sighting is – potentially – of greatest concern in the absence of other forms of level crossing protection) indicates that train strikes and near misses seem no more common where sighting times are short. However, in combination with other risk factors (such as impaired mobility or pedestrians accompanied by dogs) marginal sighting may pose an additional risk.
- In isolation, neither train speed nor number of tracks appear to act as additional risk factors, but low train frequency does appear to influence risk, where a proportional sense of risk is only maintained where train services are relatively frequent.
- Train strikes and near misses occurring at crossings at stations are relatively more common when moment is accounted for. This confirms previous intelligence about the additional risks for these crossing types that are less common at other crossings.

Proving this evidential link between risk profiles, level crossing features and user behaviour is an important basis for risk reduction. Subtle and site-specific differences in the level crossing environment may influence user behaviour in different ways not intuitively picked up within risk assessment. Hence, in order to move the debate forward beyond acknowledging that risk profiles and user behaviours are complex, this link must be proven.

During WP 7 (see Chapter 2. Approach) all the possible risk factors were recorded from research team discussion and grouped into three categories:

- **Factors associated with crossing users**, and otherwise independent of influence from any crossing features.
- **Factors associated with a given crossing feature**, and otherwise independent of influence from the crossing user.
- **Factors associated with the railway**, and therefore applying equally to any number of crossings and users where that factor is present.

Each category of risk factor is discussed in the following sections. The table at the start of each section gives a summary of the factors and whether they are positively supported by the available evidence (⊕) or, where there is no or little evidence for them being a risk factor (×).

Factors associated with crossing users

This section concerns factors that are independent from either influence by the railway (for example, number or speed of trains) and by the level crossing (for example, type of level crossing). The identified factors are listed in the table below. T984 found evidence for all of the factors with the exception of the influence of familiar and unfamiliar users on risk. The evidence for each is discussed in the following sections.

Table 2 – Factors associated with crossing users

Feature	Comments	Indication
User encumbrance	User encumbrance (especially dog walkers) is a reoccurring theme, suggesting users cope poorly with crossing safely under these circumstances.	⊕
Checking for trains	A small but significant minority of users fail to check for trains in either direction, and some users check for trains when not in a position of safety.	⊕
User age	The risk of being struck by a train at level crossings increases steadily with age for adult users. Males are more commonly struck by trains at level crossings than females.	⊕
Familiar and unfamiliar users	Familiar and unfamiliar users appear to show some differences in behaviour, but there is no overall evidence for either being more at risk.	×

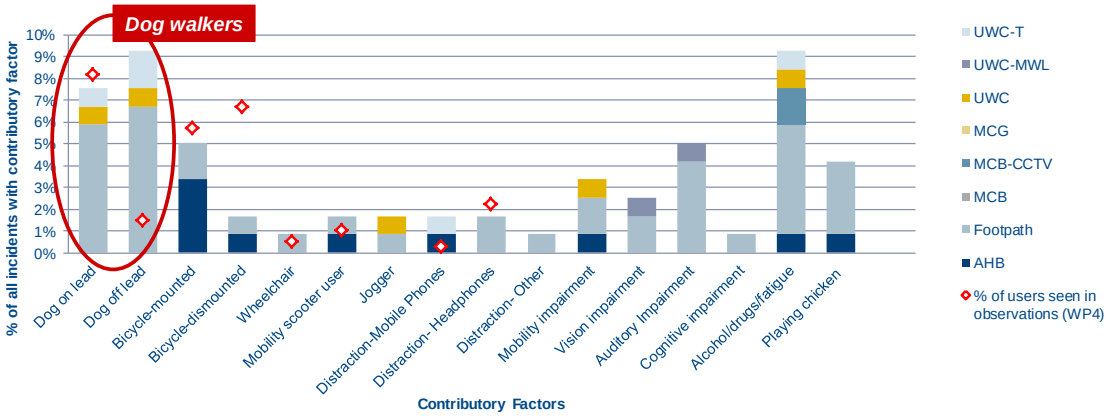
User encumbrance

Within the context of this research, an encumbered user means someone who is crossing with something that reduces their agility and can cause distraction. Encumbered users include those with pushbikes, or who are carrying objects (eg bags, cases and inflatables to the beach), and especially dogs either on or off the lead.

Accidents involving dogs especially are a reoccurring theme, suggesting users cope poorly with crossing safely under these circumstances. It is notable that in 17% of train strikes, the pedestrian was walking a dog – usually off the lead but sometimes on the lead.

During the site visits only 8% of observed users had dogs on the lead, and 1% had dogs off the lead (the red dots on the graph below). Although only a sample (and may not be representative of the population as a whole), this suggests significant *over-representation of dog walkers* in train strikes where the *dog is off the lead*. However, there are examples (such as Fairfield) that are the exception – in this case the dogs were noted as on the lead.

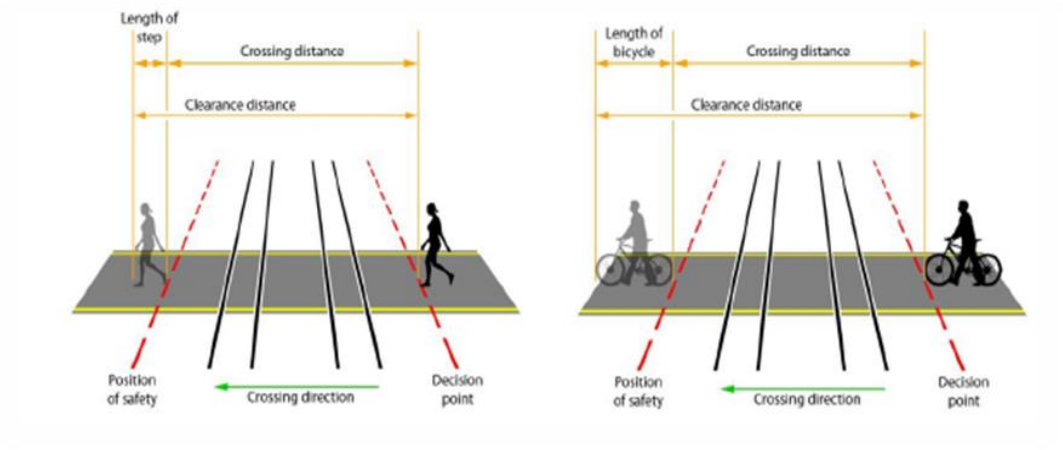
Figure 2 – Incident contributory factors



Source: Arthur D. Little

It was also observed during site visits that users with pushchairs and bicycles sometimes had difficulty in opening and closing the crossing gate. In some cases, where the gate is located within 3m of the running rails, the longer forward footprint of these users can mean that they are in a position of danger before checking it is safe to cross.

Figure 3 – Encumbrances can affect position of safety



Source: LR Scandpower, 2013

T984 therefore considered there to be sufficient evidence proving the influence of user encumbrance on the risk of pedestrian-train collisions.

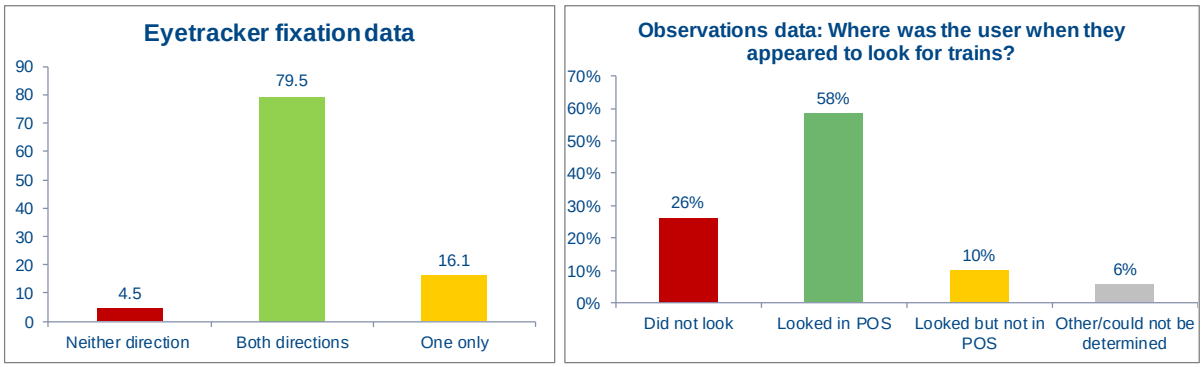
Failing to check for trains

The site visit observations using eye tracker fixation data ascertained that a small but significant minority of users (around 5%) fail to check for trains in either direction. A further 16% only looked in one direction anywhere on the approach or traverse.

Although these figures are a minority, it reveals that some users are placing themselves at greater potential risk, presumably relying on peripheral vision, hearing or an expectation that no train is coming.

These data were supported by user observations completed separately from the eye tracker studies that indicated around 10% of all users did look but not in a position of safety (POS) (ie only looked when they were on or near the line).

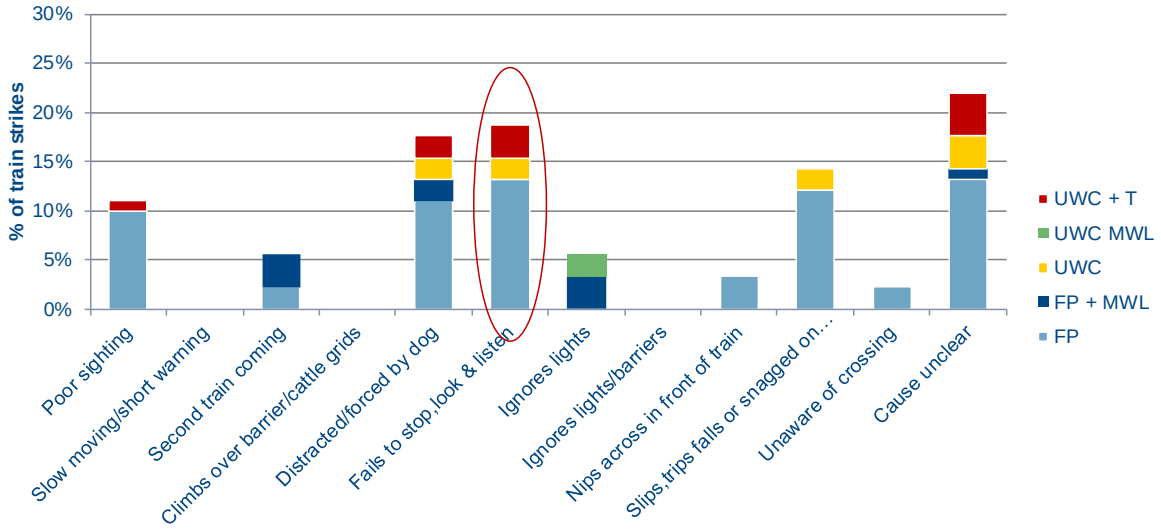
Figure 4 – Eyetracker fixation data



Source: ERM analysis of site visit data

When the causes of train strikes with pedestrians are examined, a large proportion are attributed to 'fails to stop/look/listen', suggesting that no other cause could be found other than a failure of the user to take reasonable care. The following graph indicates the relative contribution of SRM causes to train strikes, indicating the 'fails to stop/look/listen' is second only to 'cause unclear' its contribution. Given the prominence of the former, it is likely (though unproven) that the latter also includes a proportion of users whose accident cause is 'fails to stop/look/listen'.

Figure 5 – SRM precursors for pedestrian train strikes at passive crossings



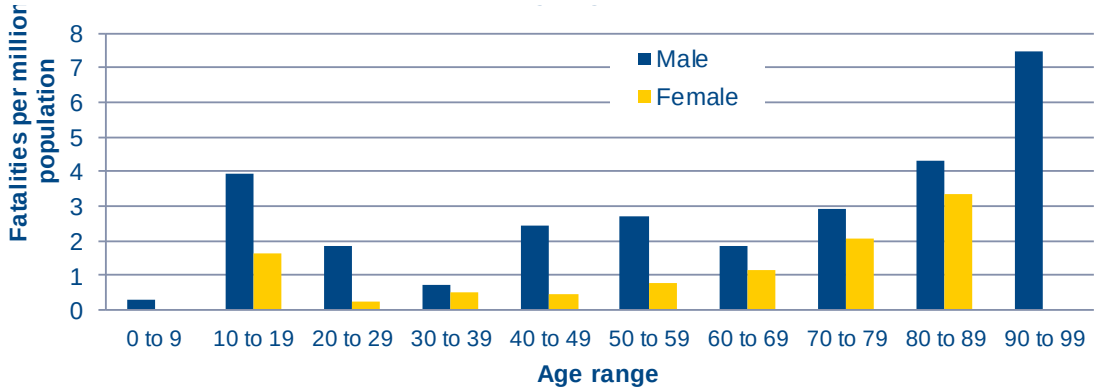
Source: Arthur D. Little analysis of SIDB data

It was therefore considered to be sufficient evidence proving the influence of the user to failing to stop look and listen on the risk of pedestrian-train collisions.

User gender and age

Males are more commonly struck by trains at level crossings than females, and the risk of being struck by a train increases steadily with age for adult users. Male pedestrians dominate accidents at level crossings, associated with 70% of all train strikes. Given that males represent approximately 50% of the population as a whole (UK government statistics), this would suggest male pedestrians are more at risk at level crossings than female pedestrians.

Figure 6 – Fatalities by age and sex



Source: Arthur D. Little analysis of SIDB data

It was therefore considered to be sufficient evidence proving the influence of gender on the risk from pedestrian-train collisions.

User familiarity

Interviews with users suggest that level crossing users that live or work in close proximity to a crossing can become familiar with the crossing attributes and procedures required for crossing (eg MWL activation durations). Their behaviour can become habitual, resulting in a failure to look for unexpected information, leaving them susceptible errors of judgment. However, the same is true of unfamiliar users who can fail to cross safely due to knowledge-based errors about correct operation.

Over three quarters of users interviewed at crossings were familiar with that crossing, being frequent users (at least once per week). Some differences in behaviour were noted between familiar and unfamiliar users, but these were sometimes counterintuitive. For example, eye tracker data revealed that first time users were less likely to look at the stop, look, and listen (SLL) sign than more frequent users. This might relate to their requirement for processing the complex crossing environment for first time, whereas more frequent users are able to prioritise key crossing information/cues, such as SLL sign. In fact, familiar crossing users were more

likely to look at all signs at a crossing (perhaps suggesting that signs help users to recognise that they are at a level crossing, even if their content is not read).

Regular users were more likely than infrequent users to perceive crossing risk to be low and could therefore be more likely to commit a violation of safe crossing procedure. This is supported by research investigating vehicle driver behaviour at crossings which revealed that 53% of red light runners (at a range of testing locations) used the crossing at least once a day.

So whilst familiarity with a crossing seems to impact user behaviour, there is no overall evidence for either group being more at risk.

Factors associated with crossing features

This section concerns factors that are independent from either influence by the user (for example, age or encumbrance) and by the railway (for example, number or speed of trains). The identified factors are listed in the table below. The report authors found no evidence supporting the mitigation of risk by SLL signs, but found evidence linking risk with gates and the recurrent theme of slips and trips. The evidence for each is discussed in the following sections.

Table 3 – Factors associated with crossing features

Feature	Comments	Indication
SLL signs	Stop, look and listen signs are not commonly viewed by users, and there is little if any evidence that users who do observe this sign are more likely to look for trains	×
Gates	Gates are generally a good design principle, but may complicate safe crossing use in certain specific circumstances	⊕
Crossing surface - slips and trips	Slips and trips are a recurrent theme reported as the cause of users being struck by trains; the crossing surface therefore has a key influence on risk	⊕

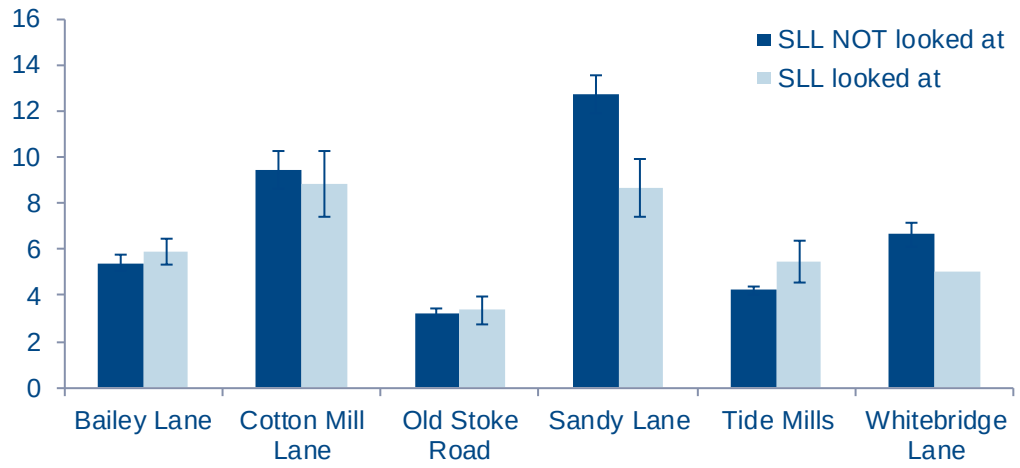
Stop, look and listen (SLL) sign

The most prominent crossing feature at passive level crossings is typically the SLL sign – this provides a warning to the user that they are approaching a level crossing, provides an indication of where the user might be best placed to observe an approaching train and – if read – gives instructions on how to cross safely.

Observations at site visits indicated that SLL signs are not commonly viewed by users, and there is little evidence that users who do observe this sign are more likely to look for trains. Users looking at the SLL sign are, on average, very marginally more likely to subsequently look for trains. It can therefore only be concluded that the sign is having at best a weak positive influence on encouraging users to take care to look for trains - perhaps because the sign is having a small positive impact, or simply reflecting the behaviour of some users who are more predisposed to looking. What is not clear is the extent to which the presence of a sign provides

a sub conscious cue for users to look for trains (compared to having no sign at all), this latter point illustrated in the graph below which compares the average numbers of times a user looked for a train per traverse where the user looked at the SLL sign and where the user did not. Overall, there was very little difference in the frequency of looks where users did and did not look at the SLL sign.

Figure 7 – Observation of SLL signs



Source: ERM analysis of site visit data

The prominence of the SLL sign did itself seem to influence whether or not it was looked at by the user; where the sign was more conspicuous, more users looked at it on approach. Note, however, that sign prominence did not influence subsequent frequency of looks for trains.

Overall T984 therefore concluded that there was no evidence positively linking observation of SLL signs with increased care taken by the user in stopping, looking and listening.

Gates

Gates are a second prominent feature commonly found at FP crossings. Well positioned, a gate can serve to cause the user to pause on approach to the crossing. Intuitively, this may increase the chance that the user then has time to look for a train – provided that this can be done adequately from the gate location. In addition, gates act as a barrier for those crossing with small children or dogs not on a lead.

The site visit work, however, did not produce evidence for an increase in the rate of looking for trains where gates are present. This is likely due to the very large number of variables that influence when and where people look for trains.

Several potential drawbacks associated with the use of gates were also noted:

- Gates can be difficult to use in high winds (especially if encumbered).
- Users with ‘large footprints’ such as those with bikes / pushchairs / horses seems to rarely be taken into account in gate positioning relative to the line, and as such it can be difficult to exit the tracks unimpeded, or make a decision to cross in a position of safety.

- At locations with interlocked gates some users, such as wheelchair users and those with pushchairs, are unable to use these gates as the locking mechanism prevents them opening fully. As such, they are forced to use the vehicle gates, potentially placing them at greater risk from accidents with a road vehicle.

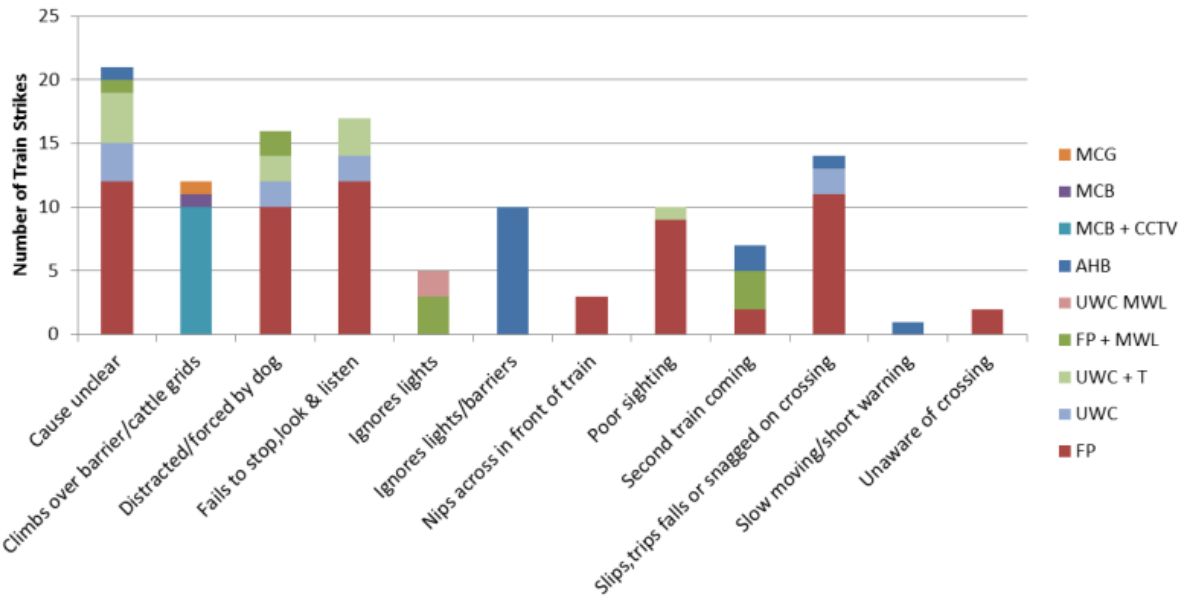
Therefore whilst gates are generally a good design principle, they may complicate safe crossing use in certain specific circumstances, further described by Turner et al (2013).

Crossing surface - slips and trips

Slips and trips are a recurrent theme reported as the cause of users being struck by trains; there are numerous mentions of this hazard within the various sources of industry data compiled on accidents. For example 14% of train strikes at level crossings (based on SRM precursors) have been attributed to slips, trips or becoming snagged on the crossing. As previously noted, a slip or trip is a single point of failure that may lead to a train strike, independent of whether the user complied with instructions for safe use. The crossing surface can therefore be regarded as having a key influence on risk.

The graph below shows total number of train strikes over the period for which data were collected, classified by crossing type and accident cause. Slips and trips are prominent amongst the different causes, after "user distraction, failing to stop look and listen and cause unclear". Slips and trips are also prominent for FP crossings (where pedestrian crossing surface is the most variable of all crossing types).

Figure 8 – SRM precursors for pedestrian train strikes



Source: Arthur D. Little analysis of SIDB data

Eye tracker data revealed that a surprisingly high proportion of users' time while crossing is spent looking down at the crossing surface (referred to as 'head down time'). 'Head down' time is expected as pedestrians look at the ground to see where they are going and to prevent slips,

trips and falls. However, the amount of time users spent looking down varied between crossings. More head down time proportionally was recorded where:

- Crossing surface was poor (uneven with worn markings).
- There were slippery conditions underfoot (snow/ice).

Improvements to crossing surface might therefore reduce the requirement for 'head down' time and afford greater opportunity for users to check for trains.

Factors associated with railway features

This section concerns factors that are independent from either influence by the user (for example, age or encumbrance) and by the crossing (for example, type of level crossing). The identified factors are listed in the table below. Amongst these risk factors, the report authors only found evidence linking risk with the colocation of crossings with stations. The evidence for each is discussed in the following sections.

Table 4 – Factors associated with crossing features

Feature	Comments	Indication
Train frequency	Risk does not appear to be proportional to number of trains; more accidents than expected occur where train frequencies are low.	×
Sighting time	There is no evidence that accidents are more common at passive crossings with short sight times.	×
Crossings at stations	Risk is higher at crossings at stations.	⊕
Train speed	Train strikes and near misses do not appear to be influenced by train speed.	×
Double track	There is no evidence for double-track crossings being a risk factor at unprotected crossings.	×

Train frequency

Data analysis shows that the occurrence of accidents does not appear to be proportional to the number of trains; in fact more accidents than expected occur where train frequencies are low. Analysis shows that two times more accidents per moment have occurred at crossings with <100 trains/day than crossings with > 100 trains/day.

In summary, whilst moment does have a strong relationship with risk (as previously reported) the component of moment that is train frequency appears to be non-linear. T000 showed that users perceived a lower level of risk where there was a low frequency of trains passing over the crossing – suggesting that risk homeostasis might be influencing the evidence. This effect is considered in ALCRM for passive crossings; specifically the likelihood of users failing to stop, look and listen is increased for crossings with low train frequencies (this was based on the work in T000 as noted above).

Sighting time

There is a lack of strong evidence that accidents are more common at passive crossings with short sight times. Although this counters a traditionally held view that maintaining good sight times is the single most important risk control at passive crossings, this finding is not new, having been previously presented in project T000. This suggested that risk homeostasis explained the lack of a relationship between risk and sight times (shorter sight times lead to more cautious behaviour). The analysis conducted for this research therefore appears to confirm that of T000.

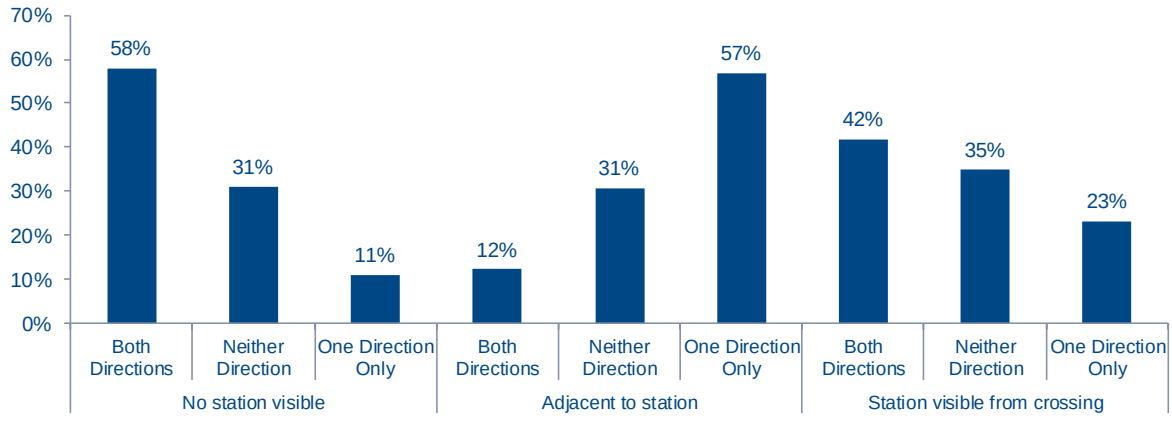
Overall, there is a lack of strong evidence for sight time having a significant impact on the rate of accidents.

Stations

Train strikes and near misses are relatively more common at station crossings when moment is accounted for (this is most clear for MCB-CCTV crossings, and evident – but less compelling at AHB crossings). This is unsurprising, as it is well understood in the industry that there are additional risk factors for level crossings at stations. There is a greater motivation for the user to violate instructions for safe use (personally optimising). Users are more likely to encounter a train (use of crossing intentionally coincides with stopping services).

Observations from site visits provide some further support for this analysis - where stations are adjacent to the crossing people are more likely to look in only one direction potentially placing them at greater risk. This may be because users tend to look more at the station (expectation of trains, distractors, more visually stimulating). Where a station was visible from, but not adjacent to, the crossing, or where there was no station in sight, people were more inclined to look in both directions.

Figure 9 – Impact of station visibility on the direction of user looks



Source: ERM analysis of site visit data

Train speed

Data analysis shows that the occurrence of accidents does not change with train speed. Therefore, there is no evidence that train speed by itself is a risk factor.

Double-track crossings

There is no evidence for double-tracks being a risk factor at unprotected crossings. In fact, for AHBs the data suggests that pedestrian train strikes are more common at single track crossings than at double track, but this is likely due to small data sets producing random variation.

The overall conclusion is that there is no evidence to suggest that pedestrians are at more risk on double track railways once moment has been accounted for.

4. Options for further risk control

Introduction

The rail industry has an active programme of technical review of emerging mitigations, supplemented by periodic local and national level education campaigns. Whilst it is *technically* possible to present information to pedestrian users in novel ways, the feasibility of implementing such depends largely on cost benefit analysis, which itself demands good knowledge of the likely risk reduction that will be achieved so as to build a business case. A review of feasibility can therefore raise more questions than it answers – unless the underlying hazards and their level of risk *specific to the crossings targeted by the mitigation* are understood.

This chapter attempts to answer such questions by stepping through the identification of risk mitigation options; the behavioural impact assessment of each option and finally a cost-benefit analysis of the options in order to provide sufficient data for their ranking (which is completed in the following chapter).

Recent (at time of this research) innovations that have been implemented at level crossings include:

- AOCL+B, 'stubby barriers' at former AOCL crossings which are primarily a risk control for vehicles.
- Lower LIDAR at new MCB-OD crossings; a mitigation to detect pedestrians who might fall on the crossing.
- Various very localised mitigations including solar edge lighting and pavement transfers.

Chronologically, this chapter is based on WP 8 (see Chapter 2. Approach), completed after some 15 months of literature review; a programme of site visits; qualitative assessment of user errors and violations and quantitative assessment of pedestrian-train collisions. This substantial body of work recorded in the various research outputs – as well as this report – provides evidence indicating those risk factors that are important, and those where a lack of evidence indicates that they are not important focuses for risk management effort.

This context is important in reminding the research that:

- There are relative few risk factors identified as systemic to risk, ie acting to change the number of pedestrian-train collisions irrespective of other site-specific factors such as user profile and sighting distance.
- Other site-specific factors are typically present in a large number of permutations, making it difficult to study any given local factor in isolation.

Such observations may be seen as counter to the active and on-going efforts to mitigate risk at level crossings. However, they are in fact a helpful reminder that there is neither a pressing need for more complicated assessment of many new risks, nor that there is a 'silver bullet' for mitigating existing risks.

The remainder of this chapter presents the risk mitigation options identified from this research and their evaluation, with the following Chapter **5. Overall assessment of mitigation options** concluding the risk mitigation assessment.

Option Assessment

The research identified 31 options for mitigating pedestrian risk at level crossings based on three main sources:

- Review of literature (research, overseas rail practices, and from the highways sector).
- Analysis of the plausible critical user errors and violations (identified through the HEA, see Chapter 4) for which there are currently only weak barriers or controls specified in standards and guidance.
- From ideas generated in an industry workshop conducted for this project, in which options were identified and systematically assessed for their impact.

The detailed assessment of all options is described within Appendix G. Option assessment. The table references within this chapter therefore cross-refer with this appendix. Each of the steps completed for option assessment is described in the following sections.

Option categories and screening

Options were first assigned to one of six categories in order to support evaluation of options with similar types of risk mitigation. The categories were:

- Improve awareness by enhanced visual information (V).
- Alert user of approaching train (T).
- Prevent access when train approaching (P).
- Improve awareness by enhanced information (E).
- Improve surface (S).
- Other (O).

Options were then screened to determine the applicable level crossing types for each option. Appendix H. Assessment approach and results give the results from the screening.

Error and violation assessment

Options were next assessed against the 26 key errors and seven key violations identified in the HEA (see Appendix F. Critical errors and violations). This was conducted independently of the risk assessment and cost-benefit analysis. A semi-quantitative approach was taken, using a four-point scale to score the options against each error/violation (Table 5 below).

Table 5 – Behavioural impact assessment – key

Impact on behaviour	Score
Eliminates error / violation	2
Reduces error / violation	1
No change	0
Increases error / violation	-1

For example, the likelihood that a pedestrian will slip, trip or fall on a crossing might be reduced with the introduction of an improved non-slip crossing surface (score '1'), but would not be affected by replacing an MWL with a 'push button and wait' type device (score '0').

The appendix presents a summary of the error / violation impact assessment, indicating the proportion of key errors and violations that each option would target. The options are presented in rank order: those that are likely to impact the greatest number of key errors and violations are ranked higher than those that might impact only a few (none in some cases). Note that this is different from the overall safety assessment of options which takes into account the relative risk at the types of crossings impacted

Unsurprisingly, those options that prevent user access to the railway are ranked highest since they target both errors and violations. Predictors+MWL and Wavetrain also score highly since they provide an active warning of approaching trains where currently there is none, thereby improving information provision to users.

Improved crossing surfaces (including tactile paving, high contrast delineation and straightened crossing surface) are in the top ten. Slips, trips and falls are a significant precursor for pedestrians being struck by trains. Improving the crossing surface not only minimises the potential for slips and trips, but can also reduce users' 'head down' time on the crossing, improving their opportunity to look for trains.

The lowest ranked options are the provision of alarms on UWC gates when gates are left open and an active 'close gates' sign, both all of which target misuse of the crossing, but are unlikely to provide any wider benefit on the key user errors considered. The low score for retro-reflective tape can be explained by the fact that it only targets one key error: failure to recognise crossing and no user violations.

Power-operated gate openers (POGOs) are also ranked low due to their potential negative impacts on user error (eg the assumption that they are interlocked with the railway leading users to cross when a train is approaching).

Cost benefit analysis methodology

Evaluating the safety benefits of mitigation options at crossings is challenging, due to the high uncertainty as to the net impact of the measure on the likelihood of accidents. While the behavioural impact assessment evaluates the relative impact of each mitigation option on specific errors and violations, 'weighing up' these individual impacts into an overall assessment is difficult because how these combine is highly complex and hard to predict in general, and this will also vary considerably by location.

Therefore, instead of trying to estimate safety benefit of a measure, we have considered the risk reduction required (in % terms) that would justify the cost of each measure. If it is judged that the risk reduction would be comfortably above this level, this would mean that the option could be 'justified' on the basis of the benefit to cost ratio (BCR). For example, if, for a mitigation measure, the cost of a measure would be matched by a risk reduction of 2%, then this mitigation would be viable if it was believed that a 2% risk reduction should be achievable. Conversely, it might be clear that a required risk reduction of 50% could not realistically be achieved, so such an option would be deemed not viable on a cost – benefit basis.

Note that this target risk reduction level is *indicative* for the groups of crossings targeted by each mitigation option; options for reducing risk would need to be assessed by Network Rail for individual crossings in their on-going programmes of risk assessment and managing risk So Far As Is Reasonably Practicable (SFAIRP). For example, the authors have not quantitatively considered the lifetime of each option within the analysis. However, the authors *have* considered implicitly considered this with the 'robustness' of each option – evaluating the likely durability of each option (and therefore its in-service lifetime).

The analysis assumes that:

- The cost is the best estimate of the total cost of the option (although this may not cover the full costs associated with approvals and research and development for the more novel options).
- The average risk (in FWI/yr) at target crossings represents the typical average risk at each crossing that is targeted for mitigation. This varies according to the target crossing type(s). If more than one type is targeted, then a weighted average level of risk is used.
- The 'risk reduction required' is then the % safety improvement that would match the estimated cost of the option.

The cost-benefit analysis is completed in Appendix G. Option assessment. The final two columns on each of the tables in the appendix repeat the analysis but examine how the mitigation options can be targeted at higher risk crossings. Two cases are considered: 'risk reduction required' if the measure were applied to the top 20% of all crossings; and also to the top 10% of highest risk crossings. This has been derived from ALCRM data (ie the risk in FWI/yr for the top 20% and top 10% of crossings, calculated from ALCRM assessments).

Cost benefit analysis results

The results show considerable variation in the risk reduction required to satisfy the costs.

Those with higher costs (such as providing warning of trains T3, T4 and T5, and preventing access when a train is coming P1, P2, P3) require significant benefits to be realised to be justifiable. Indeed, such options would not be justified at all crossings of the target type (shown by the fact that the risk reduction would need to be '>100%').

In contrast, a number of relatively inexpensive options require very small benefits to justify the costs of implementation. Examples include pavement transfers (V2), mesh on gate (O1), 'eyes signs' (O2), anti-climbing rollers (P5). However, by their very nature many of these options would have a smaller impact in user behaviour (and consequent risk) and care needs to be taken to make sure that no adverse impacts on behaviour or risk are created which could offset any foreseen benefits.

The right hand columns in the tables above show the impact of targeting higher risk crossings, rather than a 'blanket approach' of all crossings. For example, solar edge marking (S2) requires a 36% safety benefit to be justified everywhere. This seems very unlikely to be achievable when it is considered that train strikes resulting from pedestrians falling from the edge of the crossing are very rare events. However, targeting higher risk crossings (and those for example which are used heavily in hours of darkness) would make more sense – supported by the cost-

benefit analysis which shows that a risk reduction of some 4% would be required to justify the expenditure at the 'top 10%' highest risk crossings.

Similarly, some of the higher cost options could have a larger impact of risk reduction – but not be affordable at all crossings. Targeting these costlier measures at the highest risk crossings makes sense, and is supported by the analysis above. Providing novel active warning of train approaches (T2, T3, T4) will range from £100k - £200k, and could not be justified at all crossings, or even the top 20% as more than 100% of risk reduction would be required. However, targeting such measures at the highest risk crossings may be justifiable – the analysis shows risk reductions of 13-69% would be required at the top 10% highest risk crossings (depending on the technology).

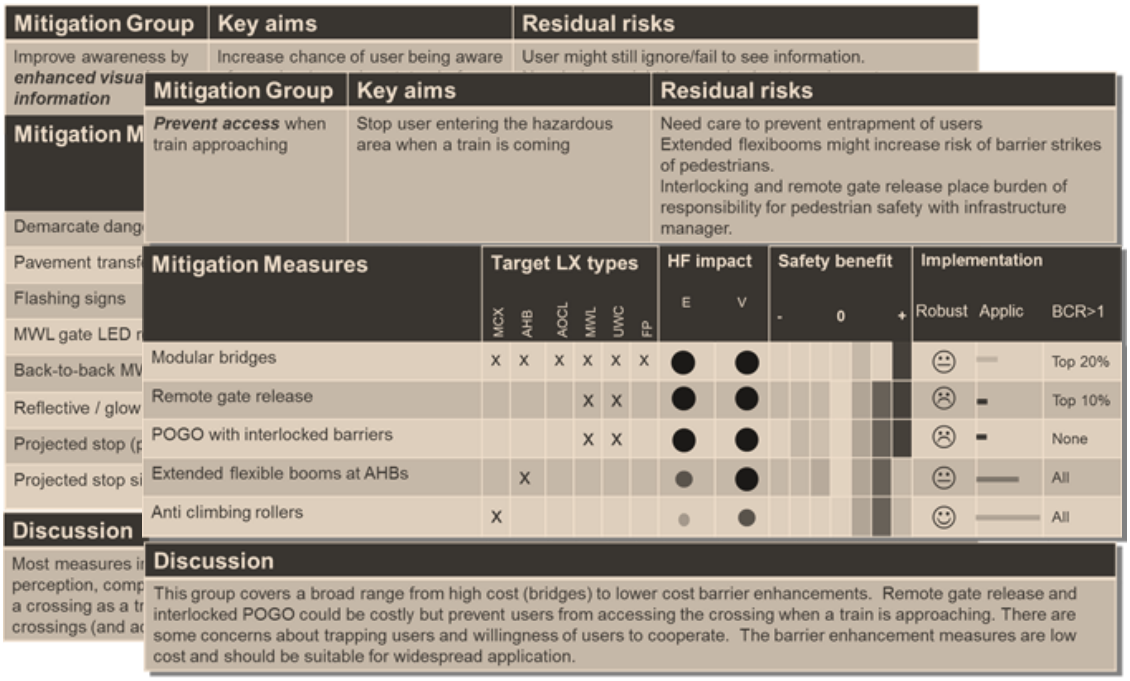
The option evaluation has to this point not considered any of the practical considerations associated with each mitigation; this is discussed in the overall evaluation of options in the next chapter.

5. Overall assessment of mitigation options

Introduction

This research included a workshop conducted as part of WP 8, to which a number of external level crossing experts were invited (see Appendix D. Risk mitigation workshop attendees). The research developed a series of risk mitigation scorecards (based on the evaluation in Chapter **5. Overall assessment of mitigation options**) and illustrated in the figure below.

Figure 10 – Mitigation assessment



Source: Arthur D. Little

The results from the scorecard review were written up in a workshop report that was re-issued to participants (see Appendix H. Assessment approach and results). The result of the overall assessment is that 21 options emerge as potential candidates for consideration to reduce risk, and 10 are not recommended for further consideration. Of the 21 potentially viable options, 12 are expected to be applicable only to specific locations, with the remaining seven applicable either to all or most crossings of the target type(s).

The evaluation of each mitigation option is described further in the following sections. Within the context of this project “potentially widespread consideration” means strong safety benefit and few site-specific factors for consideration so that the mitigation option is likely to be applicable to many sites, and “limited consideration” means mitigation options with safety benefit but only within specific circumstances or when noted technical limitations have been overcome.

The authors note that the effectiveness of many of the mitigation options is contingent on good education campaigns – for example demarcating the ‘danger zone’ with colour. The cost of

such campaigns has not been included in the cost benefit analysis, but equally no assumptions have been made as to whether (or not) a given campaign would be effective. As such education remains a 'cost neutral' element of the option evaluation.

Options for potentially widespread consideration

V1 – demarcate 'danger zone' with the colour yellow.

The option to demarcate the crossing surface with a single block of colour emerged from the specific workstream on decision points (see decision point report, RSSB, 2013). The idea is to provide a clear distinction between the zone in which there is a risk of being struck by a train, from the crossing approach and exit areas in which there is no such risk.

The railway (Network Rail and its predecessors) have provided such demarcation at selected FP crossings in the past, so although this mitigation is not novel, the research concludes that it should be extended much more widely, and also include user-worked crossings.

A key success factor for this mitigation will be sourcing surface materials which are coloured throughout (rather than being only on the surface which could wear out) and which also provide a non-slip surface (thus encompassing mitigation option S1). Provided that such materials can be sourced at reasonable cost, then no dis-benefits have been identified either in terms of adverse safety impacts or wider implications. The safety benefits are likely to be comparatively small, suggesting that as an *additional* risk mitigation measure the 'top 10%' of FP and UWC should be targeted. However, if the surface can be provided at little or no incremental cost over standard surfaces then coloured surfaces could be used to replace traditional surfaces when they are life expired.

V4 – Augment gates at MWLs with LED repeater lights

Providing repeater lights on the gate of MWL crossings is a novel idea (as far as this research has been able to determine) so some further design work and validation would be required if this option is to be taken forward. The idea is to increase the chance that a user acknowledges the status of the MWL before entering onto the crossing.

This option has been identified as potentially viable at a wide range of MWL crossings. Potential difficulties are not likely to be significant, although a standard design is likely to require detailed review and eventual approval. In particular, the additional lights will need to have a proven robustness and to make them practical and cost effective they would not require additional power requirements over the existing MWLs. A design aspect that would need attention is whether or not the repeater lights are visible from both 'entry' and 'exit' to the crossing. Care would also need to be taken to ensure that when showing a green aspect this cannot be seen by train drivers.

Provided that the costs can be kept low (we have modelled based on a cost of £5,000 per crossing) then cost benefit analysis would indicate that the 'top 20%' of MWL crossings should be targeted.

V5 – Back to back MWLs

Back to back MWLs are an established but relatively new mitigation measure in Great Britain. They are installed currently at one trial site (Farnborough North station pedestrian crossing) to mitigate the risks associated with the large groups of users who cross there simultaneously, where the original single set of lights was often obscured from members of the group located behind others. A second trial is imminent at Rushton No.2 crossing in Dorset.

Back to back lights provide additional warning to users of the crossing status and on that basis are potentially viable at any MWL crossing where light obscuration by users from other users is problematic.

In order to be practical and cost effective, the additional lights should run off the power source of the existing MWLs. As with repeater lights (above), care should be taken to ensure that train drivers are unable to see the red aspect.

The cost benefit analysis indicates that the 'top 20%' of MWL crossings should be targeted.

T1 – Smarter auditory alarm

This option emerged as a strong candidate for consideration – effectively replacing standard auditory alarms with ones which automatically adjust to background noise levels to improve audibility. For the purposes of cost benefit modelling, we have assumed an additional cost of £10,000 per crossing above traditional alarms costs but note that if the design were established then the incremental costs could be negligible. Even based on this incremental costs, consideration should be given to widespread fitment of 'smart' alarms at all relevant crossing types at such time that equipment is due for replacement.

Care would need to be taken to calibrate effectively at each location, to cater for lowest and highest noise levels, and to manage the impact of the noise of the alarms on railway neighbours. Reliability of the alarms would need to be proven to be no lower than that of existing alarms.

P5 – Anti-climbing rollers

As far as the research has been able to determine, this is a novel option applied to railway level crossings. The purpose would be to prevent deliberate misuse at full-barrier crossings involving pedestrians climbing barriers to cross after the crossing has been closed. The safety benefits have been modelled as potentially quite high since the option could mitigate a significant proportion of the current pedestrian risk at full barrier crossings. Applicability should be widespread, but maybe less effective where there are unlocked pedestrian wicket gates (since pedestrians can still freely enter the crossing when the main barriers are closed).

If this option is to be further considered work will need to be carried out to explore different designs, and to validate their effectiveness – and ultimately to secure a design at reasonable cost. We have modelled the BCR analysis assuming an incremental cost of £1,000 per crossing over and above traditional booms (this assumes that this would not be a retrofit but only carried out where barriers are replaced). On this basis, the safety benefits are likely to exceed the costs at all full barrier crossings.

The safety benefits have, however, been modelled as potentially uncertain due to the possibility of increasing the chance that pedestrians are trapped on the crossing. To clarify the balance of safety benefits / dis-benefits (and also the potential for injury should someone attempt to climb over when the rollers are fitted), the safety case for anti-climbing barriers should include a detailed review of incidents in which pedestrians have been trapped at full barrier crossings, and the proportion of times that pedestrians escaped by climbing the barriers as opposed to simply moving out of a position of harm but still inside the barriers.

P6 – Higher barriers to prevent climbing

This option aims to have a similar benefit as anti-climbing rollers (P5) discussed 5 above – ie to stop pedestrians deliberately climbing full barriers when they have been closed to users. As such, these two options could be further researched in parallel to evaluate which one is more feasible, and could deliver the benefit at a reasonable cost.

The potential safety benefits and uncertainties with respect to trapping are similar to those discussed for option P5. A possible additional difficulty with 'higher barrier to prevent climbing' is the additional weight and wind loading which may place additional load requirements on barrier machines.

S1 – Improved crossing surfaces

The research has shown that the quality of a crossing surface can have a significant impact on user ability to traverse safely. A good even, non-slip surface not only reduces the chance of a slip or trip, but also means that their 'head down' time could be reduced, leaving more time to focus on looking for trains or on a change of status of the crossing.

Although providing good crossing surfaces applies of course to all types of crossings, we have focussed this as a mitigation measure specifically at user-worked and footpath type crossings, as it is these where there is a wider variation in crossing surface standards quality, and where most benefit could therefore be gained.

Provided that the surfaces are slip resistant and introduce no additional trip hazards due to the surface breaking up with use, there are no foreseen negative impacts. Assuming a cost of £10,000 to provide good surfaces, this could potentially be extended to all passive crossings. Practically, the best approach would be to target proactively crossings with heavy footfall (and high risk) and improve surfaces more widely at such time that existing crossing surfaces need replacement of significant maintenance. This should be combined with mitigation option V1 to demarcate the crossing with a single block of colour (ie a material to provide a level and non-slip surface, with colour).

Options for limited consideration

S3 – veloSTRAIL

A number of accidents have occurred in which users have fallen on the flange gap (including both wheelchair users, cyclists and general pedestrians). Flange gap fillers aim to mitigate this risk – such as veloSTRAIL, an inner panel system that eliminates the flange grooves, which has been in use on other European railways since 2006.

Network Rail granted full product acceptance on 30 April 2014 to the veloSTRAIL filled flangeway system following a 12 month trial at Network Rail's Innovation Development Centre (RIDC) in Tuxford. The acceptance certification has caveats that address hazard identification conducted by Network Rail during the trial. Network Rail was satisfied on trialling the technology that, when used within the defined tolerances, the technology does not import risk to the network (i.e. create new hazards that may offset the risk reduction achieved by the technology).

In correspondence with Network Rail for this research, the costs have been noted as approximately £45K per crossing fitted with the veloSTRAIL system. On this basis the indicative cost benefit analysis completed for this report suggests that use of veloSTRAIL could be justified at higher risk crossings only, or more specifically where pedestrian / cycle / wheelchair risk associated with falls at the flange gap is particularly high.

T2– Wayside horns

Although we have included wayside horns in the 'limited consideration' category, we note that there a number of potential safety concerns that would have to be overcome for them to be a viable mitigation option. We have scored the safety benefits as positive, however, this is on the basis that design and implementation avoids creating potential hazards:

- Wayside horns are not 'fail safe' – unlike a MWL the user cannot detect their failed status. It is important therefore to make the warning as reliable as possible, recognising this.
- During the research, the workshop debated what should be the sound relayed by the wayside horn; there was one view that it should not mimic an actual train horn as this might be confused with an actual train horn but signifies a different warning.
- Care needs to be taken on double track and bi-directional sections to make sure that a train leaving the section does not sound the warning. This could lead to a hazard whereby an approaching train is ignored by a user who assumes that the sound is being triggered by a train leaving the section.

Wayside horns have been retained for consideration, despite the above, since they may at very selected locations provide an improved means of alerting users to an approaching train at a lower cost (and therefore justified on the basis of cost benefit analysis) that other more costly active warnings. However, in general we consider that warnings which include visual active warning are preferable.

The method for train detection will have a significant impact on the cost – it was assumed a cost of £50,000 on average since costs much in excess of this will mean that visual warnings should be sought in preference (see options T3, T4 and T5). On this basis, wayside horns could be justified on a cost benefit basis at the highest 20% passive crossings; however as noted above, their application is likely to be very limited according to local site specific factors.

T3, T4, T5 – 'Novel' warnings – MWL dark mode, predictors, Wavetrain®

The standard MWL provides an active warning at passive crossings and as such reduces the risk to users associated with a failure to either look for, or to see an approaching train. However, traditional means of providing MWLs have very high cost which means they can generally only be justified at the very highest risk footpath and user-worked crossings. There

are therefore significant potential gains in lower cost options to provide active warning as a more widely applicable upgrade path from footpath and user-worked crossings. Whilst typically active warning is targeted at crossings with sub-standard sight times, active warnings provide more general safety benefit even where sight times are acceptable.

The three options (T3, T4 and T5) are alternative methods for providing active visual warnings to users at lower cost than traditional MWLs. At the time of publication of this report, Network Rail had carried out research and trials on each of these technologies and had granted product approval for WaveTrain® as of 23 December 2013. However, Network Rail has not indicated which technologies (if any) would be further carried forward. The research has identified a number of issues concerned with reliability and applicability according to factors such as bi-directionality, double track and electrification. Clearly, further work is required to reach firm conclusions as to which technologies could provide a cost effective reliable active warning. At the conclusion of further research, some form of safety approval will be required to provide the assurance that a target level of safety improvement can be delivered.

Indicative cost estimates suggest targeting the top 10% or top 20% of crossings with lower cost active warnings. In comparison, providing traditional MWL warnings would only be justified at a much smaller number of crossings – those with particularly high levels of use and associated risk.

T6, T7 - Alternative arrangements for calling the signaller

Telephones provide a current form of risk mitigation against short sight times at UWCT- typically where the railway has established that sight times are insufficient for the user to decide whether or not it is safe to traverse when taking a vehicle over the crossing. At a very small number of crossings, telephones are provided for pedestrian users or those on horseback.

The idea of mitigation T6 is to explore whether there are specific UWCT where pedestrian users should be asked to phone the signaller. Although this would be a deviation from standard practice, there are some crossings where the sight times are short not only for vehicle users but also for pedestrians. This is considered for very limited locations only which satisfy criteria such as:

- The signaller has good information on the position of the train so can give accurate information to the caller.
- The user(s) are willing to comply with the new requirements.
- The signaller workload is not adversely impacted by additional calls from pedestrians which could increase the risk of errors in other signalling duties.

Costs of implementation would be very low – but in summary this is an option for consideration at only very specific locations.

The second option (T7) is for users to call the signaller on a mobile phone, where there is currently no user-worked fixed telephone provided. We are aware that this is a local practice that has been established at very specific locations where the caller and signaller have established a good relationship. The conditions required for this to be viable option would be similar to those above for option T6, and in addition good mobile phone signal coverage would

be required. Option T7 could be used either routinely at specific locations, or during periods of seasonal activity such as harvest or when large vehicles are taken over the crossing.

P1 - Modular bridge

Network Rail's highest priority to reduce risk at level crossings is closure – either by locking out an existing passive crossing, or providing grade separation. The second of these options is typically high cost, meaning that only the very highest risk crossings can be justified for replacement with a bridge.

So-called 'modular' bridges aim to reduce the unit cost of grade separation, and although still the highest cost option considered in this research, do achieve risk elimination (assuming that users are completely prevented from crossing the tracks at grade).

We have assessed that on the best available unit cost of £400,000; modular bridges would be justified at the top 10% of highest risk crossings of all types. This only considers the benefit to pedestrians – modular bridges which also include vehicular traffic would of course also remove the vehicle risk at the level crossing, and so the business case will be easier to achieve.

Aside from the financial considerations, the practicality of bridges is often constrained by local surroundings including the space available – so for this reason we have indicated that although highly desirable, it is likely that bridges will only be viable at a limited number of locations.

P2, P3 - Remote gate release with interlocked barriers

The research identified some concerns with both options P2 and P3 – which both aim to restrict the physical access that a user has to a crossing, based on it being locked out either automatically by the signalling, or manually by a signaller. The potential concerns include:

- The difficulty in achieving reliable locking / interlocking. This would be location specific, and would need to be reliable so that users do not experience a failed state in which they are erroneously allowed to open gates, or open the POGO when a train is coming. Note that these concerns are not specific to POGO, which is evaluated separately under mitigation O3
- The uncertainty over the safety benefit that would be achievable (shown by the wide range indicated in the table below), owing to the variations in the exact specification for train detection, means of communicating with the signaller in the case of remote gate release, the behaviour of users involved, and the design of user controls and communications.

Potentially, however, these options could provide a significant positive risk reduction at passive crossings – if the above concerns could be overcome. We therefore include these options for further consideration, but note that this would be subject to rigorous hazard identification and safety approval at specific locations.

P4 – Extended flexi-booms

Flexi-booms aim to restrict physical access to the crossing on train strike-in, in effect creating full separation of the road from the railway in the same manner as other full barrier crossings.

The boom extension is designed to be flexible to prevent entrapment – for example so that vehicles can still move clear of the crossing through the barrier in the event of blocking back.

Whilst this mitigation is principally aimed at vehicle users, it may have some benefit in discouraging pedestrians from walking around the barriers after they have lowered.

The research felt that it was possible to for flexi-booms to achieve a positive risk reduction. However, there were some concerns with the option that made a business case for its implementation less straightforward. In particular:

- The lightweight boom construction was felt to make them prone to damage (for example, if a vehicle pushed pass them as they were lowered) and therefore require more regular maintenance.
- The barrier does not provide significant disincentive to prevent pedestrian violations; it does not have, for example, a skirt in the same way as a MCB.

It was also noted that the barrier may increase the risk of entrapment – for example for horse riders and cyclists caught between the barriers. This would be a new risk for AHB and may offset other (positive) safety benefits. The mitigation would therefore need rigorous hazard identification and safety approval at specific locations for it to be adopted.

E2 – Active sign 'close gates' when gates left open at UWC

This option arose from discussions on option E1 (audible alarms when gates left open), but is preferred as it could provide a warning without potentially masking the sound of an approaching train. Best estimates of the cost suggest that it could be targeted amongst the top 10% of riskiest UWC type crossings, but practically application would be quite limited for example, it could be targeted where:

- Gate misuse is known to be common.
- Other measures to prevent gate misuse have failed (for example threats to fine the offenders).
- The user would welcome the active sign to be installed.

S2 - Solar way marking

This option is proposed for further consideration given the low cost, and low potential safety benefit. The impact on user behaviour is noted to be very marginal, but it could be provided at very specific locations where there is a high level of use in hours of darkness, and where the edge of the crossing surface presents a particular hazard (for example crossings which are narrow or do not traverse the tracks orthogonally).

O2 - Official looking 'eyes' sign

This option is a very low cost measure that might be beneficial at locations which are subject to high levels of misuse or horseplay. The idea is to dissuade people from behaviour on or near the line that could result in a train strike.

Although the safety impact is likely to be relatively low, in combination with other measures (such as CCTV or visits by BTP or rail staff) it could be used at those sights which are known or suspected to have high levels of misuse.

Options not for further consideration

V2 – Pavement transfers

Although we have included this option as 'not for further consideration', Network Rail may consider very specific use of pavement transfers as part of local campaigns. The main reason this option has been rejected, is that safety benefits are thought to be very small (they rank poorly in behaviour impact), and there are some concerns / experience of wear. The research concludes that it would be preferable to prioritise option V1 – demarcating crossing surfaces with single blocks of colour.

V3 - Flashing signs

Although it is possible that flashing signs may provide some safety benefits, there is some concern that they might distract users when using a crossing and actually therefore lead potentially to a failure to look for trains. They rank poorly in terms of behaviour impact. Because the flashing sign is not 'intelligent' – ie it is not linked to the arrival of a train, it is likely that any initial positive impact would wear off quickly to users who become familiar with the warning.

V6 - Retro-reflective tape on pedestrian gates

The behavioural impact and safety benefit of this measure is considered to be very low, and as such – despite low costs – not be worthwhile. The authors also note that a light source is needed for the mitigation to function (which makes the tape of limited value to pedestrian users unless they have a torch)

V7 - Projected stop sign – no warning of train provided

This option has been rejected for similar reasons to option V3 – namely that the sign would not specifically warn of an approaching train and could be distracting rather than helpful. In addition, there are likely practical difficulties with projecting a stop sign onto the ground given the variation in lighting conditions and surfaces.

V8 - Projected stop sign at active crossing

This option has been assessed to have a stronger behavioural impact than option V7, because it would be used at active crossings and as such be able to provide a warning specifically when a train was detected. Effectively it would therefore provide a supplementary warning to the traditional lights / alarms / barriers.

Practical difficulties with projecting a sign on the ground in different lighting conditions is the main reason that this option is not suggested for further consideration.

T8 - App for alert user to approaching train

This option has been rejected from further consideration due to a number of reasons:

- It is not clear what information the app would provide to a smart phone user, and at what time in the crossing sequence.
- It is not clear that it would be possible to provide a suitably timed warning to a user when approaching a crossing.
- There is a concern that a message sent to a user when approaching a crossing may be a distraction and actually a cause of accidents as much as a mitigation.
- The penetration (in terms of people who would download and use the app) is likely to be limited.
- The costs of developing, deploying and maintaining such an app are likely to be high.

E1 - Alarms on gates at UWC – when gates are left open

On balance, this option was rejected from further consideration due primarily because there of a concern that the alarm may be a distraction to users, or mask the sound of approaching trains (ie increase risk). There is also a concern that such an alarm would not be robust in the environment typical of many UWC (farms, etc), and it could be vandalised by users who found it an irritation.

Review of this option at the industry workshop led to the development of option E2 (active sign reminding users to close the gates at UWC) which is suggested for further consideration.

E3 - Alarms on gates at UWC – when gates are opened

This option has been rejected for similar reasons as option E1; ie the concern of masking the sound of an approaching train, and robustness.

O1 - Mesh front to gate

Adding a mesh front to pedestrian gates to stop users swinging on the gates has not been put forward for further consideration primarily due to the negligible behavioural impact and safety benefit.

O3 - POGO

On balance, the research concludes that there is insufficient evidence that POGO crossings provide a net safety benefit compared with more traditional UWC. The correct use of POGOs by users could reduce the level of risk exposure – particularly due to the removal of the need for pedestrian traverse. However, misuse (leaving the gates open) and the fact that staying in the vehicle affords an impaired view of approaching trains compared to that possible on foot leads us to this conclusion.

For this reason, the research does not recommend them for further consideration, but would support further research to examine the net safety benefits / dis-benefits.

6. Conclusions

Pedestrian accidents at level crossings

- RSSB (2013) calculates that approximately eight pedestrians are struck by trains per year at level crossings on Network Rail managed infrastructure, resulting approximately seven fatalities.
- Just under half of these occur at footpath crossings, and most of the remainder occur at user-worked crossings, automatic half-barriers and manually controlled barriers with CCTV.
- The level of protection provided clearly has a very strong impact on the occurrence of accidents when normalised by traffic moment; normalised by moment, pedestrian train strikes at the least well protected crossings – passives - occur 50 more often than at the best protected – manually controlled full-barrier crossings.
- A model developed for this research for footpath crossings suggests that users are failing to protect themselves from trains strikes approximately once in 50,000 traverses on average. This is a very good level of human performance considering the myriad distractions that many users face, poor weather conditions, and the risk taking behaviour that is frequently observed.

Causes of accidents

- Overall, the research concludes that there is a strong link between the occurrence of pedestrian accidents and pedestrian moment.
- Accidents are also more common at station crossings and for male users, and increase with age above 30.
- There is poor or no evidence that *overall*, other user, crossing and environment factors can be associated with higher rates of accidents.
- Therefore, the current risk assessment approach (ALCRM), which is focused primarily on pedestrian moment, is robust.
- However, at specific locations, combinations of characteristics of users, trains, the crossing layout and equipment, and other factors may 'add up' to cause users to have particular difficulties in crossing safely. This supports the idea that improved site specific hazard assessment should be carried out alongside quantitative risk assessment. Such ideas are currently being discussed with industry at the time of the research (T936 *and* related discussions). Inclusion of such improved hazard identification would also help to satisfy requirements for a 'suitable and sufficient' risk assessment.

Risk mitigation options

- This research has identified and ranked a number of mitigation options which are either new, or have already been considered to some degree but are not currently standard solutions. Many of these would not be applicable to a wide range of crossings, due to practical difficulties in installation, or because they would be of benefit to address specific hazards that do not exist at all crossings. Indicative cost benefit analysis has been used

to highlight in broad terms whether each candidate option is likely to be affordable at all crossings, or the top 10 / 20% of highest risk.

- Amongst the most promising options assessed for this research are:
  - 'Danger zone' demarcated with a single block of yellow colour (passive crossings).
  - MWLs – back to back lights, or repeater LED lights on gates.
  - Improved auditory alarms at active crossings.
  - Anti-climbing rollers at full barrier crossings.
  - Improved crossing surfaces (at all crossings – particularly passive crossings) - in combination with demarcation of the 'danger zone' as noted above.
- Overall, we conclude that the greatest gains in reducing accidents are likely to come from a focus on fewer specific actions:
  - Establishing reliable, low cost active warnings to upgrade passive crossings – where existing methods for warning cannot be justified because of high cost. The research has reviewed three alternative means of providing such lower cost active warnings, but notes that in all cases a final conclusion on their adoption has not been reached. We consider that establishing workable designs for low cost active warnings solutions is a high priority given the potential benefits to be gained by increasing the number of passive crossings that could be upgraded.
  - Providing good surfaces at all crossings (non-slip, demarcated zones of colour at FP and UWC). This should not be constrained by having to seek 'business cases' for improving crossing surfaces, but prioritise improvements based on the current level of risk - from highest to lowest or whenever existing surfaces are due for renewal.
  - Busy stations crossings should be specifically prioritised for risk reduction due to evidence of higher accident rates than crossings located away from stations.
  - At passive crossings, 'design principles' should be followed when upgrades / maintenance work is carried out – documented by Turner et al (2013).

References

This report refers to the following publications external to RSSB's own research programme; abbreviations to relevant RSSB research referred to in this report are given in the Glossary.

Embrey, D.E. (1986) SHERPA: *A Systematic Human Error Reduction and Prediction Approach*. Parbold, Lancs: Human Reliability Associates

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Reason, J. (2000) *Human Error*. Cambridge University Press

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JG13

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Ref:	**NR/L2/OPS/100**
Issue:	3
Date:	5 September 2020
Compliance date:	5 December 2020

Level 2

Business Process

Provision, risk assessment and review of level crossings

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Published and Issued by Network Rail, 2nd Floor, One Eversholt Street, London, NW1 2DN.

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Issue record

Issue	Date	Comments
1	December 2006	New Standard
2	June 2008	Phase 2A / Engineering reorganisation responsibility change
3	September 2020	Revisions based on current way of working

Reference documentation

NR/L2/OPS/031	Risk assessment and briefing of timetable change

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1 Purpose

This business process sets out the requirements that must be complied with for Network Rail to have a robust and consistent process for determining the safety requirements for new level crossings, and the risk assessment and management processes that shall apply to both new and existing level crossings.

2 Scope

This business process defines the requirements for a robust and consistent process to determines the safety requirements for new level crossings, and the risk assessment and management processes for both new and existing level crossings.

It applies to all level crossings on Network Rail Managed Infrastructure.

It does not apply to authorised walking routes that cross the railway unless they are classified as a staff crossing with white lights. It does not apply to road rail access points or track access points.

3 Roles and responsibilities

R – Responsible is the person or people who are responsible for performing a certain task or action. **A – An Accountable** person is one who has overall accountability to make sure that a task or action is completed. **C – Consulted** people have an input into the task or action, this can be providing information, reviewing documents or attending workshops etc. **I – Informed** people are those who receive the output of a task or process. * Denotes option for delegation		Level Crossing Manager	Risk Assessor	Risk Assessor [TECH CLERK]	Route Level Crossing Manager	Operations Risk Advisor	S&T RAM	Off Track Section Manager	Operations [OM/LOM]	Regional Director, Engineering & Asset Management	Property Director (Regions)	Director, HSQE (Regions)	Head of Maintenance Delivery
5	Provision, risk assessment and review	R	R	R	A	A						I	

	of level crossings												
6	Procedure	R	R	R	A	A	C	C	C	A	A	A	A
7	Risk Assessment and Risk Management	R	R	R	A	A	C	C	C			I	
8	User Worked Crossings	R	R	R	A	A						A	
9	Level Crossing Orders	R	R		A	A						A	A
10	Records	R	R	R	RA							A	

Table 1 – RACI chart

4 Definitions

For the purpose of this document, the following terms and definitions apply.

Term	Definition
Authorised walking route	A designated route providing pedestrian access to places of work for railway staff (including booking-on points and stabling points) and which is suitable for use by people not certificated as competent in personal track safety.
Automatic crossing	A level crossing where the protective equipment is automatically activated by the approaching train. **NOTE:** for example, barriers and active warnings which is a device which warns users of the imminent arrival of a train. Such devices are either visual or audible.
Blocking back	The formation of a stationary or slow-moving queue of road traffic over a level crossing, due to road traffic conditions in the vicinity of the level crossing, causing obstruction of the line.
Crossing Keeper	A person appointed at a permanent gate box to carry out the normal operating procedure of a level crossing.
Crossing Speed	The permissible speed applying between a special railway speed restriction board and a locally monitored level crossing.
Crossing Time	Time taken for a user to traverse the crossing from the decision point to a position of safety on the other side of the railway. Crossing time

Term	Definition
	includes time taken for the user to make a decision to cross.
Decision Point	The point at which a level crossing user makes a decision to cross or wait.
Level Crossing	An intersection at the same level of a road, footpath or bridleway and one or more railway tracks.
New Level Crossing	A level crossing provided at a location where previously there was no means of crossing the railway at the same level; or A level crossing altered to provide vehicular access where previously there was no vehicular access; or A level crossing altered to provide access for horse riders and cyclists where previously there was only access for pedestrians
Railway Staff	A person employed in the railway industry, acting in accordance with their duties.
Signaller	A person responsible for the operation of the signalling system, to safely control the passage and regulation of trains, usually located in a signal box.
Train Crew	A driver or guard who is authorised to operate level crossings.
Type (of level crossing)	A recognised combination of control measures used at level crossings, appropriate to particular circumstances, for example ABCL (automatic barrier crossing, locally monitored); CCTV monitored barrier crossing; staffed gated crossing.
User	A person who uses a level crossing.
Whistle board	A sign to instruct the train driver to sound the horn.

Table 2 – Terms and definitions

5 Provision, risk assessment and review of level crossings

5.1 New level crossings

A level crossing at a new location shall be provided only if it is not practicable to provide some other means of crossing the railway.

NOTE 1: *for example, an overbridge, underbridge or subway.*

A new level crossing shall be provided to replace an existing level crossing/s when it increases the safety of the railway and crossing users.

NOTE 2: *for example, by closing two level crossings in exchange for one new level crossing.*

Unless the new crossing replaces one or more existing crossings and provides an overall reduction in risk, new user worked crossings (including footpath and bridleway crossings) shall not be installed where there are more than two running lines,

New level crossings shall not be provided where the permissible speed exceeds 100 mph.

New level crossing shall conform to the configuration outlined in Appendix A.

5.2 Existing level crossings

Existing level crossings should conform to the appropriate configuration outlined in Appendix A.

Where it is planned to increase the permissible speed to greater than 125 mph, the level crossing shall be closed before the line speed can be increased.

There shall be a signed off risk assessment in place for each level crossing.

Existing risk assessments shall remain valid until a review and update of the risk assessment is required.

NOTE: *See clause 6.*

The All Level Crossing Risk Model (ALCRM) and the Narrative Risk Assessment process shall be used to assess the risk.

This should be supported as necessary by expert judgement.

When a risk assessment has been undertaken, the appropriate action shall be taken:

a) Where the risk is unacceptable, the level crossing shall be closed, or additional control measures applied;

NOTE: *for example upgrading to a more protective type, or providing additional safeguards to reduce the risk.*

b) Where the risk is sufficiently high for it to be reasonably practicable to provide another means of crossing the railway, closing the level crossing shall be taken into account;

c) Where the risk is sufficiently high for it to be reasonably practicable to do so, the level crossing shall be upgraded to a more protective type or additional safeguards provided;

d) Where the risk is sufficiently low for it to be not reasonably practicable to provide additional safeguards, no further action other than routine inspection and monitoring shall be required until the next risk review.

5.3 Competence requirements for undertaking level crossing risk assessments, checking, authorisation and retention of records

Site visits and census shall be undertaken by an individual who has been briefed in and practically demonstrated their ability to undertake the process and complete the documentation.

The level crossing risk assessment shall be undertaken by an individual who has been trained and met the competence requirements for use of the ALCRM and the Narrative Risk Assessment process.

The level crossing risk assessment shall be checked and signed off by an individual:

a) other than the assessor who undertook it; and

b) who has been trained and met the LCM competence framework.

Documents and electronic records relating to level crossing risk assessments shall be retained in accordance with NR/L3/OPS/045/3.09 – Level Crossing Administration.

6 Procedure

6.1 General

The roles shown below will have a process in place to meet the intent of their accountabilities.

The Regional Director, Engineering & Asset Management shall check that, when level crossing equipment falls due for renewal, it is subject to risk assessment and cost benefit analysis in accordance with the Network Rail Investment requirements.

NOTE: *This is to determine the most suitable type of protection to be provided.*

The Property Director (Regions), shall;

a) identify whether the planning applications might have an adverse impact on specific level crossings;

b) to consult with the Director, HSQE (Regions) as to the scope of that impact; and

c) respond to the planning applications.

The Director, HSQE (Regions) shall review and respond to planning applications received from the Property Director (Regions).

The Director, HSQE (Regions) shall have a process in place that addresses any changes of land use that might affect the utilisation of the level crossing.

The Head of Liability Negotiation shall pursue closure or reduction in status of all types of level crossing when the opportunity arises, and the work can be done at an economic cost, and to involve The relevant Liability Negotiations Manager at an early stage.

7 Risk assessment and risk management

The Director, HSQE (Regions) shall have sufficient personnel who are trained and competent in the:

1) use of the ALCRM and in the interpretation of the results; and

2) Narrative Risk Assessment process.

NOTE: *see Appendix B for the minimum content for an NRA.*

The Director, HSQE (Regions) shall check level crossings are risk assessed using the ALCRM, and that the risk assessments are reviewed and updated periodically. Level crossings shall be risk assessed:

a) as outlined in NR/L2/OPS/031;

b) When the volume of vehicular traffic, pedestrians or animals using a level crossing has increased significantly;

c) When evaluating new level crossings or those to be renewed;

d) Prior to responding to planning proposal consultations;

e) Following a report of significant change in the environment on the approach to a level crossing;

f) Following a formal expression of concern by Network Rail, a Train Operator, the safety regulator (ORR), or the relevant Highway Authority.

The Director, HSQE (Regions) shall monitor accidents and incidents at level crossings. They shall review and update risk assessments following incidents and accidents and develop and implement suitable local risk mitigation schemes if reasonably practicable.

8 User Worked Crossings (UWC)

The Director, HSQE (Regions) shall write to the principal crossing user at each UWC at intervals no longer than three years to formally:

a) Remind them of the correct method to use the crossing safely;

b) Remind them of their obligation that they, and other authorised users, use the crossing correctly;

c) Seek information about crossing use and the user's willingness to consider closure of the crossing remind them of the correct method to use the crossing safely.

9 Level crossing orders

The Director, HSQE (Regions) shall seek new or amended Level Crossing Orders in compliance with the Level Crossing Act 1983 and the Level Crossing Regulations 1999.

Level crossing orders shall be required when:

1) amending the arrangements at a level crossing already subject to an order;

2) changing the level of control at a public level crossing that does not have a current order;

3) requested to submit an order by the Secretary of State.

The General Counsel provides legal guidance to those preparing orders.

The Head of Maintenance Delivery shall examine compliance with the Level Crossing Order at least annually through the inspection arrangements, and take remedial action.

10 Records

10.1 Level crossing files

The Director, HSQE (Regions) shall keep a file for each level crossing. They shall provide clear specification of what needs to be maintained at each level crossing to the Head of Maintenance Delivery.

NOTE: *so that the risk mitigation methods are defined, and*

Level crossing files shall be maintained for the lifetime of a level crossing and for 7 years thereafter.

Archiving non-active documents within the file, particularly electronically, may be undertaken

Appendix A - Minimum combinations of control measures for new level crossings

Table A.1 shall be used as the minimum permitted combinations of level crossing control measures.

NOTE: *see clause 5.*

	Controlled by:	Monitored by:	Type of barrier required	Fixed signs required?	Phone to signaller required for user?	Active visible warning required?	Active audible warning required?	Limit on train speed	Additional requirements	Current crossing type meeting these requirements
A	Railway passenger at a station to gain access to a platform (pedestrian only)	Not monitored	None	Yes	No	Sometimes - see additional requirements	Sometimes – see additional requirements	Not to be provided where permissible train speed > 100 mph	An active visible warning is required where direct observation of trains does not give sufficient warning time (that is, the warning time is less than the crossing time). Audible warning of the approach of a second train shall be considered where the level of risk justifies it.	Station footpath crossing
B	Railway staff supervised at a station to gain access to a platform (pedestrian only, or with barrows and trolleys)	Not monitored	None	Yes	Sometimes - see additional requirements	Sometimes - see additional requirements	No	Not to be provided where permissible train speed > 100 mph	**Either** an active visible warning or a phone to signaller is required where direct observation of trains does not give sufficient warning time (that is, the warning time is less than the crossing time or less than 30 seconds).	Barrow crossing

C	User (pedestrian only)	Not monitored	Gate or stile	Yes	No	Sometimes - see additional requirements	Sometimes - see additional requirements	Not to be provided where permissible train speed > 125 mph	Active visible and audible warnings are required where direct observation of trains does not give sufficient warning time (that is, the warning time is less than the crossing time) or where permissible train speed > 100 mph, except where whistle boards are currently provided as a means of extending the warning time.	Footpath crossing
D	User (including vehicle driver, horse rider, cyclist, person moving farm animals on the hoof and pedestrian)	Not monitored	Gate or lifting full barrier	Yes	Sometimes - see additional requirements	Sometimes - see additional requirements	Sometimes - see additional requirements	Not to be provided where permissible train speed > 125 mph	**Either** a phone to signaller **or** an active visible warning is required where direct observation of trains does not give sufficient warning time (that is, the warning time is less than the crossing time) or permissible train speed > 100 mph. An active audible warning is also required where	Bridleway crossing. User worked crossing.

									an active visible warning is provided at a crossing over which there is a public right of way. Not to be provided on public roads.	
E	User (including vehicle driver, horse rider, cyclist, and pedestrian)	Not monitored	None	Yes	No	No	No	The speed of trains over the crossing should not exceed 10 mph	There should not be more than one line over the crossing. The maximum daily traffic moment not normally to exceed 2000 or the peak hour traffic moment 30 or the maximum actual daily road vehicle user 200. The 85%ile road speed at the crossing to be less than 35 mph.	OC (Open Crossing)
F	Automatic control system	Train driver	None	Yes	Yes	Yes	Yes	Speed of trains to be limited so that drivers can stop short of the crossing from the point at	Not to be provided where there is more than one running line.	AOCL (Automatic Open Crossing, Locally monitored)

								which the crossing comes fully into view. The crossing speed shall not exceed 55 mph		
G	Automatic control system	Train driver	Lifting half barrier	Yes	Yes	Yes	Yes	Speed of trains to be limited so that drivers can stop short of the crossing from the point at which the crossing comes fully into view. The crossing speed shall not exceed 55 mph	Not to be provided where there are more than two running lines. Barriers are to close only the entrances to the crossing, leaving the exits clear.	ABCL (Automatic Barrier Crossing, Locally monitored)
H	Automatic control system	Signaller	Lifting half barrier	Yes	Yes	Yes	Yes	Not to be provided where permissible speed > 100 mph	Not to be provided where there are more than two running lines. Not to be provided where grounding or blocking back of traffic is considered likely. Barriers are to close only the	AHBC (Automatic Half Barrier Crossing)

									entrances to the crossing, leaving the exits clear.	
I	Train crew, locally	Train crew (integral with working of crossing)	Gate or lifting full barrier	Yes	No	Sometimes - see additional requirements	Sometimes - see additional requirements	Not applicable - train comes to a halt at the crossing	Active visible and audible warnings are required, except where existing crossings are fitted with gates.	Train crew operated gated crossing. Train crew operated barrier crossing.
J	Signaller or crossing keeper, remotely (by CCTV)	Signaller or crossing keeper (integral with working of crossing)	Lifting full barrier	Yes	No	Yes	Yes	Not to be provided where permissible train speed > 125 mph		CCTV monitored barrier crossing.
K	Obstacle detection	LIDAR/RADAR	Lifting full barrier	Yes	No	Yes	Yes	Not to be provided where permissible train speed > 125 mph		Obstacle detection monitored barrier crossing.
L	Signaller or crossing keeper, locally	Signaller or crossing keeper (integral with working of crossing)	Gate or lifting full barrier	Yes	No	Sometimes - see additional requirements	Sometimes - see additional requirements	Not to be provided where permissible train speed > 125 mph	Active visible and audible warnings are required, except where existing crossings are fitted with gates.	Staffed gated crossing. Staffed barrier crossing.

Table A-1 -

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Ref:	**NR/L2/OPS/100**
Issue:	3
Date:	5 September 2020
Compliance date:	5 December 2020

V4

Appendix B - Minimum content requirements for a Narrative Risk Assessment

The minimum content requirements for an NRA set out in Figure B-1 shall be followed.

1.1 Title Page

1.2 Reason for Risk Assessment

Network Rail has a responsibility and legal duty under the Health and Safety at Work Act 1974 for the health, safety and welfare of its employees and for protecting others against risk.

Network Rail also has a legal responsibility under the Management of Health and Safety at Work Regulations 1999. Section 3 focuses on the requirement for suitable and sufficient assessments of risk to health and safety of employees and others in connection with their undertaking.

Network Rail is committed to reducing the risk on the railway and has identified that one of its greatest public risks is at level crossings. This is where the railway has a direct interface with other elements e.g. vehicles and/or pedestrians. Network Rail is working to reduce this risk to as low as is reasonably practicable.

1.3 Brief description of Level Crossing

- A photograph of the level crossing shall be included [front title page]
- Level crossing name.
- Level crossing type.
- Line of route and mileage.
- Network Rail Region & Route.
- Number of running lines.
- Maximum permissible line speed over the level crossing.
- OS grid reference.
- Road name and type or Footpath No.
- Postcode – if applicable.
- Local or Highway Authority.
- Supervising Signal Box / Control Centre.
- Electrification and type.
- Level Crossing Order [if applicable] – title & date of the Order – attach as appendix
- Level Crossing Layout Plan number [if applicable] – version & date – for all types.
- ALCRM, FWI & risk per traverse scores

- Orientation of crossing

1.4 Description of the Site

- A satellite image and map [minimum 1:25,000] is to be provided as a visual representation of the topography and the nearby roads and crossing approaches.
- Extract from Sectional Appendix.
- Brief asset description [does the crossing have RTLs, barriers and audible warning devices.]
- Highway layout [how many lanes]. Describe surface characteristics, tactile paving [supported by photos]

1.4.1 Approaches

- Name, classification and road number – photo of each road approach to the crossing.
- Status of the roads and footpaths and whether they are public or private and whether they have bridleway status. Specify if Green Lanes / BOATs etc.
- Whether the road is maintained by the Highways Authority and state which authority has responsibility.
- Approximate width of the road [in metres] and/or path e.g. single or double carriageway.
- Gradients and crossing surfaces [Details of current Nairn's assessment if applicable].
- Legal speed limit on the approaches and over the level crossing & actual speeds. 85% speed [from 9-day census if applicable]
- Is the crossing on a skew [LCG06: Assessing the impact of skewed alignment]
- Any Indications of grounding and / or skidding
- Any junctions or turnings in proximity (200m) to the level crossing in all directions. Approaches long/ straight etc.
- Condition of the approaches such as vegetation that could impact on the risk; e.g. obscuration of signs or road traffic signals.
- record any additional existing mitigation e.g., Red Standing Man, Barrier Protection management provided, RLSE, surveillance cameras.
- Signage [including any non-standard] telephones, gates, fences and decision points.
- Sighting distances and calculated crossing times. Strike in times [from Amber initiation to train arriving at crossing]

- Barrier down time – per hour.
- Ambient noise, lighting in the vicinity of the crossing.
- Any other relevant information.

1.4.2 The Nature of the Area

- Rural, Urban or Coastal.
- Local properties, businesses and amenities.
- Residential, industrial or mixed. Include brief detail of the type of industry if applicable.
- Whether there are any local amenities or ‘attractions’ that affect the level crossing. This could sometimes be a distance away but still affect the level crossing if a route to/from that destination is over the level crossing. This includes shops, supermarkets, schools, sheltered housing, rail/bus station, religious centres, cinemas, pubs etc. Annual Events.
- Whether it is a Heritage or Conservation area [is the crossing located in a SSSI].
- Is the crossing on Flood Plain?
- Highways information – is the route over the crossing classified as a designated diversionary route. Is flooding prevalent, gritting etc.

2 Road & Rail Usage

2.1. Rail Approach and Usage

- Any detail about line speed(s) over the crossing, such as any changes to line speed directly on the approach to the level crossing.
- Whistleboard locations, distance to any adjacent lineside signals that can impact on crossing.
- Protecting signals if applicable, the controlling signal box and the distance from the level crossing of both the signal box and the protecting signals. Also identify whether overrun protection is present. [Feed from LCM/ORA Team – LXSORAT].

2.2. Rail Operations

- Signaller workload issues – contact LOM/OM. Is LC referenced in any Signal Box Special Instructions? Wrong direction moves, bi-directional?

- Understanding of possible human error scenarios, workload issues, Signal Box layout, repetitive tasks that could result in human error. Include picture of panel layout, concentrator etc.
- For crossings equipped with telephones provide examples of traverse times given to Signaller – is signal protection provided.
- Engagement with Operations., Long Sections issues – how are the Signallers managing long signal sections.
- Trains stationary that can affect operation of the crossings – e.g., standing over the crossing or adjacent to and impacting on sighting.
- Train count for passenger and freight. For station level crossings and those in close proximity to stations include the mix of stopping and non-stopping services. Evidence of any trains passing each other at crossing or in close proximity.
- Whether the railway live over the crossing is on a potential diversionary route or not.
- In/correct use of stopping/non-stopping controls
- Example of barrier down times for highway level crossings, do adjacent stations impact on this.
- MSL timings – design timings [ref where timings were taken from] & actual timings from site visits.
- Access provisions – access for staff vehicles – access gates for staff to REB etc.
- Comms checks – voice comms. Checks with Occurrence Books
- Signallers issues with sighting of crossing – CCTV monitor or sighting of crossing if MCB – fencing obscuring approaches?
- Does the crossing have a history of repeat failures?
- Workforce issues – are there WARAs for MGH crossings etc.
- Has the LCM carried out any cab rides over this crossing? Evidence of TOC/FOC liaison?

2.3 Census

2.3.1 Scope

This specification details the type of census to be undertaken at the level crossing sites, which provides a road/rail interface between the public highway and Network Rail infrastructure. Within the specification are guidelines as to the type of data required. [Ref: LC Guidance Doc: Census Good Practise].

- Road Traffic Census
- Pedestrian Census
- Stakeholder feedback – private and public

- Blocking Back Analysis if applicable

2.3.2 Duration

The census will record a 24-hour period on each specified day for all surveys unless otherwise stipulated. The census is to be taken on consecutive days, for example;

- A nine-day census shall include two weekends.
- The census is to be undertaken during school term periods if there is a school in the vicinity of the crossing
- Census should be broken down if there is any form of ‘seasonal’ use.

2.4 Road Traffic Census

The road traffic census will be classified into the following categories for the entirety of the specified census duration:

- Number of cars utilising the crossing.
- Number of light goods vehicles utilising the crossing.
- Number of motorcycles utilising the crossing.
- Number of heavy goods vehicles utilising the crossing.
- Number of agricultural vehicles (tractors and vehicles with trailers) utilising the crossing.
- Number of buses utilising the crossing.
- Number of horse riders utilising the crossing.
- Number of pedal cycles utilising the crossing.
- Occurrences of herded animals utilising the crossing.
- Also include narrative on any occurrences of abnormal loads using the crossing.

The following information shall also be supplied:

- The weather conditions during the time period.
- General observations relating (but not restricted) to: crossing misuse or unusual occurrences; long low or slow vehicles; parked vehicles close to the crossing that change the crossing usage.
- Commentary on peak flow – times of increased road/rail traffic and any impact.

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2.5 Pedestrian Census

The pedestrian census will record the following data for the entirety of the specified census duration:

- Number of adult pedestrians and accompanied children utilising the crossing (non-railway personnel).
- Number of railway personnel utilising the crossing (maintenance staff, crossing operator etc).
- Number of unaccompanied child pedestrians utilising the crossing.
- General observations relating (but not restricted) to: crossing misuse or unusual occurrences;
- vulnerable users such as the elderly, impaired or mobility scooters; pedestrians utilising (or forced into) the carriageway.

3 Future Development

- A commentary about whether any known future developments are planned or any which could affect risk at the crossing; e.g. new significant infrastructure; housing developments, superstores, schools etc. Details are to be provided of the applicable planning authority, who within the authority was contacted and the date contact was made. Reference to highway or local plan, include any discussions at RRPG.
- Include any NR correspondence relating to planning applications affecting the crossing.
- Details of any potential line speed changes, service strengthening, planned changes to rolling stock using line. Include details of the research undertaken; e.g. contact with the RAM and the Network planning team and when such contact was made.
- Line of route information such as nearby level crossings which could be subject to closure or change that affects the risk at the level crossing being assessed. Examples would include closure and diversion over this level crossing or upgrading a nearby AHB where the increased barrier down time might lead to an increase in road traffic over the level crossing being assessed.
- Any planned upgrade to nearby lines which could lead to increased use as a diversionary route. Include details of the research undertaken; e.g. contact with the RAM and the Network planning team and when such contact was made. NR future plans for linespeed increases, station developments – lifts etc. Changes to method of signalling. Re-control of lines to ROC etc.
- Reference to analysis undertaken on the social/economic costs of crossing upgrades through use of the AXIAT.
- Reference to long term Route strategy.

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4. ALCRM Scores / Options Evaluated - using existing NRA template data and CBA analysis [NB – this will change with ALCRM 2.]

5. Hazards and Risks

5.1 Incident History over the last 5 years

Provide a table with details of any known safety incidents at the level crossing (excluding technical failures unless they were caused by deliberate misuse); the table should include:

- Fatalities – include suicides (complete history where reasonably practicable)
- Collisions. (complete history where reasonably practicable)
- Near misses.
- Barrier Strikes.
- Other (if any) – maintenance failure data from LXDST – highlight any recurring faults.
- incidents within proximity of crossing both from a road and rail perspective [250m].

Specify where data has been obtained from – i.e., should not purely be limited to SMIS. [RLSE, DMRT etc.]

Usage compliance – gates left open or regular incorrect crossing usage

Any stakeholder engagement that has highlighted concerns about the crossing – both internal and external.

Distraction issues; vehicular – adjacent road junctions, pedestrian – low flying aircraft?

Provide a qualitative narrative about whether the level crossing is subject to regular deliberate misuse; e.g. the level crossing has regular red light running possibly due to high road speed on the approaches, or barriers struck on a regular basis etc.

5.2 Current Risks or Hazards

This section shall describe the residual risks that are present at the level crossing today. Show the key risk drivers from ALCRM and those from local knowledge including:

- Vehicular risks:
    - High usage / high proportion of HGVs, Large/Low Slow, Hazardous Goods.
    - Red light running/Speeding vehicles.
    - ‘Zigzagging’ around lowered barriers.
    - Late braking (perhaps made worse by steep gradients).

- Sunlight issues (ghosting or washout of the road traffic lights/reflection of road surface, rain & sun).
- Grounding risks.
- Blocking-back or other issues caused by nearby road junctions.
- Turning onto the railway.
- Orientation of railway/road approaches parallel etc.
- Driver distraction
- Insufficient width for vehicle types
- Ice/mud on approaches
- Lighting – rural to urban etc.
- Crossing equipment is it adequate – audible, visual warnings, signs.
- UWCTs in long sections.
- Realistic decision points – where do users decide when to cross.

- Pedestrian risks:
  - High usage.
  - Trespass.
  - Playing chicken.
  - Vulnerable users noting precedents such as school children. Users wearing headphones etc
  - Sighting – Whistle Boards
  - Second train coming issues.
  - Groups crossing as the same time – Ramblers etc.
  - Adverse weather conditions.
  - Willingness to wait.
  - Decking is it adequate for known usage.
  - Appropriate access for known usage demographic
  - Skewed crossings.
  - Layout of crossing – approaching with back to traffic, steps up on to the railway etc
  - Station pedestrian crossings – does the station layout lead to increased use of the crossing e.g., passengers use crossing to access ticket machines etc.
  - Distractions (layout, ambient noise levels).
  - Darkness risks such as slips, trips and falls.
  - Crossing equipment, is it adequate – audible, visual warnings, signs.

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Compliance date:	5 December 2020

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- Deck issues following re-profiling etc – HOBC

5.3 Sighting and traverse [where applicable]

For passive crossings describe decision points, sighting distances, length of crossing, traverse speeds. If sighting time is inadequate and mitigations measures have been implemented how effective are, they, telephone usage etc?

Imposition of TSRs where they impact on crossings – increasing barrier down times, transferable risks.

6. Sun Glare Assessment – if applicable [LC Guidance 13 Risk Assessing for sun glare at Public Road level crossings, including sun calculations]

7. Asset Inspection Arrangements

8. Signalling Design

- Narrative of any discussions with RAM team on future plans for crossing.
- Equipment design.
- Age of crossing equipment – last renewal date – relevant details from current SICA Report
- Whole Life Cost of crossing renewal

9. Summary & Recommendations – brief summary of key points/factors.

10. Conclusion

i). High Level Optioneering, Decision
ii). Responsible person – OPS, RAM – Steering/Tactical Group
iii). Date for completion

11. Stakeholder Consultation

- Who was consulted during this NRA? [Signature Sheet]

12. Peer Review & sign off – competency requirements